ACCESSING TRANSIT

Design Handbook for Florida Bus Passenger Facilities

Version II, 2008

Florida Planning and Development Lab
Florida State University

Accessing Transit: Design Handbook for Florida Bus Passenger Facilities

Report Prepared for:

Florida Department of Transportation Public Transit Office

By:

Florida Planning and Development Lab
Department of Urban and Regional Planning
Florida State University

July 2008

This page left intentionally blank

Comments and Suggested Revisions

The Public Transit Office at the Florida Department of Transportation and the Florida Planning and Development Lab at Florida State University welcome your comments and suggestions for revisions to this handbook. Please contact the persons below.

Amy Datz, FDOT
Florida Department of Transportation
605 Suwannee Street
Tallahassee, Florida 32399-4500
Phone (850) 414-4500
Fax (850) 414-4508
email: amy.datz@dot.state.fl.us

Harrison Higgins, AICP and Ivonne Audirac, PhD
Florida Planning and Development Lab
Department of Urban and Regional Planning
Florida State University
Tallahassee, Florida 32306-2280
Phone (850) 644-8513
Fax (850) 645-4841
email: hhiggins@fsu.edu

This page left intentionally blank

Accessing Transit: Design Handbook for Florida Bus Passenger Facilities

Prepared by:

Harrison Higgins, AICP
Ivonne Audirac, PhD

Florida Planning and Development Lab
113 Collegiate Loop
Department of Urban and Regional Planning
Florida State University
Tallahassee, Florida 32306-2280
Phone (850) 644-4510
Fax (850) 645-4841

Program Manager:

Amy Datz, FDOT
Florida Department of Transportation
605 Suwannee Street
Tallahassee, Florida 32399-4500
Phone (850) 414-4500
Fax (850) 414-4508

This page left intentionally blank

The Florida Department of Transportation (FDOT) requested that Florida State University (FSU) provide Florida transit agencies design guidelines for bus passenger transit facilities. Beyond identifying the minimum standards, the purpose of this study is to provide transportation agencies with feasible alternatives when developing bus passenger facilities that focus on the interaction of transit facilities with transit operations and the built environment.

The following members of the FSU communities and FDOT participated in conducting the research, analysis and preparation of this report:

Principal Investigators:

Harrison Higgins, AICP and Ivonne Audirac, PhD

Research Assistance:

Anthony Robalik
Chandrima Mukhopadhyay
Dristi Neog
Jon Skinner
Mollie Heibert
Torsha Bhattacharya

Editorial Assistance:

Kathy Mackinen

Designer:

Groves Design

With Participation From:

Mary Ann Koos
Rob Quigley
Dwight Kingsberry

TABLE OF CONTENTS

USER'S GUIDE I

CHAPTER ONE: CURB-SIDE GUIDELINES

1.1 Introduction 1
1.2 Bus Stop Signs 2
1.3 Bus Benches 4
1.4 Bus Stop Pads 8
1.5 Bus Stop Shelters 12
1.6 Bus Stop Shelter Hurricane Wind Loads 19
1.7 Bus Stop Information and Way-Finding Devices 20
1.8 Bus Stop Shelter Lighting 22
1.9 Landscaping 24
1.10 Bus Stop Leaning Rails 25
1.11 Bus Stop Trash Receptacles 27
1.12 Bollards 29
1.13 Bike Racks at Bus Shelters 30
1.14 Shopping Cart Storage at Bus Shelters 32
1.15 Public Telephones 33
1.16 Police Call Box 33
1.17 Vending Machines 34
Notes Chapter One Text References 35-36

CHAPTER TWO: STREET-SIDE GUIDELINES

2.1 Introduction 37
2.2 Roadway 38
2.3 Special-Use Lanes 38
2.4 Traffic Signals and Giving Transit Priority 39
2.5 Street Lighting 43
2.6 Vehicle Characteristics 43
2.7 Pavement Marking 48
2.8 Bus Stop Location 49
2.9 Emergency Medical Services (EMS) Access 55
2.10 Road-Side Bus Stop 55
2.11 Bus Bay 56
2.12 Queue Jumper Bus Bay 58
2.13 Bus Bulb 58
2.14 Off-Street Half-sawtooth Bus Bay 60
2.15 Bus Stops and Railroad Crossings 61
2.16 Bike Lanes 62
2.17 Pedestrian Crossings 62
2.18 Intersection Nubs 63
2.19 Raised Pedestrian Crossing/Speed Table 66
2.20 Pedestrian Islands 67
2.21 Transit Provision During Construction 67
Notes Chapter Two Text References 68-70

CHAPTER THREE: FACILITY PROTOTYPES

3.1 Introduction 71
3.2 On-Line Bus Stop 73

3.3 Primary Stop 75
3.4 Transit Mall 75
3.5 Transfer Center 78
3.6 Park-and-Ride Facilities 80
3.7 Air-bus Intermodal Transfer Centers 82
3.8 Rail-bus Intermodal Transit Stations 85
3.9 Bus Rapid Transit (BRT) 88
3.10 University Transfer Center 93
Notes Chapter Three Text References 95-96

CHAPTER FOUR: LAND USE GUIDELINES

4.1 Introduction 97
4.2 Key Land Use and Site Design Principles 99
4.3 Transit-discouraging Residential Development 103
4.4 Transit-oriented Residential Development 104
4.5 Transit-discouraging Multi-family Development 105
4.6 Transit-oriented Multi-family Development 106
4.7 Transit-discouraging Mixed-use District 107
4.8 Transit-oriented Mixed-use District 108
4.9 Transit-discouraging Retail Shopping Center 109
4.10 Transit-oriented Retail Shopping Center 110
4.11 Transit-discouraging Office Building 111
4.12 Transit-oriented Office Building 112
Notes Chapter Four Text References 113

CHAPTER FIVE: SAFETY

5.1 Introduction 115
5.2. Environmental Factors Related to Crime at Bus Passenger Facilities 115
5.3. Crime Prevention Through Environmental Design (CPTED) 116
5.4. Passenger Injury 117
Notes Chapter Five Text References 120

APPENDICES

Appendix A Glossary 121
Appendix B Planning Procedure for Shelters Provided and Maintained by Others 131
Appendix C Checklists 132
Appendix D Zoning Review 134
Appendix E Bus Stop Evaluation Program 135
Appendix F Bus Passenger Facility Development Thresholds 137
Appendix G Pedestrian Improvement Thresholds 138
Appendix H Recommended Transit-Supportive Language and Policies for Local Government Planning Documents 139
Appendix I Passenger Amenities 142
Appendix J Bus Shelter Manufacturers 143
Appendix K Costs 146
Notes Appendices 150

USERS GUIDE

This handbook can be used for a variety of purposes. Transit agency directors and planners can customize these guidelines to provide specific physical design criteria within their agencies for identifying programs, capital resources, and operations. Land use planners and growth managers, traffic engineers and transportation planners, and bicycle-pedestrian coordinators can work with their local transit agencies and metropolitan planning organizations to integrate the standards and guidelines with local comprehensive plan policies, land use and concurrency ordinances, pedestrian plans, and street design guidelines. The design guidelines may also be used by a developer or builder who is interested in developing a project that is transit friendly or who is seeking to conform transportation concurrency requirements through transit provision.

Transit agencies will want to use the handbook as a basis for planning access improvements to transit facilities and for working with local jurisdictions to comply with transit concurrency levels of service in existing and proposed transit service areas. Some agencies will want to use the handbook when attempting to plan a bus passenger facility in tandem with street improvements. Others will want to integrate them into the broader policies of the local government and everyday practices. Although the various parts of the handbook have been developed to be used together, they have also been designed for individual use by section and within sections by individual guidelines or standards.

The handbook is divided into five chapters:

Chapter 1: Curb-Side Guidelines

This chapter presents guidelines for improving the accessibility to buses and bus mobility in the right of way, including the coordination of bus stop elements like bus stop signs, benches, bus stop pads, bus stop shelters, way findings, shelter lightings, landscapings, leaning rails, trash receptacles, bollards, bike racks, shopping cart storages, public phones, police call boxes, and vending machines. It is appropriate information for transit planners, for transit agency officials involved in shelter siting and advertising programs, and for transportation and civil engineers and architects who provide for bus passenger facility site layouts and circulation in the right of way and on private property.

Chapter 2: Street-side Guidelines

This chapter presents guidelines for improving the bus passenger experience at the street level, including special use lanes, traffic signalization, street lighting, bus stop locations, and the connection to pedestrian and bicycle circulation.. It is appropriate information for transit planners, transportation and civil engineers and architects who provide for bus passenger facility site layouts and circulation in the right of way and on private property. Developers responsible for initial site selections, programming and project development, and agency staff involved with local jurisdictions who review such proposals to ensure transit needs are being met are also a prospective audience for this chapter. Individual property owners already accommodating transit and wishing to improve conditions on their site will also find this chapter useful.

Figure A | Legend for specific guidelines.

Legend


Accessibility Guidelines


Safety and Security Guidelines


Green Building Guidelines

Chapter 3: Facility Prototypes

Bus passenger facilities meet different operational and passenger needs, come in an array of sizes, and are located on both private and public land. Yet all facilities share the important function of providing access to and from the bus transit network and to and from other modes of transportation. This section provides prototypical designs of bus passenger facilities in development contexts that are typical for Florida. The facilities considered include:

- On-line Bus Stops
- Primary Stops
- Transit Malls
- Transfer Centers
- Park-and-Ride Facilities
- Air-Bus Intermodal Transfer Centers
- Rail-Bus Intermodal Transfer Centers
- Bus Rapid Transit (BRT)
- University Transfer Centers

Each type of facility is accompanied by development guidelines for location, required site areas, pedestrian connections and connections to other modes of transportation, and an inventory of the individual design elements that are combined to create that facility. This chapter also contains appropriate information for transit planners, transportation and civil engineers, and architects who provide for bus passenger facility site layouts and circulation in the right of way and on private property. Developers responsible for initial site selections, programming and project development and agency staff involved in local jurisdictions who review such proposals to ensure transit needs are being met are also the prospective audience for this chapter. Individual property owners already accommodating transit and wishing to improve conditions on their site will also find this chapter useful.

Chapter 4: Land Use Guidelines

This chapter describes methods for creating transit supportive development. Different examples are provided for typical types of development and development standards supportive of transit and a multi-modal transportation network are provided. This chapter is appropriate for elected officials, land use planners, growth management planners and transit planners as a reminder of key issues and relationship between different disciplines that will result in a stronger transit environment. Agencies planning to locate facilities on State of Florida rights of way should consult the Florida Department of Transportation's *Plans Preparation Manual* (PPM) for criteria that apply to the state highway system. Local roadway design is advised by the *Manual of Uniform Minimum Standards for Design and Maintenance for Streets and Highways* (the "Florida Greenbook"), but some municipalities may have adopted the PPM as their minimum standards. Additional local ordinances, especially regarding signage and landscaping, may also apply. State of Florida manuals are available at www.dot.state.fl.us/rddesign/Publications/pub.htm.

Chapter 5: Safety

This chapter discusses safety of riders involving both crime prevention and traffic around the transit stop. For transit agencies, ways to increase the perception of safety at passenger facilities are discussed. Maintenance of the transit stop and the environment surrounding it is critical to passenger safety. This includes keeping the area clean of graffiti and litter and keeping landscaping neat and trimmed. The two types of accidents detailed in the chapter are traffic collisions and other accidents, including falls. Through design, passenger facilities can prevent vulnerability and ensure passenger safety.

To highlight specific guidelines related to accessibility, safety and security, and green building, a key has been provided in Chapter 1 and 2 of the handbook. A legend to that key is shown in Figure A.

This page left intentionally blank

CHAPTER ONE

CURB-SIDE GUIDELINES

This page left intentionally blank

CHAPTER ONE: CURB-SIDE GUIDELINES

1.1 Introduction

A transit agency's goal should be to provide all transit patrons, of all ages and abilities, with comfortable equipment and facilities that provide shelter from the sun, rain, and other elements. Transit patrons should be provided with waiting areas that are outside pedestrian flows yet connected to pedestrian infrastructure and separated and secured from automobile traffic. Ideally bus stop pads should be provided at all bus stops, and connectivity to sidewalks should be considered when selecting bus stop locations.

Designing transit facilities with Florida's climate in mind, using renewable energy technologies, and reducing potable water consumption further enhance bus transit's environmentally friendly profile.

Additionally, transit agencies should create facilities that are usable by all passengers, including but not limited to disabled transit patrons. For instance, transit agencies should seek to accommodate "parents pushing strollers, travelers pulling luggage, the older man needing a little more time to cross a street."[1]

Most transit agencies' resources for providing passenger facilities are limited, forcing them to make difficult choices. Some agencies adopt a point system in order to decide which stops to prioritize for shelter placement or the location of other facility elements like benches, trash receptacles, or bike racks.

A typical point system, based on one used by the Hillsborough Area Regional Transit (HART) in Hillsborough County, Florida, appears below.[2] Such a system might provide shelters at bus stops with ten or more points and unsheltered benches and trash receptacles at bus stops with six points using the criteria in Table 1.1.

Additional information on the role of facilities in enhancing transit quality service can be found in the second edition of *Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual,* available from the Transportation Research Board. American Public Transit Association members can obtain free copies of the report from http://www.trb.org/news/blurb_detail.asp?id=2326.[3] Transit agencies seeking more information on how to provide the varying facilities needs of children, older adults, the disabled, and others should consult the *Toolkit for the Assessment of Bus Stop Accessibility and Safety* provided by Easter Seals Project ACTION. The report can be accessed at http://www.projectaction.org.[1]

Table 1.1 | Typical point system based on one used by HART in Hillsborough County, Florida

Points	Criteria	Variable	Measurement
7 points or 3 points	High boarding or transferring	Number of patrons getting on the bus	7 points for 20 boardings per day; 3 for 10 boardings per day
4 points	Special needs	Concentration of patrons with special mobility needs	Adjacency to land uses like senior centers, medical offices, libraries, hospitals and schools for the deaf or blind or mentally challenged
4 points	Activity locations	High potentials for ridership	Adjacency to land uses with high densities of occupation like apartment buildings, office buildings, malls, shopping centers, schools and universities, and convention centers
2-4 points	Weather exposure	Absence of other kinds of shelters	Absence of landscaping or buildings for sun and rain protection
3 points	Wait time	Bus headways	Stops at which patrons must typically wait 20 minutes or more for a bus
2 points	Distribution	Spread of improvements	Locations in areas where very few of the bus stops are sheltered or where benches are provided
2 points	Demand	Requests for improvements	Patrons requesting improvements

Source: Hillsborough Area Regional Transit. (1995). *Transit Friendly Planning and Design Handbook and Technical Manual*. Tampa, FL: Hillsborough Area Regional Transit.

1.2 Bus Stop Signs

Purpose

Bus stop signs are references for bus operators and passengers. Important aspects to be considered in placing transit signs are passenger convenience, public safety, and bus stop visibility.

Accessibility Considerations

Transit signs should be located on the bus stop landing pad in a place where they are visually accessible to passengers. For patrons using wheelchairs, the bus stop pole should indicate where to access the wheelchair lift. The bus stop sign poles should be designed in such a way that passengers with visual impairment can distinguish it from other poles on the same area. A perforated square pole would be a good example of this. [1] See Figure 1.1.

Location Factors

Bus stop signs should be posted at all bus stops and bus passenger facilities. Separate lateral clearance requirements apply to signs and their supports, sometimes called signposts. Different clearance dimensions are also provided for roads with or without paved shoulders, curbs, or sidewalks. Sign and signpost placement should conform to Americans with Disabilities Act (ADA) requirements for height, width, visibility, and other design criteria.[4] See Figures 1.2 for typical bus stop signpost installation. Figure 1.3 shows a solar powered bus stop sign post.

Additionally, the *Florida Department of Transportation (FDOT) Design Standards* apply on all state roads. Index 700, *FDOT Design Standards* requires a minimum clearance of 4 feet from the face of the curb to frangible signposts.[5] In rural areas, where roads are not typically constructed with curbs, clearance is generally measured from the edge of the travel lanes or paved shoulders. Index 17302, *FDOT Design Standards* stipulates that the lateral offset from the nearest edge of the sign itself must be at least 12 feet from any travel lanes and at least 6 feet from the edge of any paved shoulder.[6] However, the edge of the sign may be as close as 2 feet from the edge of the road in business or residential areas. See Figures 1.4, 1.5 and 1.6 for critical dimensions regarding bus stop signpost location.

On non-state roads, according to the *Manual on Uniform Traffic Control Devices* (MUTCD), a minimum offset of 1 foot from the face of the curb to the nearest edge of the sign may be used in urban areas where the sidewalk width is constrained or where other vertical structures (e.g. utility

Figure 1.1 | A typical pole collar working as an information panel.

Figure 1.2 | A bus stop sign placed between the sidewalk and the travel lane near a sheltered bus stop.

poles) are located close to the curb.[7] Otherwise, signposts should be located further away from the face of the curb in order to be visible to the bus operator. Additionally, sign panels must be located to provide a minimum sidewalk clearance of 36 inches. [8]

Design Factors

Bus stop signs must comply with all the applicable requirements set forth in the MUTCD.[7] The sign dimensions depicted in Figure 1.7 are typical, but not mandatory, dimensions for rectangular bus stop signs.

continued on page 4

CURB-SIDE GUIDELINES

Figure 1.3 | This solar-powered bus stop signpost provides bus flagging capability and security lighting.

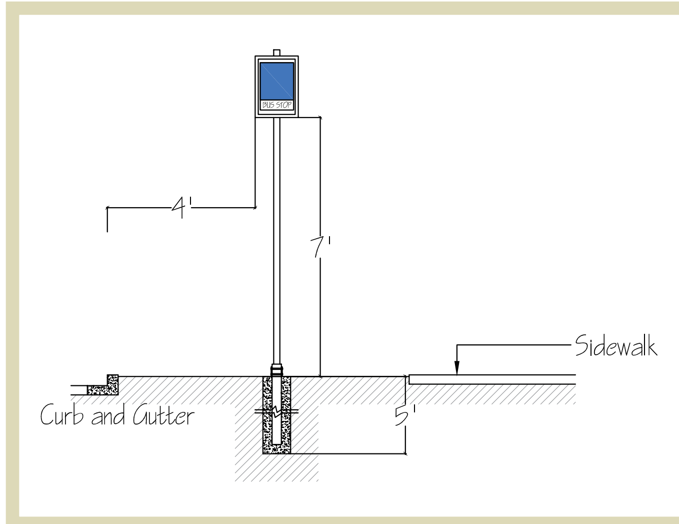


Figure 1.5 | Dimensions for a bus stop sign placed in a planting strip adjacent to the travel lane.

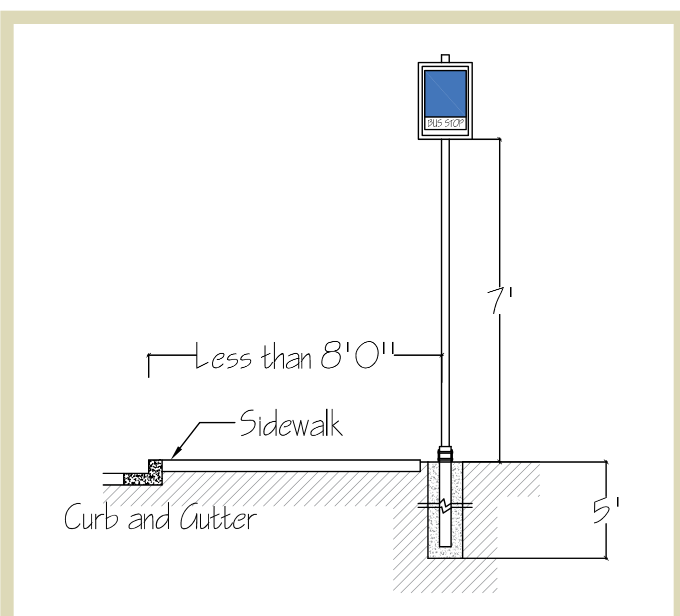


Figure 1.4 | Dimensions for a bus stop sign placed on the far side of a sidewalk adjacent to the travel lane.

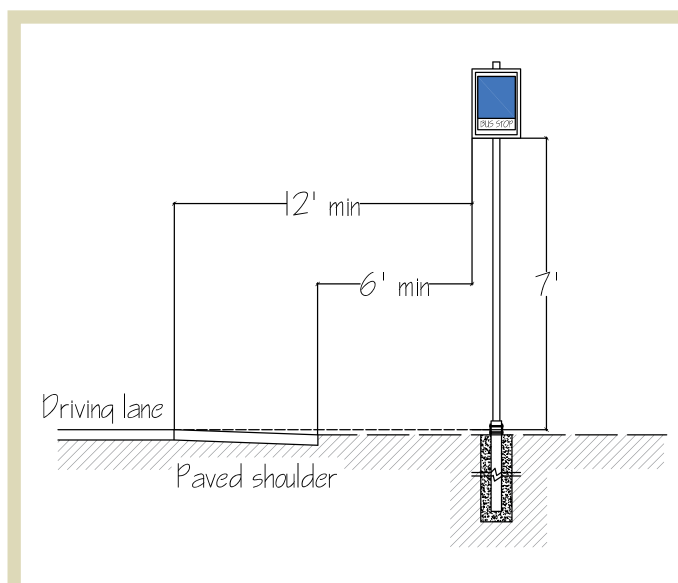


Figure 1.6 | Dimensions for a bus stop sign placed adjacent to the travel lane of a road without curb and gutter.

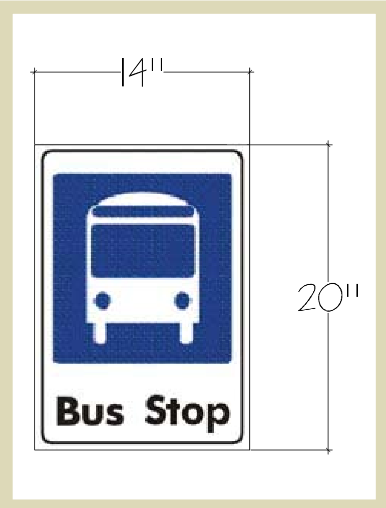


Figure 1.7 | Typical, but not mandatory, bus stop dimensions for a rectangular bus stop sign.

Bus stop signs should be designed with a uniform size and shape and should coordinate with the agency's identity package. Signs should clearly display information. When possible, easily understood symbols should be used in lieu of written information. Double-sided signs provide visibility from both directions. For nighttime visibility, signs should use retro-reflection. Finally, high-contrast colors on bus stop signs can be employed to enhance readability. Suggested information on signs includes the transit agency logo, the transit agency telephone number, the route number, the hours of operation, and schedule information. Expanded information, including schedules in a format that is easy to update and system maps with the bus stop location highlighted, can be added along high volume routes.

Signposts should break away without slowing the vehicle by more than 15.4 feet per second (5 meters per second) and of no more than 4 inches (100 mm). [9] Breakaway mechanisms include slip bases and bases incorporating a component with low impact strength. [10] Signposts placed near intersections should be of an omni-directional design, meaning that the support is symmetrical and will break safely when struck from any direction. Signposts in the clear zone (a roadside that is traversable and unobstructed by fixed objects to allow vehicles that leave the roadway to recover safely) should also be designed with breakaway mechanisms or else protected by a barrier or crash cushion.

Existing schedule displays and signs can be retrofitted with self-contained, solar-powered bus stop signposts to provide bus-flagging capability, security lighting, and on-demand sign illumination with a renewable energy source.[11] See Figure 1.3.

1.3 Bus Benches

Purpose

Seating, most often in the form of benches, is a very important component in the provision of amenities at the facility site. Benches may be sheltered or unsheltered.

Many transit agencies have relied on private advertising vendors to supply unsheltered benches, but as more cities and counties have adopted restrictive sign ordinances, the use of the benches with advertising has become problematic if not forbidden. Placement and design of bus benches is governed by Rule 14-20.003, "Placement of Transit Bus Benches", Florida Administrative Code. [12]

Accessibility Considerations

Transit users who experience difficulty walking and standing benefit from benches while waiting for the bus. Benches are beneficial when a shelter with other seating is not provided and if bus headways are longer than 15 minutes. At stops with high ridership, benches may be provided in addition to shelters to accommodate patrons.[1]

Location Factors

Benches may be provided in high ridership locations that have weather protection but no seating and at bus stops located adjacent to properties with features attracting riders to use them for seating (e.g., retaining walls, stairs, low fences). See Figure 1.8. Benches should not be placed in completely exposed locations. Landscaping should shield customers from the weather. Unsheltered benches may be provided in locations where the regular number of riders does not warrant a shelter or in high use areas that are unsuitable for shelters because of high levels of pedestrian movement in a small area. Benches should allow transit patrons a clear view of the transit and bus drivers a clear view of waiting patrons and should not be placed near an area where someone could hide, harm, or rob a waiting transit patron. If possible, benches should be placed on non-slip, properly drained concrete pads or on grass, gravel or rubber sidewalks. Benches may not be placed on medians or on limited access roadways.[2] Figure 1.9 shows custom benches designed for a downtown intermodal transit center in St. Petersburg, Florida. Figure 1.10 shows a typical sheltered bus bench.

Benches should be kept clear of passenger loading and unloading areas and placed no closer than 5 feet and no further than 12 feet from the forward end of any bus stop.[13]

CURB-SIDE GUIDELINES

Benches should be placed so that streetlights or other objects do not obscure the visibility of waiting passengers or oncoming buses.[2] See Figure 1.10. Bench placement should accommodate passengers' legs and feet without placing them too close to traffic. Proper horizontal clearance to benches should also be provided. In urban areas, the minimum distance from the face of the curb to the bench is 4 feet. In rural areas, the distance will vary according to the design speed of the road; the higher the roadway speed, the further the bench should be placed from the lane. If a sidewalk is provided, F.A.C. requires a minimum 3-foot clearance from the bench to the edge of the roadway for passing pedestrians.[12] Figures 1.11 to 1.13 provide critical dimensions for sheltered bus benches.

Figure 1.8 | Correct placement of a bus bench outside of a sheltered bus stop

Design Factors

According to Florida law, benches shall not exceed 74 inches in length, 28 inches in depth and 44 inches in height.[12] See Figure 1.14. Per ADA requirements, seat dimensions shall be as follows: between 20 and 24 inches in depth; 42 inches minimum in height; between 17 (preferred) to 19 inches above the ground or floor; and back support that extends from a minimum of 2 inches above the seat to a maximum of 18 inches above the seat.[4] Further, benches must be able to support 250 pounds of force applied at any point on the seat, fastener, mounting device, or supporting structure.[4] All benches should be slip-resistant and designed to shed water.[7] Grab handles should be provided for those with difficulty standing up.

Benches should suggest sitting patterns and number of users. See Figure 1.9. Two-person benches (4 feet, 2 inches long) can be placed at bus stops with medium ridership levels. These are usually placed inside shelters but can also be freestanding. Freestanding, three-person benches can be placed at bus stops with high ridership levels and/or high visibility. Benches should discourage opportunities for sleeping or reclining.

Figure 1.9 | Divided bus bench seating at an inter-modal bus passenger facility.

Possible Materials for Use

Bench materials should be weather resistant, discourage vandalism and vagrancy and require little maintenance.[14] Concrete bases (end pieces) are recommended for stand-alone non-secured benches. In such cases, weight discourages moving or stealing the benches. Agencies should consider bus benches composed from recycled materials including high density polyethylene, one of the most popular types of recycled plastic, and renewable materials like wood. See Figure 1.15. Avoid uncoated, dark metal seating surfaces, as they are hot in the summer and cold in the winter.

Figure 1.10 | Bus bench within a bus shelter that allows sitting patrons a clear view of oncoming buses.

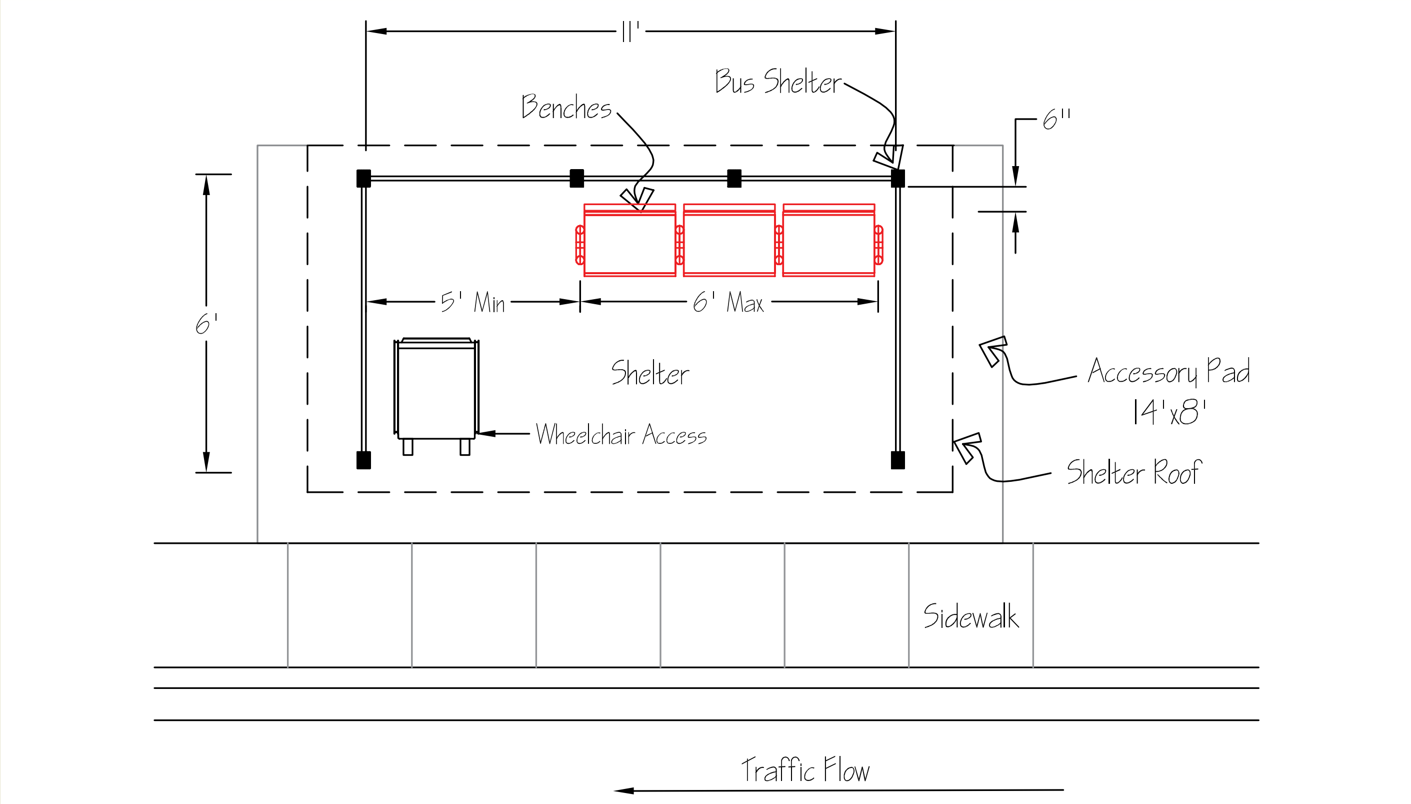


Figure 1.11 | Locations of bus benches within a bus shelter with opening on one side.

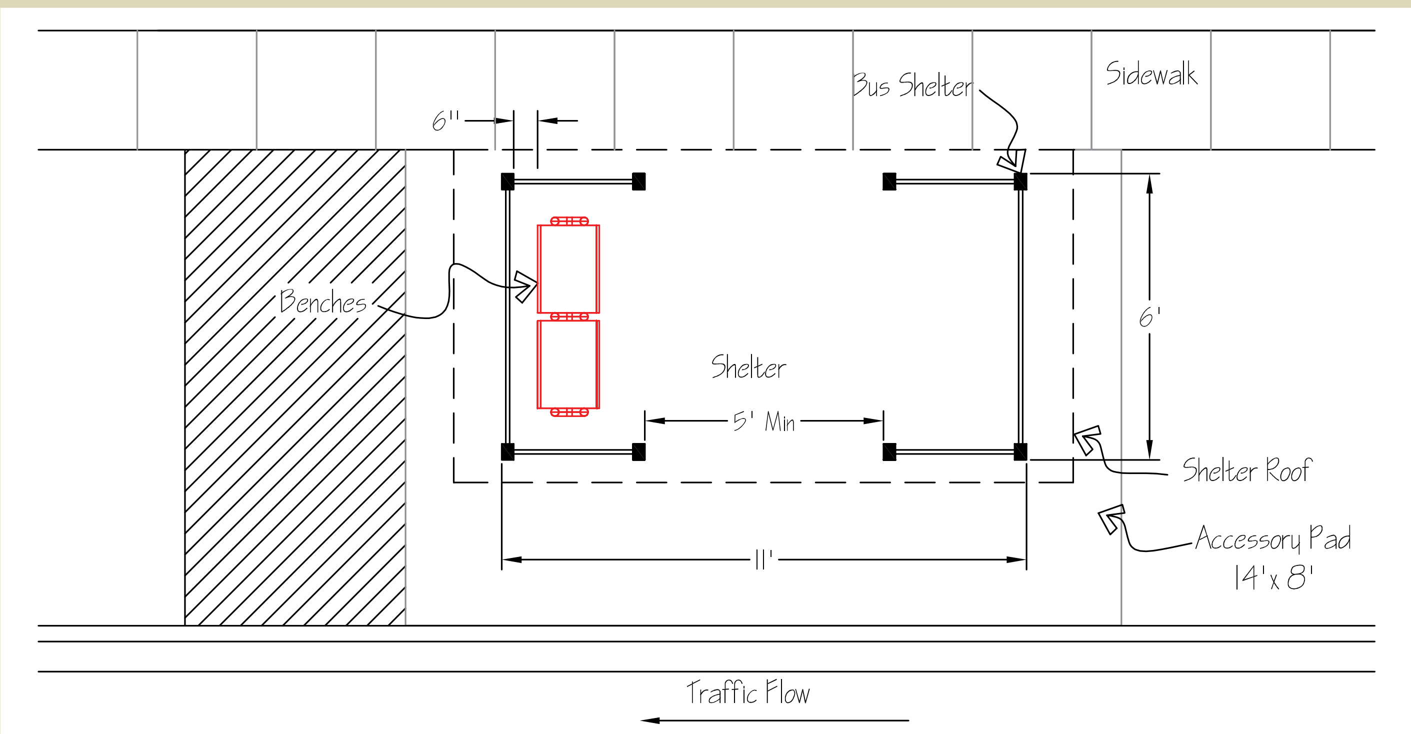


Figure 1.12 | Locations of bus benches within a bus shelter with opening located centrally on two sides.

CURB-SIDE GUIDELINES

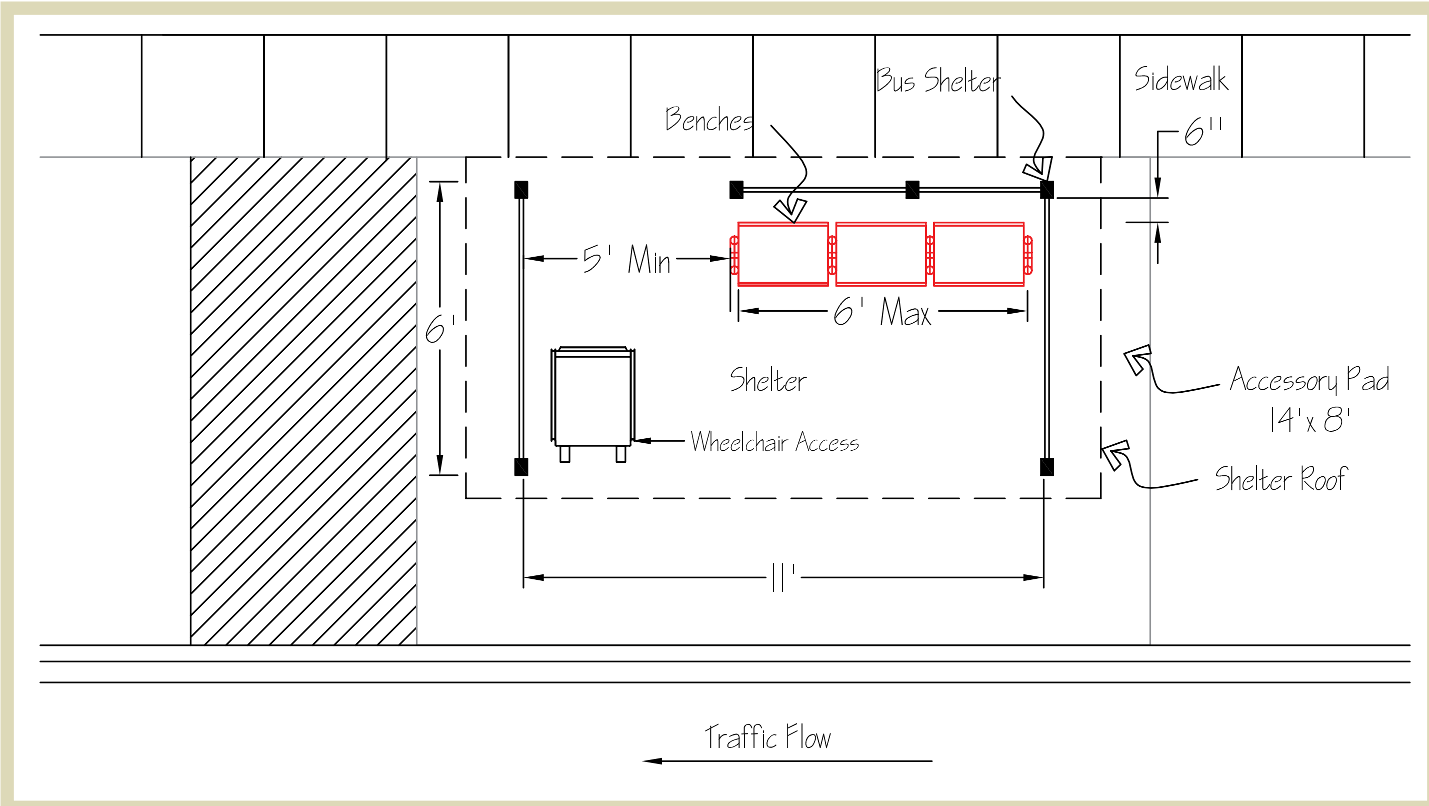


Figure 1.13 | Locations of bus benches within a bus shelter with different side panel alignment and opening on two sides.

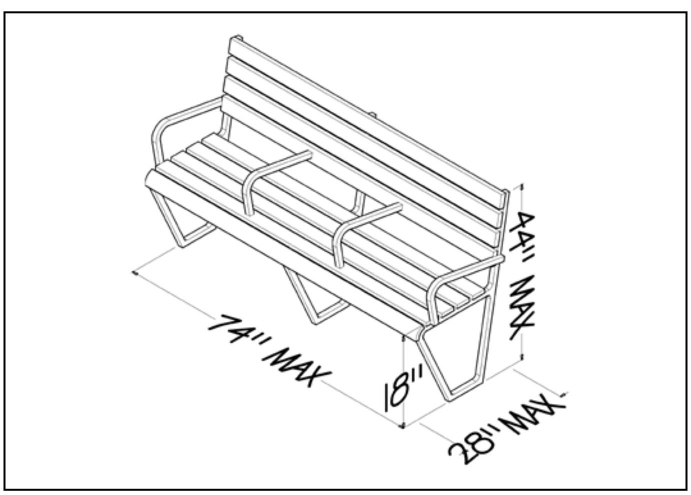


Figure 1.14 | The required dimensions for divided bus benches with backs.

Figure 1.15 | Recycled plastic bench.

1.4 Bus Stop Pads

Purpose

Bus stop pads (including the area that is accessible to wheelchair users and other landing areas) provide a well-drained, non-slippery surface with adequate space for amenities and passenger movement on and off buses. Providing a designated bus stop area benefits all transit users. An area the length of the bus for transit purposes provides a comfortable waiting, alighting, and boarding area for both front and rear doors and denotes the transit agency's presence.

Accessibility Considerations

Wheelchair and scooter users, as well as elderly and encumbered passengers (such as parents with strollers and shoppers with bags), will have less difficulty boarding and alighting the bus when there is a stable, level, and unobstructed landing pad to operate the wheelchair lift and ramp. Wheelchair and scooter users require more space to turn around in than other transit users and therefore benefit from sufficient area at the bus stop to maneuver.[1]

Location Factors

Bus stop pads should be placed at all bus stops with shelters. It is preferable to provide pads at unsheltered bus stops with benches.

Design Factors

The dimensions of bus shelter pads may be adjusted as necessary to accommodate site conditions. The minimum size of bus stop pads, per ADA requirements, shall be 8 feet (perpendicular to roadway) by 5 feet (parallel to roadway).[4] The ideal bus stop pad size is 10 feet by 30 feet. See Figures 1.16 through 1.19 for alternative stop pad designs. In urban areas, and where right of way permits, the ideal is to provide a continuous 8-foot wide concrete pad along the entire length of the bus stop (40 feet for a standard bus and 60 feet for an articulated bus) adjacent to the curb and gutter. An additional 50-foot length is recommended for each additional bus expected to stop at the bus stop. When the available space for a pad is less than 10 feet by 30 feet, the pad should be as large as possible. If a shelter is planned for the location, the pad should follow the shelter profile. The pad should extend 6 inches beyond the area under the shelter canopy in order to prevent soil erosion caused by runoff.

Any easement obtained for installing a pad should extend 2 feet beyond the pad. Bus stop pads should be connected to streets, sidewalks or pedestrian paths by an accessible route, the criteria for which are defined by the ADA regulations.[4] Bus stop pads should be designed to maintain a minimum clear width of 48 inches and vertical clearance of 80 inches from the sidewalk to the stop.[1,4] ADA requirements mandate a maximum slope of 2 percent to allow for drainage.[4] Pads for sheltered stops may include conduits and junction boxes for utilities.

For rural bus stops, the concrete pad for a shelter, if it exists, should not be obstructed by the bus stop sign or any other sign. See Figures 1.20 a and b. The concrete pad should be located outside the clear zone. Concrete sidewalks should meet ADA criteria. [4]

Possible Materials for Use

Bus stop pads should be constructed of reinforced concrete over an aggregate base or alternatively they may be made of recycled plastic or rubber aggregate. The thickness will vary according to the design of the anchoring required for various bus stop elements as affected by expected wind loads.[15] Free edges of pavement should be strengthened with reinforcement.

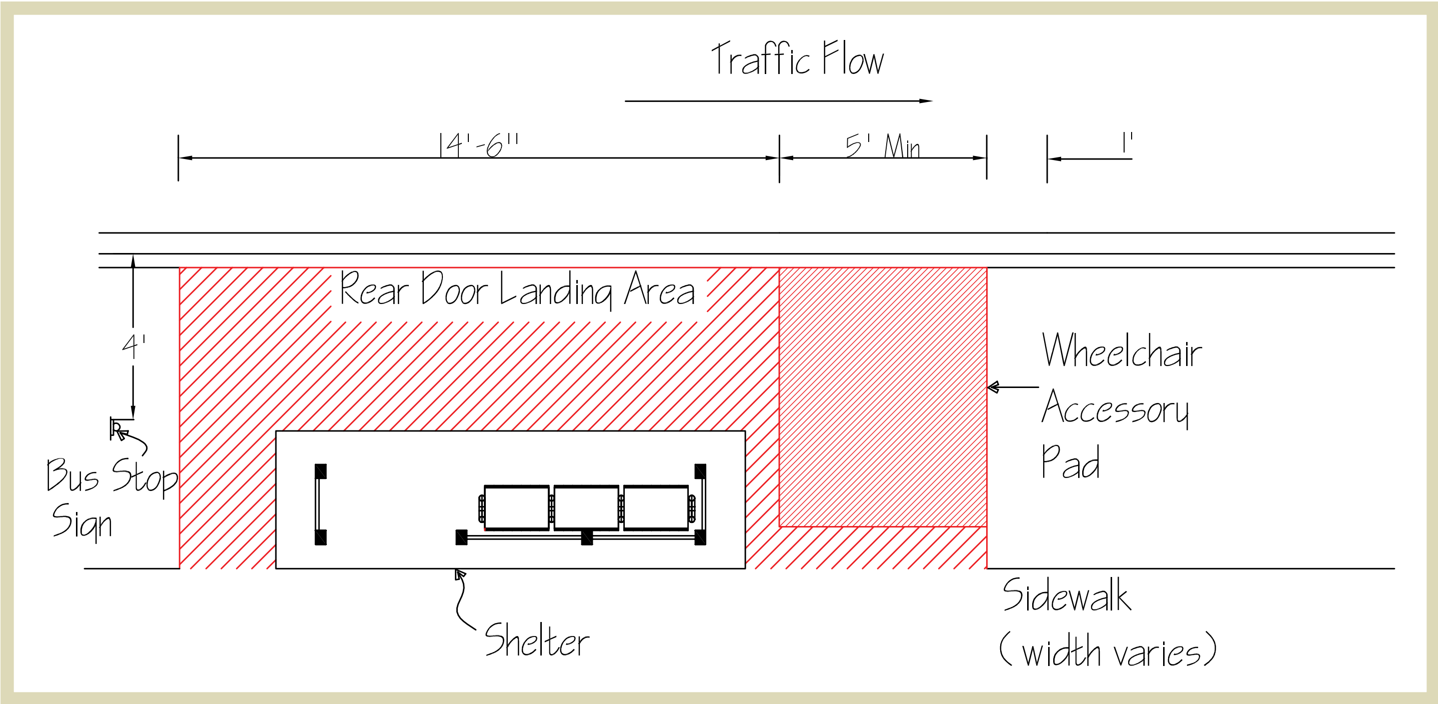


Figure 1.16 | Bus stop pad with shelter.

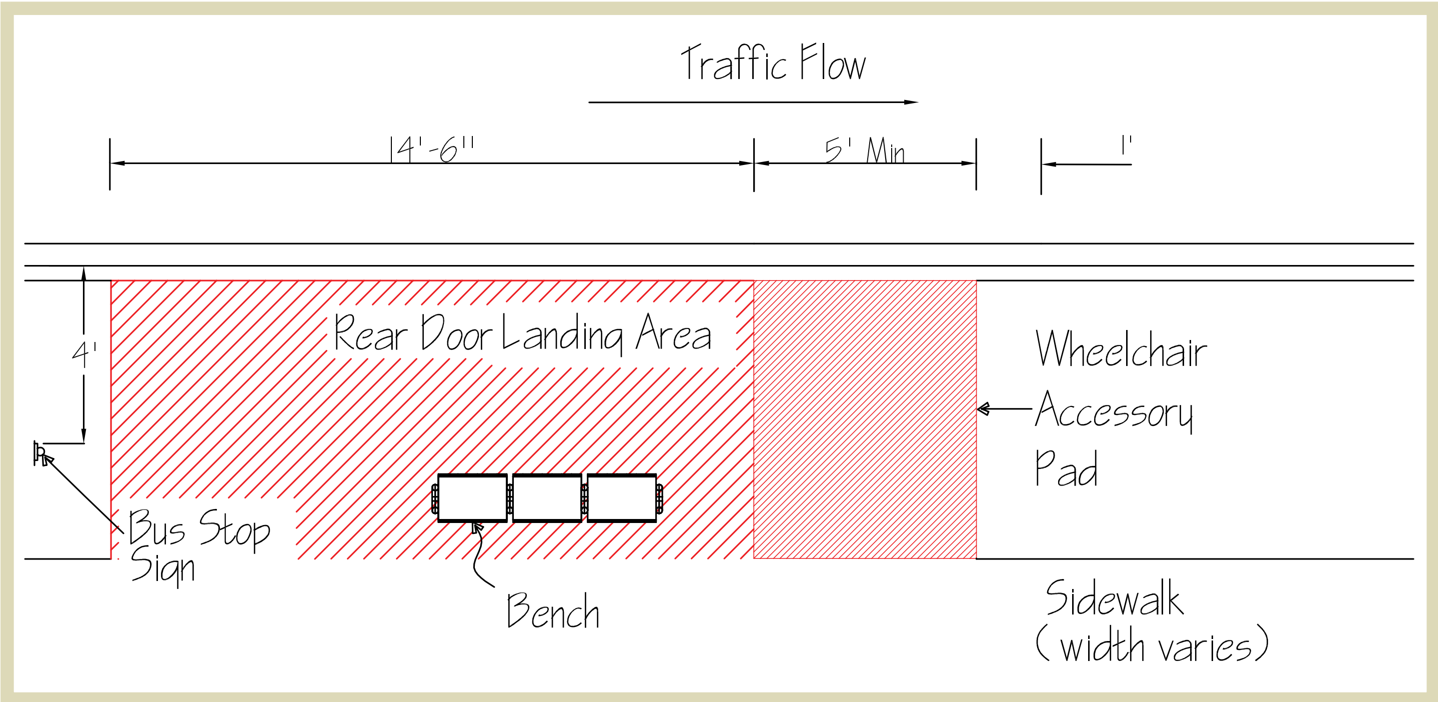


Figure 1.17 | Bus stop pad without shelter but with bench.

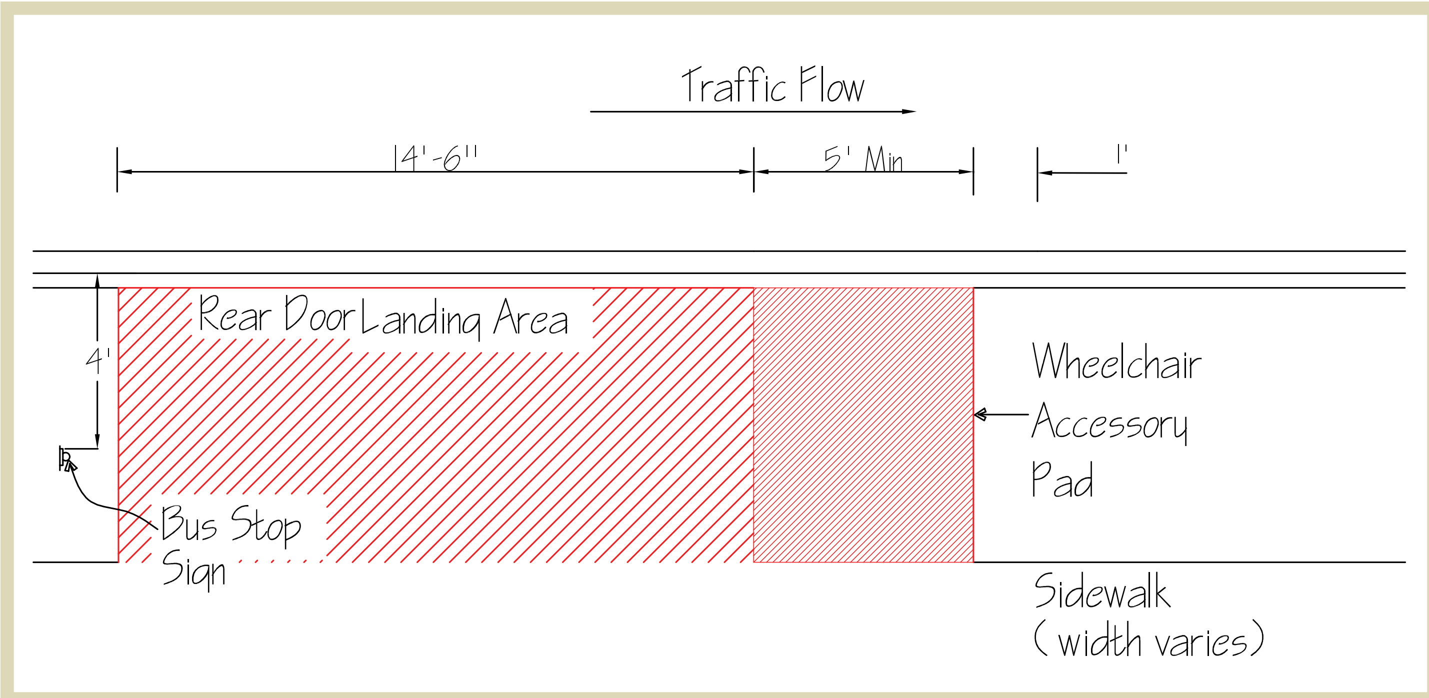


Figure 1.18 | Bus stop pad without shelter and bench.

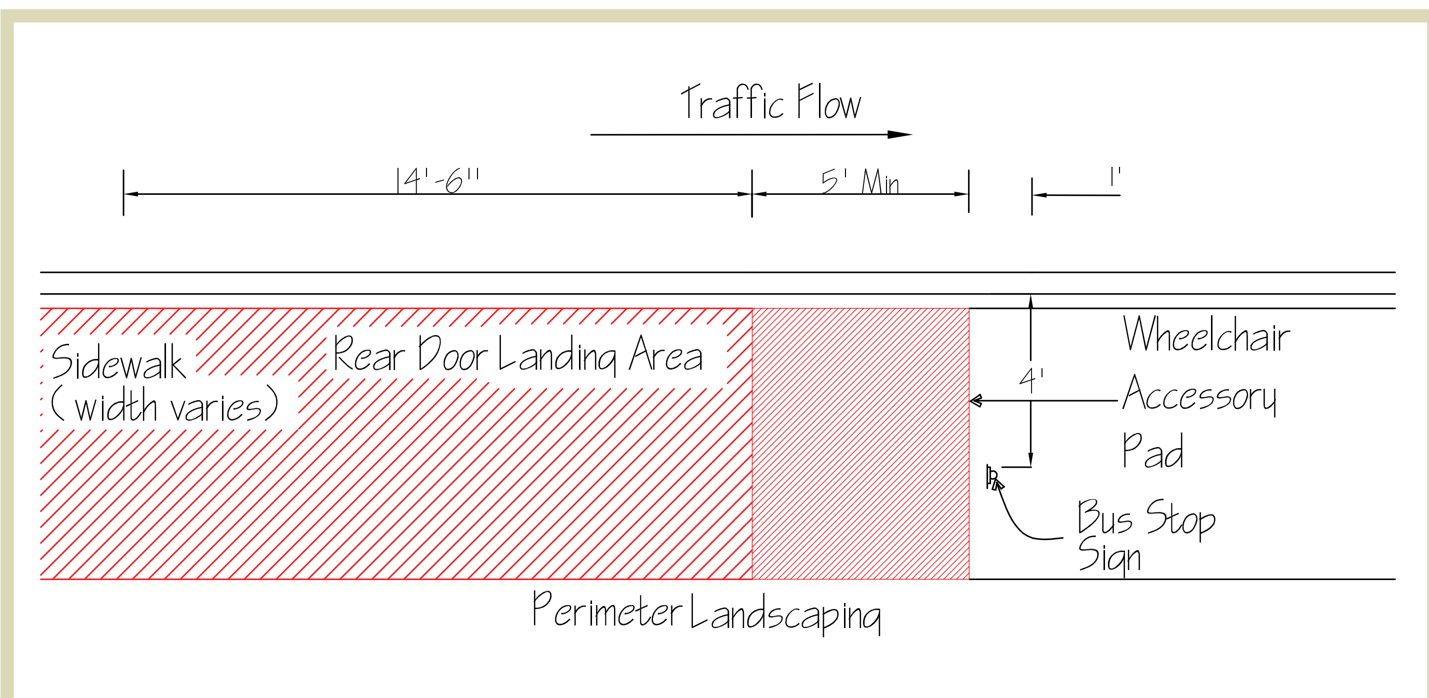


Figure 1.19 | Landing pad configuration when the sidewalk is directly adjacent to the curb.

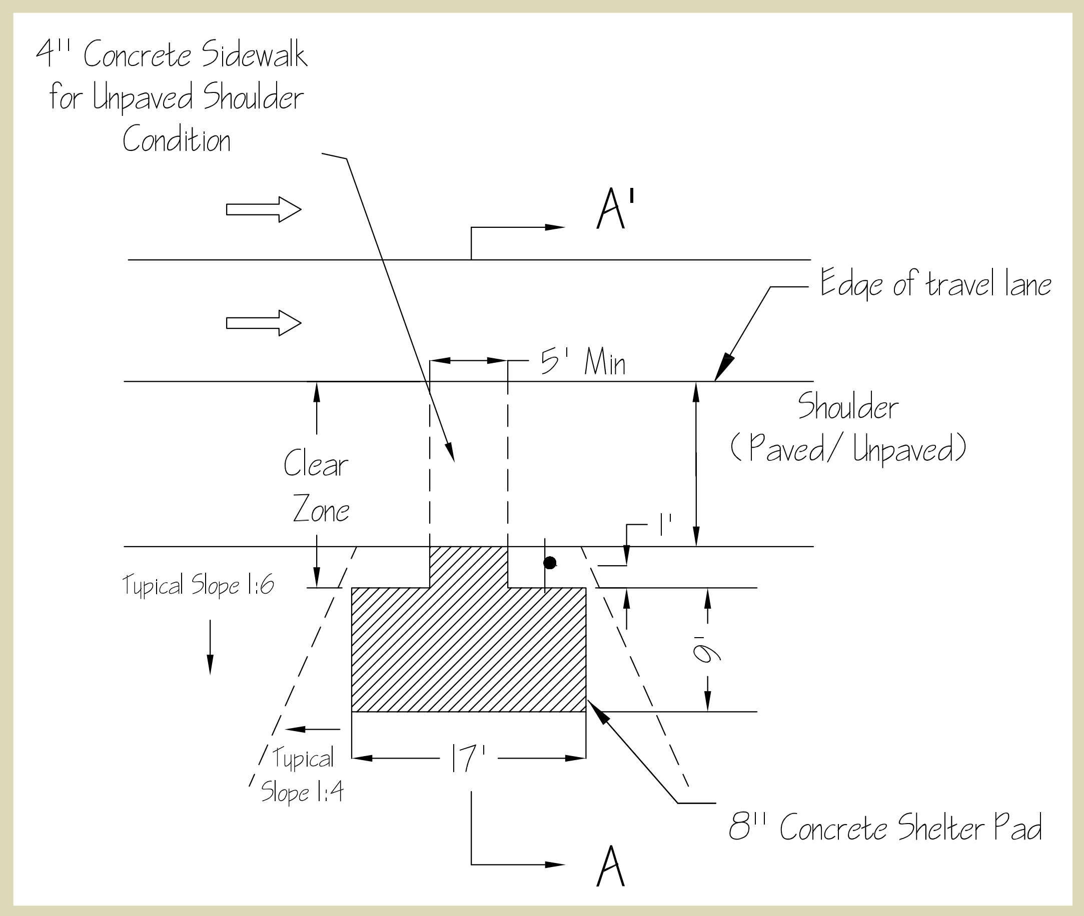


Figure 1.20 a | Plan showing landing pad configuration for rural bus stop.

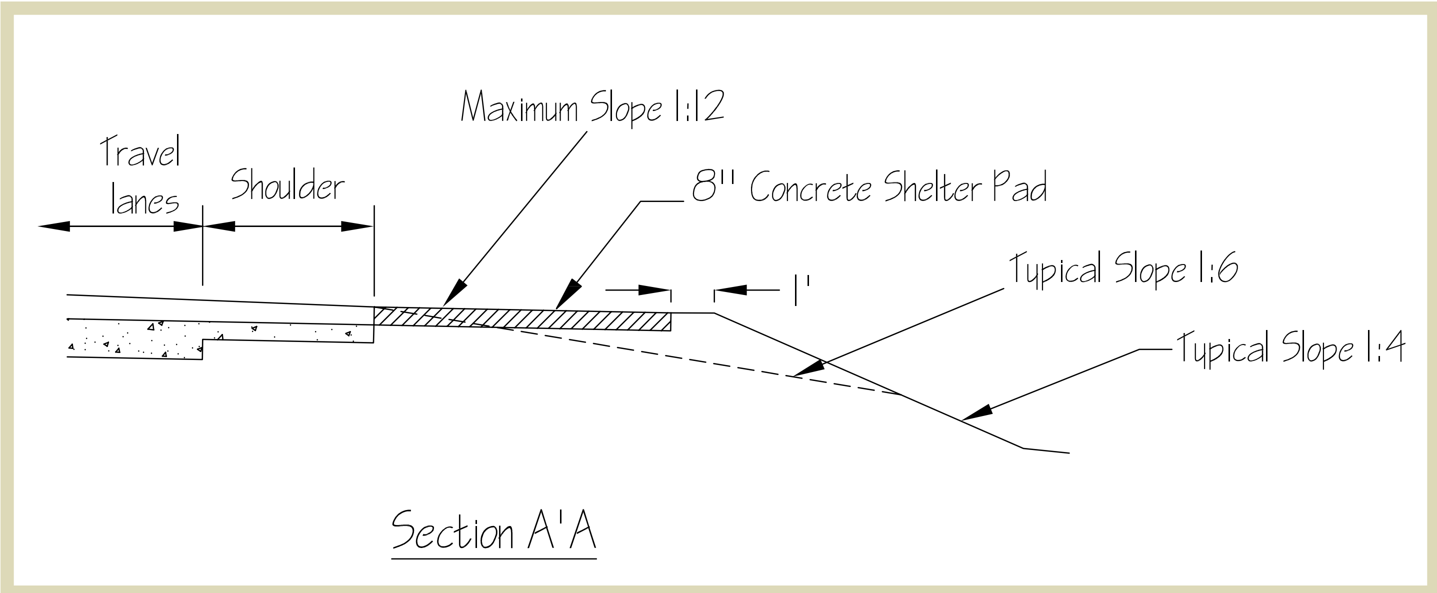


Figure 1.20 b | Cross-section showing landing pad configuration for rural bus stop.

1.5 Bus Stop Shelters

Purpose

Shelters protect waiting passengers from exposure to the sun and rain. The minimal form of a shelter is an overhead canopy beneath which passengers wait for the bus. Optional side enclosures for shelters and the provision of other amenities under or near the shelter enhance the image of the transit service and offer a comfortable and convenient transit trip for patrons. See Figure 1.21. In Florida, it is of particular importance to design with the climate in mind.[16] Solar radiation, heavy precipitation and high relative humidity make waiting for the bus, especially in summer, extremely uncomfortable for passengers. As a result, allowing for shading, shelter, and ventilation is important considerations.

Opportunities also exist for agencies to incorporate recycled or renewable materials into shelters and their components. Renewable energy technology, including wind and solar power, can be adapted by transit agencies to provide shelters with electricity for illumination and cooling.

Accessibility and Safety Considerations

The seating and protection provided by shelters benefit bus patrons with mobility impairments. Additionally, a shelter clearly marks a bus stop, supplies an area to post route and timetable information and provides refuge for waiting passengers, separated from the public way. Shelters located in areas with good lighting and visibility from surrounding land uses enhance the safety of the stop.[1]

Location Factors

Operations Factors

Bus shelters should be provided at any stop with at least 25 boardings a day. Bus shelters should also be provided at stops that are major generators of peak hour transit ridership or are major transfer points between routes. Stops that attract large concentrations of patrons that are young, elderly, or temporarily or permanently disabled – such as universities, recreation centers, senior citizen housing facilities, or hospitals – should be sheltered. See Rule 14-20.003 , F.A.C. for the placement of transit and school bus shelters. [4,12]

Right of Way Factors

The open side of a shelter should be placed toward oncoming traffic and should be grade separated from the travel lane. Bus shelters shall be located a minimum of 12 feet from an intersection, as measured along the tangent line of the

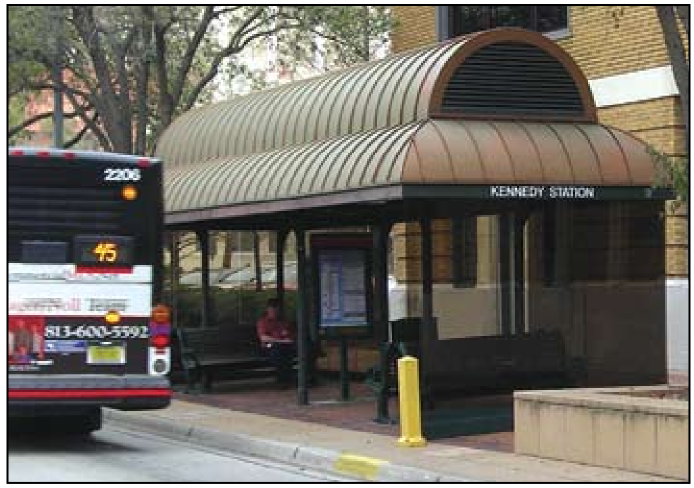


Fig 1.21 | Patron waiting at a sheltered bus stop.

state road beginning at the point of the intersection of the radius of the connecting road and tangent of the state road.[14] Shelters should be located upstream of the bus zone without interfering with passengers boarding and alighting, in order to maximize the visibility for approaching buses, passing traffic and waiting passengers. The location of bus shelters should minimize walking distances for waiting passengers. Shelters should be located at least 5 feet from the front door of the bus along the direction of travel in order to provide adequate circulating space for persons in wheelchairs.

Proper horizontal clearance to shelters should be provided. In rural areas, the distance will vary according to the design speed of the road.[5] Shelters shall not be placed on sidewalks where they could obstruct the movement of pedestrians. A minimum 3-foot pedestrian pathway, per ADA requirements, shall be maintained on three sides of the shelter.[4] In areas with high pedestrian volumes, a 6-foot pathway on one side of the shelter is preferred. The sidewalk adjacent to the shelter should be designed so that two wheelchair users can pass traveling in opposite directions.[1] Do not place shelters on the wheelchair landing pad area required by ADA. [2,4] Shelters should be located at least 15 feet away from a fire hydrant or a parking space for the disabled and at least 7 feet from a utility pole. [2,4]

Environmental Factors

Shelters should be oriented so that they provide as much protection as possible from sun, wind and rain.

CURB-SIDE GUIDELINES

Design Factors

General Factors

The shelter shall have provisions to accommodate elderly and disabled people in order to meet ADA standards. A shelter that is accessible to people in wheelchairs must have a minimum clear floor area 30 inches wide and 4 feet deep entirely within the perimeter of the shelter.[3] Access entry points should not have less than a 36-inch wide clearance. [4] There should be no steps between the sidewalk or bus pad and the shelter.[1]

Shelters should incorporate seating whenever possible, both to make the service more attractive generally, but especially to serve patrons with mobility impairments (such as the elderly, pregnant women, those with temporary injuries, etc.).[1] Shelters should include route maps and schedules. These should be easily readable by people in wheelchairs and those with visual impairments, to the greatest extent possible.[1] Shelters can also be designed to incorporate benches and/or leaning rails and may also include telephones, newspaper vending and trash receptacles.

When available right of way is limited, it is better to provide a smaller shelter than not to provide a shelter at all.

Sizing Factors

The size and design of shelters vary with the number of boarders at a bus stop and with space availability. Dimensions for shelters of various sizes are given in Figures 1.22 through 1.30.

Defensible Space Factors

As the first image of the transit system, the shelter should speak to the attractiveness and security of the system. Shelters should be designed with transparent sides for greater visibility; if transparent materials are used, they shall be shatterproof.[14] Glass panels should be marked with distinctive patterns, using contrasting colors, to indicate their presence.[1]

Shelters should allow for unobstructed views into and out of shelter structures. The design of the shelter should not create blind spots or hiding places in order to protect the facility and its patrons from crime. It is better to have no advertising panels on the shelters at all to avoid limited visibility. If advertising is an important revenue source for shelter provision, care should be taken with advertising placement. According to Rule 14-20.0032, F.A.C., there shall be no more than one advertisement per side, including the roof, and said advertisement shall be no greater than 72 inches by 60 inches in size.[12]

The shelter should be designed with adequate illumination for security at night.

It is important to maintain the cleanliness of the bus stop. A well-maintained stop communicates to the community that the bus stop is an important public space.[1] Shelters also should provide a clear opening at their bottoms in order

continued on page 15

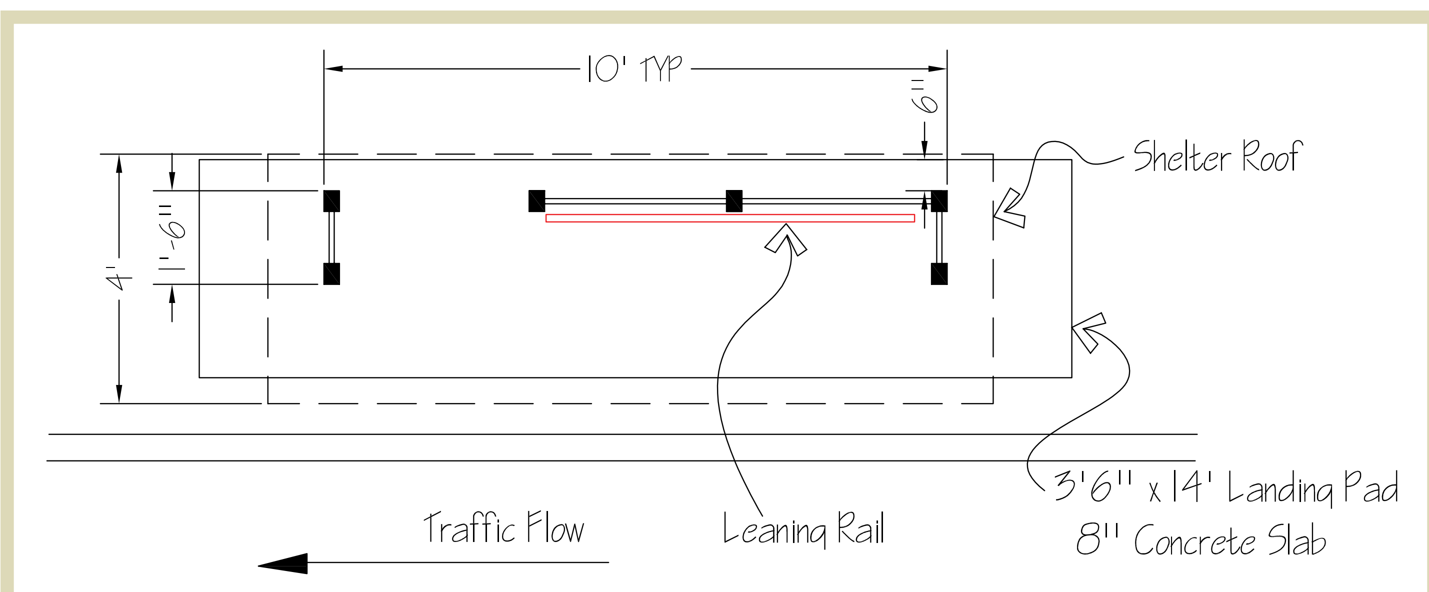


Fig 1.22 | Typical dimensions of a small bus shelter with a leaning rail but no seating, applicable to stops with limited right of way width.

CURB-SIDE GUIDELINES

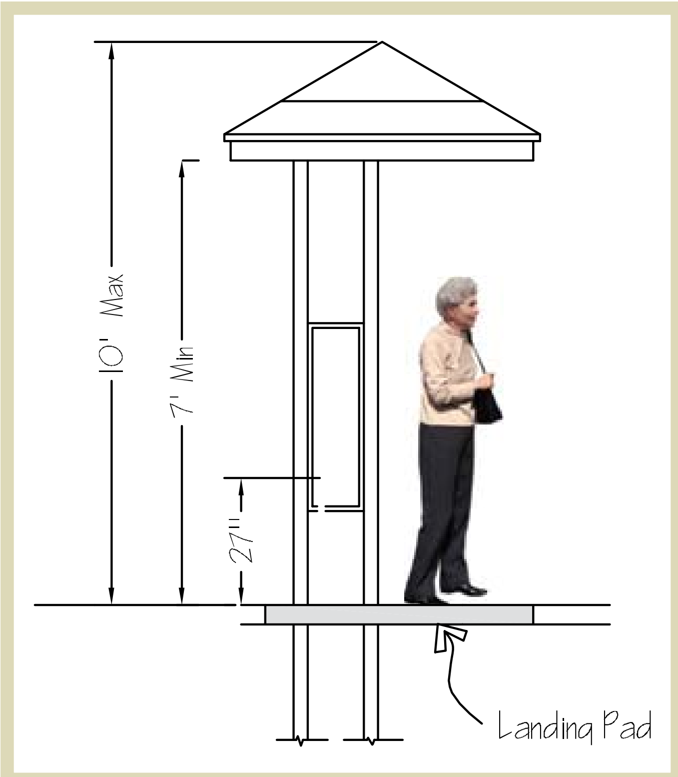


Fig 1.23 | Cross-section of a small bus shelter with a leaning rail but no seating, with typical vertical dimensions.

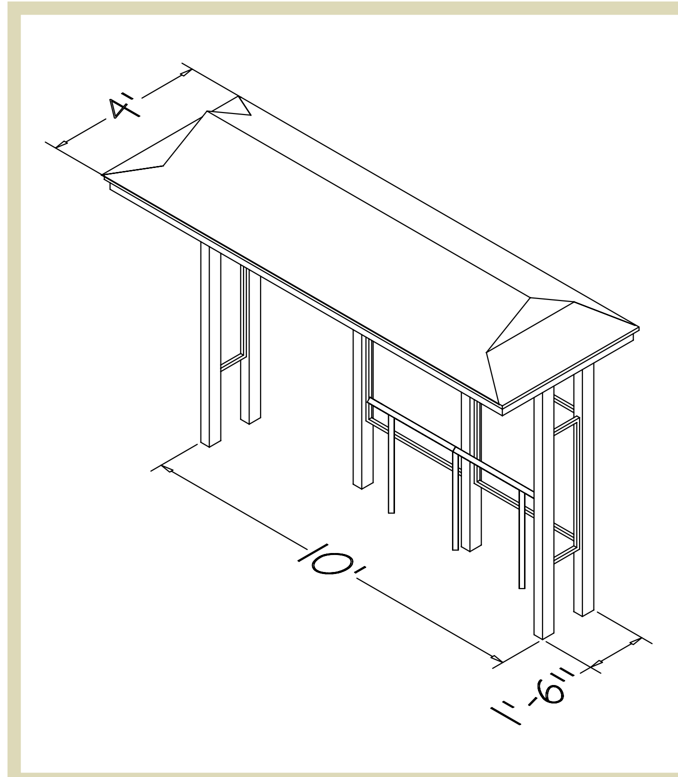


Fig 1.24 | Small bus shelter with a leaning rail but no seating shown in three dimensions. Plan view of the same bus shelter shown in Figure 1.22.

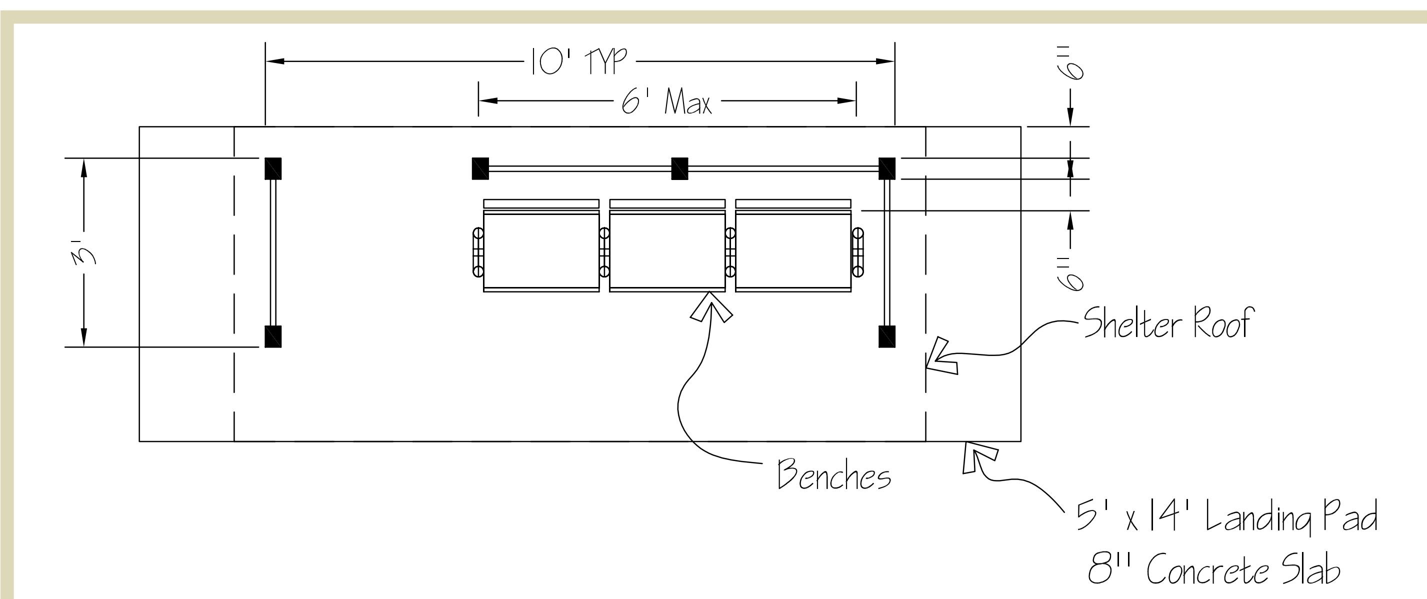


Fig 1.25 | Typical dimensions of a small bus shelter with seating.

to allow for cleaning and increased security, and a clear minimum area of 2 feet should be provided behind a shelter for maintenance. [4] Shelters should not be placed in front of store windows of adjacent properties.[2] When a shelter is located in front of a building, a minimum 12-inch space should remain between the building and the shelter to allow for cleaning.[2]

Environmental Factors

Shelter canopies should take into account sun and rain protection. Shelters should be designed to maximize shading and to encourage cooling air movement. Sun shade protection should exist on all sun-exposed sides of the shelter. Shelters oriented to the southeast and southwest may be uncomfortable for passengers if adequate shade is not provided. See Figures 1.32 and 1.33. Impervious side panel materials are poorly suited to Florida's climate. Pervious side panels allow for ventilation.

If an agency is going to employ a variety of shelter designs, the architecture of the various shelter should be indicative of nearby land uses; it should provide the rider with a means orienting themselves within the community. See Figure 1.34.

Frangibility

Bus shelters with which errant vehicles may collide in any run-off-the-road crash should incorporate breakaway mechanisms in order to be frangible or breakaway. Breakaway mechanisms include slip-bases and bases incorporating a component with low impact strength. Breakaway supports placed near intersections should be of an omni-directional design, meaning that the support is symmetrical and will break safely when struck from any direction. The criteria for breakaway supports focus on the velocity change of the impacting vehicle and the height of the stub of the support remaining after impact. As with bus signpost support, breakaway mechanisms for shelter include hardware that breaks away without slowing the vehicle by more than 15.4 feet per second (5 meters per second) and that leaves a stub with no substantial remains taller than 4 inches (100 mm) may be acceptable. [9]

Possible Materials for Use

Shelters should be designed to require low levels of maintenance. It should be easy to clean the shelters and the concrete landing pad beneath and around the shelters. In order to achieve this, the shelter should be made out of materials that are durable and vandal-resistant. Agencies should also identify opportunities for incorporating local,

continued on page 17

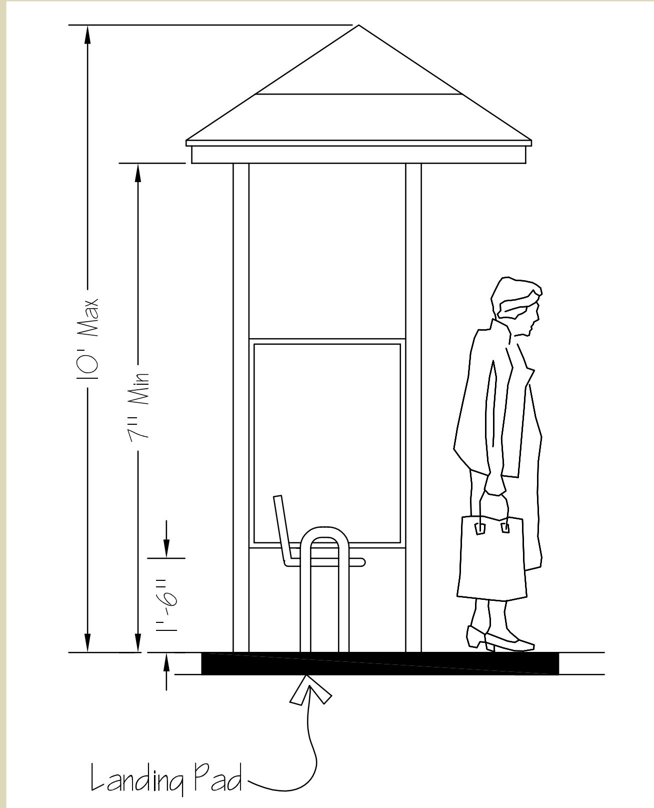


Fig 1.26 | Cross section of a small shelter with seating with typical vertical dimensions.

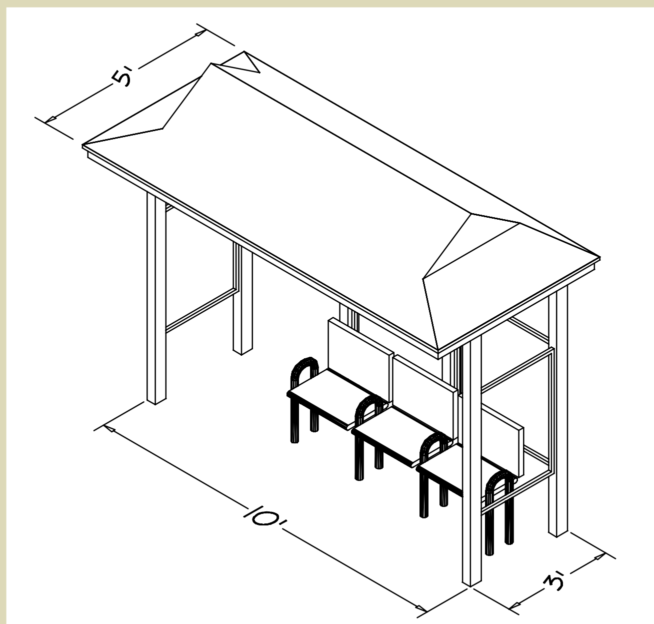


Fig 1.27 | Bus shelter with seating shown in three dimensions. Plan view of the same small bus shelter with a leaning rail shown in Figure 1.25.

CURB-SIDE GUIDELINES

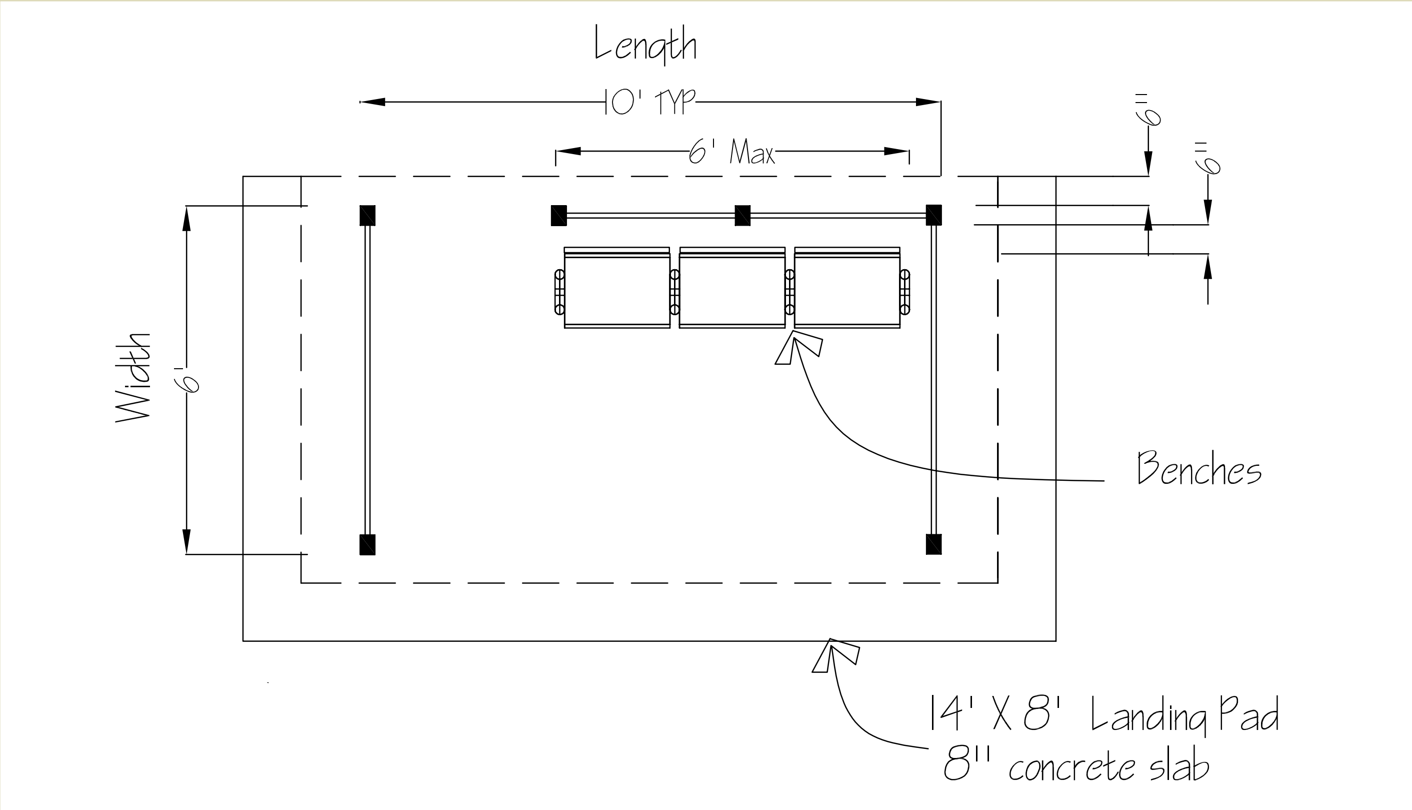


Fig 1.28 | Typical dimensions of a mid-sized bus shelter.

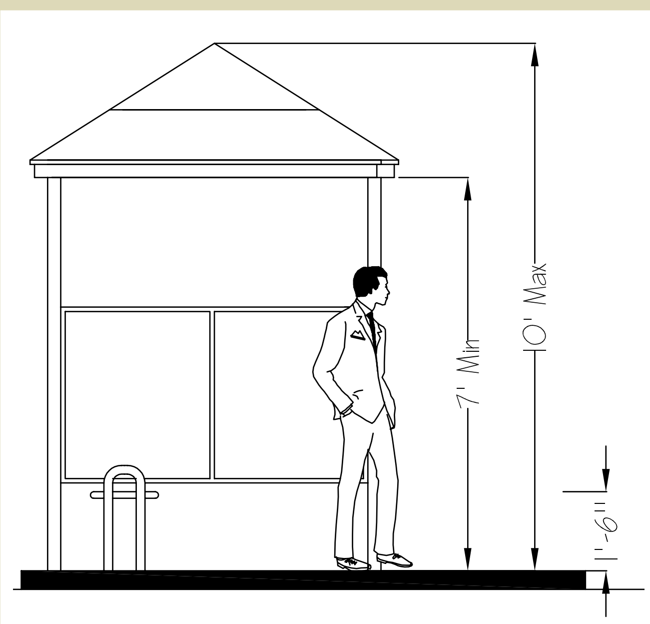


Fig 1.29 | Cross section of a mid-sized bus shelter, with typical vertical dimensions.

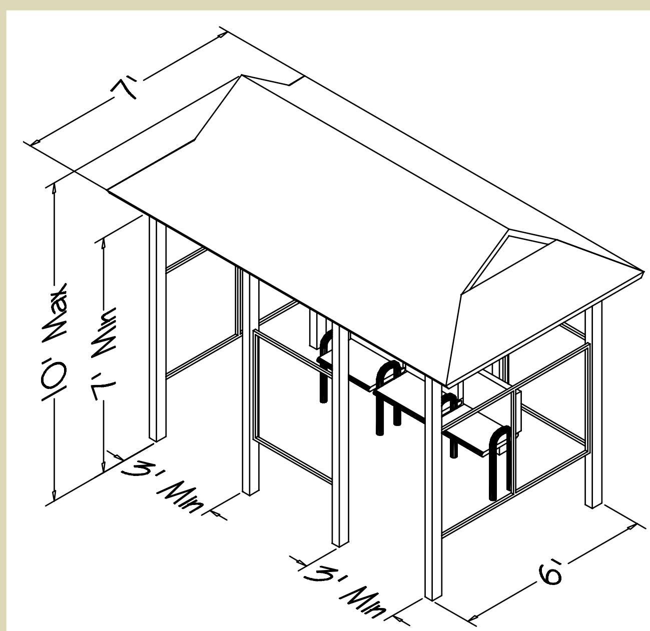


Fig 1.30 | Mid-sized bus shelter, shown in three dimensions.

CURB-SIDE GUIDELINES

recycled or renewable materials into bus shelter designs and should consider reusing existing bus shelters when possible. See Figure 1.35.

In areas where the unique character of the urban environment is particularly important (e.g., in historic districts and traditional downtowns, along the waterfront, etc.), agencies should consider soliciting local artists with a competition to modify the design and look of individual shelters. It will give the shelters local flair that the community will appreciate. With local participation comes a feeling of ownership which may reduce vandalism.

Agencies should investigate opportunities for using renewable energy technologies. See Figures 1.31, 1.35 and 1.36. Agencies should consider constructing bus passenger facilities surfaces (e.g., shelter canopy, landing pad and sidewalks) from light-colored, high-albedo materials in order to reduce heat absorption.

Fig 1.31 | A solar powered bus shelter

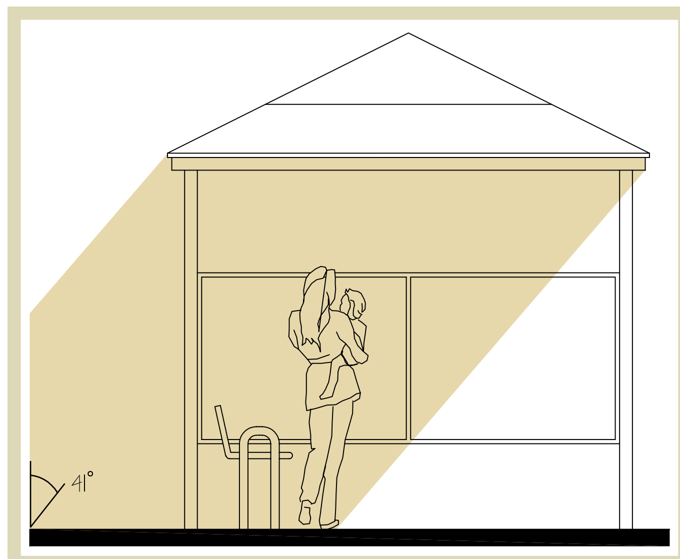


Fig 1.33 | Approximate angle (41 degree) of the sun during late afternoon peak commuting hours in midsummer in central Florida for a southwest facing bus shelter.

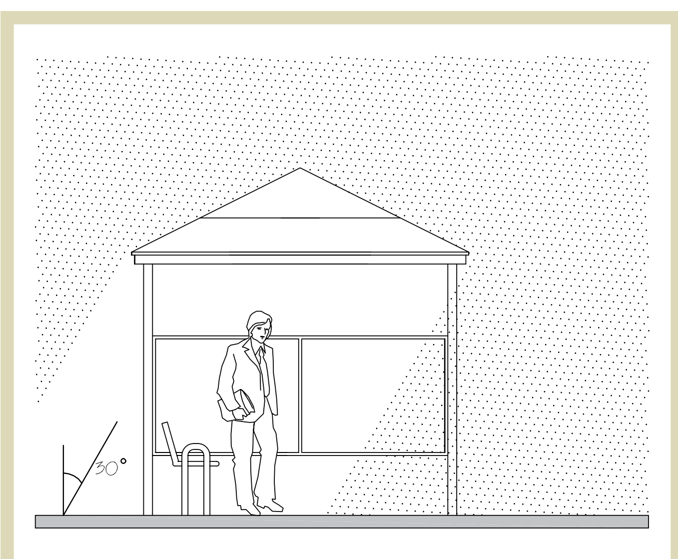


Fig 1.32 | Typical angle (30 degree) of falling rain in Florida and the related bus shelter canopy required for protection.

Fig 1.34 | A custom designed shelter at the downtown transit mall in Tampa, FL.

CURB-SIDE GUIDELINES

Fig 1.35 | A bus stop designed according to "green building" design principles.

Fig 1.36 | The solar powered bus shelter illuminates its information systems and advertising panels with power generated by photovoltaic panels, independent of the electricity grid.

1.6 Bus Stop Shelter Hurricane Wind Loads

Purpose

In areas that experience hurricanes, bus shelters are prone to damage and may become sources of flying debris if they are not adequately anchored, sized, and fabricated to resist high wind speeds. The *Florida Building Code* has minimum requirements to ensure that bus shelters in hurricane prone areas can withstand high winds and the impacts of wind-borne debris. [17] See Figure 3.17.

Design Factors

As defined in the *Florida Building Code*, bus shelters must be properly anchored to the ground. Designers must consider uplift against the force of gravity by hurricane force winds.[16] The *Florida Building Code* also indicates that bus shelters must be fabricated to withstand exterior wind pressures. In wind-borne debris regions (areas with wind speed of 120 mph and above), all exterior coverings must be made of shatter resistant materials.[17] Some Florida counties may have stricter design and construction standards than those in the *Florida Building Code*. Transit agencies should check local regulations before starting plans and designs.[17]

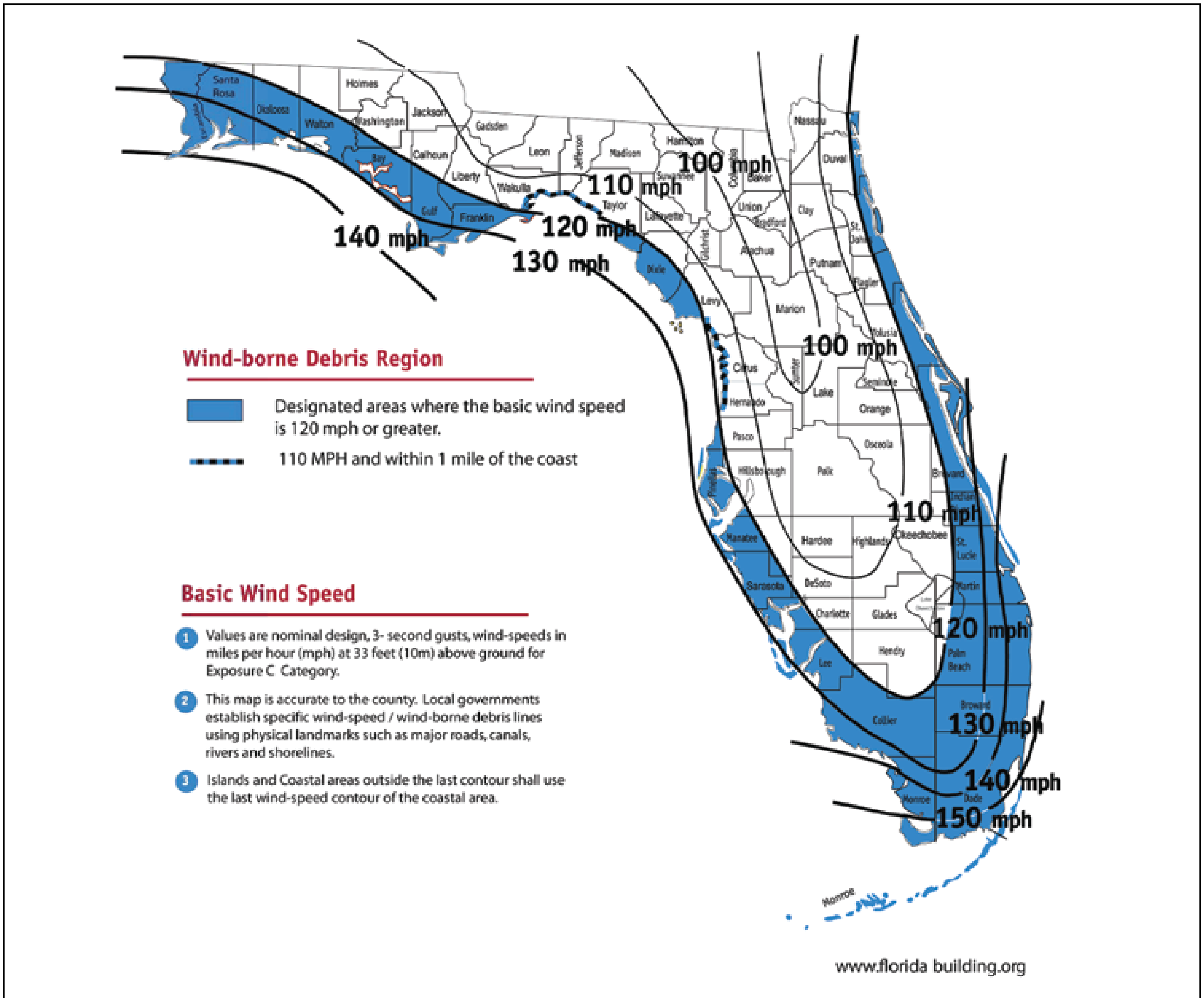


Fig 1.37 | Design wind speeds for wind loads and wind-borne debris regions used in different areas of Florida, as established by the Florida Building Code.

1.7 Bus Stop Information and Way-Finding Devices

Purpose

Providing system maps and fare information at bus passenger facilities is both useful to passengers and provides the transit agency an opportunity to educate passengers and potential passengers about bus transit services.

Location Factors

System maps and information should be provided at all bus stops with high passenger volumes and at stops that serve as transfer points between routes. Figure 1.38 shows a fixed information display in a bus shelter. Fixed maps should be sheltered from inclement weather and should be easily visible to passengers.

Design Factors

System maps highlight bus stop locations in order to assist passengers with trip planning. Shelters or stops should be designed to accommodate route or schedule information in a manner that does not reduce visibility or security.[1] Fixed information displays should have a format that is easy to change, so that schedule and route updates can be readily posted. Figures 1.38 through 1.43 depict different types of free-standing information displays.

Route maps should be easily understandable to transit passengers. Maps and schedules should adopt uniform graphic standards, sizes and color codes. Color schemes should be highly contrasting in a manner that complies with ADA guidelines.[11] See Table 1.2 on page 21. Information can be made accessible to a wider group of passengers by minimizing the use of text and incorporating pictograms and other symbols. Where text is necessary, it should be large and easy to read. Agencies should consider using multiple languages in areas with large visitor or other non-English speaking populations. Additionally, the overall design of maps and schedules should also consider the needs of sight and hearing impaired passengers. For instance for the visually-impaired, a button may be provided that gives audio information when pressed.[21]

Real-time information displays at key bus stops give patrons up to the minute information on bus arrival times and delays. Information displays should be backlit with energy efficient Light Emitting Diodes (LEDs) for nighttime visibility. Solar or wind-powered on-demand illumination is suggested for bus stop information and way finding devices.

Fig 1.38 | A system information panel incorporated into a bus shelter panel.

Fig 1.39 | A free standing transit system information panel.

Remaining figures on pages 21 and 22

Fig 1.40 | One of several devices used to display route information for patrons.

Fig 1.41 | One of several devices used to display route information.

Table 1.2 | Acceptable color combinations based on contrast

	Beige	White	Dark Grey	Black	Brown	Pink	Purple	Green	Orange	Blue	Yellow	Red
Red	Acceptable	Acceptable									Acceptable	
Yellow			Acceptable	Acceptable	Acceptable		Acceptable	Acceptable		Acceptable		
Blue	Acceptable	Acceptable										
Orange				Acceptable								
Green	Acceptable	Acceptable										
Purple	Acceptable	Acceptable										
Pink												
Brown	Acceptable	Acceptable										
Black	Acceptable	Acceptable										
Dark Grey		Acceptable										
White												
Beige												

Acceptable (70% contrast or greater) (grey cells)   Do not use (white cells)

Source: Transit Cooperative Research Program (TCRP) Report 12, *Guidelines for Transit Facility Signing and Graphics 1996.* [18]

Fig 1.42 | A digital reader board displaying real-time information about bus arrivals and departures at an inter-modal facility.

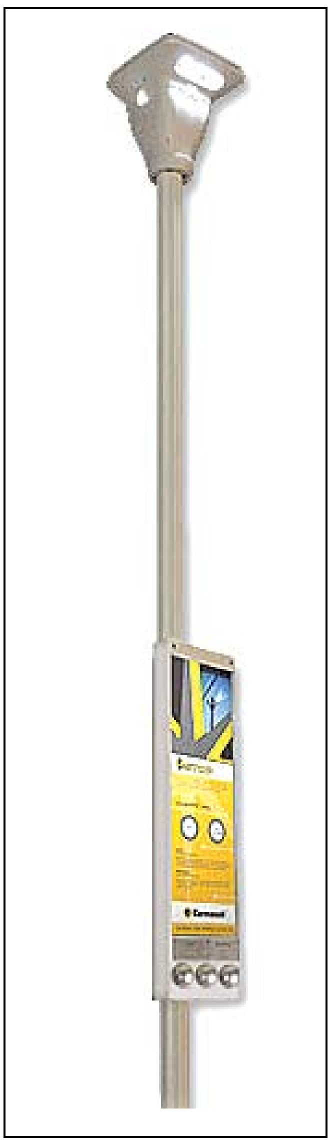


Fig 1.43 | This self-contained, solar-powered transit stop provides bus flagging capability, security lighting and on-demand schedule illumination.

1.8 Bus Stop Shelter Lighting

Purpose

The purpose of lighting at facilities is to enhance the safety of patrons and to illuminate passenger information and advertising where applicable. Adequate lighting enables the bus driver to see waiting passengers and to approach and depart from a bus stops safely.

Location Factors

Bus passenger facilities along routes that offer nighttime or after-dark services should have optimum levels of lighting incorporated in their design. Adequate lighting greatly influences actual safety and passengers' perception of safety, especially at off-street facilities. Local transit stops without shelter should be located within 30 feet of an overhead light source.

Design Factors

Light fixtures should be visually non-obtrusive so as not to attract the attention of vandals. Light should be concentrated at the shelter or the stop while minimizing overthrow of glare onto the street. Off-site lighting and night sky light pollution can be avoided through proper lighting direction and lamp shielding. For road lighting installations, light near and above the horizon should be minimized to reduce glare and visual intrusion. See Figure 1.44. Specifically designed lighting equipment may be used to minimize this upward spread of light.[17] Illumination should also be achieved to prevent harsh shadows which could pose a security hazard.[1]

If a bus shelter is provided, the level of lighting at the shelter pavement should be between 2.0 and 5.0 foot-candles.[1,3] The lower end of this range may be as effective for enhancing safety as the higher end, and care should be taken to avoid "over lighting" or "spotlighting " the shelter which may make it difficult for patrons to observe their surroundings. If pedestrian paths adjacent to transit stops are illuminated, the height of the light fixture should be appropriately scaled.

Possible Materials for Use

The fixtures should be vandal-resistant and durable. Lamp compartment and electrical access areas should be secured with a recessed hex head screw or equal means. If possible, electrical services should be low voltage to reduce the risk of electrical shock. Cutoff luminaries, low–reflectance surfaces and low-angle spotlights can be employed to reduce light pollution.[3]

CURB-SIDE GUIDELINES

The use of solar technologies for lighting provides many benefits. At the very least, agencies should consider employing solar lighting in areas where there is currently no utility service or as a temporary measure until utilities can be established for the shelter or stop. Portable solar lighting may be used when transit service is detoured during construction projects. See Figures 1.45 and 1.46. Other technologies, including LEDs, are also very energy-efficient and can provide agencies with cost savings as a result.

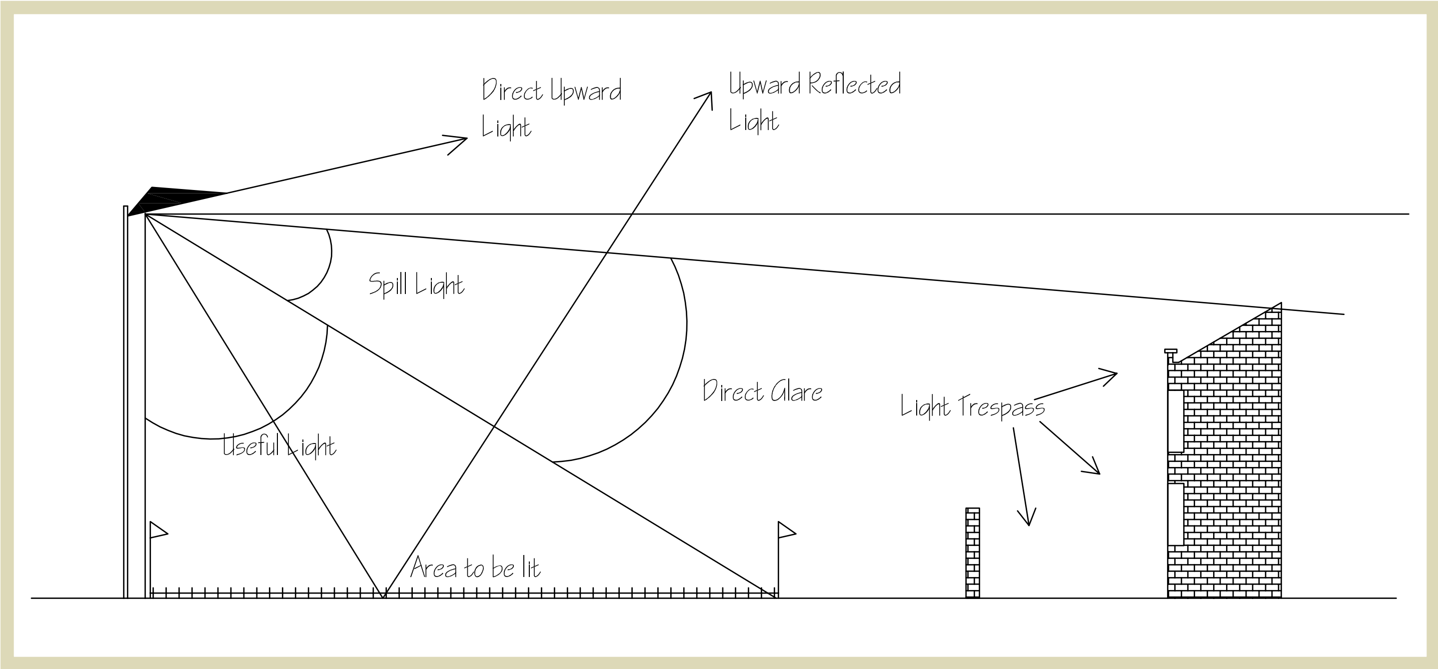


Fig 1.44 | Light pollution is wasteful of energy resources and causes dangerous glare to spread into the right of way.

Fig 1.45 | A solar powered bus shelter illuminates its information systems and advertising panels.

Fig 1.46 | A solar-powered safety light offers riders an illuminated area.

1.9 Landscaping

Purpose

Landscaping at bus stops promotes transit ridership by enhancing its image. Landscaping also contributes to the safety, security, and comfort of passengers, reducing heat islands (thermal gradient differences between developed and undeveloped areas) and minimizing the facility's impact on the microclimate. Transit agencies should limit or eliminate the use of potable water for landscape irrigation in order to conserve potable water resources.

Accessibility Considerations

A properly-landscaped bus stop can be an oasis of calm and beauty in a "concrete jungle." Care, however, must be taken to prevent landscaping from obstructing views and thus presenting both accessibility and safety hazards. Trees can provide transit patrons with a low-cost shelter from wind and rain and can, together with other landscaping elements, make a bus stop more inviting, both visually and physically.

Location Factors

Landscaping should be located so that it buffers waiting passengers from traffic and provides them some degree of protection from the weather. Landscaping should not block the view of patrons from outside the bus stop.

Design Factors

In order to ease maintenance and ensure longevity, native plants and wild flowers should be used. In landscapes installed in coastal areas, plants should also be salt tolerant. Exotic plants should be avoided. All landscaping along FDOT rights of way must comply with standards in the latest editions of the *Plans Preparation Manual* (PPM)[10], the *Florida Highway Landscape Guide*, [19] and the *FDOT Design Standards,* Indices 546 and 700. [5,9,20] Transit agencies should coordinate landscape installation with the state or local agency assigned the responsibility of maintaining the landscaping.

Efforts should be made to shade all constructed surfaces. Shade trees should be high branching so that they do not interfere with breezes or sightlines. Trees should be pruned to allow 12 feet of vertical clearance from sidewalks or transit stop pads. Low vegetation should not block air movement beneath the shelter. In order to maintain a defensible space and preserves visibility, the height of groundcover plants should not exceed 2 feet and the height of shrubs should not exceed 3 feet at maturity. See Figure 1.47. When river-rock and other masonry materials are used, the material should be grouted to prevent removal by hand. River-rock should be grouted so that only one-third of the rock is exposed above ground.

Whenever possible, agencies should minimize the use of potable water in landscape irrigation through the use of high efficiency irrigation systems, low-water use native plants, or the reuse of storm water or gray water for irrigation. See Figure 1.48. Recycled materials like plastic or rubber may be used for sidewalk installed near trees to allow water to seep in between panel seams. They also can be easily relocated when tree roots surface and avoid the maintenance problems associated with concrete.

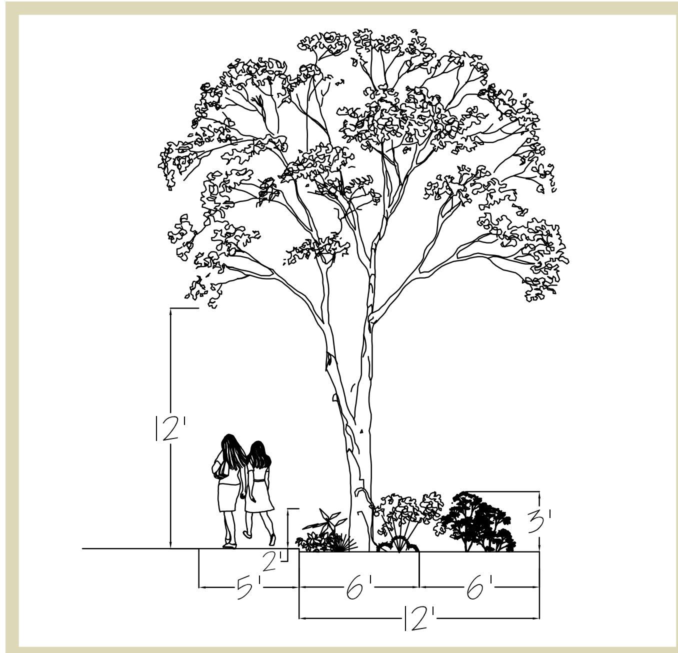


Fig 1.47 | Appropriate locations and vertical dimensions for landscaping adjacent to a sidewalk.

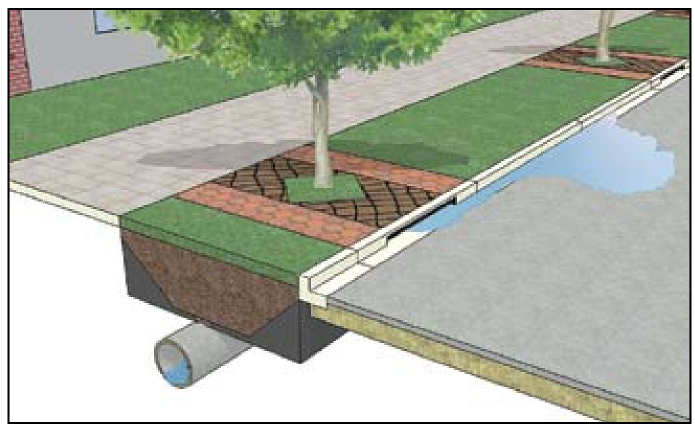


Fig 1.48 | Manufactured tree box filters are effective in controlling storm water runoff.

1.10 Bus Stop Leaning Rails

Purpose

A number of passengers prefer leaning to sitting while waiting at bus stops. Leaning rails also provide a place to shelve objects passengers may carry. Agencies that have placed leaning rails at their bus shelters claim that they are inexpensive to install and are heavily used by passengers.[18]

Location Factors

Leaning rails can be mounted on shelter walls, be free standing or can be built into the landscape. See Figures 1.49 and 1.50.

Design Factors

Freestanding leaning rails should be between 27 and 42 inches in height. See Figure 1.51.[18] Leaning rails attached to bus shelters should be no more than 27 inches in height. Leaning rails should have a round as opposed to square or rectangular section, with a diameter of 1 ½ to 2 ½ inches.[18]

Leaning rails can be sheltered or unsheltered. When unsheltered, landscaping should be provided to shield patrons from the weather.

Possible Materials for Use

Leaning rails should be constructed of anodized aluminum in order to enhance their durability.[18]

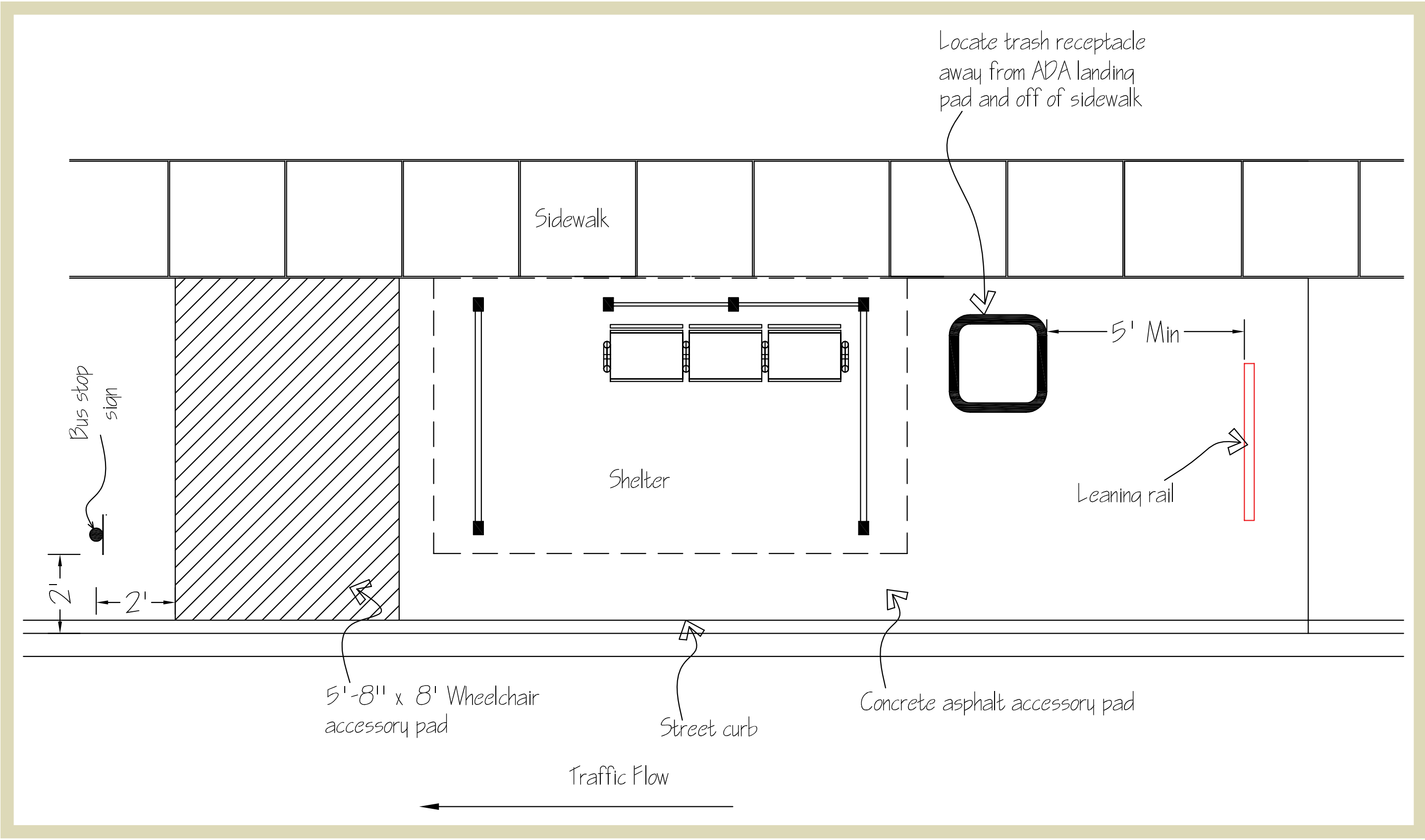


Fig 1.49 | Correct location of a leaning rail located outside a bus stop shelter.

CURB-SIDE GUIDELINES

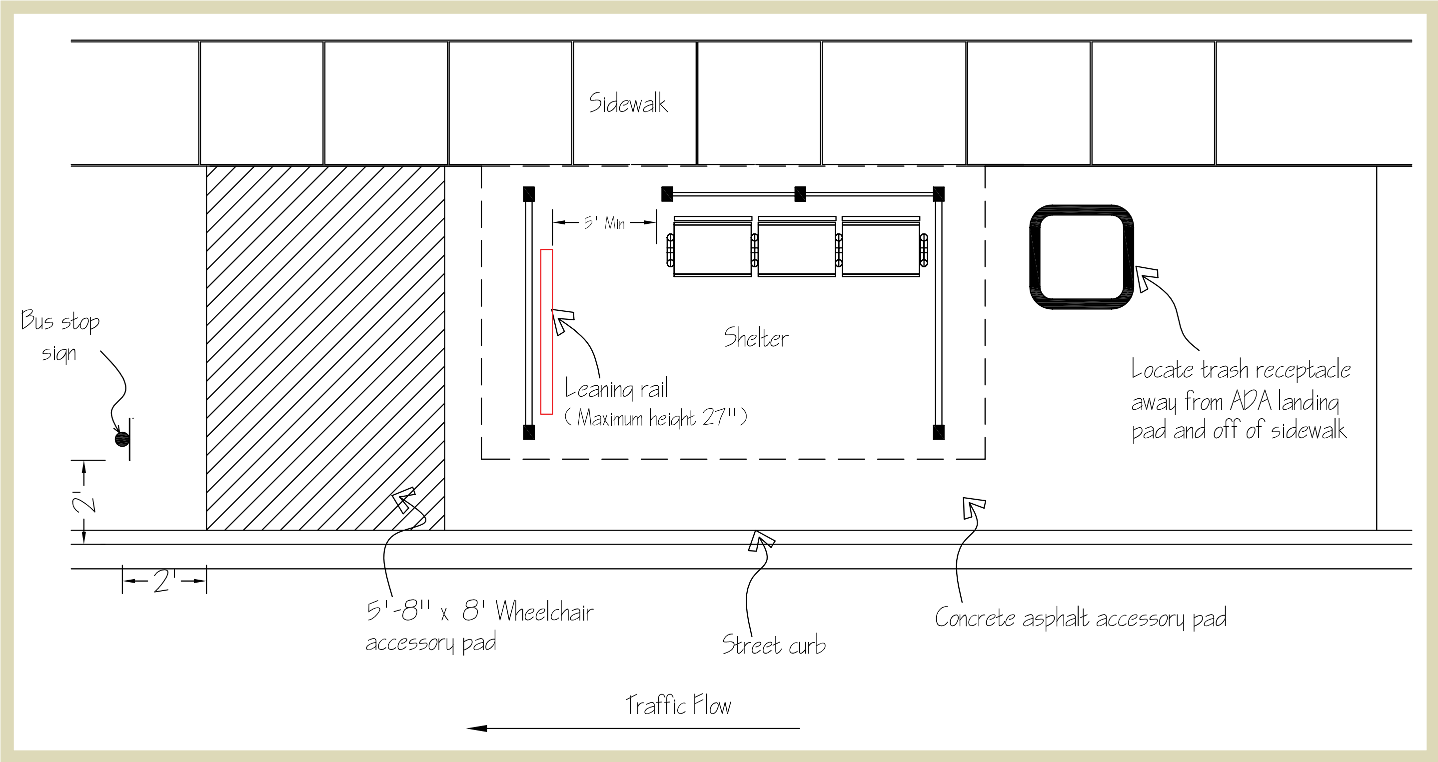


Fig 1.50 | Correct location of a leaning rail located inside a bus stop shelter.

Fig 1.51 | Correct height dimensions for bus stop leaning rails.

1.11 Bus Stop Trash Receptacles

Purpose

Trash receptacles should be treated as normal parts of most bus passenger facilities. Maintenance of trash receptacles and trash pick-up are important considerations when receptacles are provided.

Accessibility Considerations

Trash receptacles should be placed so as not to interfere with the accessibility of the site or with passage along any adjacent sidewalks. Additionally, transit agencies should choose receptacles that can be used by those with difficulty manipulating objects with their hands, such as those with arthritis or other disabilities.

Location Factors

Trash receptacles shall not be placed on wheelchair landing pads as outlined below to comply with the ADA. See Figures 1.52 and 1.53. Trash receptacles should be placed at least 4 feet back from the face of the curb. Trash receptacles should not impede pedestrian circulation in and around the transit stop.

Design Factors

The receptacles should be anchored to the pavement or landing pad in order to prevent unauthorized movement.[2] They may also be attached to the side of the shelter as a pre-fabricated feature. The receptacles should be placed so that they do not obstruct a driver's vision while turning. See Figure 1.54. If possible, trash receptacles should not be placed in direct sunlight. Direct sunlight exposure may result in odors.[2] If possible, trash receptacle designs should coordinate with benches and other furniture at the bus stop or transfer center in regard to material and finish color. If vandalism is a concern, agencies should consider trash receptacles with lockable lids or other anti-vandal features. See Figure 1.55. Trash receptacles could be subject to storing explosive devices. If the bus stop or transfer center is going to be used by a large number of people, the transit agency should consider placing explosive containment trash receptacles in the facility.

Possible Materials for Use

Trash receptacles should be made out of steel with a powder-coat paint finish. Steel receptacles are capable of handling a certain amount of explosives; agencies should ensure that container itself does not become shrapnel during an explosion.

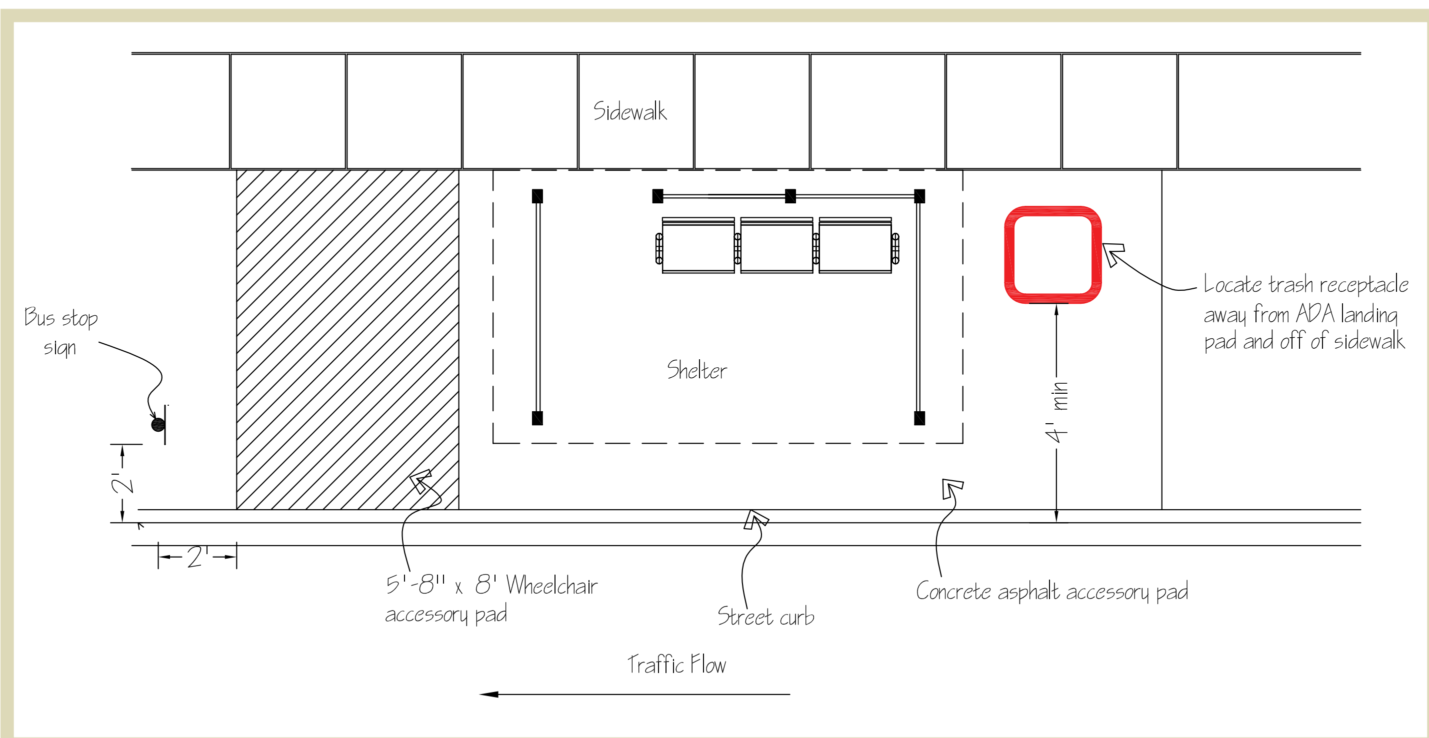


Fig 1.52 | Correct location of bus stop trash receptacle at a curbside sheltered bus stop.

CURB-SIDE GUIDELINES

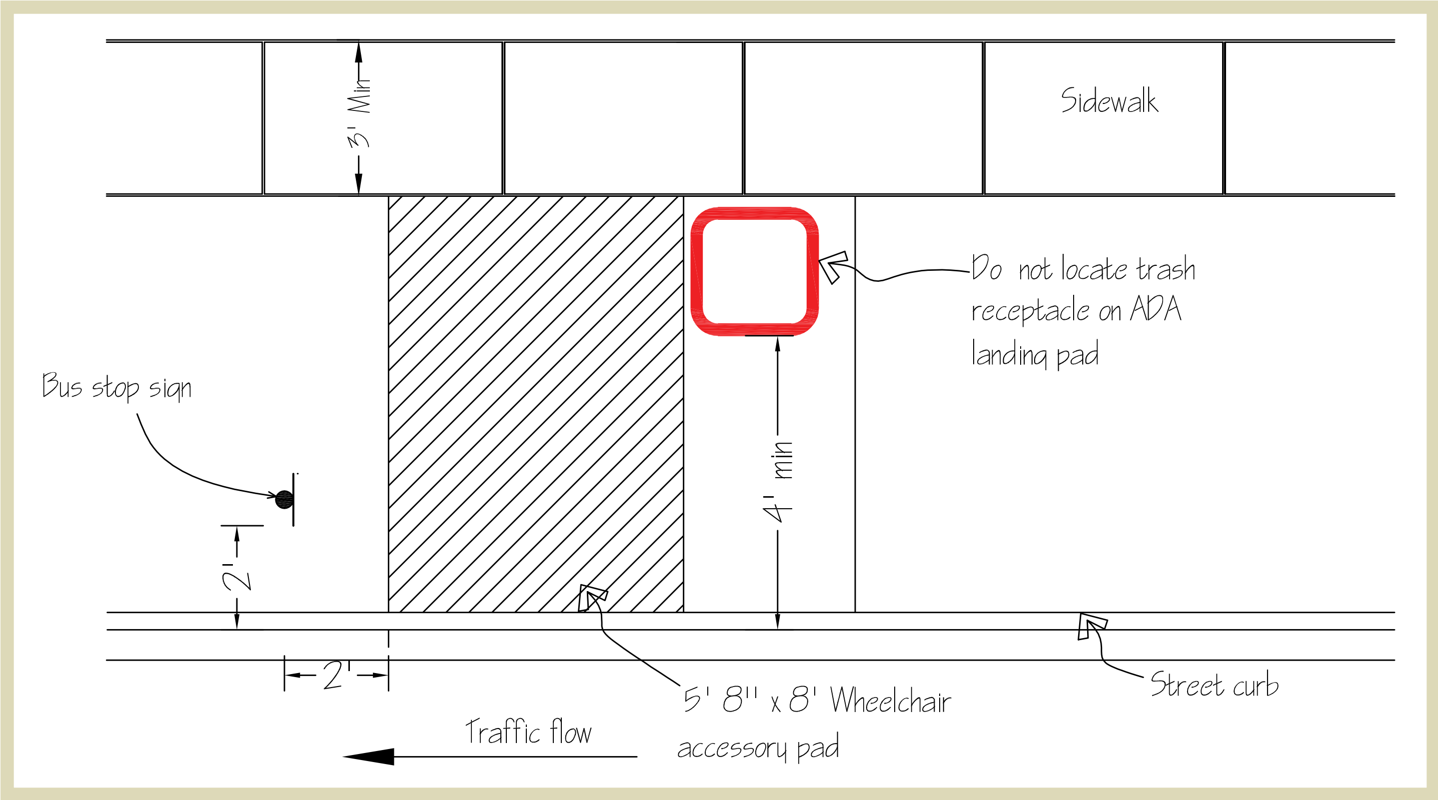


Fig 1.53 | Correct location of trash stop receptacle at a curbside bus stop without shelter.

Fig 1.54 | Correct location of a trash receptacle at a bus stop in Orange County, Florida.

Fig 1.55 | Blast-resistant and blast-mitigating trash receptacle.

1.12 Bollards

Purpose

Bollards separate pedestrian and vehicular areas in order to protect people, buildings and site elements. They are sometimes illuminated in order to provide path lighting. They are especially important in areas where errant buses may threaten waiting passengers or pedestrians.

Accessibility Considerations

Like other elements, such as trash receptacles, benches and shelters, bollards must not interfere with the accessibility of pedestrian routes, either around or to and from bus stops.

Location Factors

Bollards should be installed at bus parking spaces where errant buses may "jump" the curb and collide with pedestrians, though the chance of such an event occurring at bus stopping locations, i.e., bus stops and gates at transit stations, is generally low. When used to separate pedestrians and vehicles, bollards should be spaced sufficiently close to clearly define the desired separation of space and to prevent intrusion of automobiles but not so close that passage of wheelchairs is impeded. See Figure 1.56.

Design Factors

Bollards may be pre-manufactured or custom designed in a style that compliments the bus stop architecture and other site furniture. Bollards should be tall enough to discourage vehicle access (standard height of 24 to 48 inches) and spaced far enough apart to allow bicycle, wheelchair, and pedestrian access. [21] Additionally, when placing bollards in pedestrian areas one should give consideration to marking them with contrasting color bands (e.g., white or red on black bollards) or retro-reflective squares or panels.

A single bollard should be designed to stop a 36,000-pound vehicle traveling at 4 mph. [22] At bus parking areas, three bollards of concrete-filled, 8-inch diameter, heavy-wall steel pipe should be located ahead of the bus. The pipes should be set vertically in a 6-foot, auger-drilled hole and retained by reinforced concrete.[22] See Figures 1.57 and 1.58. They should be spaced at 5 feet on center in heavily trafficked location to protect pedestrian-only zones.

continued on page 30

Fig 1.56 | Planters and bollards to separate pedestrian and vehicular areas.

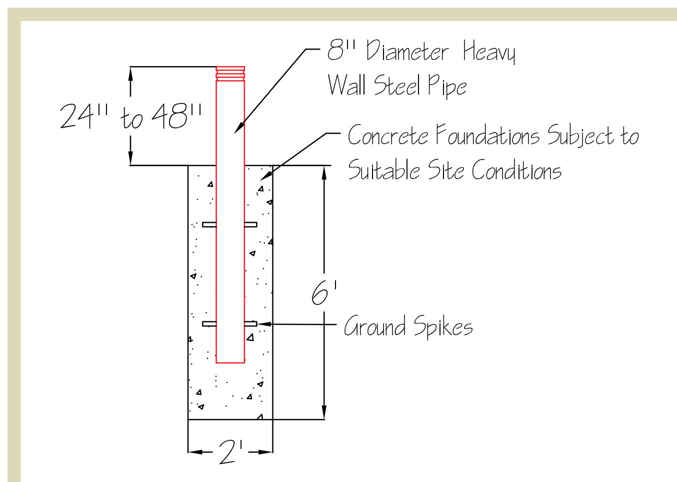


Fig 1.57 | Detailed section of a typical bollard.

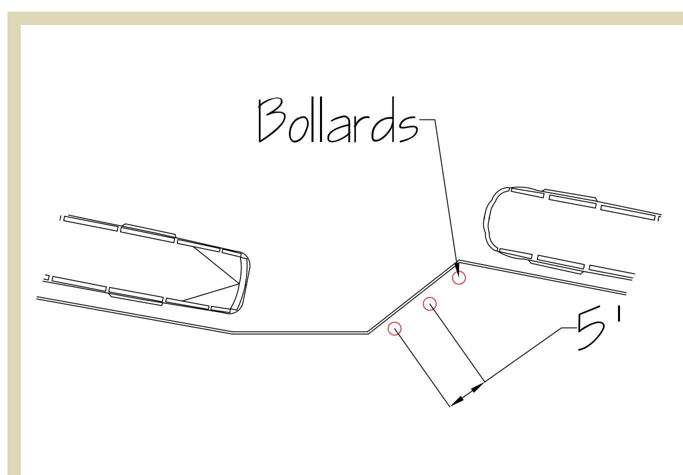


Fig 1.58 | Plan showing bollards in an off-street half saw-tooth bus bay.

Possible Materials for Use

Bollards should be solid for durability and stability. They can either be permanently installed by embedding or may be made removable through the introduction of an in-ground sleeve or receiver, in order to provide temporary service and emergency access.[21] Some bollards can be equipped to accommodate chains (e.g., eyebolts). If chain barriers are used in conjunction with bollards, care should be taken to assure that the chain is easily visible and not a hazard.

Fig 1.59 | A typical bike rack for multiple bikes.

Fig 1.60 | Multiple bikes secured at multiple single bike racks.

1.13 Bike Racks at Bus Shelters

Purpose

Transit agencies are increasingly recognizing the needs of the inter-modal bicyclist-passenger. A study by Center of Urban Transportation Research (CUTR) has found that a significant proportion of transit riders are so-called "bike-on-bus", or BOB, users.[23] While an increasing number of buses accommodate bicycles with racks mounted at the front of the bus, less has been done to accommodate bicycles at bus passenger facilities. Some bicycle storage facilities offer more security to bike owners than others. For instance, inverted "U" racks provide more security for bicycles than the traditional "comb" bicycle racks. See Figures 1.59 and 1.60. In the CUTR survey of BOB users, it was found that over 60 percent of these commuters bicycle one mile or more to access transit, significantly expanding bus transit service area.[23]

Accessibility Considerations

Although BOB commuters effectively expand the bus transit service area by making a portion of their trip by bike, providing bike commuters better access to buses must be accomplished in a manner that maintains full access for other patrons. Bike racks should not be placed on ADA-mandated landing pads.[4] Like other street furniture, bike racks should not be placed so as to obstruct pedestrian traffic either on the sidewalk or to and from the bus stop landing pad.

Location Factors

Many BOB users only need their bicycle on one end of the transit trip, typically from home to transit stop and vice versa. Bike racks should be placed at bus stops along routes where bus-mounted bike racks are at capacity and cannot accommodate more bike passengers without causing those passengers to wait for the next bus. Along routes where bus-mounted bike racks are at capacity, transit agencies should consider installing three-bike capacity racks and allowing patrons to bring bicycles on board (when the wheelchair area is vacant). At park and ride lots, it may be appropriate to add a bike and ride section to encourage use in a more secure area.

Bicycle storage areas should be placed in spaces that are physically and visually accessible. Placement along heavily trafficked streets and walkways protects bicycles from theft and vandalism. Bike racks and lockers should never be located in the corner of a parking garage or in other areas with low visibility. Where bus shelter pads are provided, bicycle parking areas should be provided on the upstream side of the pad. Where possible, bicycle racks should be kept underneath a covered area to protect the bikes from exposure to the weather. See Figure 1.61. To avoid unnecessary water damage to bicycles, bike racks should not be placed near sprinkling systems.

CURB-SIDE GUIDELINES

Design Factors

Association of Pedestrian and Bicycle Professionals guidelines mention that bike racks should support bikes by their frames at two points (as opposed to supporting them by the wheel as common in comb and toast racks).[24] An inverted "U" is a simple effective design to do this. See Figures 1.62 and 1.63. Bike racks should provide 48-inch aisles, measured from tip to tip of bike tires across the space between racks or between the tip of the tire and an adjacent obstacle. One person should be able to walk one bike through the aisle. Seventy-two inches of depth (6 feet) should be allowed for each row of parked bicycles. Racks should be located no less than 24 inches from walls. Inverted "U" racks should be placed no less than 36 inches apart widthwise.[24] If the bike rack is covered, it should be designed so that explosive devices cannot be hidden in the area.

Fig 1.61 | Sheltered bike racks protect bikes from inclement weather.

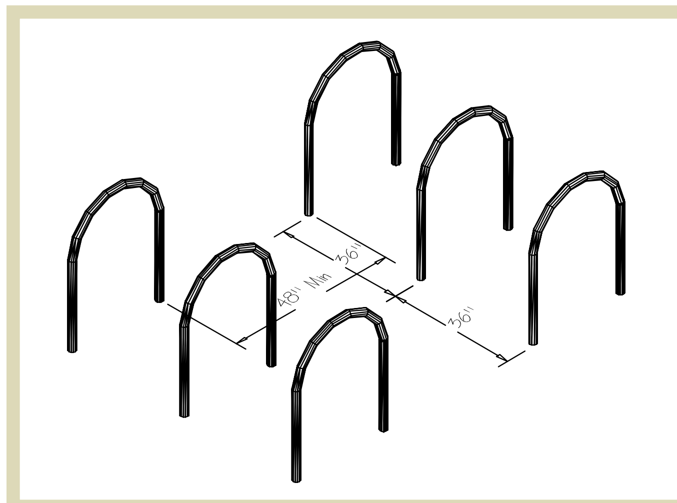


Fig 1.63 | Spacing for inverted "U" bike racks.

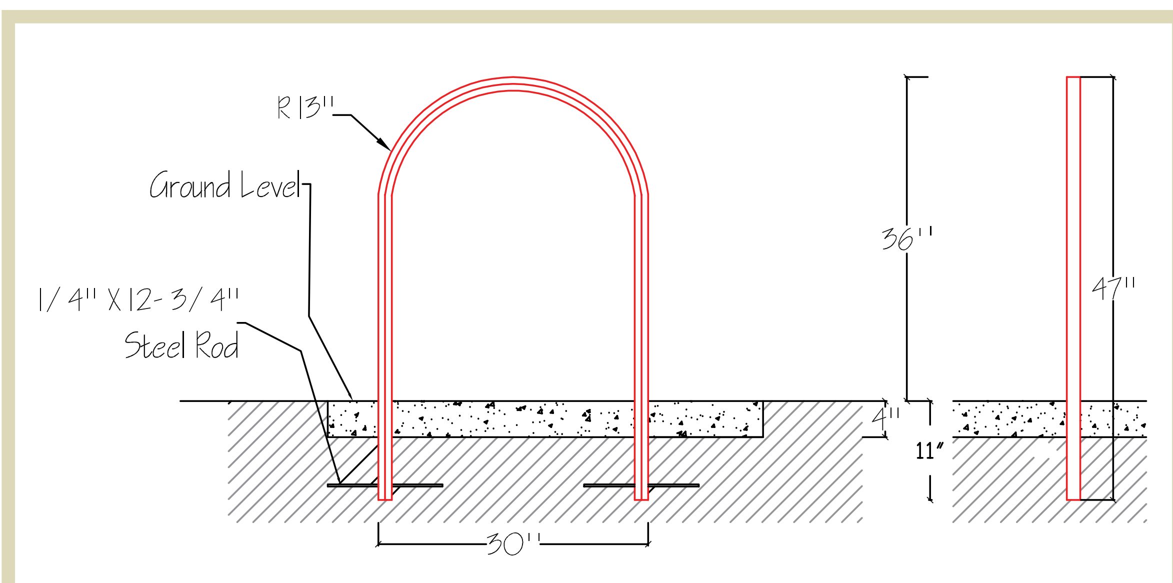


Fig 1.62 | Critical dimensions for installing an inverted "U" bike rack.

1.14 Shopping Cart Storage at Bus Shelters

Purpose

Bus stops usually do not have facilities for shopping cart storage but they are a convenience at stops near retail centers. Abandoned shopping carts are a nuisance to shopping center managers and a hazard to pedestrians and vehicles. The transit agency should make arrangements with shopping center managers to have the cart corrals periodically emptied.

Location Factors

Shopping cart storage should be provided at bus stops adjacent to retail centers. It should be located at least 4 feet back from the face of curb and should remain clear of sidewalks. To maintain accessibility, bus stop landing pads may not be used for shopping cart storage. See Figure 1.64.

Design Factors

The frames for shopping cart corrals should be constructed from steel pipe. Surface mounted flanges should be constructed from flat steel bars. Figure 1.65 provides dimensions for a typical shopping cart corral.

Possible Materials for Use

Standard hot-dipped galvanized steel pipes should be used, to resist corrosion and rust.

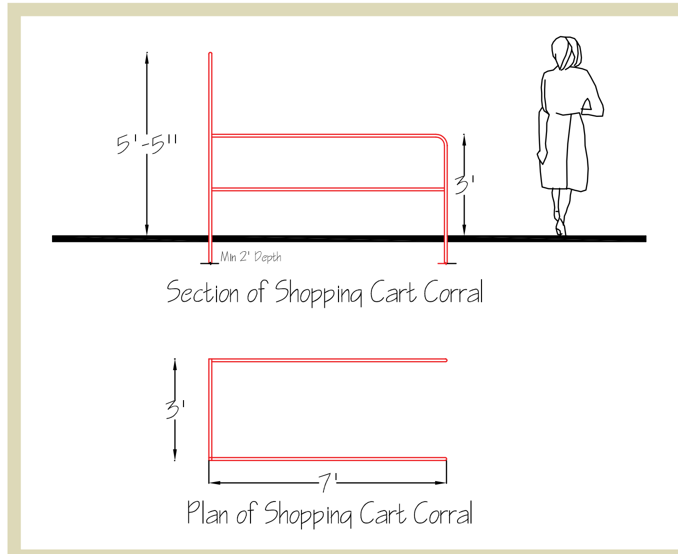


Fig 1.65 | Typical vertical and horizontal dimensions for shopping cart corrals.

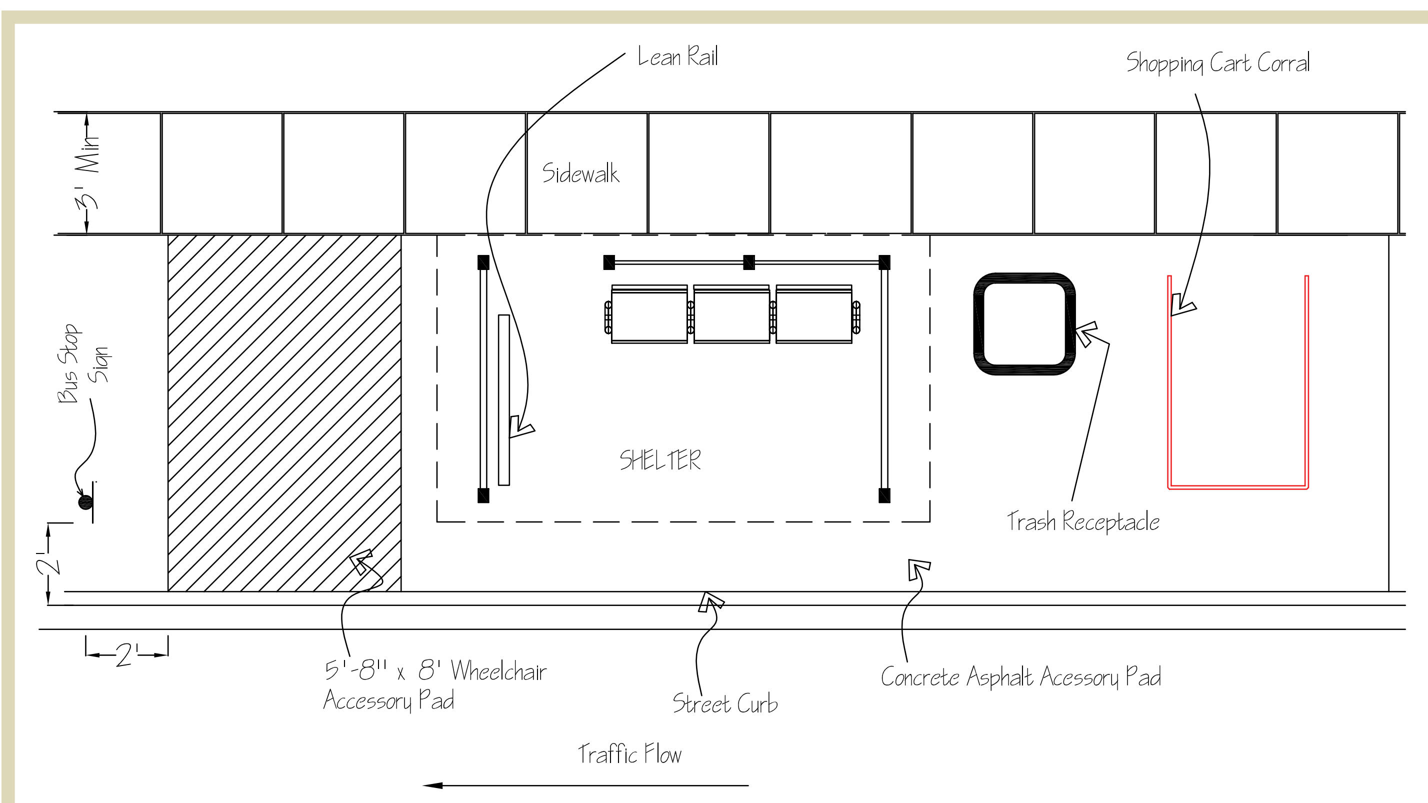


Fig 1.64 | Appropriate location of a shopping cart corral at a sheltered bus stop.

1.15 Public Telephones

Purpose

Telephones at bus stops offer many potential benefits for bus patrons, including the ability to make personal and emergency calls while waiting for the bus. [1]

Location Factors

Where public telephones are provided, at least one telephone should be accessible by persons using wheelchairs. It must be located so that the receiver, coin slot and control are no more than 48 inches above the floor.[1, 4] The phone and the bus stop waiting area should be separated by a short distance when possible.[1]

Design Factors

Public telephones should be fixed on a clear floor or ground space at least 30 inches by 48 inches, not impeded by bases, enclosures, and fixed seats, and allows either a forward or parallel approach by a person using a wheelchair.[1] The highest operable part of the telephone and telephone books should be located within the reach of wheelchair users. [1,4] See Figure 1.66. The length of cord should be a minimum of 29 inches.[1] Phones should be hearing aid compatible and volume control equipped. [1, 4] They should be limited to outward calls only. [1]

Fig 1.66 | Wheelchair users should be able to access the operable parts of public telephone.

1.16 Police Call Box

Purpose

Police call boxes establish a safe environment, especially at stops with fewer patrons as well as those located in suburban and rural areas. They require less maintenance, do not encourage loitering by non-bus patrons, and can be solar powered.[1] See Figure 1.67.

Location Factors

The call box must be located in such a place that it does not obstruct access to the stop. [1]

Design Factors

Call boxes may be identified instantly in the event of an emergency and must be suitable for users with hearing impairments and those using a wheelchair.[1]

Fig 1.67 | A typical solar powered emergency call box.

1.17 Vending Machines

Purpose

Vending machines can provide passengers with reading materials while they wait for the bus. See figure 1.68.[1]

Location Factors

Newsprint companies usually seek high profile sites to locate their machines. [1] Transit agencies have limited regulatory authority concerning the placement of vending machines.[1] However, vending machines, newspaper boxes and other street furniture cannot reduce clear spaces required by ADA Accessibility Guidelines (ADAAG).[1,4] ADA mobility guidelines should be followed for improved site circulation. [2]

Design Factors

Vending machines should be anchored to the ground to reduce vandalism and placed at least 4 feet back from the face of the curb. [1]

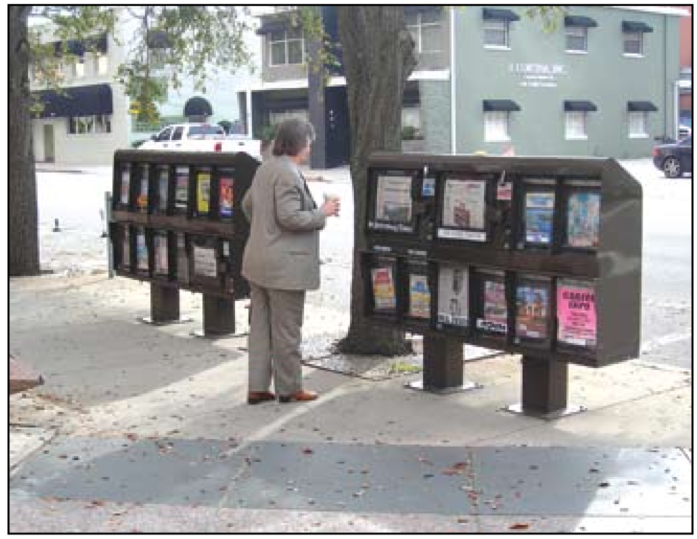


Fig 1.68 | A typical vending rack.

Text References

Endnotes

1 National Easter Seal Society, Project ACTION. (2005). *Toolkit for the assessment of bus stop accessibility and safety.* Washington, DC: Easter Seals Project ACTION.

2 Hillsborough Area Regional Transit Authority. (1995). *Transit friendly planning and design handbook and technical manual.* Tampa, FL: Hillsborough Area Regional Transit.

3 Transportation Research Board. (1996). Transit cooperative research program report 100, *Transit capacity and quality of service manual.* Washington, DC: National Research Council.

4 U.S. Architectural and Transportation Barriers Compliance Board (Access Board). (2002, September). *Americans with Disabilities Act: Accessibility guidelines for buildings and facilities (*ADAAG), Section 10 Transportation facilities. Retrieved June 3, 2008, from http://www.access-oard.gov/adaag/html/adaag.htm#tranfac

5 Florida Department of Transportation. (2006a). *Design standards*, Index No. 700. Retrieved June 3, 2008, from http://www.dot.state.fl.us/rddesign/rd/RTDS/06/2006Standards-700.htm

6 Florida Department of Transportation. (2006b). *Design standards*, Index No. 17302. Retrieved June 3, 2008, from http://www.dot.state.fl.us/rddesign/rd/RTDS/06/17302.pdf

7 Federal Highway Administration, U.S. Department of Transportation. (2004, November). *Manual on Uniform Traffic Control Devices* (MUTCD). Retrieved June 3, 2008, from http://mutcd.fhwa.dot.gov/HTM/2003r1/part2/part2a.htm#section2A19

Federal Highway Administration, U.S. Department of Transportation. (2007, December). *Manual on Uniform Traffic Control Devices* (MUTCD), Section 2A.19 Lateral Offset. Retrieved June 3, 2008, from http://mutcd.fhwa.dot.gov/htm/2003r1r2/part2/part2a.htm

8 Florida Department of Transportation Districts One and Seven. (2007). *Transit facility handbook.* Retrieved June 10, 2008, from http://www.dot.state.fl.us/transit/Pages/FDOT_D1_D7_Transit_Facility_Handbook.pdf

9 American Association of State Highway and Transportation Officials. (2006). *Standard specifications for structural supports for highway signs, luminaires, and traffic signals* (4th ed.). Washington, DC: American Association of State Highway and Transportation Officials.

10 Florida Department of Transportation. (2006, January). *Plans preparation manual: Plans preparation and assembly* (Topic #625-000-008). Retrieved June 3, 2008, from http://www.dot.state.fl.us/rddesign/PPMManual/2006/Volume2/Volume2Text.pdf

11 Text retrieved on January 12,2004 from http://www.carmanah.com/

12 Fla. Admin. Code Ann. r. 14-20.0032 (2008).

13 Sacramento Regional Transit District. (1987). *Design guidelines for bus and light rail facilities*. Sacramento, CA: Regional District.

14 District Office of Modal Development. (2002). *District 4 transit facility guidelines.* Ft. Lauderdale, FL: Florida Department of Transportation.

15 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida mobility design manual.* Orlando, FL: Central Florida Regional Transportation Authority. Revised by LYNX, 2000

16 Science Applications International Corporation. (1999). *Transit friendly design guidelines.* St. Petersburg, FL: Pinellas Suncoast Transit Authority.

17 To view final drafts of the 2007 Florida building codes on-line and to order copies, see the Florida Department of Community Affairs web page, Building Code Information System, at http://www.floridabuilding.org/BCISOld/bc/default.asp

18 Kittelson & Associates. (2003). *Transit capacity and quality of service manual* (2nd ed.). Washington, DC: Transportation Research Board.

19 Lott, G.G., & P. Graham, Jr. (1995). *Florida highway landscape guide.* Retrieved June 3, 2008, from http://www.dot.state.fl.us/emo/beauty/landscap.pdf

20 Florida Department of Transportation. (2006c). *Design standards,* Index No. 546. Retrieved June 3, 2008, from http://www.dot.state.fl.us/rddesign/rd/RTDS/06/546.pdf

21 Public realm guidelines. (n.d.) Retrieved February 26, 2007, from http://www.townofcary.org/depts/dsdept/P&Z/tcap/publicguide.pdf

22 National Transportation Safety Board. (1998). *Highway accident summary report: Bus collision with pedestrians, Normany, Missouri, June 11, 1997.* Washington, DC: National Transportation Safety Board.

23 Center for Urban Transportation Research. (2005). *A return on investment analysis of bikes-on-bus programs.* Tampa, FL: National Center for Transit Research, Center for Urban Transportation Research, University of South Florida. This report may be ordered from http://www.nctr.usf.edu/pdf/576-05/pdf

24 Association of Pedestrian and Bicycle Professionals. (n.d.) *APBP bicycle parking guidelines*. Retrieved March 18. 2007, from http://www.bicyclinginfo.org/pdf/bikepark.pdf

Image credits for images by others

1.3 Image and caption retrieved on Jul. 12, 2007 from http://www.e-tran.org/images/i-stop.JPG

1.4 Hillsborough Area Regional Transit. (1995). *Transit friendly planning and design handbook and technical manual.* Tampa, FL: Hillsborough Area Regional Transit.

1.5 Hillsborough Area Regional Transit. (1995). *Transit friendly planning and design handbook and technical manual.*Tampa, FL: Hillsborough Area Regional Transit.

1.15 Image and caption retrieved on June 4, 2008, from http://www.arborrec.com/images/dumor/bench88pl.jpg

1.16 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops (TCRP Report 19).* Washington, D.C.: Transportation Research Board. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

1.17 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops (TCRP Report 19)*. Washington, D.C.: Transportation Research Board. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf. 1.20a-b State of Florida. Department of Transportation. (2008) District 1 and 7 Transit Facility Guidelines. Tampa, Fl: Florida Department of Transportation District

1.31 Image and caption retrieved on Jul. 12, 2007, from http://www.spratley.com/munilink/communities/cuyahoga-falls/page.php3?page=2

1.32 Central Florida Regional Transportation Authority. (2000). *Customer Amenities Manual*. Orlando, Fl: Herbert Halback and Associates, Inc. Updated by LYNX.

1.36 Image and caption retrieved on Jan 15, 2004, from http://www.rpt.com.hk/kmb_pve.htm

1.37 Image and caption retrieved on Jul. 19, 2007 from http://www.dca.state.fl.us/fbc/maps/Wind_borne_MAP021407v2.pdf

1.43 Image and caption retrieved on May 20, 2008,, from http://shop.solardirect.com/images/p-istop-d.gif

1.44 Image and caption retrieved on Jan. 15, 2004, from ci.novato.ca.us/cd/dsp/dspdesig.html

1.45 Image and caption retrieved on May 20, 2008, from http://www.design21sdn.com/attachments/0000/0926/_bus_shelter1_471x231_.jpg

1.46 Image and caption retrieved on May 20, 2008, from http://www.unpluggedliving.com/wp-content/uploads/2007/01/solar-powered-street-light.jpg

1.47 Image and caption retrieved on Jan. 15, 2004, from http://www.ile.org.uk/documents/guidance-notes-light-pollution.pdf

1.52 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops (TCRP Report 19)*. Washington, D.C.: Transportation Research Board. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

1.53 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops (TCRP Report 19)*. Washington, D.C.: Transportation Research Board. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

1.55 Image and caption retrieved on June 05, 2008, http://www.blastgardintl.com/images/product_model_91.jpg

1.56 Image and caption retrieved on Jan. 15, 2004 from http://www.all-in-one.co.uk/Anti_Ram_Raid_Posts/Bollards/bollards.html

1.59 Image and caption retrieved on Jan. 13, 2004, from http://www.sitespecifier.com/siteamen/BikeRacks/bikeracks.htm. 1.66 Image and caption retrieved on March. 25, 2008, from http://accessit.nda.ie/files/guidelines_img_coin_phone_and_chair.jpg

CHAPTER TWO

STREET-SIDE GUIDELINES

This page left intentionally blank

CHAPTER TWO: STREET-SIDE GUIDELINES

2.1 Introduction

Purpose

The following guidelines are intended to accommodate all modes of travel but are focused on the needs of bus operators and bus passengers in the road right of way. As such, the guidelines view the road as a multimodal facility. A wide variety of street design characteristics increase multimodal access in the following ways:

- treating public transit preferentially;
- clearly marking transit stops;
- slowing vehicle speeds;
- providing automobile drivers with reminders that other users are present;
- buffering pedestrians from traffic flow; and
- clearly marking pedestrian crossings.

In Florida, and elsewhere, multimodalism and good transit provision depend on continuous street patterns and the presence of pedestrian infrastructure. Road widening and improvement projects (including "Safe Routes to School" initiatives) present transit agencies with opportunities for enhancing transfers between different modes of travel. The following guidelines provide basic support for buses, pedestrian travel and bicycling. They represent illustrative cases. The characteristics of the roadway, including its design speed, will affect what types and variety of transit amenities will be applicable to each individual bus stop site.

Buses

Proper planning for bus facilities should be a major part of multimodal road design. Adequate right of way widths and curb radii are necessary for the convenient and safe circulation of buses. Right of way designs can deliver different degrees of priority treatment for buses and reduce conflicts between buses and other vehicular traffic.

Pedestrians

In order to make bus service efficient, pedestrian facilities should be given high priority in the design of multimodal streets, including the clear demarcation of pedestrian crossings to guide pedestrians at longer crossings and the provision of properly designed sidewalks. Accessibility is particularly important. Transit authorities should make use of universal design solutions so that all people, through every phase of life and with the widest range of abilities, can have equal access to transit. Whenever possible, crossing delays and out-of-direction pedestrian travel should be minimized.

Safety is the most important consideration in planning for pedestrian facilities linking bus stops to passengers' origins and destinations. Pedestrian facilities characterized by good visibility, adequate lighting, grade separation, clear demarcation and surface differentiation are likely to reduce conflicts between pedestrians and other travel modes.

Bicycles

Priority treatments for bicyclists include providing separate bike lanes and adequate bike storage at destinations. The design should also maximize a bicyclist's access to transit.

Location Factors

The following bus stop configurations are provided as guidelines. Actual bus stop placement should take all location factors into account and should be judged safe by professional engineers. The following guidelines apply to most configurations:

- All bus stops in urban areas (areas where curb and gutter and sidewalk are present) should be situated so that passengers board and alight at a location where full height curbs and gutters are present and not in a section of drop curb.
- All bus stops in urban areas (again where curb and gutter and sidewalk are present) should be situated 20 feet or more away from the edge of a drainage structure like gutter and 15 feet or more away from a fire hydrant or disabled parking space.
- When possible, the bus stop should be located at an existing roadway light pole. The recommended illumination level is 2.0-5.0 horizontal foot-candles for the entire bus stop area.[1] A 4-foot clear travel path must be provided on sidewalks at all times in the vicinity of the bus stop.
- For Americans with Disabilities Act (ADA) landing pad requirements, see Chapter 1.4.
- All bus bay drawings represent a bus stop with space for one bus at a time. If more than one bus is expected, 40 feet should be added for each additional standard bus and 60 feet for each additional articulated bus.
- Deceleration/acceleration land requirements should be considered for bus bay type designs if right of way allows.

2.2 Roadway

While FDOT is responsible for construction, maintenance and operation of state roads and transit facilities along state roads, non-state roads are maintained by local and county governments. There are guidelines for transit facility related issues applicable to both state and non-state roads.

State Roads

Purpose
This handbook provides guidelines for a broad spectrum of issues related to transit facilities along state roads. Although FDOT is responsible for the construction and maintenance of the roadway, transit facilities are typically built and maintained by transit agencies, local governments, private developers or non-governmental agencies. [2]

Location Factors
State roads typically provide connectivity to the attraction side of a trip since major commercial areas are often located along or near state roads.

Design Factors
Traffic patterns and transit demand along the state roads can be different from the other types of roads. Construction procedures to build transit facilities along state roads must comply with FDOT requirements. Under all conditions, all facilities must comply with applicable FDOT and local regulations.

All applicable departments within the FDOT and local or county governments should be contacted to identify site-specific construction procedures and specifications. Agencies responsible for the following should be contacted during the planning process:

- utilities;
- electricity supply and maintenance;
- traffic impacts and related issues;
- environmental planning;
- historic preservation; and
- adjacent property owners, especially in cases where construction could, temporarily or permanently, affect residents' sight view, access to property, etc.

Non-state Roads

Purpose
Typically, county governments are responsible for traffic operations and other issues related to county roads. Local roads are mostly under the jurisdiction of local governments and constitute a high proportion of roadway mileage in the State of Florida.

Location Factors
County roads often act as arterial streets. However, in many rural areas, they also serve as collector streets that provide access to abutting properties.

Design Factors
From a transit operation and facility design perspective, county roads pose unique challenges due to a range of alignment variations and land uses of abutting properties. Large parts of rural areas are accessible only by two-lane rural highways. From a transit service point of view, service on local roads is especially important as they provide, in many instances, the final connections to origins and destinations.

2.3 Special-Use Lanes

Bus service can be operated within various types of roadway configurations, ranging from streets with mixed traffic to exclusive bus-only lanes. A greater degree of separation from non-transit traffic reduces travel times, increases service reliability, and makes a transit trip less stressful. The separation between transit and non-transit vehicles can be achieved using the following two methods.

Exclusive Bus Lanes

Purpose
Exclusive bus lanes are operated on high-volume congested routes. (See Figure 2.1).

Location Factors
Experiences around the country show that an exclusive bus lane is best implemented by adding lanes to an existing roadways.

Design Factors
The provision of designated bus lanes also serves a marketing function as it indicates an institutional preference for buses.

High-Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes for transit

Purpose
HOV lanes are the most commonly used method of preferential treatment for bus traffic. (See Figure 2.2.) HOT lanes allow single occupancy vehicles to gain access by paying a toll. Because HOT lanes are, for the most part, HOVs overlaid with a pricing strategy, the discussion below pertains to both.

Fig 2.1 | Exclusive bus lane.

Location Factors
Buses can successfully operate in HOV or HOT lanes if capacity permits. Buses of any type, even without passengers, can use an HOV lane as it helps adherence to schedules.

Design Factors
The HOV or HOT requirement vary widely depending on local policies. Occupancy requirements can be raised in order to maintain a desired level of services and increase person moving capacity. They can also be adjusted to reduce the negative public perception caused by the "empty lane" syndrome and maintain the beneficial effects of HOV on transit travel times.

Fig 2.2 | High Occupancy Vehicle lanes for transit.

2.4 Traffic Signals and Giving Transit Priority

Purpose

Signal priority for transit vehicles improves transit operations and service quality. An improvement in transit performance provides additional incentive for people to switch travel modes to transit and thereby reduce traffic congestion. An effective Bus Signal Priority (BSP) system ensures that transit vehicles in all directions can be assisted without excess delay to non-transit vehicles. The volume of bus passengers, degree of existing congestion level and delay to non-transit vehicles are all important variables that must be considered in developing a BSP. The following guidance relies heavily upon information found in *Effectiveness of Bus Signal Priority* (2002). [3]

There are several ways to realize a BSP system: vendors can install entire systems, software and hardware can be purchased from different vendors or entirely customized solutions can be developed by consultants. As a result many different, discrete local solutions are in existence. The most appropriate priority method may be one that combines the various elements of existing priority techniques. The following focuses on the characteristics and issues regarding the most widely available commercial BSP system.

The efficiency levels of the priority system vary, depending on congestion. In general, non-transit traffic is less affected by priority systems in low congestion areas. Though some small delay to non-transit traffic is inevitable, it can be minimized through signal controls that limit the green light extension for buses. Additionally, at highly congested intersections, green extensions are limited to every other cycle.

continued on page 40

Characteristics of an ideal BSP System

According to *Effectiveness of Bus Signal Priority* (2002), BSP systems operate with a variety of different techniques. Important elements include the following:

- *The ability to track bus movements accurately. Most transit agencies now apply some form of automated vehicle location systems. A system that constantly tracks the location of a bus is ideal. Rather than relying on the bus to cross a sensor in the road, advanced systems know if a bus has been delayed before reaching the next intersection. Constant monitoring particularly improves the effect of any system that operates as a network of intersections. Such systems can also be integrated into real-time passenger information services to provide estimated arrival times.*
- *The ability to measure and record statistics on the bus routes to form transit plans based on statistical analysis and to consider traffic volume, passenger occupancy and other related data.*
- *The ability to offer a wide variety of priority techniques for different situations.*
- *The ability to minimize delay to non-transit traffic and to offer compensation to that traffic.*
- *The ability to estimate cost to both passenger and transit agency (based on average delay) associated with enacting any given priority method.* [3]

Table 2.1 | Types of BSP depending on priority concepts.

Priority Concepts	
Active priority	Signal is adjusted for each bus on detection at intersection approach.
Passive priority	Signals are adjusted to suit the bus schedule along the route.

Source: Chada, S and Newland, R (2002) *Effectiveness of Bus Signal Priority*. National Centre for Transit Research Centre for Urban Transportation Research

The two basic types of bus priority concepts are characterized as active or passive. (See Table 2.1.)

In an active priority system, buses are detected as they approach to an intersection. See Figure 2.3. Such systems use both real and fixed-time control strategies and schedule and headway-based control strategies. In general, active priority systems are viewed as more effective than passive ones.

Passive priority systems prioritize the traffic signals using a combination of fixed-time and schedule-based control strategies. Passive priority is usually implemented only on

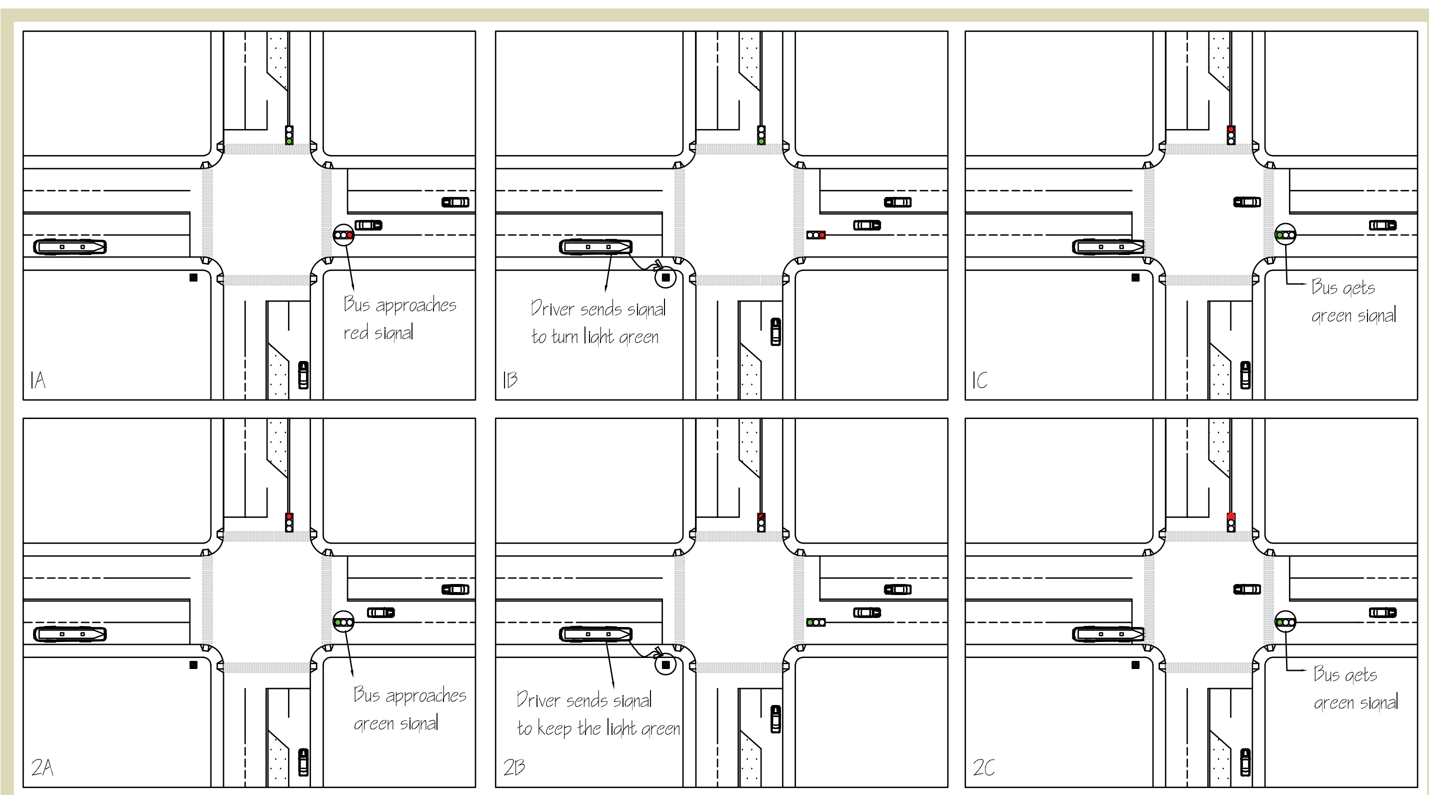


Figure 2.3 | Active BSP system.

roads with high transit usage, often close to the buses, origin point where departure schedules are fixed. An active priority system, on the other hand, is usually installed at the points along the corridor. Passive priority is less expensive than active priority but in general is less effective. [2,3]

Location Factors

BSP systems should be used on high ridership corridors with moderate numbers of buses. In order to determine suitable coverage, the effects of varying numbers of buses and passengers, signalization patterns and phasing, and patterns of bus arrivals should be analyzed. Bus routes with greatest delays should be considered as the highest priority for BSP system implementation.

Placement of Bus Stops

The implementation of a BSP system may call for changes in the positioning of bus stops in order to gain the highest potential benefits from the technology. For instance, bus detectors should be placed further upstream if bus stops are located on the far side of an intersection. The addition of a bus-only lane could further alleviate bus impedance at intersections. Active signal priority should be used at these far-side bus stops to ensure that signal priority calls are not wasted for stopped vehicles. [3]

Design Factors

Depending on the level of congestion, the placement of bus stops, the availability of express bus service, and the number of transit vehicles on the route, BSP systems use different techniques to offer buses priority at signals. There are different techniques based on control strategy and priority concepts. According to *Effectiveness of Bus Signal Priority* (2002), there are four types of signal control strategies (See Table 2.2):

- *Real time*
  Real-time control relies on constantly updating information to make decisions regarding signal priority. A real-time signal control model is more flexible, given changing conditions, and is hence judged generally more effective overall than other control systems.

- *Fixed-time*
  Fixed-time control applies to a signal control plan based on the average conditions of an area in place of constantly updated real-time information.

Table 2.2 | Summary of BSP strategies

Control Strategy	
Real-time	Priority changes based on constantly updated information
Fixed-time	Applies a fixed plan to make decisions regarding priority
Scheduled-based	Priority awarded based on the bus schedule
Headway-based	Priority awarded based on the headway between buses

Source: Chada, S and Newland, R (2002) *Effectiveness of Bus Signal Priority*. National Centre for Transit Research Centre for Urban Transportation Research

- *Schedule-based*
  In schedule-based control priority is awarded based on the bus schedule. If the bus is running late then it receives priority through intersections. Schedule-based control is more effective than other control techniques at reducing bus travel times. Since schedule-based control does not need information on bus locations it requires less communication equipment, which also makes it more cost effective.

- *Headway-based*
  Priority is awarded based on the headway between buses. Buses avoid bunching up with other buses in this control strategy. Headway-based control is more effective than other systems at reducing wait times for passengers.[3]

On occasion, the terms "direct" or "indirect" priority are used. Direct priority provides solutions for a particular bus when it has reached or is very close to an intersection. Indirect priority looks to clear up congested intersections ahead of time, so buses can eventually travel through with little or no congestion.

Unconditional signal priority should only be implemented for express bus service during off-peak hours and should be implemented by placing limits on green extension and red truncation lengths, especially at intersections with busy cross streets. [3]

Those techniques also utilize a variety of different control strategies such as phase suppression, synchronization, compensation, and green recall.

continued on page 42

Table 2.3 | Pre-implementation checklist point system.

Pre-implementation Checklist	If answer is yes	If answer is no
Express bus service?	Plus one point	No point
Express bus service during off-peak?	Plus one point	No point
Far-side bus stop?	Plus one point	No point
Highly saturated cross streets over 1.0 v/s ratio?	No point	Plus one point
Heavy volume intersections in the network?	No point	Plus one point
Many instances of two transit vehicles approaching one intersection?	No point	Plus one point
Do you have Automatic Vehicle Location (AVL) technology installed?	Plus one point	No point

Source: Chada, S and Newland, R (2002) *Effectiveness of Bus Signal Priority*. National Centre for Transit Research Centre for Urban Transportation Research

Impact of BSP Strategies

In general, in bus actuated systems, the more flexible real-time signalizations are preferred over fixed-time control systems and perform better when the side street traffic is accounted for. Nevertheless, the challenges associated with processing on-line data limit the benefit realized from either system type. Additionally, though almost all systems provide reasonable control features, some fail in situations where two or more transit vehicles are coming concurrently from different approaches. Active signal priority may congest cross streets that may not clear before the next call.

Pre-Implementation Checklist

In *Effectiveness of Bus Signal Priority* (2002), there is a checklist of criteria to consider before implementing a BSP system. The checklist consists of seven questions pertaining to transit services and features and traffic conditions. See Table 2.3.

The first two questions are about the provision of express bus service and the next question asks about the presence of far-side bus stops. If the transit system includes these features, BSP might be beneficial. The next few questions concern traffic congestion. If cross streets are characterized as highly saturated (see Table 2.4 for priority recommendations, based on different levels of the volume to capacity ratio), or if there are heavy volume intersections, then BSP has more limited potential. Similarly, scheduling which frequently results in the approach to an intersection of two buses at the same time would limit the usefulness of BSP. The final question asks whether traffic signals are equipped with Automatic Vehicle Location technology. If so, BSP is promising.

Answers to the questions are scored, as indicated in Table 2.3, and then totaled. The total scores form the basis for recommendations about BSP implementation:

- A score of less than three suggests changes may be necessary before bus prioritization is feasible.
- A score of three or four means bus prioritization may be feasible within existing conditions.
- A score over four rates a strong recommendation for implementation of bus prioritization.

Transit agencies may use the questions in the checklist as a guide to identify the types of changes needed to enhance the effectiveness of BSP.

Table 2.4 | Recommendations based on saturation level.

Saturation Level	Strategy
Under 0.25	Unlimited priority
Over 0.25 / under 0.8	Priority with limits
Above 0.8	10-second priority
1.0	Priority may not be effective

Source: Chada, S and Newland, R (2002) *Effectiveness of Bus Signal Priority*. National Centre for Transit Research Centre for Urban Transportation Research

2.5 Street Lighting

Purpose

Street lighting, although not directly under the purview of transit agencies, can play an important role in designing and locating transit facilities. Lighting along streets is typically designed for smoother vehicular movement and meets illumination requirements of a transit stop. As needed, lighting should be made suitable for stop areas. When possible, solar lighting should be used to reduce operating costs and to increase functionality during black out periods.

Location Factors

Minimum condition

Where possible, local transit stops should be located within 30 feet of an overhead light source. A minimum distance of 15 feet is recommended between a shelter and light pole. Lighting fixtures should be oriented so that bus stop infrastructure (such as the shelter or other amenity) does not cast shadows on the waiting area and allows the bus driver to see waiting patrons.

Desirable condition

Lighting scaled to the human body helps create pedestrian-friendly environments. Agencies should consider its installation at bus stops that attract significant ridership in the evenings or early mornings.

Design Factors

Minimum condition

Lighting fixtures of any height should minimize glare that could adversely impact drivers and should provide even and uniform illumination over the whole area. Glare on signs should also be minimized to enhance their legibility. Places such as mid-block crossings associated with bus stops, where significant vehicle-pedestrian interactions may occur, should be illuminated to enhance safety of bus patrons. Uniform illumination, rather than lighting patterns that produce bright and dark areas, is also helpful in preventing crime at bus stops.

In rural areas, efforts should be made to maximize the safety and security of bus stops with proper lighting. The conditions for lighting transit facilities in rural areas should be reviewed on a location-specific basis. Where utility service is not readily available, solar powered illumination should be considered.

Desirable condition

Transit agencies should initiate private-public cooperation with neighborhood businesses, malls, hospitals and recreational or sport facilities to provide lighting at the scale of the human body at bus stops. [2]

2.6 Vehicle Characteristics

Purpose

The actual dimensions of bus vehicles should be used to establish minimum functional street-side standards for transit operations. Vehicle lengths, widths and heights, as well as operating characteristics, should be coordinated with roadway and facility designs. Bus turning radii requirements are equally important. Two types of buses are commonly used in Florida: standard buses (used for most local bus transit service) and mini buses (used most commonly in providing para-transit and in limited cases local transit services). Articulated buses (used exclusively for public transportation) are also in use.

Design Factors

Typical bus dimensions are provided in Figures 2.4 through 2.10.[1] Roadway dimensions must take into account the minimum space in which buses can turn in order to ensure safe roadway turning movements. The minimum radii required for a 40-foot long coach (the standard bus) and 60-foot long articulated bus are illustrated in Figure 2.11 and 2.12. [1] The desirable width for traffic lanes used by buses is 12 feet. See Figure 2.13 and Table 2.5.

Roadway grades should be based on bus performance characteristics for grade ascents or descents under fully loaded conditions. Turning radii requirements for a standard 40-foot long city transit bus are as follows:

- minimum interior radius = 24½ feet; and
- minimum outer radius = 42 feet.[4]

Additional turning radii requirements will be needed under the following conditions:

- buses turning at speeds greater than 10 mph;
- buses making reverse turns;
- buses turning in areas with sight distance limitations;
- buses making turns involving changes in pavement grade;

continued on page 48

STREET-SIDE GUIDELINES

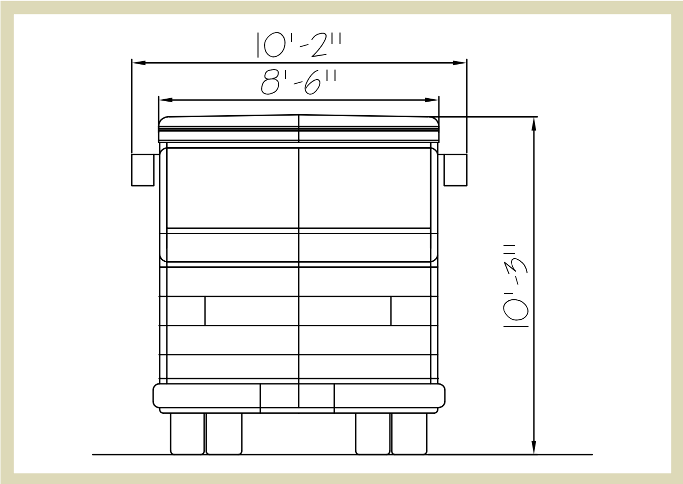


Fig 2.4 | Front view of a standard 40-foot bus.

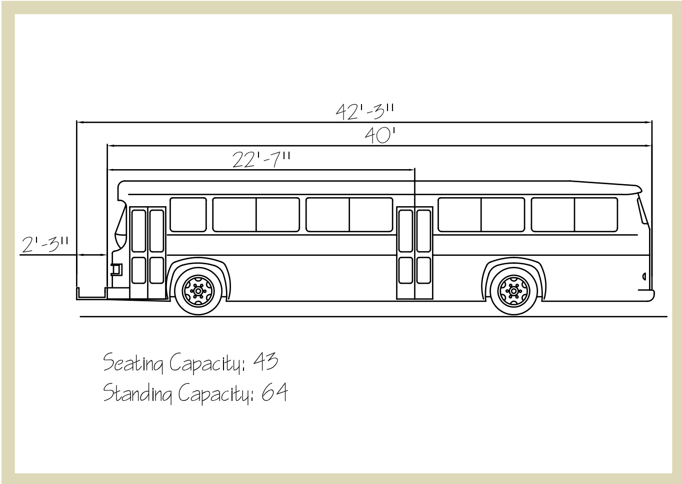


Fig 2.5 | Side view of a standard 40-foot bus.

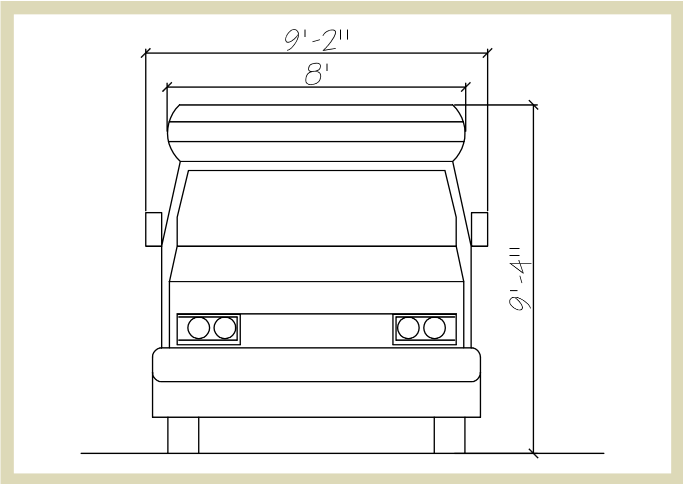


Fig 2.6 | Front view of a mini bus or para-transit vehicle.

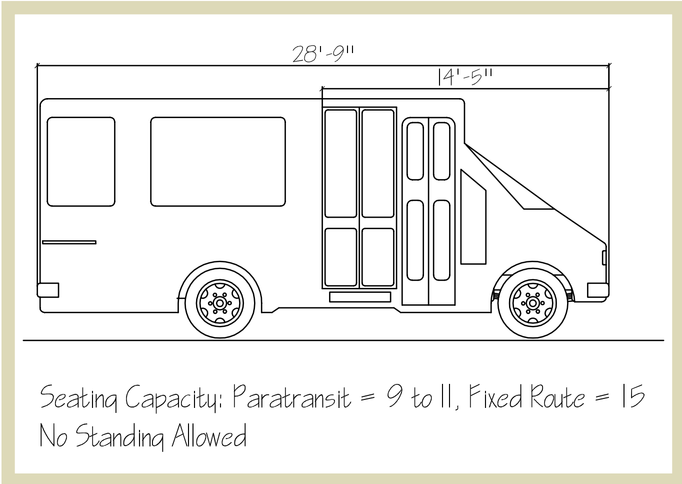


Fig 2.7 | Side view of a mini bus or para-transit vehicle.

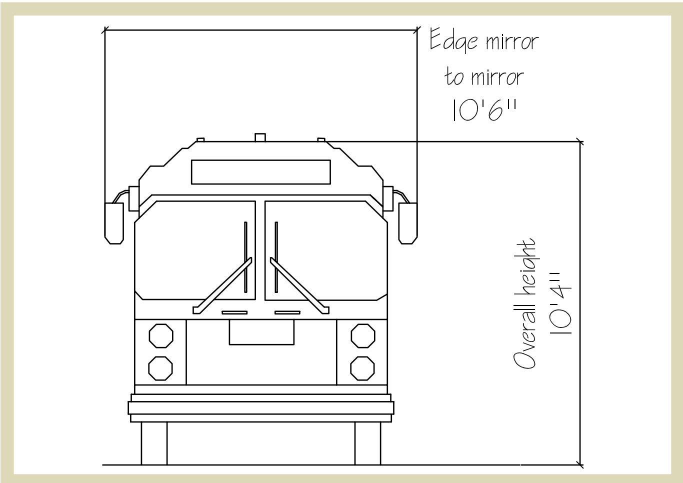


Fig 2.8 | Front view of an articulated bus.

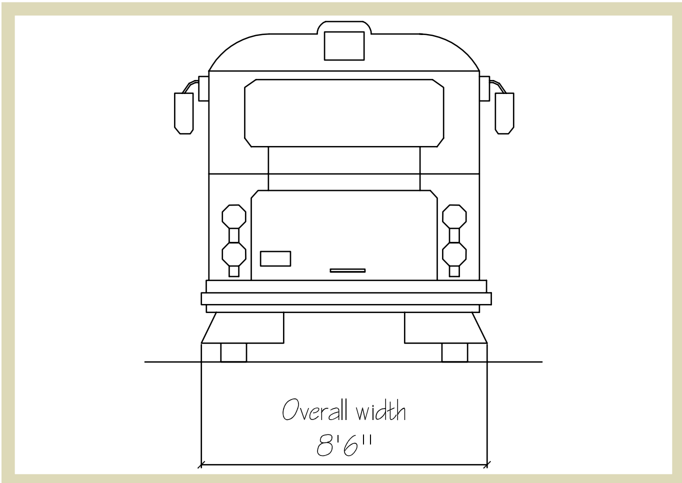


Fig 2.9 | Rear view of an articulated bus.

STREET-SIDE GUIDELINES

Table 2.5 | Desirable minimum width for traffic lanes used by buses.

A Approach Width (feet)	B Entering Width (feet)	C Radii* (feet)
12 (1 lane)	12 16 20 24	50 45 40 35
16 (1 lane with 4-foot shoulder)	12 16 20 24	45 40 30 25
20 (1 lane with parking)	12 16 20 24	40 35 30 25

* Assumes no parking on cross street and minimal lane encroachment on opposing travel lanes.

Source: Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press.

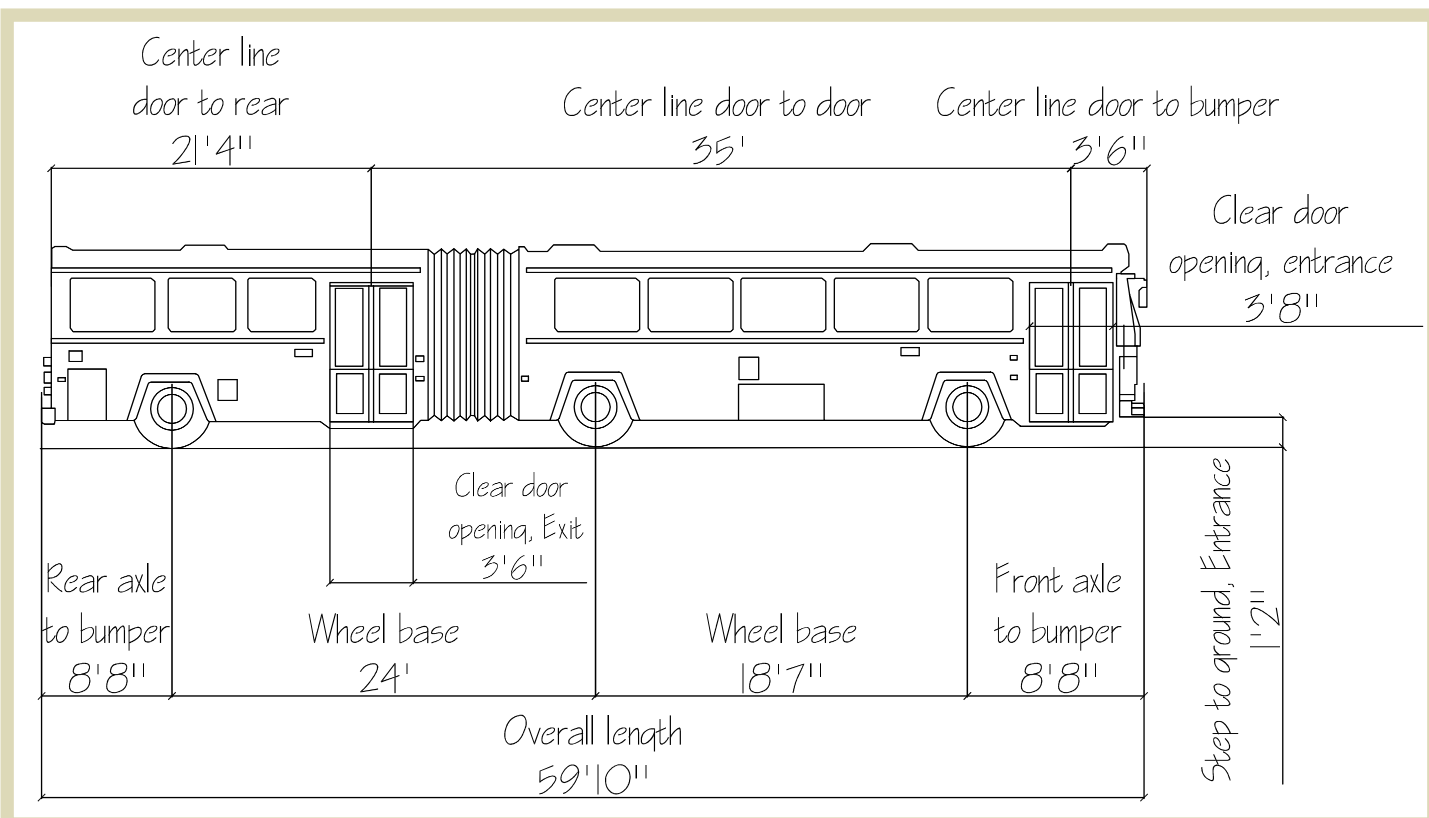


Fig 2.10 | Side view of an articulated bus.

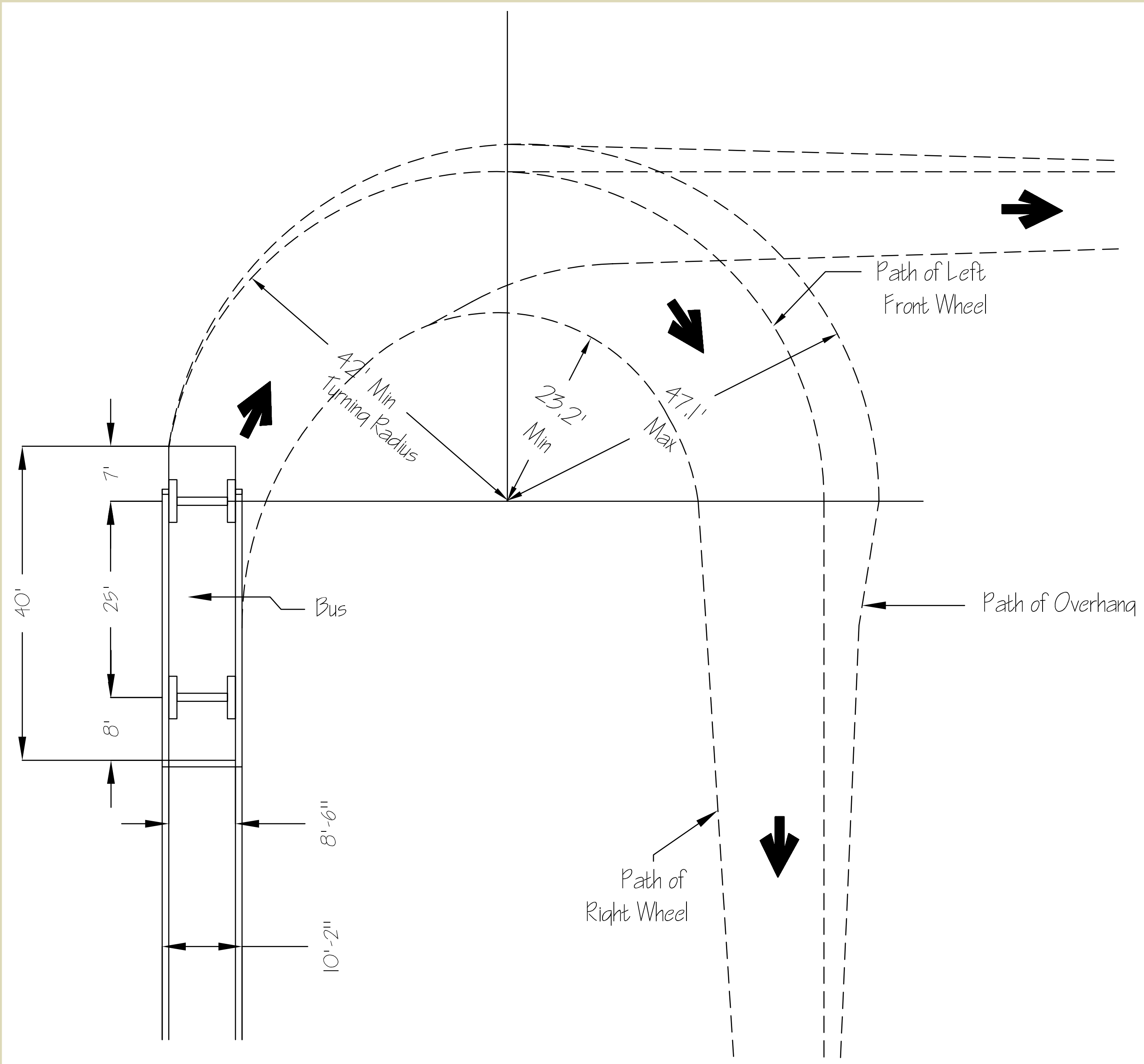


Figure 2.11 | Template of bus turning movement geometry for a 40-foot bus.

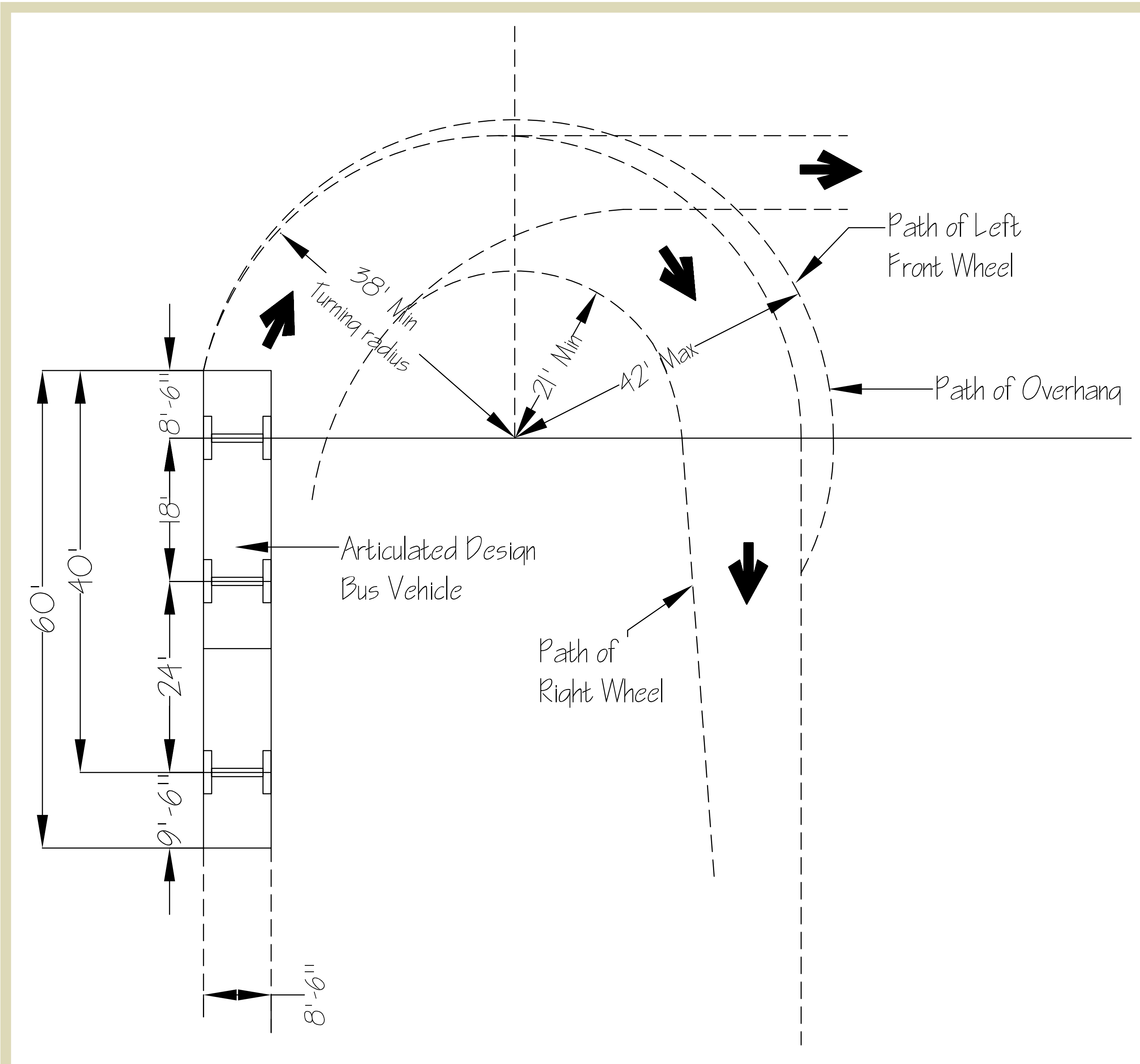


Figure 2.12 | Template of bus turning movement geometry for a 60-foot bus.

- buses turning in areas which restrict the movement of the bus overhang; and
- buses equipped with bike racks.

Low or absent curbs make boarding and alighting more difficult for passengers. Higher curbs may interfere with wheelchair lifts, [1] but low-floor buses require some curb to minimize the angle of the ramp. To make the articulated buses nimble enough to navigate streets safely at their increased length, they are fitted with an extra axle (set of wheels) and a joint usually located slightly behind the midpoint of the bus, behind the second axle. See Figure 2.10.[1]

Possible Materials for Use

Additional consideration should be given to pavement design in areas where buses start, stop and turn; or along roadways with higher bus volumes; and in areas with special soil conditions.

Typical asphalt roadways may be subject to additional wear and tear. At bus stops accommodating very high bus volumes, reinforced concrete pads should be provided.

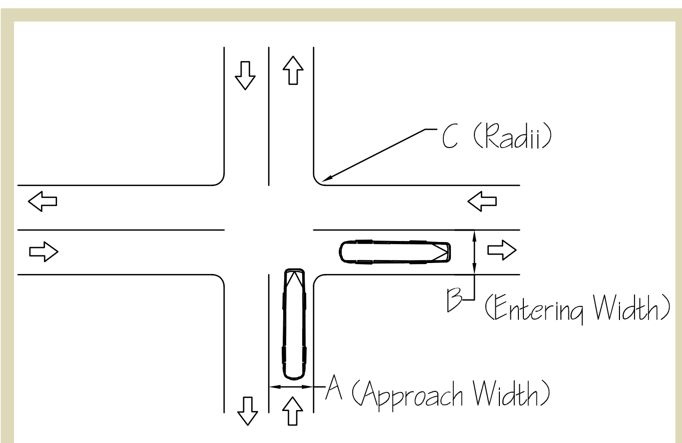


Figure 2.13 | Important measurements related to bus turning movements.

2.7 Pavement Marking

Purpose

Pavement markings are necessary for roadway safety by helping to provide orderly and predictable movement of all traffic. Pavement markings help guide transit vehicle flow and provide information to the transit vehicle driver. See Figure 2.14.

Design Factors

Major marking types include pavement and curb markings, object markers, delineators, colored pavements, barricades, channelizing devices, and islands. The following should be considered:

- pavement markings should be in compliance with maintaining agency regulations and standards in the *Manual of Uniform Traffic Control Devices* (MUTCD) manual [5] and
- physical obstructions in and around bus stops, if identified as a hazard to vehicular or pedestrian safety, should either be removed or adequately marked by painting or by use of other highly-visible material. [2]

Figure 2.14 | Pavement marking.

2.8 Bus Stop Location

Purpose

Bus stop locations are generally defined in relation to intersections. Table 2.6 describes the intersection bus stop location criteria. The types are described as follows:

- at the far side (downstream) of the intersection;
- at the near side (upstream) of the intersection; or
- mid block (halfway between intersections).

Figure 2.15 provides typical dimensions required for each type of stop.

Location Factors

Different agencies opt for different bus stop spacing standards. See Table 2.7 for examples of two widely used industry practices. Often bus stops are added on as-requested basis along existing bus routes - a practice that can lead to operational inefficiencies and negatively impact service reliability. To address this, a periodic reexamination of stop spacing is recommended. Tables 2.8a and b describes the bus stop locating process. Table 2.9 identifies the advantages and disadvantages of various bus stop locations.

Far-Side Stops

Far-side bus stops are generally preferred to near-side stops because they result in fewer traffic delays, provide better vehicle and pedestrian sight distances, and cause fewer conflicts among buses, cars, pedestrians and bicyclists. They are recommended for use under these circumstances:

- in areas where the right of way permits cars to pass the bus and especially in areas where a near-side stop will impede other motorists;
- where a route alignment requires the bus to turn left before stopping; and
- at complicated intersections with multiphase signals.

Table 2.10 lists the minimum distances between point of bus traffic re-entry and any upstream turning movement at various speeds. Roundabouts should be treated similarly to conventional intersections. The goal when locating a bus stop in relation to a roundabout should be to avoid the queuing of vehicles back into the circulatory roadway. Since the bus stop should, where possible, be located on the far side of the roundabout after the exit, the stop should either utilize a bus bay or be far enough downstream from the splitter island to avoid a long queue from interfering with circulation within the roundabout.[6]

Near-Side Stops

Where far-side stops cannot be provided, near-side stops should be located at least 100 feet in advance of the intersection in order to avoid conflicts with vehicles. Use near-side stops on two lane roads, where vehicles are restricted from going around the bus, in order to prevent the stacking of vehicles in the intersection. Near-side bus stops are also appropriate:

- at prioritized signalized intersections;
- when the bus must stop in the travel lane because of curb-side parking in order for the front door of the bus to access an intersection and crosswalk;
- in combination with curb extensions or bus bulbs to provide direct access from the bus to the sidewalk; and
- in a right turn lane if a queue jump signal is provided to allow the bus to merge back into the travel lane and if accompanied by a sign on the side of the road.[1]

Avoid near-side stops at intersections with dedicated right-hand turn lanes where right-on-red turning is permitted.

Mid-Block Stops

Mid-block stops are generally to be avoided. They are only appropriate when:

- route alignments require a right turn and the curb radius is short;
- the distances between intersections is unusually long and major transit generators are located mid-block and cannot be served at the nearest intersection; and
- the pedestrian crossing is accompanied by pavement marking and road lighting.

Special Consideration for Schools

Transit facilities near schools should have the following safety related measures:

- near primary schools, stops should be placed in an area where they can be visually monitored by school personnel and/or crossing guards to increase security; and
- mid-block stops near schools are not recommended.

Design Factors

Bus stops should be clearly identified with signs or pavement markings to indicate that transit vehicles have exclusive use in the stop area. The bus stop location should minimize the need for buses to change lanes before intersections and before approaches to left hand turns.[7] The location of a bus stop should be chosen to minimize having the stopped buses block driveways. Whenever possible, bus stops should be located

continued on page 55

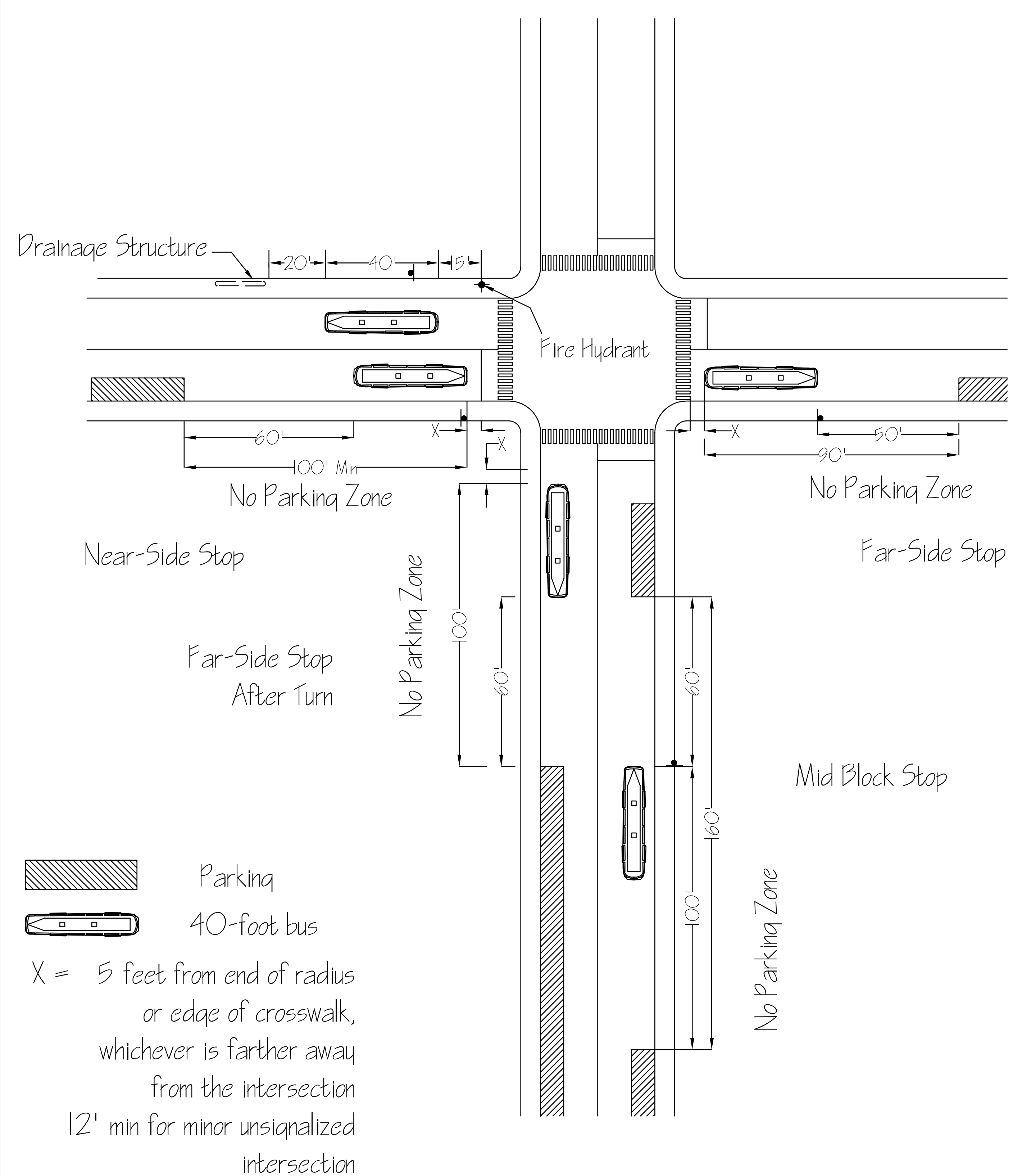


Figure 2.15 | Dimensions associated with bus stops located at different points with reference to the intersection.

STREET-SIDE GUIDELINES

Table 2.6 | Intersection bus stop location critieria.

Bus Stop Variables	No turn lanes in direction of transit	Right turn lane on near side in direction of transit	Right turn lane on near side and auxiliary lane on far side in direction of transit **	Auxiliary lane on far side in direction of transit ***
Dimension (A) (Near-Side Major Intersection)	Not recommended * unless 2-lane roadway	Not recommended unless 2-lane roadway 10' before entry taper for turn bay 100' if drop lane	Not recommended unless 2-lane roadway	Not recommended unless 2-lane roadway *
Dimension (B) (Far-Side Major Intersection)	40' for a standard bus (60' for an articulated bus)	40' for a standard bus (60' for an articulated bus)	110' **	45' for a standard bus (65' for an articulated bus) ***
Dimension (C) (Near-Side Minor Intersection)	12' min.	As close to entry taper as possible	N/A	N/A
Dimension (D) (Far-Side Minor Intersection)	40' for a standard bus (60' for an articulated bus)	40' for a standard bus (60' for an articulated bus)	N/A	N/A

* If necessary, 12' minimum dimension is required.
** This combination of bus bays is referred to as a queue bus bay.
*** This arrangement is referred to as an open bus bay.
Note: This table is prepared as a guideline for the location of bus stops along a state road facility where on-street parking does not exist.

Source: Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.*

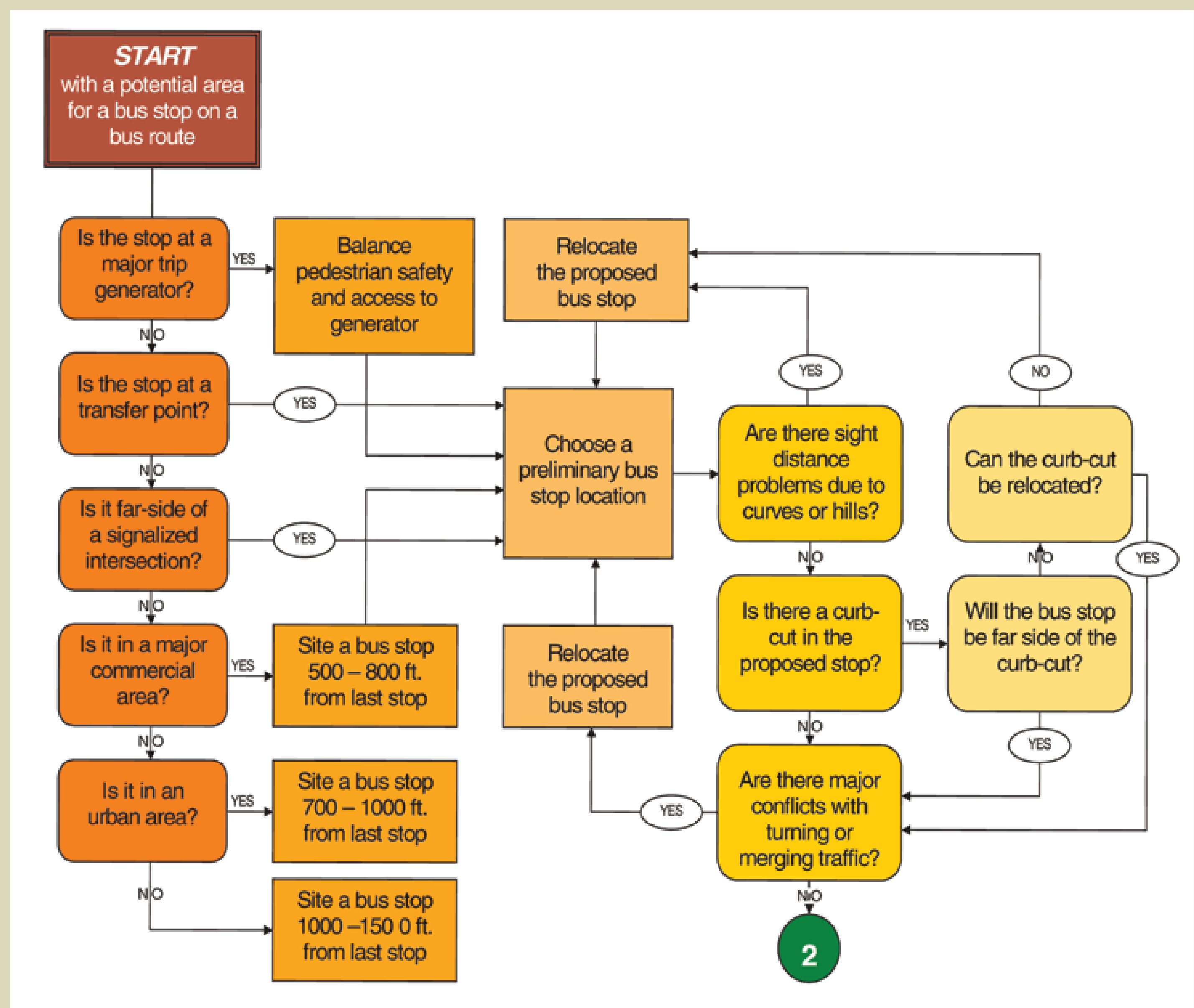
Table 2.7 | Bus stop spacing.

	TCRP Report 19	**NCHRP Report 69**
	Range (typical spacing in feet)	**Range in feet**
High density residential areas, CBDs, and major employment centers	300-1000 (600)	440-528
High density residential employment centers	500-1000 (750)	660-880
Suburban residential areas	600-2500 (1000)	1056-2640
Rural areas	650-2640 (1250)	1320-2640

Source: Florida Department of Transportation Districts One and Seven. (2007). *Transit facility handbook.*

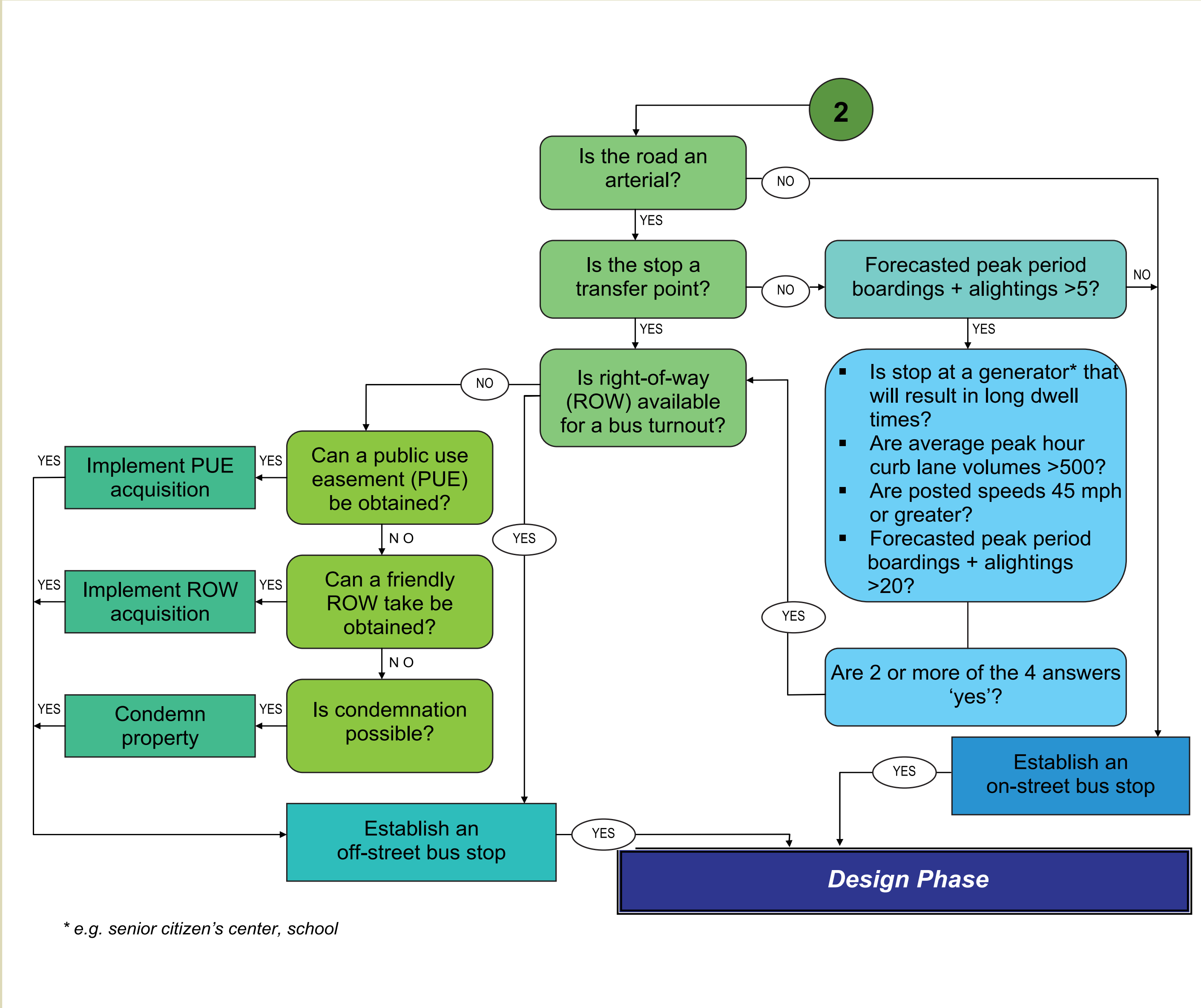
STREET-SIDE GUIDELINES

Table 2.8a | Bus stop location flow chart.



Source: Grand Junction/Mesa County Metropolitan Planning Organization. (2003, July). *Transit design standards and guidelines.* [8]

Table 2.8b | Bus stop location flow chart.



Source: Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.*

STREET-SIDE GUIDELINES

Table 2.9 | Advantages and disadvantages of various bus stop location.

Near-Side		Far-Side		Mid-Block	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**	**Advantages**	**Disadvantages**
Near-side bus stop minimizes inter-faces when traffic is heavy on the far side of the intersection.	Conflicts with right turning vehicles are increased here.	Far-side bus stop minimizes conflicts between right turning vehicles and buses.	For this type of bus stop intersections may be blocked during peak periods by queuing buses.	Mid-block bus stop minimizes sight distance problems for vehicles and pedestrians.	It requires additional distance for no-parking restrictions.
For this type of bus stop, passengers can access buses closest to crosswalk.	Stopped buses may obscure curb-side traffic control devices and crossing pedestrians.	It provides additional right turn capacity by making curb lane available for traffic.	Sight distance may be obscured for crossing vehicles here.	Passenger waiting areas experience less pedestrian congestion.	It encourages patrons to cross street at mid-block.
In this type, intersection is available to assist in pulling away from curb.	Sight distance is obscured for cross vehicles stopped to the right of the bus.	It minimizes sight distance problems on approaches to intersection.	It increases sight distance problems for crossing pedestrians.	Passengers access buses closest to crosswalk.	It increases walking distance for patrons crossing at intersections.
This type of bus stop does not require double stopping. Buses can service passengers while stopped at a red light.	The through lane may be blocked during peak periods by queuing buses.	It encourages pedestrians to cross behind the bus.	For far-side bus stop, bus gives stopping far-side after stop-ping for a red light interferes with bus operations and all traffic in general.		
It provides driver with opportunity to look for oncom-ing traffic including other buses with potential passengers.	It increases sight distance problems for crossing pedestrians.	This type of bus stop requires shorter deceleration distances for buses.	It may increase number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light.		
	Pedestrians may cross the street in front of the bus, unseen by traffic in the left lane.	Gaps in traffic flow are created for buses re-entering the flow of traffic at signalized intersections here.			

Table 2.10 | Far-side bus stop placement.

Far-Side Bus Stop Placement	
Design Speed (mph)	**Minimum distance between point of bus traffic re-entry and any upstream turning movement**
35	75′
40	75′
45	100′
50	135′

Source: Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.*

beyond driveways to minimize conflicts between buses and other vehicles leaving or entering driveways.[7]

The higher the roadway design speed is, the greater will be the distance of the bus stop from the radial point in the road before or after the intersection. Transit agencies have been considered liable for injury sustained by their passengers, if, for example, patrons must use a dangerous crossing to reach a bus stop.[9]

2.9 Emergency Medical Services (EMS) Access

Purpose

The free movement of emergency vehicles is very important. To accommodate emergency vehicles, the following should be considered while planning and designing transit infrastructure and amenities.

Location Factors

Bus facilities should not obstruct fire lanes or other similar emergency facilities and equipment. The bus stops should be located further than 15 feet from a fire hydrant.[10] When planning transit facilities near hospitals, fire stations and police stations, those agencies should be contacted to seek their input on bus stop locations.

Design Factors

During the operation of transit signal priority, buses must accommodate emergency vehicles at all times.[2] Exceptions to parking prohibitions at bus stops should be permitted to allow standing by emergency vehicles.

2.10 Road-Side Bus Stop

Purpose

Curb-side stops and stops along roads with soft shoulders are the most frequently used street side bus stop facilities. They provide easy access for drivers and result in minimal delays to service. They require minimum design and are easily relocated. In areas with high traffic volume, they can result in conflicts with other traffic. Special attention needs to be given, especially to wheelchair users, at stops along soft shoulder roads.

Location Factors

Although all curb-side stops will not meet the following guidelines, ideally curb-side stops are provided in locations where:

- the design speed is less than or equal to 45 mph;[2]
- there is adequate space in the right of way for improvement of shelters and benches;
- access can be provided for passengers with disabilities;
- major trip generators are nearby;
- connections exist to pedestrian facilities;
- nearby major intersections are signalized;
- street lighting exists for nighttime routes; and
- adequate curb length is present to accommodate the bus stop zone.

For all stops, the following guidelines should be kept in mind.

- Stops should be located so that passengers are not forced to wait for a bus in the middle of a driveway. The stopped bus should not block the driveway;
- Stops should be located so that patrons board or alight directly from the curb rather than from the driveway;
- Stops should be located so that the front door ADA landing pad is located outside the driveway;
- Consider relocating a bus stop to a downstream parcel should a corner location prove to be unacceptable. See Figure 2.16.

Design Factors

Figure 2.15 illustrates typical curb-side bus stop dimensions and Figure 2.13 and Table 2.5 illustrate turning radii for a bus turning before and after stopping. The following can be noted by these illustrations:

- Far-side curb-side bus stops should be a minimum of 90 feet in length.

continued on page 56

- Near-side curb-side stops should be a minimum of 100-feet in length.
- Mid-block curb-side stops should be a minimum of 150-feet in length.

More information on this can be accessed from FDOT's *Driveway Handbook.* [11]

2.11 Bus Bay

Purpose

Bus bays allow buses to pick up and discharge passengers outside travel lanes. This allows other traffic to flow freely while the bus is stopped, giving priority to non-transit vehicles. Additionally, bus bays increase safety for passengers by increasing the distance between them and moving traffic, and they lessen the chances of a stopped bus being rear-ended by another vehicle.

Location Factors

The following areas are ideal for bus bays:

- areas characterized by high traffic volumes and traffic speeds of upto 40 mph; [2]
- areas where other vehicles have a history of colliding with the rears of stopped buses;
- areas where a high volume of passengers embark or alight from the bus or where dwell time exceeds 30 seconds during peak hours;
- areas where there are extended layover times to accommodate transferring passengers; and
- areas where there are high volumes of buses at peak hours.

Bus bays at far-side stops should be placed at signalized intersections so that the signal provides gaps in traffic that permit bus re-entry into the travel lane.[1] Near-side bus bays should be avoided because of conflicts with right-hand turning vehicles and delays in service resulting from the difficulty associated with bus re-entry into the travel lane. When bus bays are placed in a near-side location, the arterial design speed should be less than 40 mph to lessen potential conflicts as the bus re-enters the flow of traffic.[2] Bus bays may be appropriate at mid-block stops associated with destinations that are major transit trip generators.

Design Factors

Bus bays are generally preferred over curb-side bus stops. When site constraints do not prevent it, closed bus bays should be used instead of open bus bays to minimize the disturbance to other vehicular movements. The design of bus bays should aim to reduce automobile-bus conflict, provide greater separation between traffic and pedestrians waiting for the bus, and allow the bus to quickly regain its travel speed upon its reentry into traffic. To achieve these goals, bus bays should be placed in a recessed curb area of the roadway, separated from moving lanes of traffic.

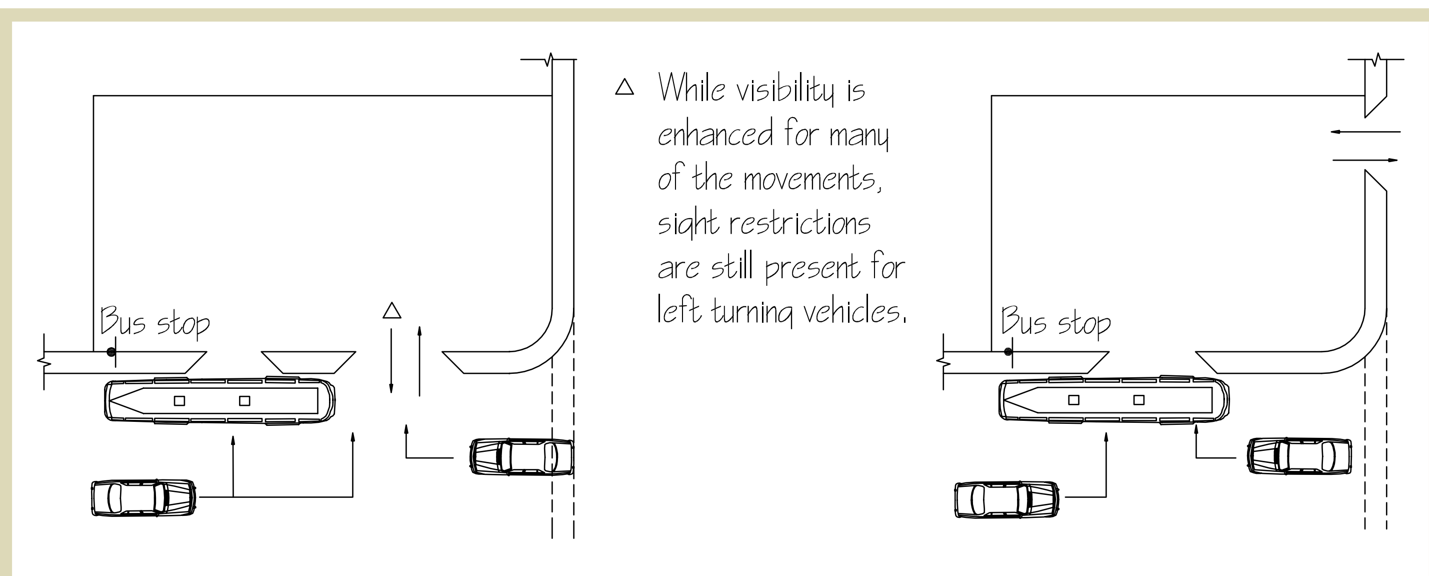


Figure 2.16 | Acceptable bus stop / driveway arrangements.

STREET-SIDE GUIDELINES

Refer to the *TCRP Guidelines for the Location and Design of Bus Stops* for special conditions and dimensions of bus bays.[1] Total length of the bus bay should allow for an entrance taper, a deceleration lane, a stopping area, an acceleration lane, and an exit taper. See Figure 2.17 and Table 2.11. Length of the bus bay should be increased by 50 feet for each 40-foot bus and 70 feet for each 60-foot articulated bus expected to be at the stop simultaneously.[1]

When no bus shelter is used, the sidewalk should be extended to provide an ADA landing pad with a minimum clear length of 8 feet and a minimum clear width of 5 feet. In rural areas where there are no sidewalks, it is desirable to construct an 8-foot sidewalk connection to the location being served, so that if sidewalks are provided in the future, the connection will exist.[10] Drainage structures are not to be located within the bus bay stopping area. Additionally, drainage structures should be kept away from the passenger loading areas.[2] Bus bay sidewalk should be connected to existing sidewalk or accessible to the shoulder.[2] For curb and gutter transition details, refer to the latest version of *FDOT Transit Facility Standards and Guidelines.*[2] A mid-block crosswalk can be used in locations where there is a major transit-oriented activity center or the distance to the next intersection is greater than 300 feet. Signalization may be provided as per the MUTCD.[5]

Possible Materials for Use

Standard asphalt pavements are normally adequate to handle bus traffic, including bus bays. When truck and bus volumes get high, the standard design is to use polymer-modified asphalts. Polymer-modified asphalt provides additional resistance to rutting from the heavy vehicles and is referred to as PG 76-22 in construction specifications.

If repeated rutting has been experienced even on a lower-volume facility, polymer modification of the asphalt pavement or a concrete pavement may be called for.

For concrete pavements, it is important to provide adequate sub-grade drainage, thickness and joint details. The use of these materials in small quantities, however, will significantly increase unit costs so using them on the entire facility roadway should be considered carefully.

Design guidance for asphalt (flexible) and concrete (rigid) pavements can be found in the FDOT's *Flexible Pavement Design and Rigid Pavement Design* manuals. These can be ordered from the FDOT Maps and Publications web site.[12,13]

For alternative pavement treatments (patterns or textures), refer to the *Plans Preparation Manual* (PPM) for guidance.[13] Architectural pavers are not acceptable for use on the state highway system in the travel way, but can be used elsewhere as specified in Volume I, Subsection 2.1.6.1, PPM.[14]

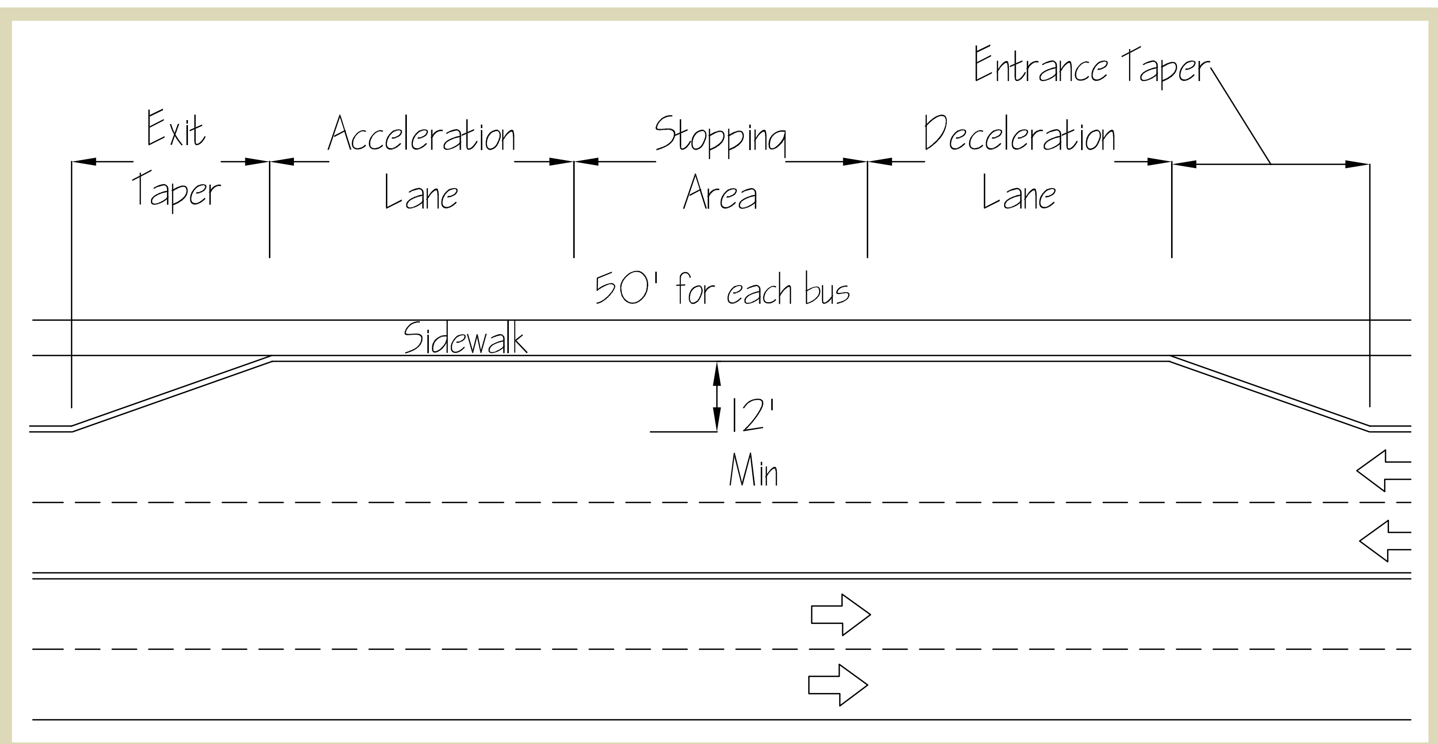


Figure 2.17 | Critical dimensions related to bus bays.

2.12 Queue Jumper Bus Bay

Purpose

Giving buses priority at intersections, queue jumper bus bay speeds up overall traffic flow by allowing buses to move ahead of other vehicles where bus stopping might conflict with other vehicle movements or right turn only lanes. The buses move in a bus-only lane and get a head start of several seconds over other traffic. See Figure 2.18. For dimensions at various speeds of travel see Table 2.11.

Location Factors

When using a queue jumper bus bay, the bus stop should be located at the far side of an intersection. Near-side stops increase bus dwell time, complicating, if not precluding, signal prioritization and preventing effective use of the queue jumper lane.

Design Factors

When designed in combination with a right turn lane, these bus stops consist of a near-side right turn lane and a far-side open bus bay. Buses are allowed to use the right-turn lane to bypass traffic congestion and proceed through the intersection. The right turn lane should be marked with signs.[1]

2.13 Bus Bulb

Purpose

Bus bulbs, also called curb extensions or nubs, are extensions of the sidewalk into the parking lane. In areas where there are high volumes of pedestrian traffic (such as in traditional downtown areas), bus bulbs allow buses to make curb-side stops without weaving in and out of the travel lane. They also provide additional space for bus shelters, benches, and signage, and allow passengers to directly access sidewalks without having to cross between parked cars. Bus bulbs have a positive effect in reducing delays associated with buses reentering traffic lanes. On the other hand, they can also result in vehicles sometimes stacking behind stopped buses. Usually these queues are relatively short.[15] Figure 2.19 describes bus bulb dimensions. Refer to the *TCRP Report 65: Evaluation of bus bulbs* for further guidance. [16]

continued on page 60

Table 2.11 | Critical dimensions related to bus bays.

Through Speed (mph)	Entering Speed (mph)	Length of Acceleration Lane (feet)	Length of Deceleration Lane (feet)	Length of Taper (feet)
Urban				
25 or less	15 or less	80 (desired) 60 (minimum)	80 (desired) 60 (minimum)	-
Suburban				
35	25	250	184	170
40	30	400	265	190
45	35	700	360	210
50	40	975	470	230
55	45	1,400	595	250
60	50	1,900	735	270

Source: Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the Location and Design of Bus Stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press.

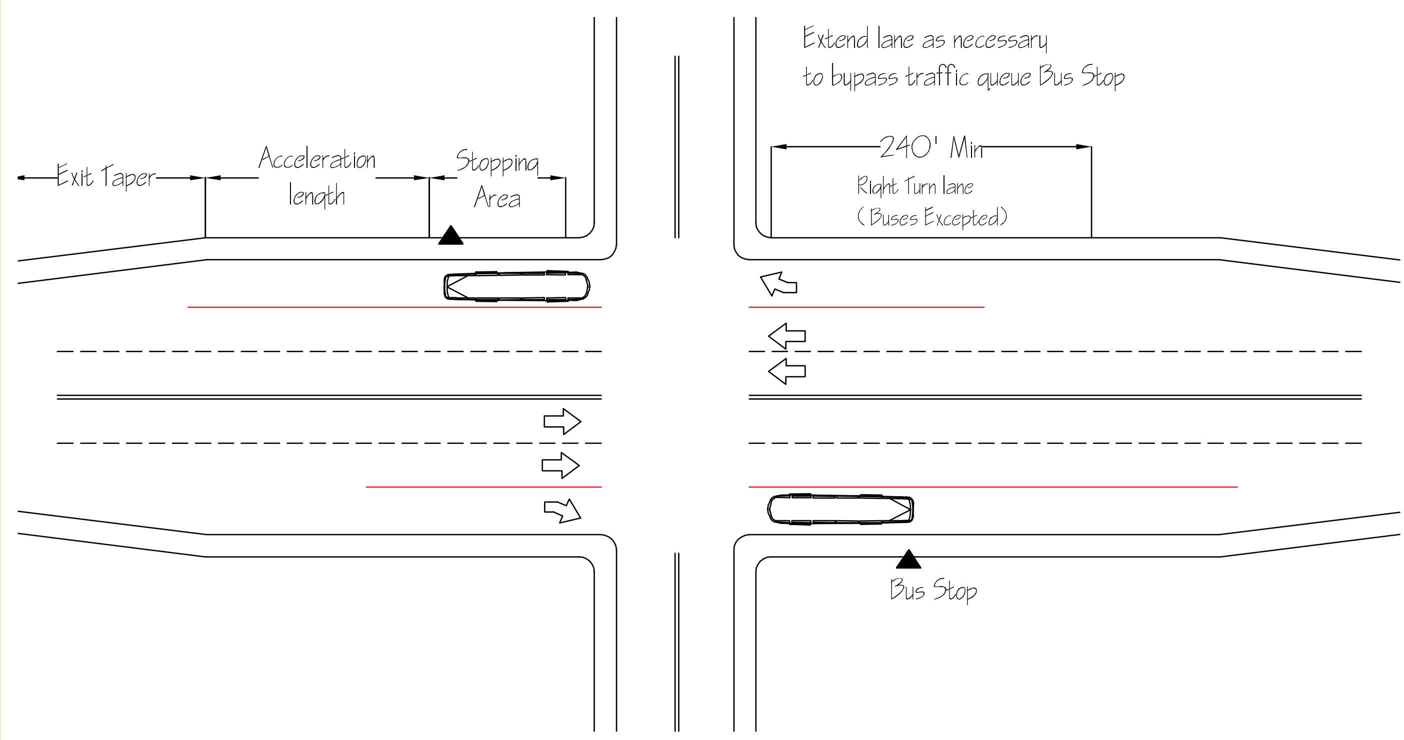


Figure 2.18 | Typical configuration and dimensions for a queue jumper bus bay.

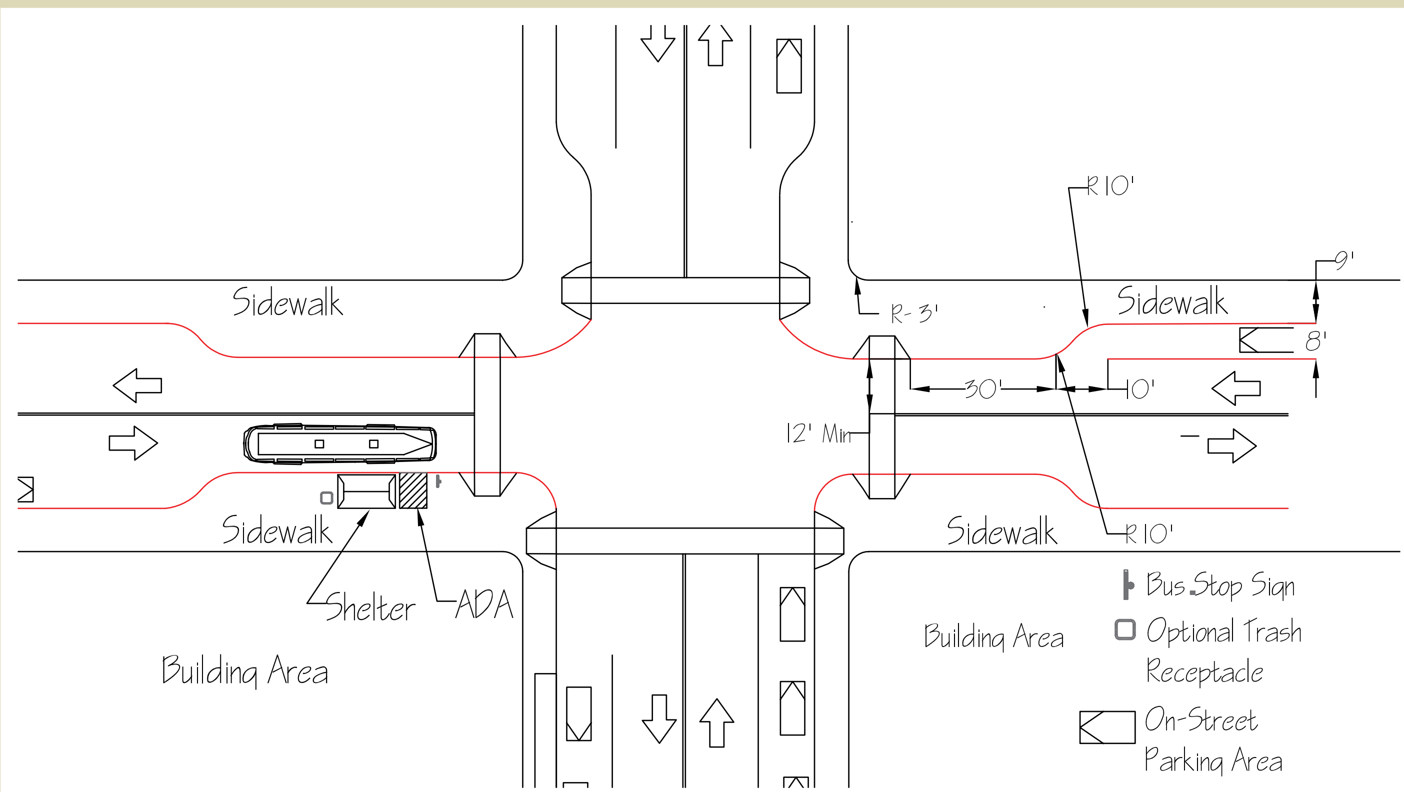


Figure 2.19 | Dimensions for a bus bulb.

Location Factors

Bulbs should be located:

- in areas where parking is critical (and bus bays may take up too much space);
- in areas where buses experience delays in re-entering the traffic lane;
- in areas where traffic calming is desired;
- on streets that are perceived to be pedestrian friendly;
- on the near-side of signalized intersections;
- on streets with design speeds upto 40 mph;
- in low traffic volume areas or on streets with diagonal or parallel parking; and
- where mid-block stops may be appropriate to serve a transit demand generator.

Bus bulbs should not be located:

- on streets with design speeds greater than 40 mph or high-volume facilities;
- where vehicle stacking behind a stopped bus is viewed as problematic; and
- at stops where the bus route requires the bus to make a right hand turn, unless the bulb precedes a right-turn lane.[2]

2.14 Off-Street Half-sawtooth Bus Bay

Purpose

Half-sawtooth bus bays are used in areas where space is limited in order to provide the optimum number of bus loading areas. The bay configuration allows buses to pull in and out of bays without having to wait for buses ahead of them to exit and without having to travel in reverse gear.

Location Factors

Compared to parallel bus bays, half-sawtooth bus bays require greater station width but allow for shorter stations. Half-sawtooth bus bays should be used at off-line transfer centers, where the length of the site is limited but where the depth of the site is adequate to accommodate bus movement in and out of bays. Half-sawtooth bus bays are also preferred at locations where parallel buses may result in delays caused by more than two buses stopping at one time.

Design Factors

The loading lane width shown in Figure 2.20 is the minimum berth length required for 40-foot buses with bus-mounted bike racks. The bus berth lengths must be increased by 20 feet for articulated buses.

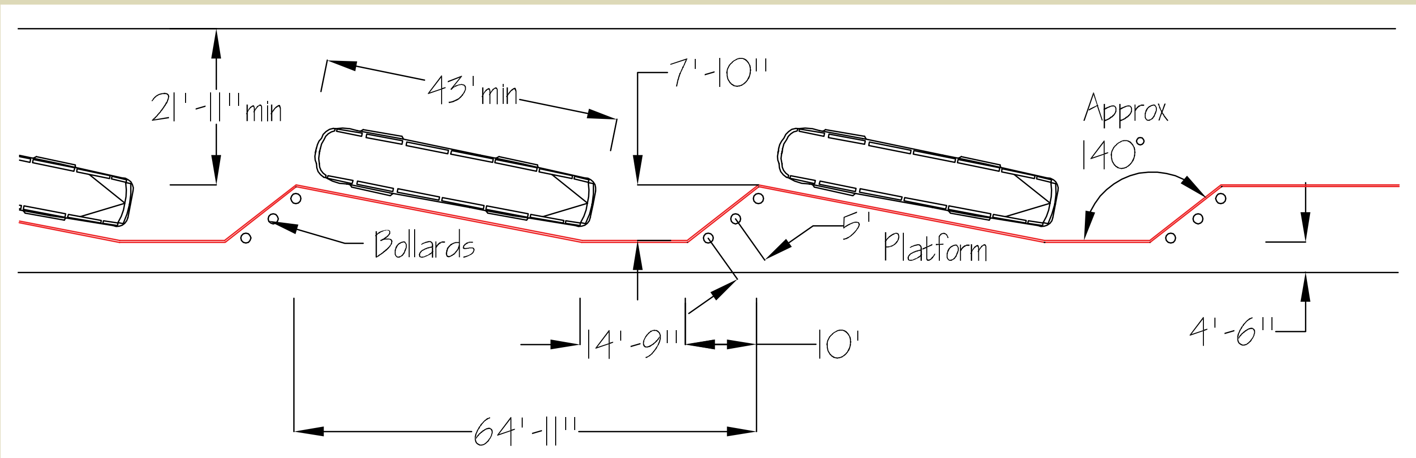


Figure 2.20 | Dimensions for an off-street half-sawtooth bus bay for a 40-foot bus equipped with a bike rack.

2.15 Bus Stops and Railroad Crossings

Purpose

Maintaining the recommended stop spacing is often difficult due to the presence of impediments like railway crossings. At the same time, it is important that transit facilities do not become hazards for pedestrians, bicyclists, and non-transit vehicles. The following guidelines address the limitations of potential locations for bus stops at railway crossings. Requirements related to minimum distances for transit facilities, sight distances, and clear zone requirements are also included.

Location Factors

When possible, it is recommended to place bus stops on the near side of a railroad crossing to avoid creating a queue that would conflict with the crossing. Near-side bus stops shall be located so that railroad warning signs are not obstructed by a stopped bus. The stopping sight distance for a bus stop near a railway crossing is shown in Figure 2.21 and Table 2.12.

Design Factors

See Indices 17346 and 17882, FDOT's *Design Standards* for railroad marking and sign details. [16] For near-side or far-side bus bays, provide a minimum of 50 feet to the nearest rail line.[16] For ADA landing pad requirements, see Chapter 1.4.

Table 2.12 | Near-side bus stop placement at railway crossings.

Near-Side Bus Stop Placement	
Design Speed (mph)	***AASHTO Stopping Sight Distance (SSD) (FT)**
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730

* Minimum value calculated based on providing appropriate stopping sight distance to railroad crossing. Distances should be verified based on the specific design conditions of each crossing.

Source: Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.*

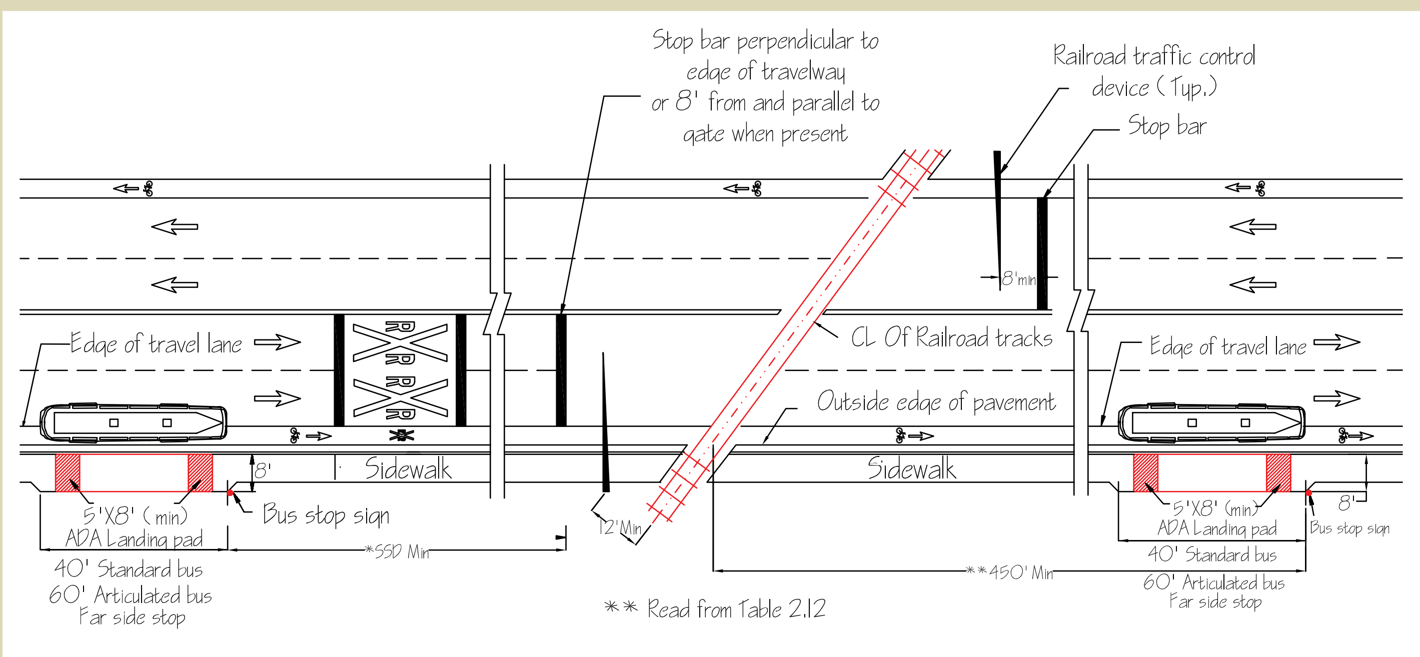


Figure 2.21 | Bus stop and railway crossing.

2.16 Bike Lanes

Purpose

Bike lanes are portions of the right of way set aside for exclusive or preferential use by bicyclists. They are designated by striping, signage and surface treatments. If properly designed, bike lanes provide a viable transportation network in a balanced transportation system. Additional information on bicycle facilities can be found in the *Guide for the Development of Bicycle Facilities* published by the American Association of State Highway and Transportation Officials.[17] FDOT has bicycle policies and design criteria that can be found by looking on both the Design Office website and the Safety Office website.

Design Factors

Bike networks should connect with other modes of transportation. Use of bikes in combination with public transit ensures improved low-density, urban and suburban public transportation. However, in designing bike lanes, conflict with other modes of transportation should be minimized. When conflict is inevitable, the shared area should be marked for visual attention. For example, when a bus stop is located in a bus bay, a potential conflict results between bicycles and transit vehicles. To alert to such potential conflict, dashed line pavement markings are used where buses are allowed to move in and out of bike lanes. Figure 2.22 shows a recommended bike lane treatment for such cases.

2.17 Pedestrian Crossings

Purpose

Pedestrian systems and vehicle systems overlap at intersections, posing conflicts between different modes of travel. Marked crosswalks guide pedestrians to walk at the safest location and alert vehicle operators to the potential of a pedestrian's presence. Crosswalks are essential to bus passengers who may have origins or destinations on either side of the roadway. It is preferable that all streets that are directly served by transit, therefore, should also be designed or retrofitted to serve crossing pedestrians. Streets within walking distance from a transit stop should be designed to accommodate pedestrians as well with an emphasis on pedestrian safety.[18] Appendix H provides guidelines on Pedestrian Improvement Thresholds.

Location Factors

At a minimum, pedestrian crossings should be provided at the following locations. For regulations pertaining to marked

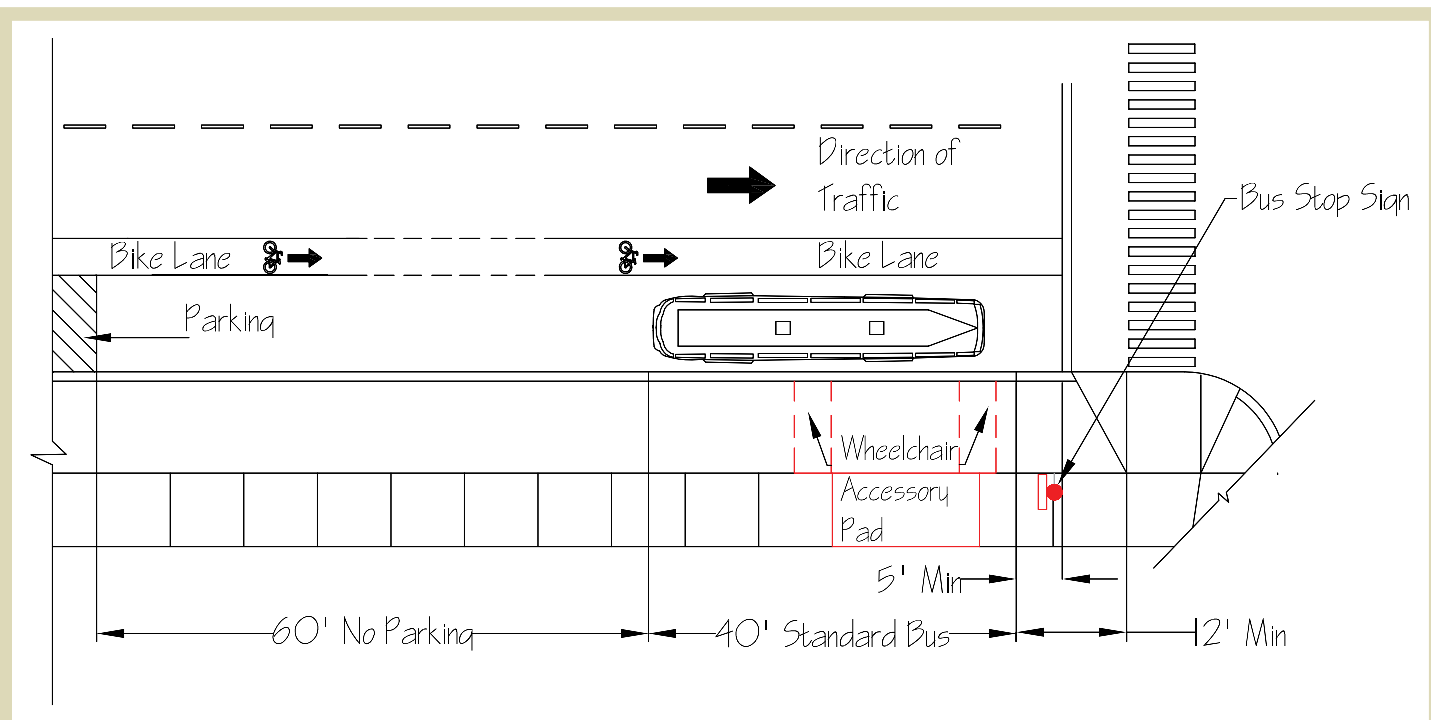


Figure 2.22 | A typical bike lane-curb side bus stop configuration.

crosswalk in uncontrolled locations and mid-block crosswalks refer to Section 8.3.3 and Subsection 8.3.3, *Plans Preparation Manual* respectively: [14]

- intersections where bus passengers are required to cross streets to transfer between routes;
- signalized intersections in urban areas with marked crosswalks on all four corners unless there is a specific reason to direct pedestrians to alternative crossing locations;
- where a marked crosswalk can channel pedestrians to a single crossing location;
- where there is a need to delineate an ideal crossing location due to confusing street geometries; [7] and
- unsignalized intersections where there are no signalized crossings within 600 feet.

Conditions for not providing crosswalks at unsignalized intersections are:

- the posted speed is greater than 40 mph,[15]
- a roadway with four or more lanes without a raised median or crossing island has (or will soon have) average traffic of 12,000 vehicles per day or greater, or
- a roadway with four or more lanes with a raised median or crossing island has (or will soon have) average traffic of 15,000 vehicles per day or greater.[15]

In an area where major transit destinations and origins are located but where crosswalks would be dangerous, consideration should be given to installing a pedestrian bridge over the roadway if transit ridership would suggest such an investment.

Design Factors

The number of delineated crossing points combined with other devices might be increased as these might not reduce pedestrian safety, if driver yielding rates can be increased by enforcement. Crosswalks shall be no less than 6 feet wide. Crosswalks of at least 10 feet are preferred. Greater widths may be necessary where the volume of pedestrian traffic is high. Crosswalk and pavement markings increase the visibility of the crosswalk. Section 3E.01, MUTCD allows use of colored pavement between white lines at crosswalks if it does not degrade contrast. [5] Too much pavement texturing, however, negatively impacts wheelchair and cane users.

ADA-compliant curb ramps (two per corner preferred) should be provided at all crosswalks, marked and unmarked. See Figure 2.23. Curb ramps should not interfere with free access to the bus stop. Bus stop locations should not be interrupted by curb ramps. Instead, an ADA landing pad should be installed (see Chapter 1.4).[2] Where the curb ramp is completely contained within a planting strip or other non-walking surface, so that pedestrians would not normally cross the sides, the curb ramps can have steep sides, and even be vertical returned curbs.[2]

Sidewalks should be constructed along both sides of arterial roadways that are not provided with shoulders, even though pedestrian traffic may be light.[2] If a raised central median extends into the crosswalk, an ADA compliant channel must be provided through the median.[19] Crosswalks should have an audio component to signal to the blind when it is and is not safe to cross.

2.18 Intersection Nubs

Purpose

Intersection nubs are extensions of the sidewalk, usually into the parking lane, that reduce pedestrians' crossing distances and make pedestrians more visible to drivers. They should be designed to allow for bus turning movement and can form bus bulbs that allow buses to make curb-side stops without weaving in and out of the travel lane. They also have a traffic calming effect.

Location Factors

Nubs are appropriate in areas where there are significant volumes of pedestrian traffic and at intersections with roads that have parallel or diagonal on-street parking. See Figure 2.24. Nubs should be avoided at intersections where the bus route requires the bus to make a right turn. They should also be avoided in low speed central business districts to avoid congestion of traffic.

Design Factors

Nubs should extend into the street for the width of a parking lane. Nubs should be used at mid-block crossings where feasible.

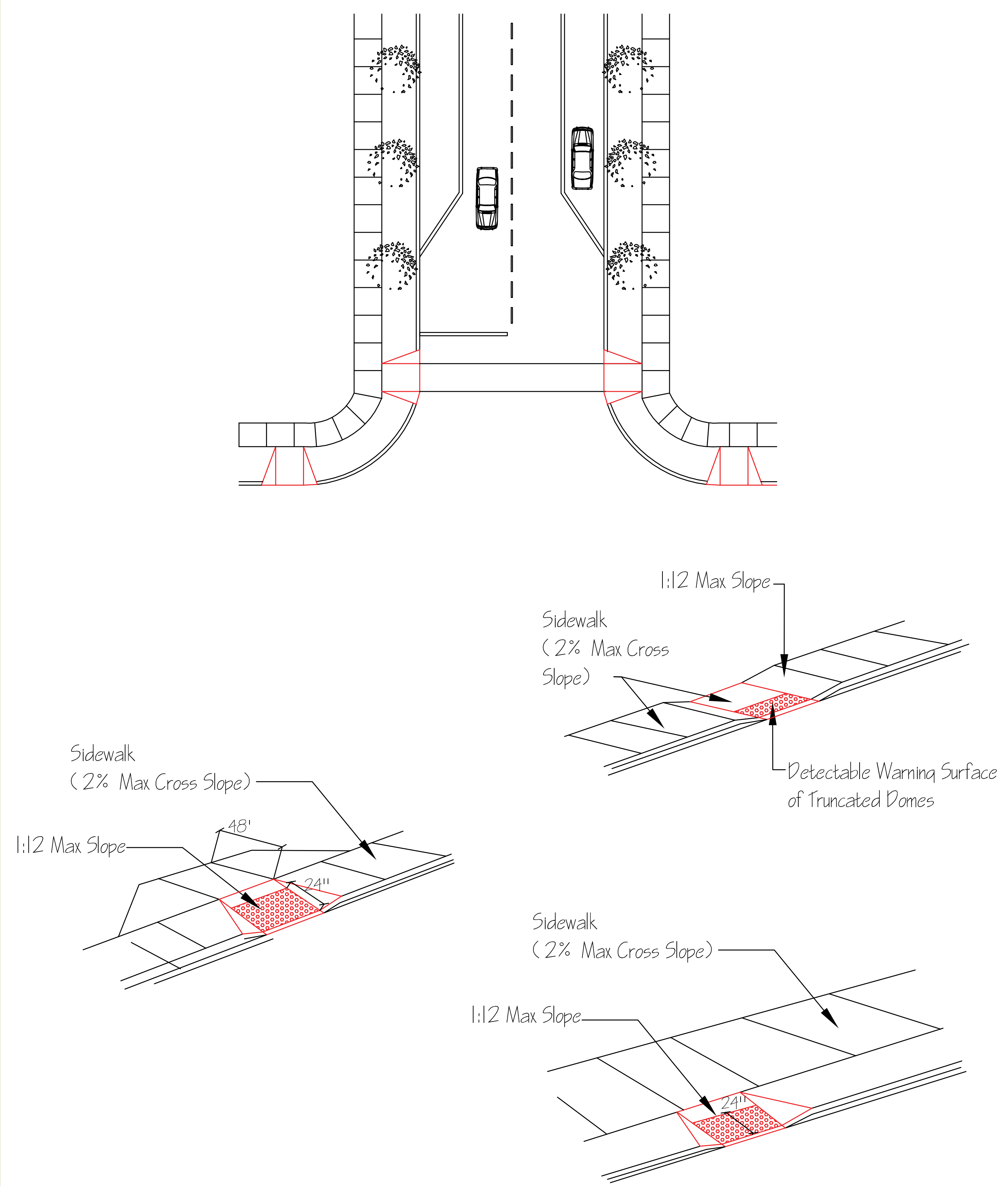


Figure 2.23 | Alternatives for accessible curb ramps.

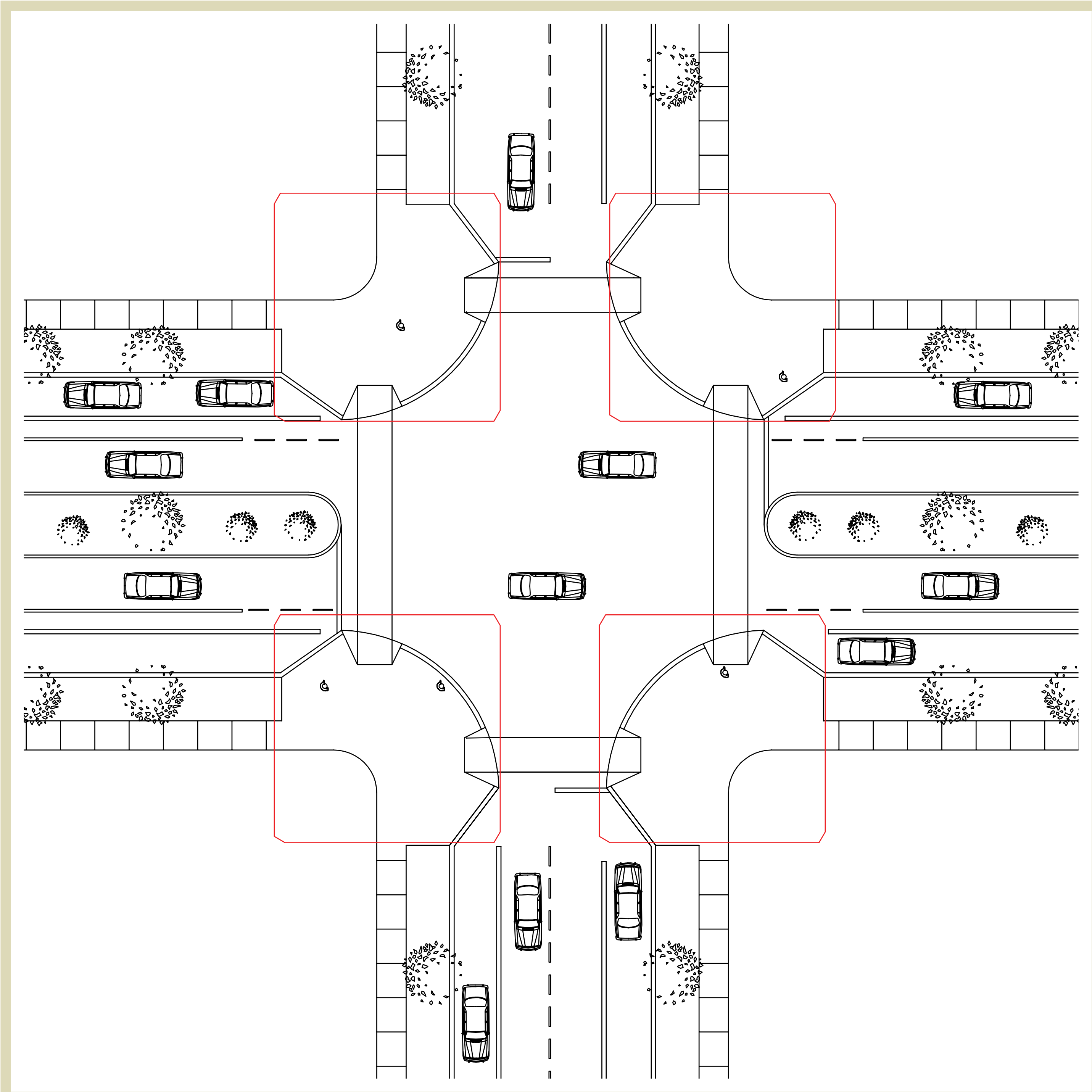
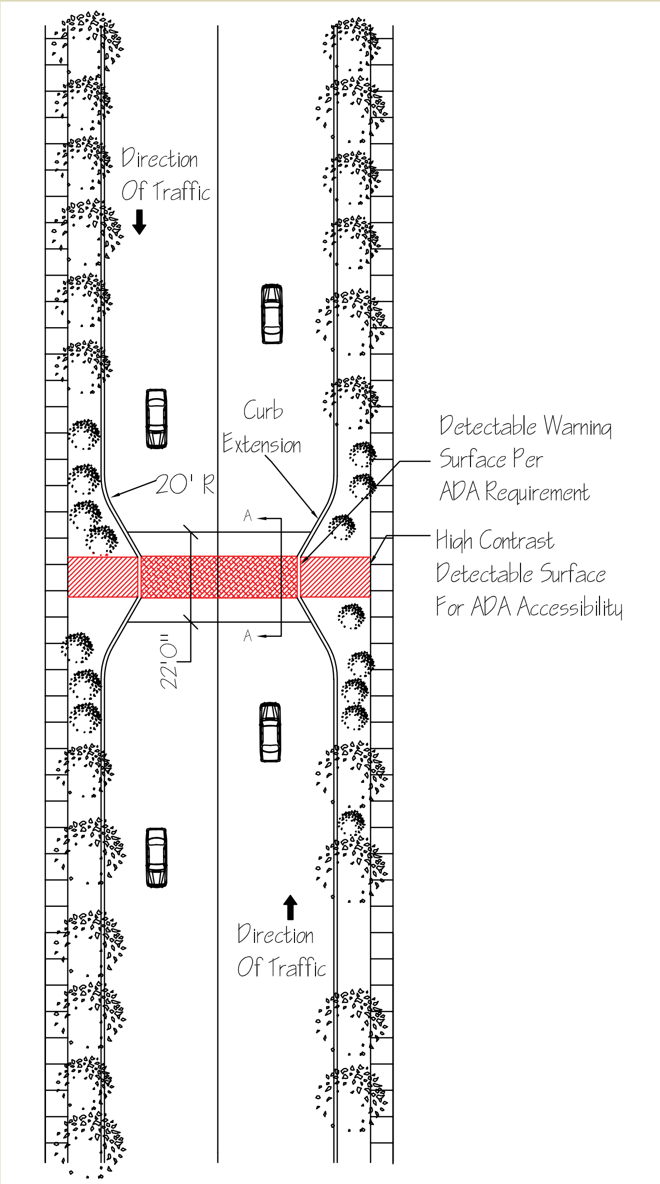


Figure 2.24 | A street intersection improved with pedestrian nubs.



Figures 2.25 | A raised pedestrian crosswalk.

2.19 Raised Pedestrian Crossing/Speed Table

Purpose

Speed tables raise the surface of the road over a short distance and promote the smooth flow of traffic at slow speeds at pedestrian crossings. However, they may make travel difficult mechanically and may result in passengers' discomfort. [15]

Location Factors

Speed tables are useful in central business districts or in other areas where there is a high volume of pedestrians.[15] See Figure 2.25. Neverthless, they are not appropriate for the state highway system or for high speed or high volume roadways.[15]

Design Factors

The most common type of speed table is 3 to 4 inches high and 22-feet long in the direction of travel. It has 6-foot ramps at the ends and a 10-foot field on top. This design generally produces an 85th percentile speed of 25 to 30 mph. Varying dimensions achieve desired target speeds for given applications. [15] See Figure 2.26.

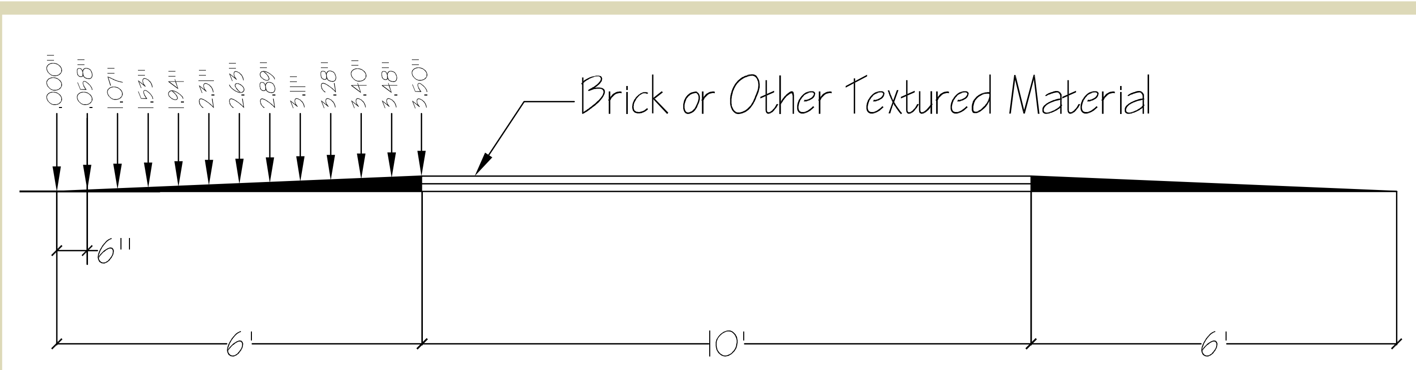


Figure 2.26 | A raised pedestrian crosswalk in cross section.

2.20 Pedestrian Islands

Purpose

Pedestrian islands (also known as refuge islands) are extensions of the median into the crosswalk area in order to improve safety for pedestrians and vehicles. They provide an area within an intersection where pedestrians may safely wait until vehicular traffic clears, allowing them to cross streets. These islands are particularly helpful for older and disabled pedestrians unable to cross the street during the available signal time. See Figure 2.27.

Location Factors

Pedestrian refuge islands work well on multilane streets and where long pedestrian crossing distances exist.

Design Factors

Pedestrian islands should be a minimum of 6 feet wide by 8 feet long. They should be well illuminated by curb-side street lighting. A raised central median extending into the crosswalk must have an ADA compliant cross-channel.[15]

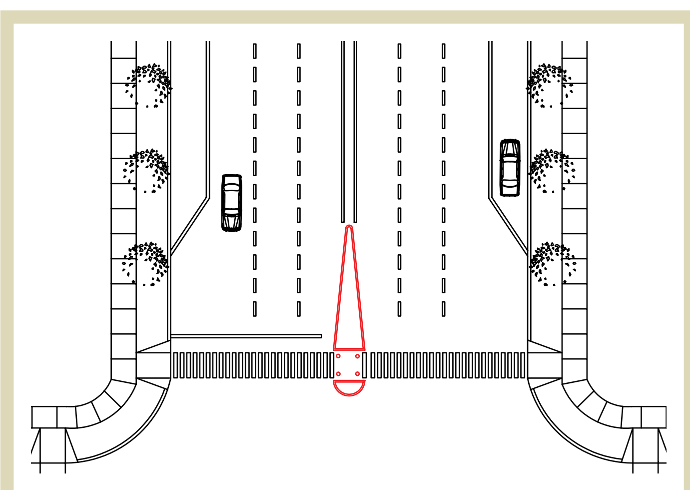


Figure 2.27 | A street intersection improved with a pedestrian island.

2.21 Transit Provision During Construction

Typically, roadway construction or improvement projects should have a Temporary Traffic Control Plan (TTCP), which is a set of specific sheets, references to standard (typical) layouts, and/or notes on roadway plans describing how traffic should be controlled through a work zone. If a road improvement project affects transit services, transit agencies should be involved in the planning of traffic control during construction.

The following should be considered while drafting a TTCP:

At transit stops, provisions should be made to ensure passengers can safely board and depart from transit vehicles. For instance, careful consideration should be given to transit operations and necessary arrangements should be made to minimize inconvenience to transit patrons.

- Traffic control devices should not be placed in locations where they will block transit stops or passenger access to stops.
- When detours are required, the geometry of the detour route should be compared against the operational requirements of transit vehicles. While designing detours, ADA requirements should be considered.[2]
- If a transit stop or route needs to be relocated, appropriate signage and advance notification to passengers should be provided.

Text References

(Endnotes)

1 Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press.

2 Florida Department of Transportation. (2008). *Districts 1 and 7 transit facility standards and guidelines.* Tampa, FL: Florida Department of Transportation District 1 & 7.

3 Chada, S., & Newland, R. (2002). *Effectiveness of bus signal priority.* Tampa, FL: National Center for Transit Research, Center for Urban Transportation Research, University of South Florida.

4 Fellows, R., & Fuhs, C.A. (2002). *Geometric design for transit facilities on highways and streets – phase I: Interim guide.* Houston, TX: Parsons Brinckerhoff.

5 Federal Highway Administration, U.S. Department of Transportation. (2003). *Manual on Uniform Traffic Control Devices* (MUTCD). Retrieved June 5, 2008, from http://mutcd.fhwa.dot.gov/index.htm

6 Florida Department of Transportation. (1996). *Florida roundabout guide.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/TrafficOperations/Doc_Library/PDF/roundabout_guide8_07.pdf

7 Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/transit/Pages/UpdatedD4TransitFacilitiesGuidelines.pdf

8 Grand Junction/Mesa County Metropolitan Planning Organization. (2003, July). *Transit design standards and guidelines.* Retrieved November 22, 2003, from http://www.gjcity.org/CityDeptWebPages/PublicWorksAndUtilities/Transportatio nEngineering/TEFilesThatLINKintoDWStoreHere/TEDS/TRANSITREGS.pdf

9 Bonanno v. Cent. Contra Costa Transit Auth., 30 Cal.4th 139 (2003). Retrieved June 5, 2008, from http://caselaw.lp.findlaw.com/ca/cal4th/30.html

10 Fla. Admin. Code Ann. r. 14-20.0032 (2008).Retrieved June 5, 2008, from https://www.flrules.org/gateway/RuleNo.asp?ID=14-20.0032

11 Florida Department of Transportation. (2005). *Driveway handbook.* Retrieved June 5, 2008, from http://www.accessmanagement.info/pdf/FL_Driveway_Handbook.pdf

12 Florida Department of Transportation. (2002). *Flexible pavement design manual.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/PavementManagement/pcs/2002%20Flexible%20Pavement%20Manual.pdf

13 Florida Department of Transportation. (2004). *Rigid pavement design manual.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/pavementmanagement/pcs/RigidPavementDesignManual.pdf

14 Florida Department of Transportation. (2008). *Plans preparation manual.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/rddesign/PPMManual/2008/PPM2008.htm

15 Fitzpatrick, K. (2001). *Evaluation of bus bulbs* (Transit Cooperative Research Program Report 65). Washington, DC: National Academy Press.

16 Florida Department of Transportation. (2006). *Design standards,* Index Nos. 17346 and 17882. Retrieved June 5, 2008, from http://www.dot.state.fl.us/rddesign/rd/RTDS/06/2006Standards-17k.htm [FYI: 2008 design standards have been posted.]

17 American Association of State Highway and Transportation Officials. (1999). *Guide for developing bicycle facilities.* Washington, DC: AASHTO Task Force on Geometric Design.

18 Tri-County Metropolitan Transportation District of Oregon. (1995.) *Planning and design for transit handbook: Guidelines for implementing transit supportive development.* Portland, OR: Tri-County Metropolitan Transportation District of Oregon.

19 City of San Diego. (2002). *City of San Diego street design manual 2002.* San Diego, CA: City of San Diego Street Design Manual Advisory Committee and City of San Diego Planning Department.

Text References

Image credits for images by others

2.1 Image and caption retrieved from http://www.dft.gov.uk/consultations/archive/2004/ltnwc/coll_ltn104policyplanninganddesi/dft_localtrans_028706-3.jpg on 25th July, 2007

2.2 Image and caption retrieved from http://www.southeastroads.com/florida050/i-095_nb_exit_006a_01.jpg on 25th July, 2007

2.3 Florida Department of Transportation Districts One and Seven. (2007). *Transit facility handbook.* Retrieved June 10, 2008, from http://www.dot.state.fl.us/transit/Pages/FDOT_D1_D7_Transit_Facility_Handbook.pdf

2.4 Tri-County Metropolitan Transportation District of Oregon. (1996). *Planning and design for transit handbook: Guidelines for implementing transit supportive development.* Portland, OR: Tri- County Metropolitan Transportation District of Oregon.

2.5 Tri-County Metropolitan Transportation District of Oregon. (1996). *Planning and design for transit handbook: Guidelines for implementing transit supportive development.* Portland, OR: Tri- County Metropolitan Transportation District of Oregon.

2.6 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida mobility design manual.* Orlando, FL: Central Florida Regional Transportation Authority. Revised by LYNX, 2000

2.7 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida mobility design manual.* Orlando, FL: Central Florida Regional Transportation Authority. Revised by LYNX, 2000

2.8 Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press., retrieved on May 20, 2008, from http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_19-b.pdf

2.9 Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved on May 20, 2008, from http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_19-b.pdf

2.10 Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved on May 20, 2008, from http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_19-b.pdf

2.11 Fellow R. and Fush C. (2002). *Geometric Design Guide for Transit Facilities on Highways and Streets - Phase I. Interim Guide.* Washington D.C.: American Association of State Highway and Transportation Officials.

2.12 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

2.13 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

2.14 Image and caption retrieved on June 8, 2008 from http://www.cutr.usf.edu/research/nuti/busway/Image95.gif

2.15 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

2.16 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

2.17 Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

Text References

Image credits for images by others

2.18 Texas Transportation Institute, Texas A. & M. Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

2.19 Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/transit/Pages/UpdatedD4TransitFacilitiesGuidelines.pdf

2.20 Texas Transportation Institute & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops* (Transit Cooperative Research Program Report 19). Washington, DC: National Academy Press. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

2.21 Florida Department of Transportation District 4. (2007) *Transit facilities guidelines.* Retrieved June 5, 2008, from http://www.dot.state.fl.us/transit/Pages/UpdatedD4TransitFacilitiesGuidelines.pdf

2.22 Sacramento Regional Transit District. (1988). *Design guidelines for bus and light rail facilities.* Sacramento, CA: Regional Transit.

2.23 Florida Department of Transportation District 4. (2007) *Transit facilities guidelines*. Retrieved June 5, 2008, from http://www.dot.state.fl.us/transit/Pages/UpdatedD4TransitFacilitiesGuidelines.pdf

2.24 Image retrieved on March 25, 2004, from http://www.dot.state.fl.us/rddesign/rd/RTDS/00304s1- 5of5.pdf

2.25 The City of San Diego. (2002). *The City of San Diego street design manual 2002.* San Diego, CA: City of San Diego Street Design Manual Advisory Committee and the City of San Diego Planning Department. Retrieved Dec. 18, 2003, from http://www.sannet.gov/ planning/pdf/peddesign.pdf

2.26 The City of San Diego. (2002). *The City of San Diego street design manual 2002.* San Diego, CA: City of San Diego Street Design Manual Advisory Committee and the City of San Diego Planning Department. Retrieved Dec. 18, 2003, from http://www.sannet.gov/planning/pdf/peddesign.pdf

2.27 The City of San Diego. (2002). *The City of San Diego street design manual 2002.* San Diego, CA: City of San Diego Street Design Manual Advisory Committee and the City of San Diego Planning Department. Retrieved Dec. 18, 2003, from http://www.sannet.gov/ planning/pdf/peddesign.pdf

CHAPTER THREE

FACILITY PROTOTYPES

This page left intentionally blank

CHAPTER THREE: FACILITY PROTOTYPES

3.1 Introduction

This chapter provides transit agencies and others with facility prototypes that show different combinations of the elements described in the first two sections.

Those elements have been developed as a kit of parts that can be assembled by agencies in different ways. Specific combinations depend on the site, the facility function, the transit agency's operational plans, land availability, and the available budget. The handbook places an emphasis on relatively low-cost facilities with interchangeable elements to allow for easy maintenance.

The development patterns represented in the handbook are mostly typical of Florida's relatively low density, auto-oriented urban and suburban fabric. This development pattern, like most of the urban contexts faced by transit agencies, poses specific mobility and accessibility challenges for bus passengers and bus operators. Care has been taken to identify feasible methods of enhancing accessibility and mobility within these contexts. Appendix G provides bus passenger facility development thresholds. Appendix L provides the range of construction cost for all these passenger facilities.

Hierarchy of Bus Stops

Most transit systems consider their bus passenger facilities within a hierarchy based on the number of passengers or bus routes served. The hierarchy used here includes local on-line bus stops, primary bus stops, transit malls, university transfer centers, transfer centers, park-and-rides, air-bus intermodal centers, rail-bus intermodal centers, and bus rapid transit centers.

Each prototypical facility in this section is accompanied by a description of the facility and the site, the required site area, a description of pedestrian connections and connections to other modes of transportation, and an inventory of the individual design elements that are combined to create that facility.

When designing these facilities on or accessing state roadways, it is advised that agencies consult the Florida Department of Transportation's *Project Development and Environment Manual* (PD & E Manual)[1] and its *Plans Preparation Manual* (PPM)[2]. *State Park and Ride Lot Program Planning Manual* should also be considered. [3]

Other kinds of facilities also exist. The most common of these is the simple unsheltered bus stop without a bench. The standards for these stops can be found in the design guidelines in the first section of the handbook. At the other end of the spectrum are intermodal centers and transit terminals, large, expensive facilities that accommodate passengers transferring between local and intercity buses or local buses and taxis, passenger vehicles, and other transportation modes. Because their construction almost always involves the hiring of an architect and/or structural engineer, and because they represent a significant capital outlay (often achieved through a partnership among local governments, the state department of transportation, and the Federal government), we have not attempted to reproduce in this handbook the complex process of design, architectural programming, and transit planning necessary to build these facilities. Such endeavors usually require agencies to write requests for proposals for architectural design services, transit planning, and facility post occupancy evaluation. Appendix F contains sample language for a request for proposal for a bus stop evaluation program.

FACILITY PROTOTYPES

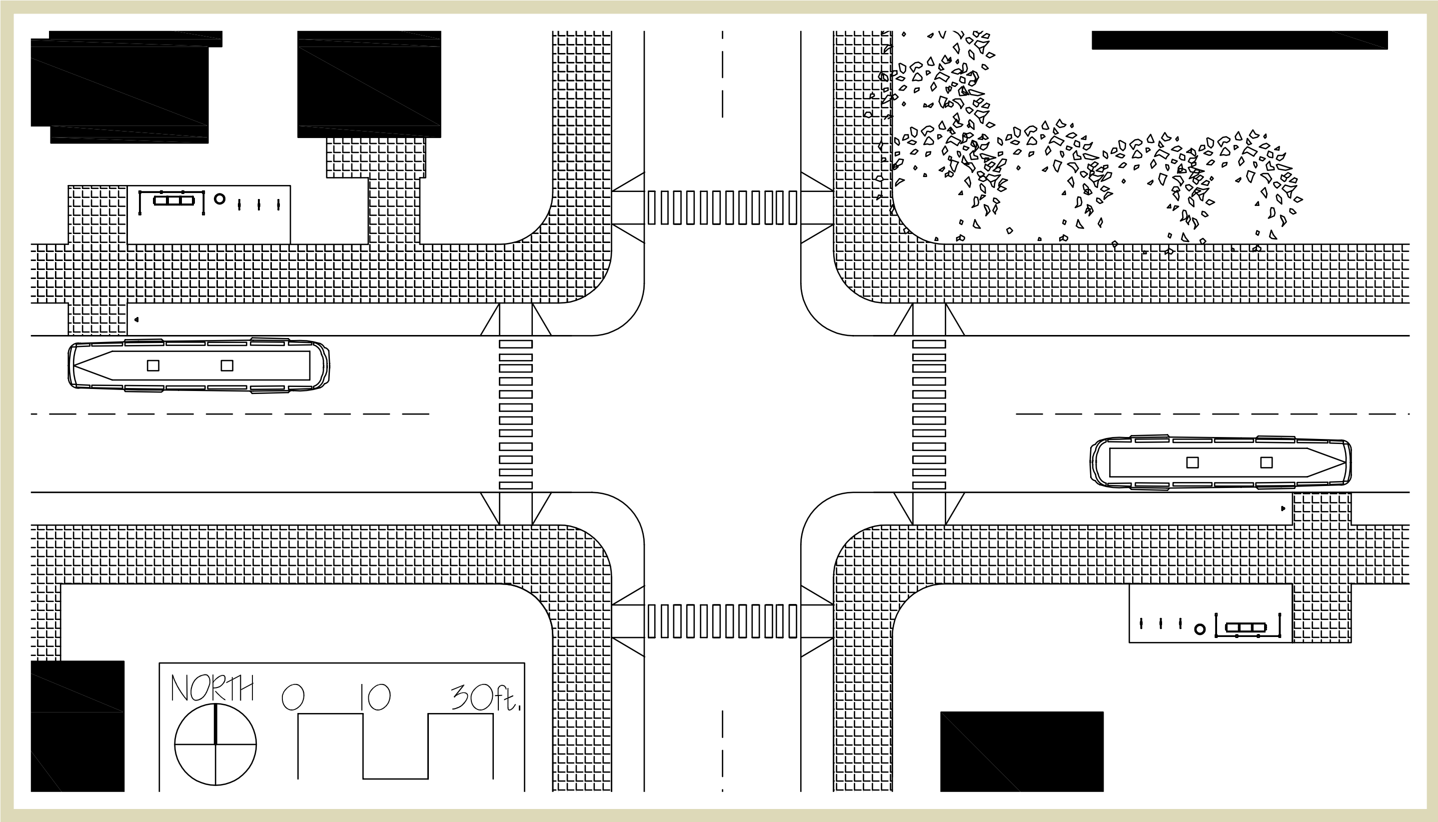


Figure 3.1 | Typical curb-side, on-line sheltered bus stops located at the far-side of an intersection.

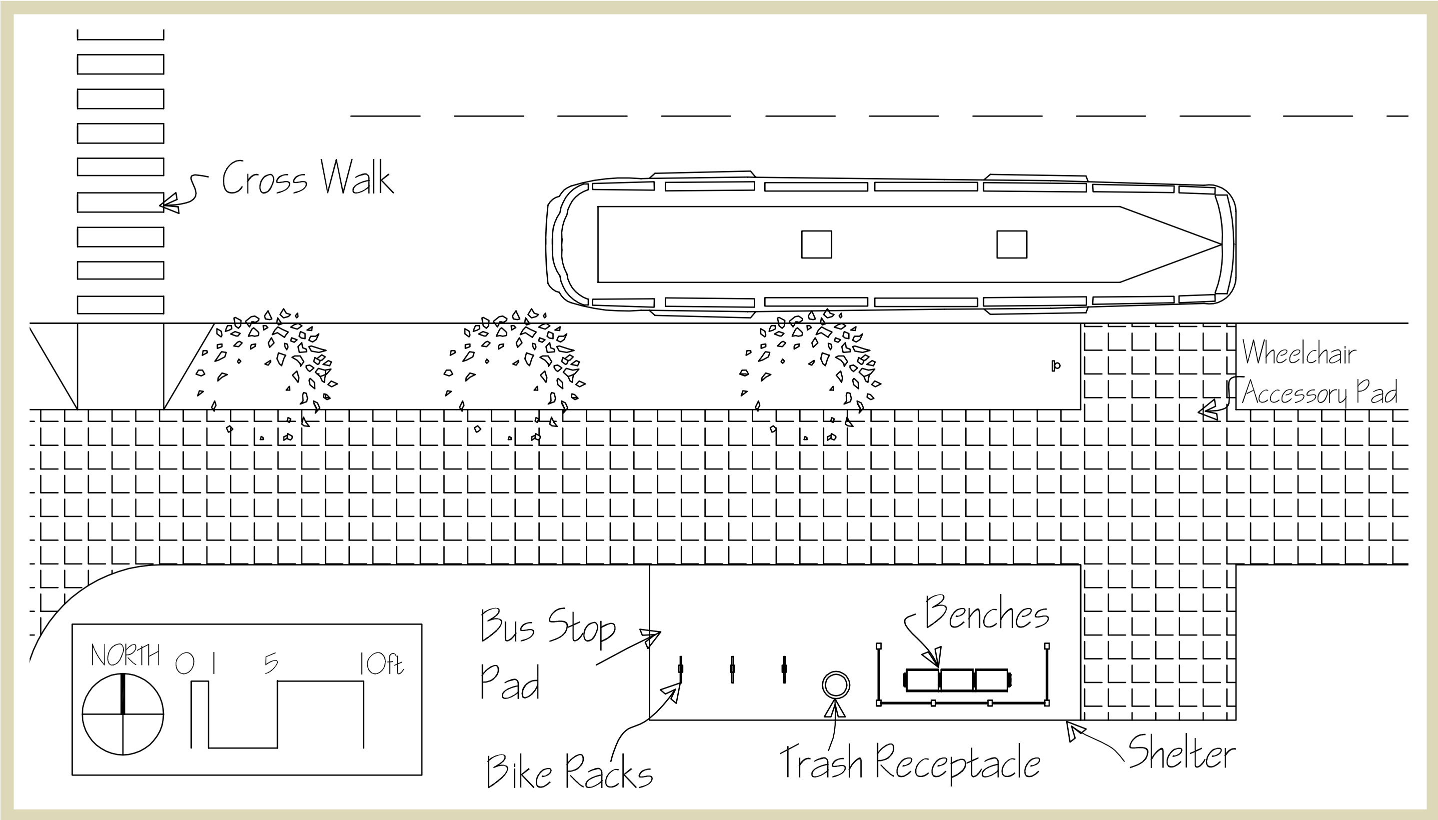


Figure 3.2 | A detailed plan of an on-line curb-side bus stop.

3.2 On-Line Bus Stop

On-line bus stops provide access to transit in a variety of locations. They may be located in the rights of way of arterial roadways or collector streets and, in some cases, along local roads. They may also be adjacent to a variety of land uses. The facility should connect pedestrian ways with bus loading areas and sidewalks should provide connections to nearby passenger destinations.

A prototypical site plan is depicted in Figure 3.1. Figure 3.2 shows a detailed plan with a landing area that complies with ADA Guidelines.[4] Figures 3.3 and 3.4 depict on-line stops in Volusia County and Hillsborough County, Florida.

Adjacent Land Use

Commercial district.

Approximate Site Area

200 square feet each.

Street Characteristics

Collector street with stop signs, sidewalks on both sides of the street, no street side parking.

Bus-side Elements

Far-side or near side curb-side bus stop.

Curb-side Elements

Sheltered bus stop with bench, trash receptacle, and bike racks on transit landing pad.

Pedestrian Connections

Sidewalk connections to landing pad and bus loading area, connected across streets with crosswalks.

Figure 3.3 | A near-side on-line bus stop with a shelter provided by shelter manufacturer in Raleigh, NC.

Figure 3.4 | A view of a near-side on-line bus stop with a custom shelter in Orlando, FL.

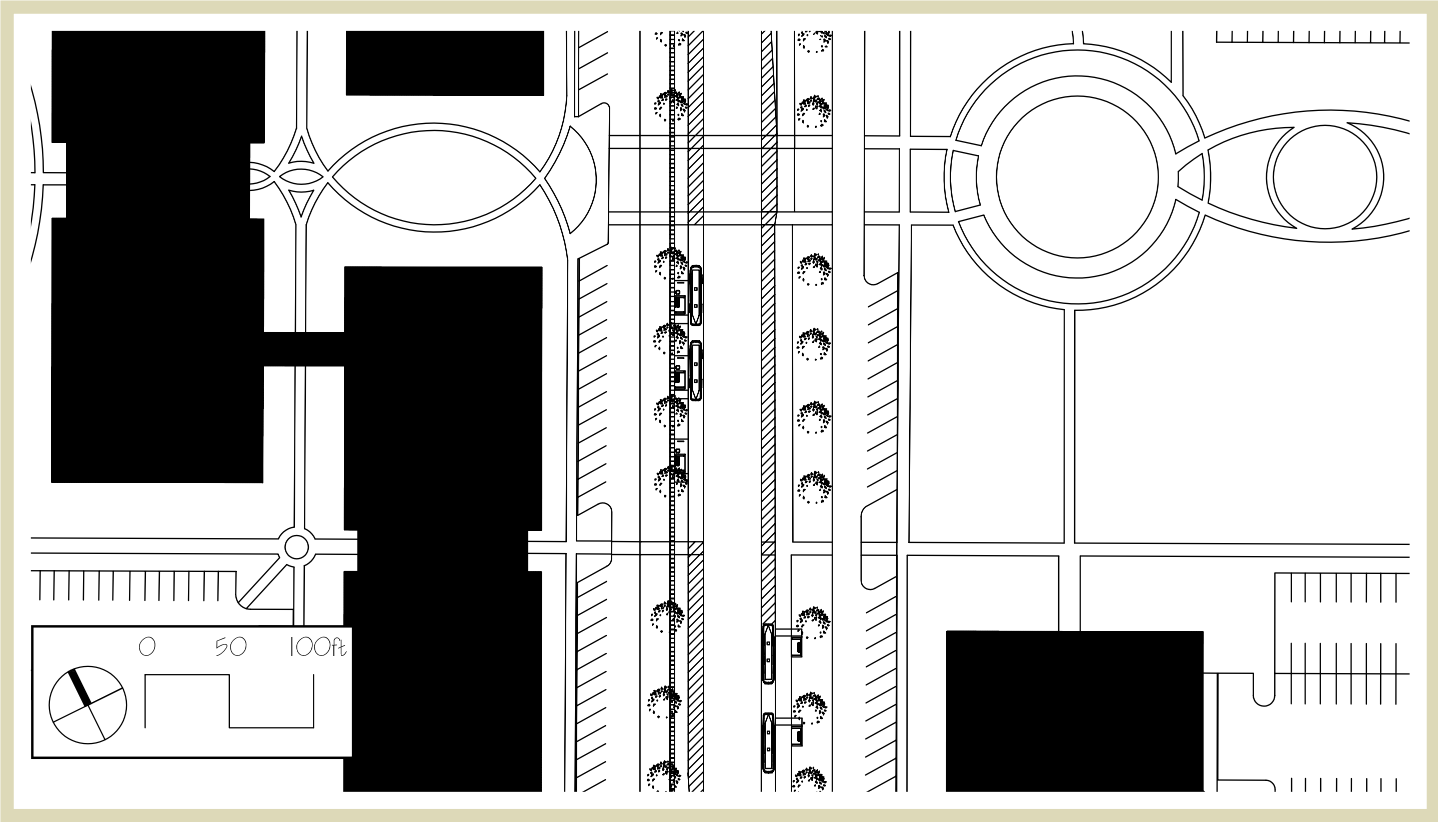


Figure 3.5 | A primary bus stop serving three routes located near an employment center.

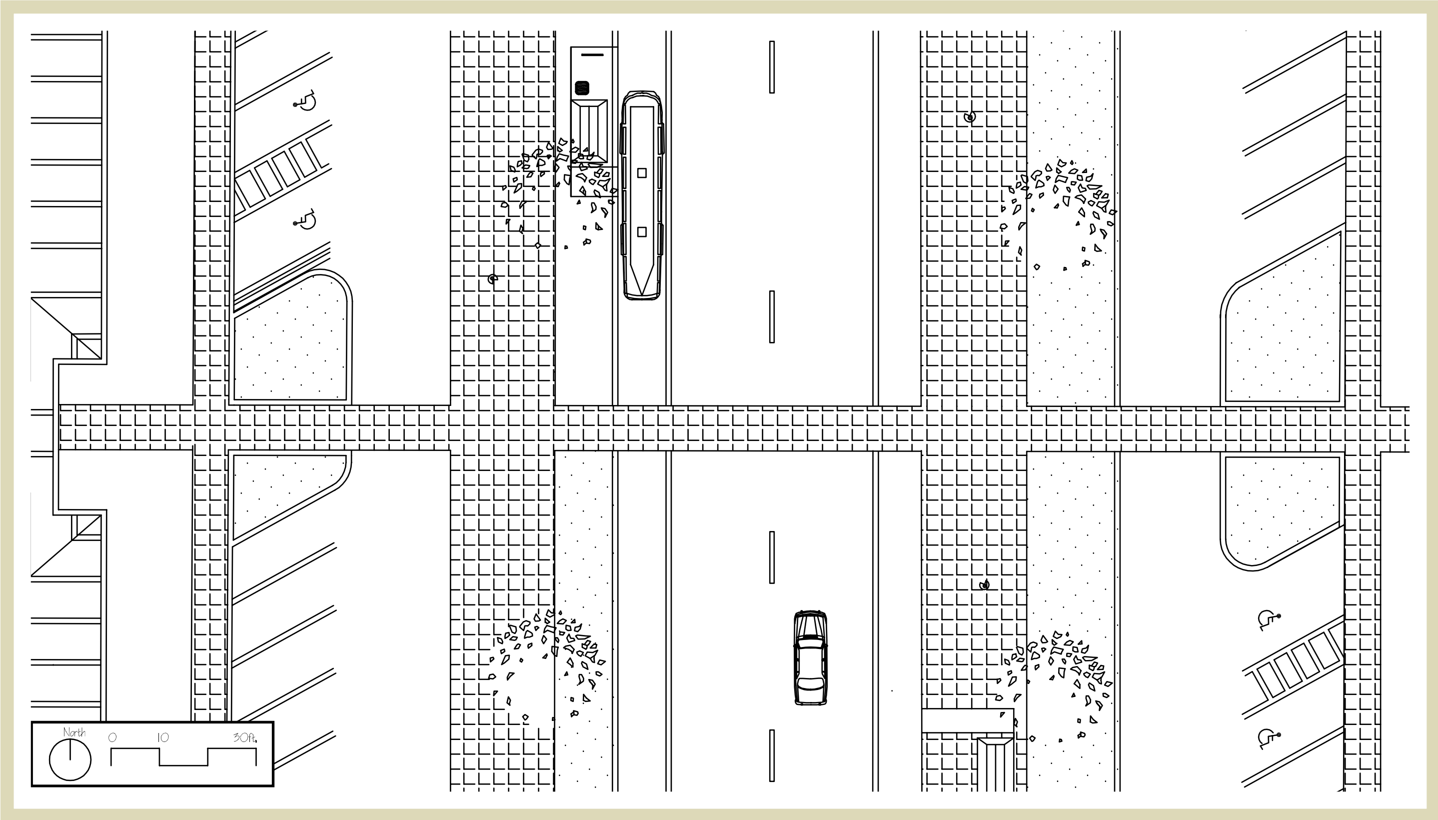


Figure 3.6 | A detailed plan of a primary bus stop.

3.3 Primary Stop

Primary stops provide transit access to important destinations whose density of employees or residents results in either high peak hour use or regular use several times a day. The facility may also serve as a transfer point for passengers transferring between routes. A crosswalk with textured surface helps to alert drivers to pedestrian movement and acts, although in a limited way, as traffic calming.

Figure 3.5 depicts a typical employment center site while Figure 3.6 shows a detailed plan and Figure 3.7 shows a view of the primary stop prototype facility.

Adjacent Land Use

Office park employment center.

Approximate Site Area

600 linear feet per side by 40 feet deep.

Street Characteristics

Limited access arterial with signalized intersections, sidewalks on both sides, no streetside parking.

Bus-side Elements

Bus bay.

Curb-side Elements

Sheltered bus stop with bench and trash receptacle on transit landing pad.

Figure 3.7 | A view of a primary bus stop.

Pedestrian Connections

Sidewalk connections to landing pad and bus loading area, connected to building entrances.

3.4 Transit Mall

Transit malls provide transit access to traditional downtowns and commercial centers and serve as a base for local circulator service, express routes, and other special modes of bus transit. The facility may also serve as the first element in a bus rapid transit mode of service provision. See Section 3.9 for information on bus rapid transit.

Figure 3.8 shows a transit mall site. Figure 3.9 shows a typical road section for a transit mall. Figure 3.10 shows a detailed plan of the intersection. A stop along HARTline's downtown Tampa transit mall is depicted in Figure 3.11. A view of the transit center prototype is shown in Figure 3.12.

Adjacent Land Use

Mixed uses in a traditional downtown or center.

Approximate Site Area

40 feet wide dedication of total right of way.

Street Characteristics

Dedicated two-way busway located within a major arterial street.

Bus-side Elements

Curb-side stops in a dedicated busway.

Curb-side Elements

Sheltered bus stop with benches and trash receptacles on transit landing pads.

Pedestrian Connections

Sidewalk connects landing pads and bus loading areas at the transit station with building entrances via textured crosswalks with pedestrian refuges.

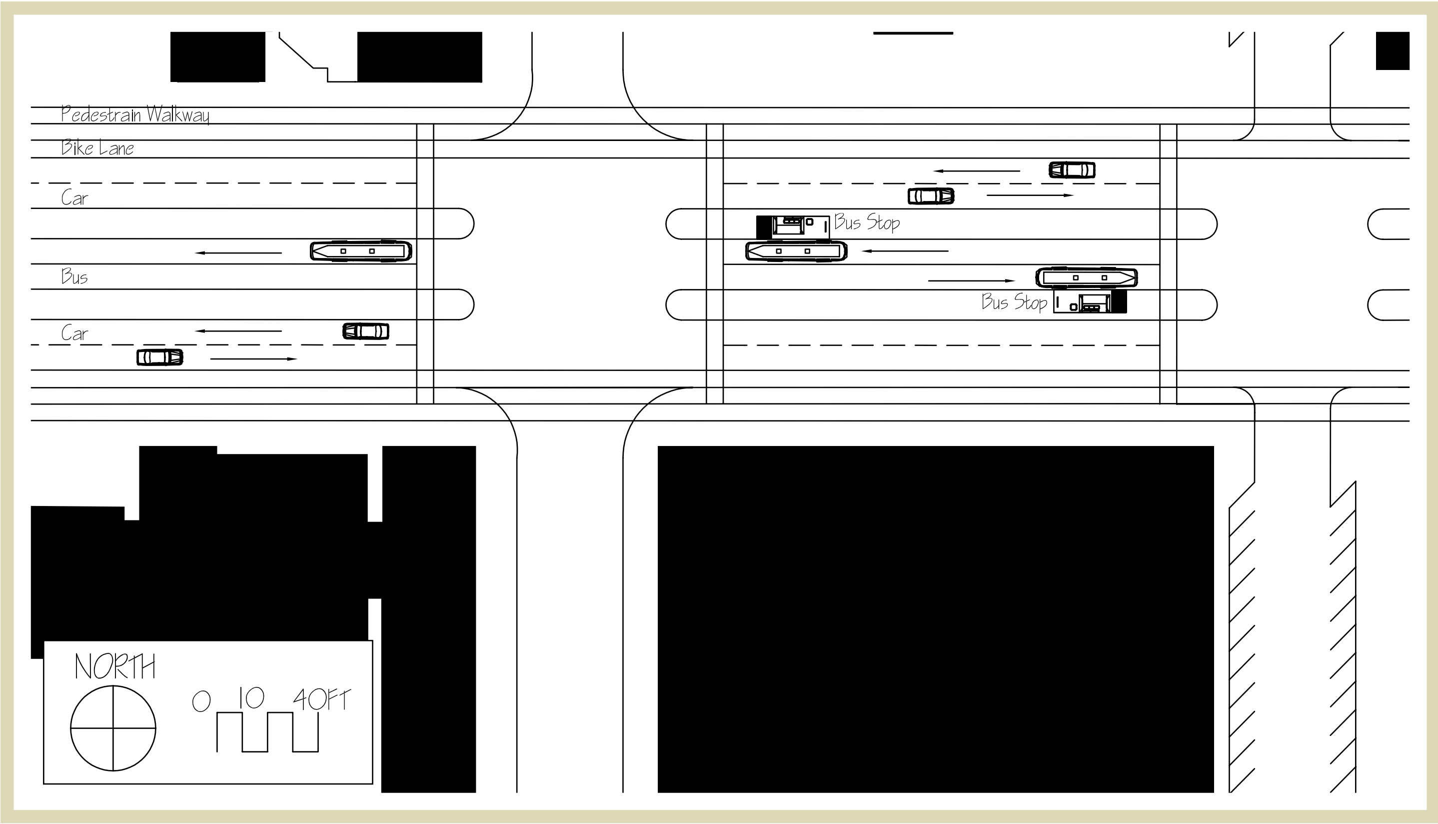


Figure 3.8 | A downtown transit mall with a dedicated busway.

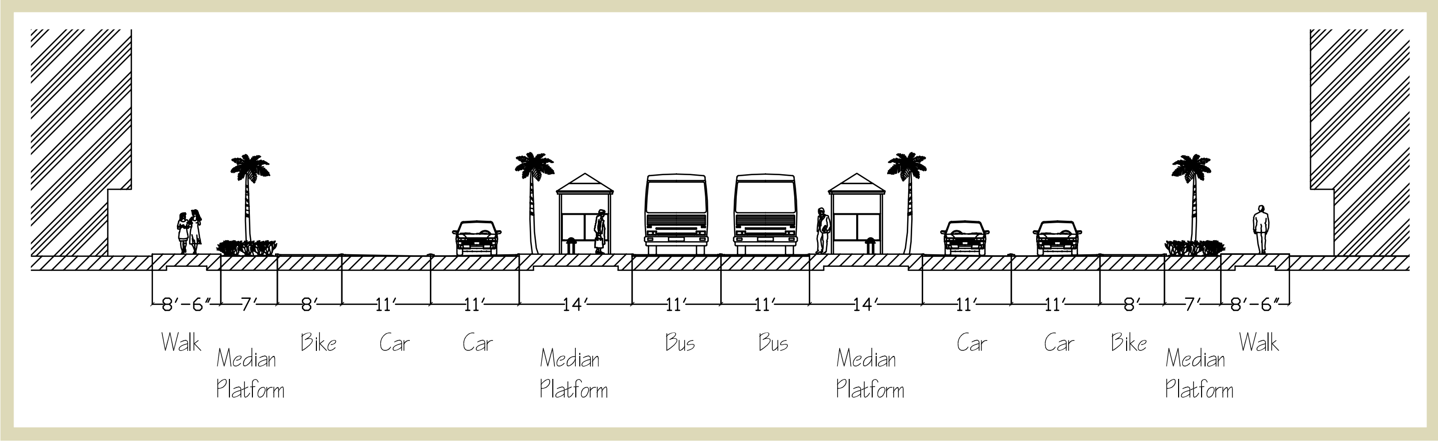


Figure 3.9 | Cross-section of the right of way for a transit mall.

FACILITY PROTOTYPES

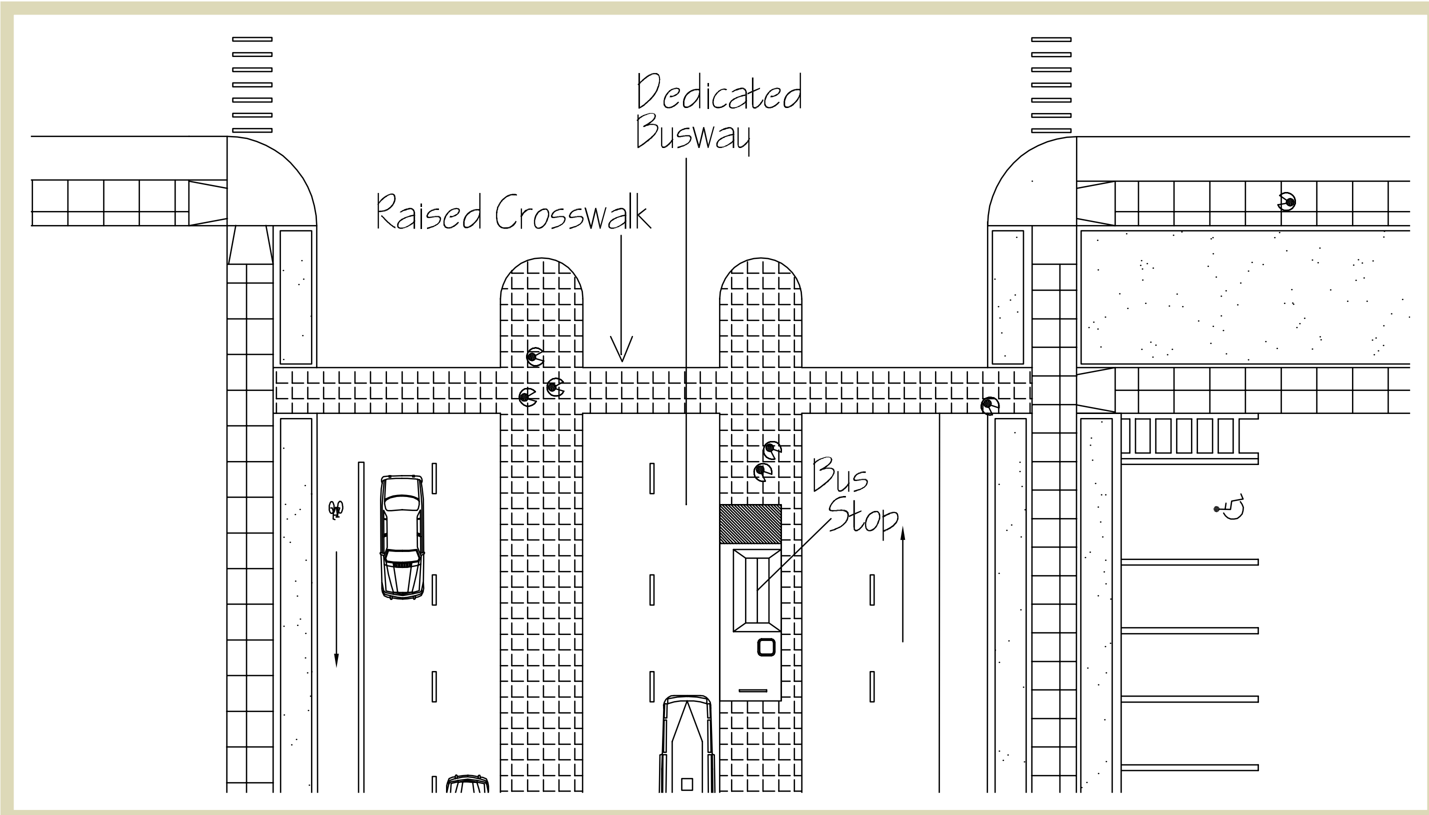


Figure 3.10 | Detailed transit mall plan.

Figure 3.11 | HARTLine's transit mall in downtown Tampa, FL.

Figure 3.12 | A view of a prototypical transit mall.

3.5 Transfer Center

Transfer centers serve as major nodes in the transit network connecting various regional and local bus lines and express routes and circulator services. Transfer centers are designed specifically to ease transferring between bus routes and between bus transit and other travel modes. They may also work as kiss and ride facilities. They are often located within major activity centers. Because they accommodate transferring passengers and multiple bus routes, transfer centers will operate most successfully if good way-finding devices are in place. For example, it is important to alert passengers to the correct bus berth with individual signposts.

Adjacent Land Use

Transfer centers are often located in the commercial or mixed-use zone in a major retail activity center. While the building orientation depicted in Figure 3.13 is not optimal, it is typical of development in Florida. Optimal land use configurations are discussed in Chapter 4 of this handbook.

Approximate Site Area

One and quarter acres.

Street Characteristics

Intersection of major arterials adjacent to a highway interchange. See Figure 3.13.

Bus-side Elements

Off-line center with dedicated bus travel lanes and half-sawtooth bus bays. See Figures 3.14 through 3.16.

Curb-side Elements

Sheltered bus stop with bench and trash receptacles.

Pedestrian Connections

Sidewalks connect landing pad and bus loading area at transit station with building entrances.

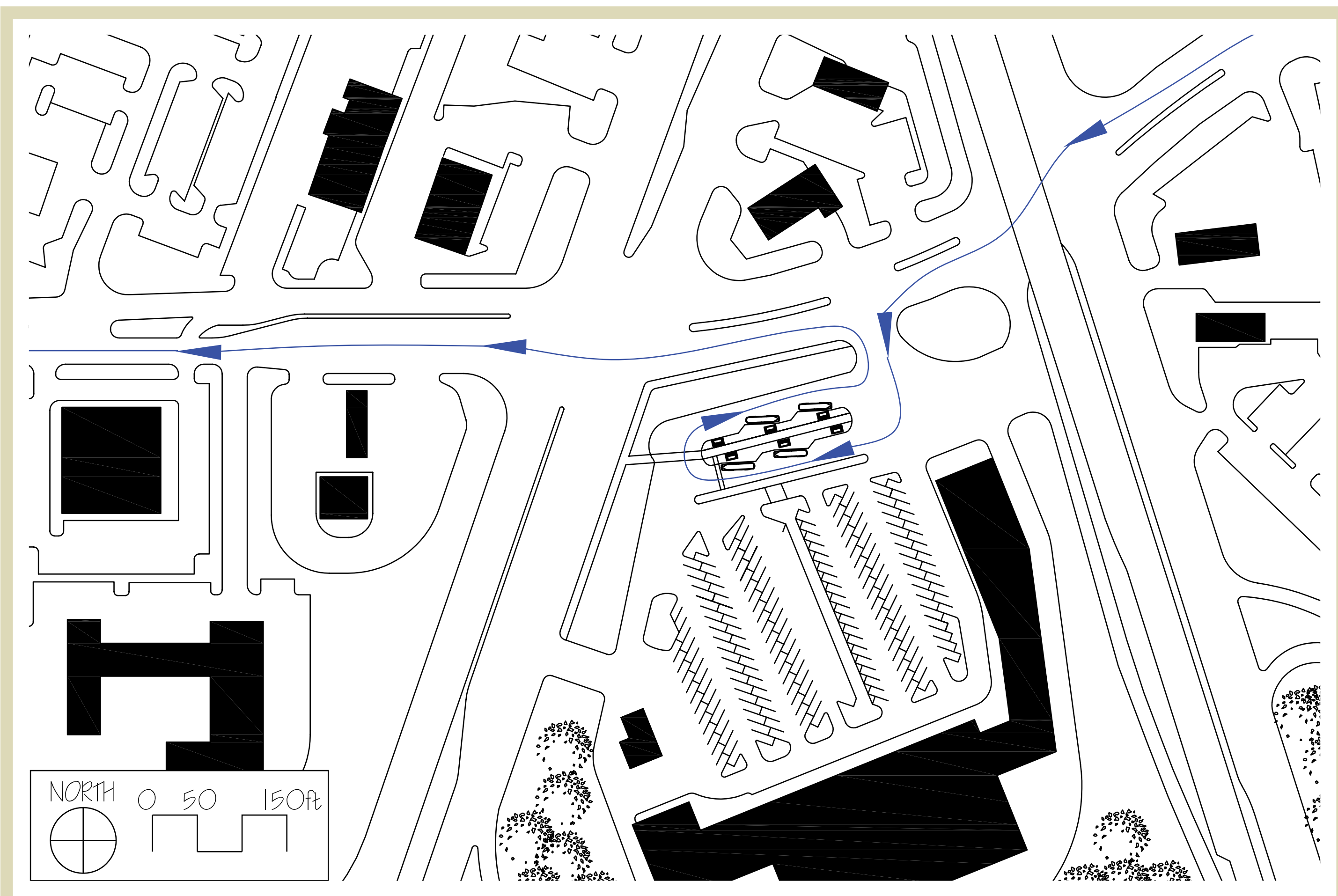


Figure 3.13 | A transit center located within a retail center near a highway interchange.

FACILITY PROTOTYPES

Figure 3.14 | A detailed view of a transfer center plan.

Figure 3.15 | A transfer center in St. Louis, Missouri.

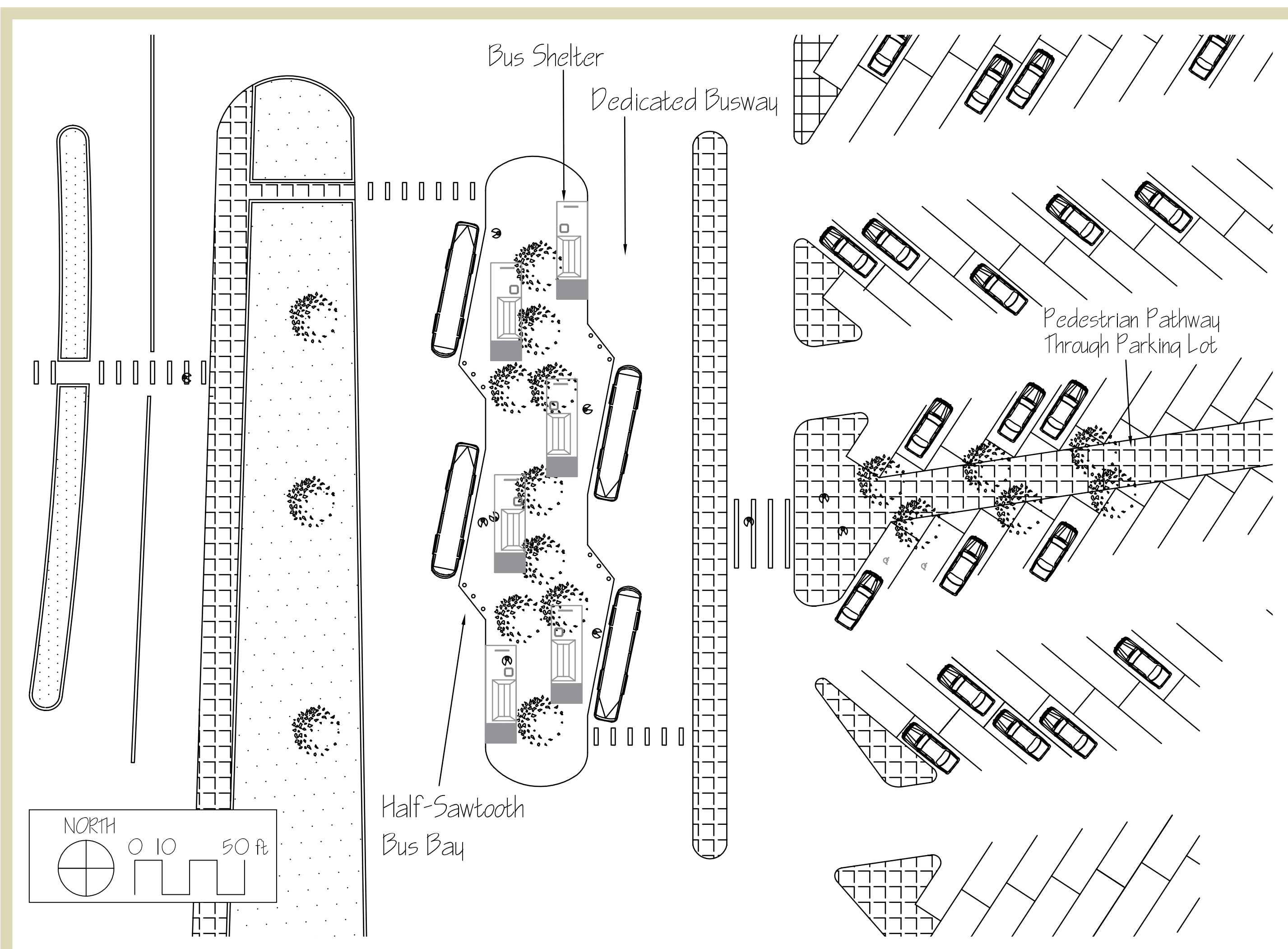
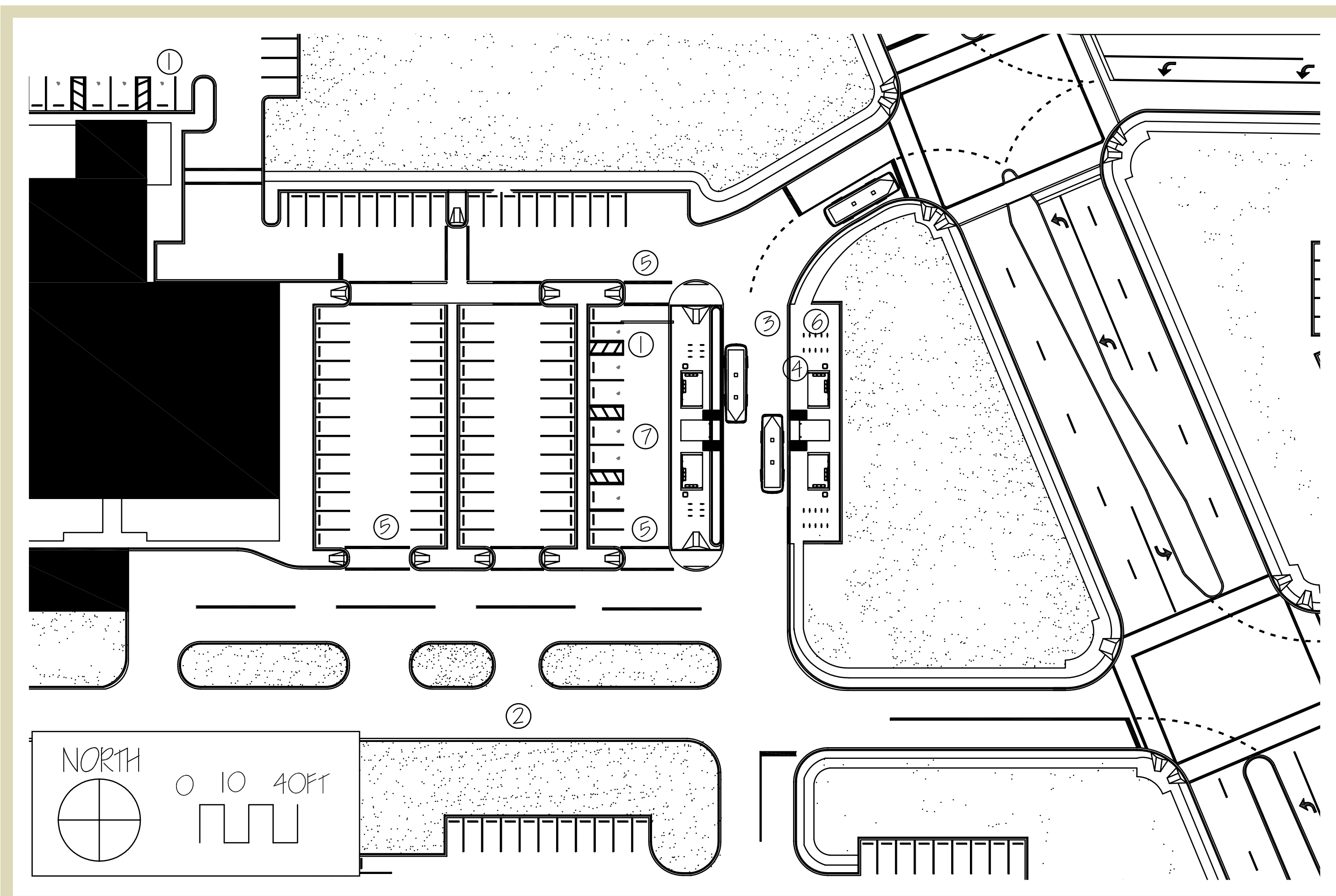


Figure 3.16 | A view of a transfer center.

3.6 Park-and-Ride Facilities

Park-and-ride lots intercept traffic flowing through a commuter shed toward a major employment destination. They are intermodal facilities that allow travelers to change their mode of travel from personal cars to transit. There are no set standards for such facilities and their designs are based on the specific characters of the individual sites on which they are located. They may be combined with other kinds of bus passenger facilities. The *State Park & Ride Lot Program Planning Manual* provides more detailed guidance to agencies seeking to implement park-and-ride facilities. [3]

Typical kinds of park-and-ride lots include suburban park-and-ride lots, peripheral park-and-ride lots, and joint use park-and-ride lots. Suburban park-and-ride lots are typically served by express routes collecting transit passengers near their homes. These facilities are located in suburbs and are likely to be used for long haul trips. Peripheral lots are generally located at the edges of activity centers. Joint use lots refer to lots where developments other than the transit facility are present. Figure 3.17 depicts a park-and-ride located in the parking lot of a church that also provides day care during the workweek. Libraries, meeting halls, sports facilities, theaters and commercial land uses along major



1. ADA Accessible Parking
2. Vehicle Access
3. Loading area
4. Waiting Area
5. Pedestrian Access
6. Bike parking
7. Kiss and Ride

Figure 3.17 | A site plan for a park-and-ride facility.

corridors which are not generally used during the workday are other potential sites for such facilities.

Facilities serving local routes are generally smaller and often require fewer amenities. Facilities serving express routes are often larger and require shelters, bus idling areas, and kiss and ride passenger drop-off areas. These should have a greater number of amenities including bike parking. Automobiles should be able to access the facility from collector or access roads intersecting arterials and bus turning movements in the direction opposite to incoming traffic should be avoided. A detailed plan of the bus passenger facility is shown in Figure 3.18 and a view of the prototypical facility is shown in Figure 3.19.

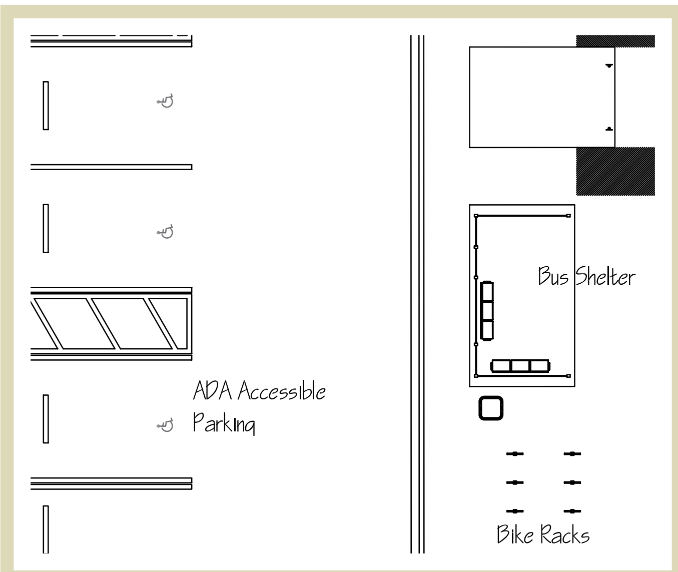


Figure 3.18 | A detailed plan for a park-and-ride facility.

Figure 3.19 | A view of a park-and-ride facility.

Adjacent Land Use

In suburban settings, park-and-ride facilities are often located within existing development. The challenge is to provide ease of access to transit in a car-friendly context. Figure 3.17 provides an example of a park-and-ride jointly developed with a church or other religious building providing day care during the week.

Site Considerations

The *State Park and Ride Lot Program Planning Manual* provides guidance to transit agencies on the site selection process for park-and-ride facilities.[3] Facilities should be located such that lots are connected to multiple streets and ensure minimum conflict with other traffic. The location of the facility should take area traffic patterns into consideration and provide for adequate queuing space for motorists to wait in cars before parking and transferring to transit. Locating facilities on the passenger side of a larger traffic stream can avoid conflicts with buses flowing in the opposite direction when bus vehicles attempt to enter the facility. Finally, the facility should be located and designed such that passenger safety, accessibility and convenience are maximized, and conflicts and congestion are minimized.

Street Characteristics

Major arterial that serves as a commuting corridor.

Bicycle and Pedestrian Connections

Walking distances between modes should be minimized. Safe, well lit, and convenient paths or walkways should connect the bus loading areas at multiple points and should limit the distance between any parked car and the loading zone to a maximum of 300 feet. Pedestrian walkways should be interconnected with resting areas and not conflict with other modes. If modal conflict cannot be avoided, crosswalks should be provided with clear markings. Sidewalks should be located next to curb-side parking lanes and loading areas. In the facility depicted in Figure 3.19, pedestrian connections, crosswalks and paths are provided through the parking lot to connect with the building entrance with sidewalks in the right of way.

Bus-side Elements

Figure 3.17 represents an off-line stop. Bus idling areas are located upstream from the loading area to ensure the possibility of unloading before idling. Loading areas are separate from roadways used by other vehicles and

continued on page 82

accommodate the largest bus sizes used by a transit agency. They allow buses access directly from the street. Vehicle access points are separate from access with other modes. The volume per lane should not exceed 250 cars per hour. There should be at least one access point for every 300 cars.[5]

Curb-side Elements

The facility depicted in Figure 3.19 is composed of a sheltered bus stop with benches in waiting areas, bike racks, trash receptacles and transit landing pads on a raised median accessed by dedicated busways.

Signage

Manual on Uniform Traffic Control Devices (MUTCD), FDOT and local guidelines should be followed to ensure clear, unobstructed and precise signs that can inform riders of the locations of park-and-ride facilities. [6] These should be easy to see from the street.

Parking

Park-and-rides require all day parking for commuters. Vehicle parking is located such that it is within 300 feet of the bus loading zone. The number of parking spots is determined on the basis of current and future ridership, but approximately 90 to 100 spaces per acre is a reasonable count for such facilities. ADA accessible parking is located closest to the loading area and should be accompanied by accessible routes throughout the facility. [4]

To reduce storm water runoff and the need for on site drainage material, permeable or semi permeable material can be used, including pervious paver blocks. Figure 3.20 illustrates a pervious paver system which consist of a layer of concrete paving blocks with small gaps or holes between them with a granular, leveling course material under it. A base rock section lies below this granular, leveling course. [7]

Figure 3.20 | Pervious paver block parking lot.

3.7 Air-bus Intermodal Transfer Centers

Intermodal transfer centers provide for fast, efficient transfers during a single trip. Bus transit systems that serve airports become an integral part of intermodal transportation systems. Bus services that provide "last mile" connectivity often receive significant ridership benefits. Given that many of these passengers are choice riders because of the nature of the traffic control of airports, these facilities are generally housed in permanent facilities and provide a full set of passenger amenities.

It is important to design air-bus intermodal transfer center with efficient modal transfer in mind. Poorly planned centers may slow down traffic for multiple modes, both on and off site. To avoid curb-side congestion, many air-bus transfer centers connect passengers to the airport and the bus passenger facilities with grade separated covered corridors. [5]

The management of airport ground access often impacts travelers' access to air-bus intermodal centers. Two types of access are generally recognized. Full access allows any licensed transportation operator to pick up and drop off passengers outside a terminal building. Exclusive concession agreements, on the other hand, permit only those with concessions to serve an intermodal center.

Air-bus transit facilities generally are of two types: proximate facilities and remote facilities. Proximate facilities typically attempt to minimize physical distances between travel modes. At an airport, curb-side space often provides the fastest and easiest link between buses and airplanes. See Figure 3.21.

Remote facilities provide connections between circulator bus service and the airport terminal. See Figure 3.22. Automated people movers, circulator buses, and moving sidewalks are all commonly used for enabling connections between air-bus intermodal centers and airport terminals.

Intermediary movement which does not add additional traffic to curb-side facilities is preferred. When such improvements

continued on page 84

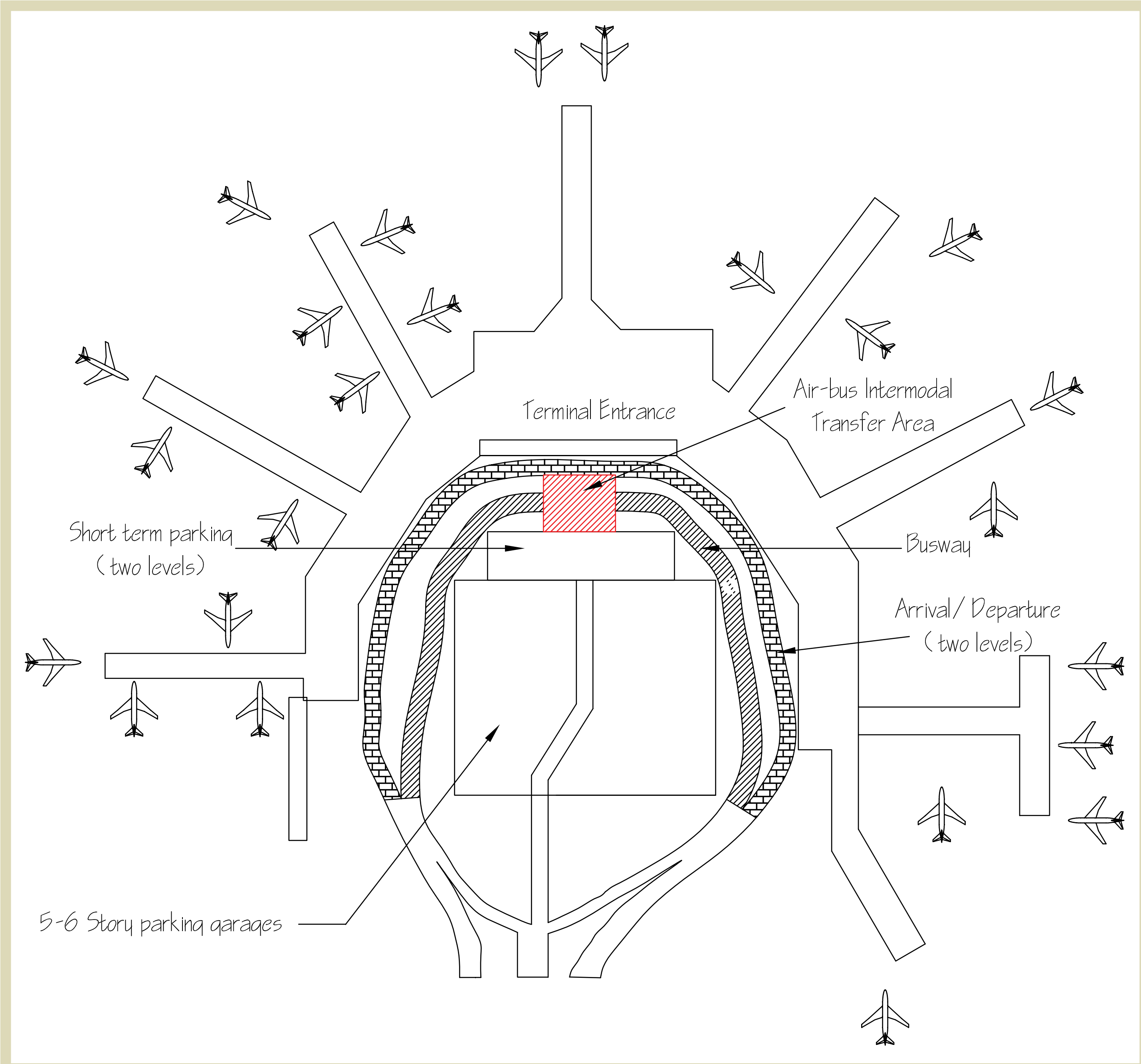


Figure 3.21 | A typical proximate model intermodal center.

are not feasible, other measures may be taken to reduce congestion. Amenities like a bus connection site, a passenger waiting area, a transit information desk and proper way-finding are recommended for efficient functioning of an intermodal center.

Adjacent Land Use

The nature of land use varies depending upon converging modes but tends to be commercial and travel related cargo services.

Approximate Site Area

The area could be 1 acre or larger but varies tremendously depending on the size of the airport, the number of transit agencies serving the airport and the amount of land available for development.

Street Characteristics

Along major arterials, close access to highways.

Bus-side Elements

Curb-side stops or sawtooth bays are most common.

Curb-side Elements

Completely sheltered bus stop waiting areas, benches, bike racks, trash receptacles, bathrooms, information areas, retail areas and adequate passenger waiting areas for passengers and their luggage.

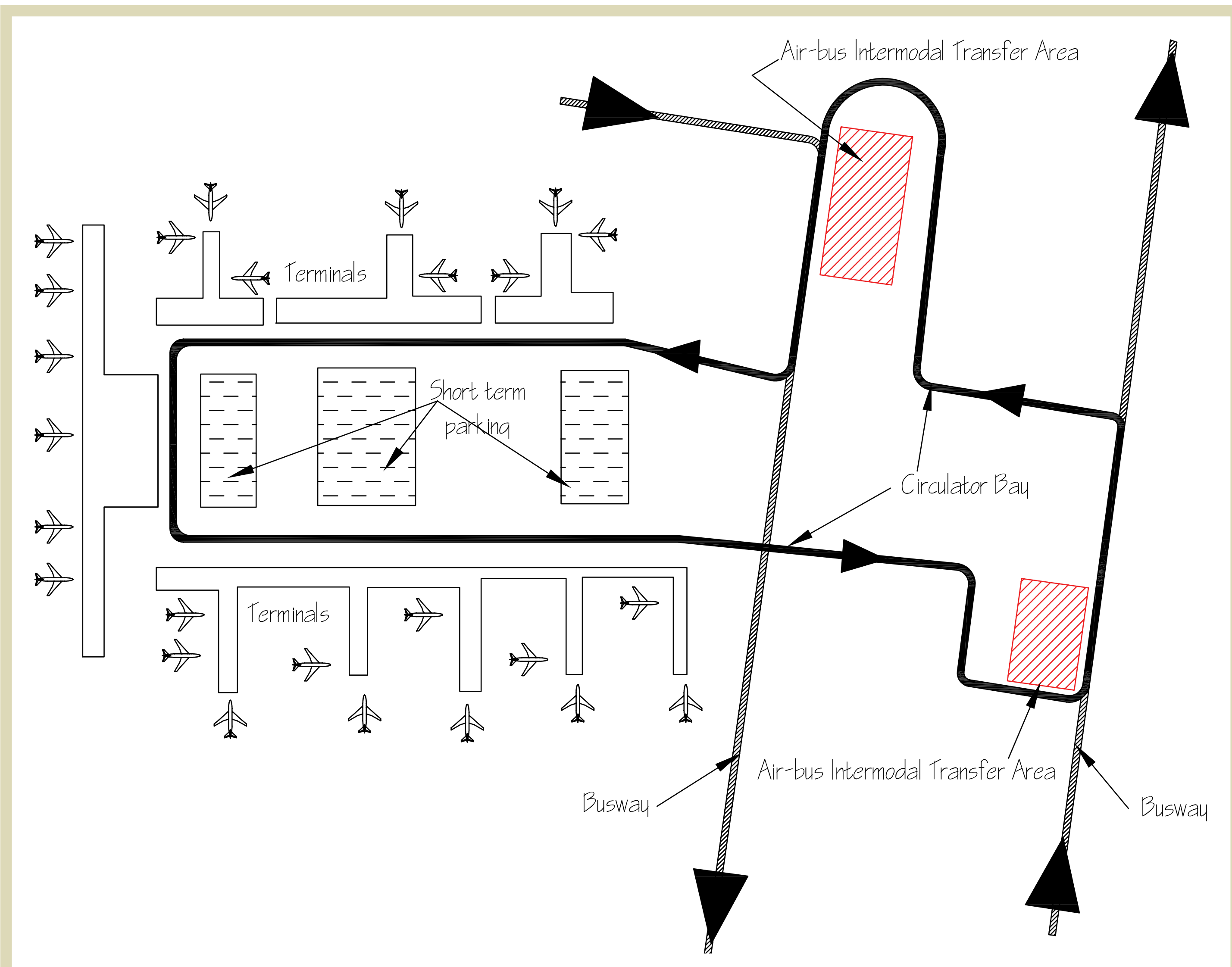


Figure 3.22 | A typical remote model intermodal center.

Figure 3.23 | View of a typical air-bus intermodal center.

Pedestrian Connections

Elevators, escalators, stairs, and ramps all are utilized so that pedestrians can avoid confronting vehicles while walking. Transit facilities should connect with exterior sidewalks, crosswalks, and parking facilities. See Figure 3.23.

3.8 Rail-bus Intermodal Transit Stations

Bus and commuter rail intermodal transit stations offer easy transition between these modes of travel. The rail line brings persons into an area, while the buses help to disperse them and bring them closer to their final destination. The stations provide citizens a new transportation alternative, linking the destinations of daily activity to their homes and complement existing transit, automobile, and bicycle mobility options. A view of a prototype for an intermodal transit station in a suburban setting is shown in Figure 3.24.

These stations should function as the entry and exit points to important activity centers. It is important for rail-bus intermodal transit stations to be in more densely urbanized areas in order to maximize ridership. The station types vary depending on land use, architectural character, and natural amenities. Most stations can be categorized into four types: neighborhood commercial centers, town center, activity centers/central business district (CBD), and interstate highway stations. [8]

Neighborhood Commercial Stations

Neighborhood commercial stations should be located within walking distance of residential neighborhoods. Design of these stations should ensure preservation of the character of surrounding neighborhoods. These stations should be small in size and provide neighborhood-friendly pedestrian and vehicular access. Figure 3.25 shows a plan of an intermodal transit station in a suburban setting with structured parking and transit-oriented development surrounding it.

Town Center Stations

Local town centers contain a diverse mix of residential, commercial, and civic uses, often within valued historic building and in a pedestrian-friendly atmosphere. The light or heavy rail stations can be integrated in many different ways to fit within these environments. These stations vary in scale, visibility, and function, supporting both existing development and acting as a catalyst for new development.

Activity Center/Central Business District Stations

Central business districts, universities, airports, and other regional activity centers provide the setting for a range of dynamic stations. Activity center stations generate high customer usage due to the range and intensity of surrounding land uses. As destination stations, activity center stations serve as intense pedestrian-oriented developments. Enhancements at activity center stations should provide opportunities for future development, creating public open spaces, plazas, and squares.

continued on page 86

Figure 3.24 | View of a prototype for an intermodal transit station.

FACILITY PROTOTYPES

Interstate Stations

Interstate stations are located within the median when interstate highways are used for rail alignments. Structural sound walls and extended canopies should be provided to ensure security of the stations. Additionally, interstate station platforms are often separated from direct pedestrian access, bus transfer facilities and parking areas, complicating convenient access to the station.[8]

A single platform shared between the bus and rail stations creates a safe and easy transfer between modes of transportation. These stations provide vehicular access in some form, ranging from small kiss-and-ride (drop-off and pick-up) facilities to mixed use park-and-ride structures. The function of station and site (size and shape) both determine parking capacity. The design of the station and parking can minimize impacts on surrounding properties and maximize

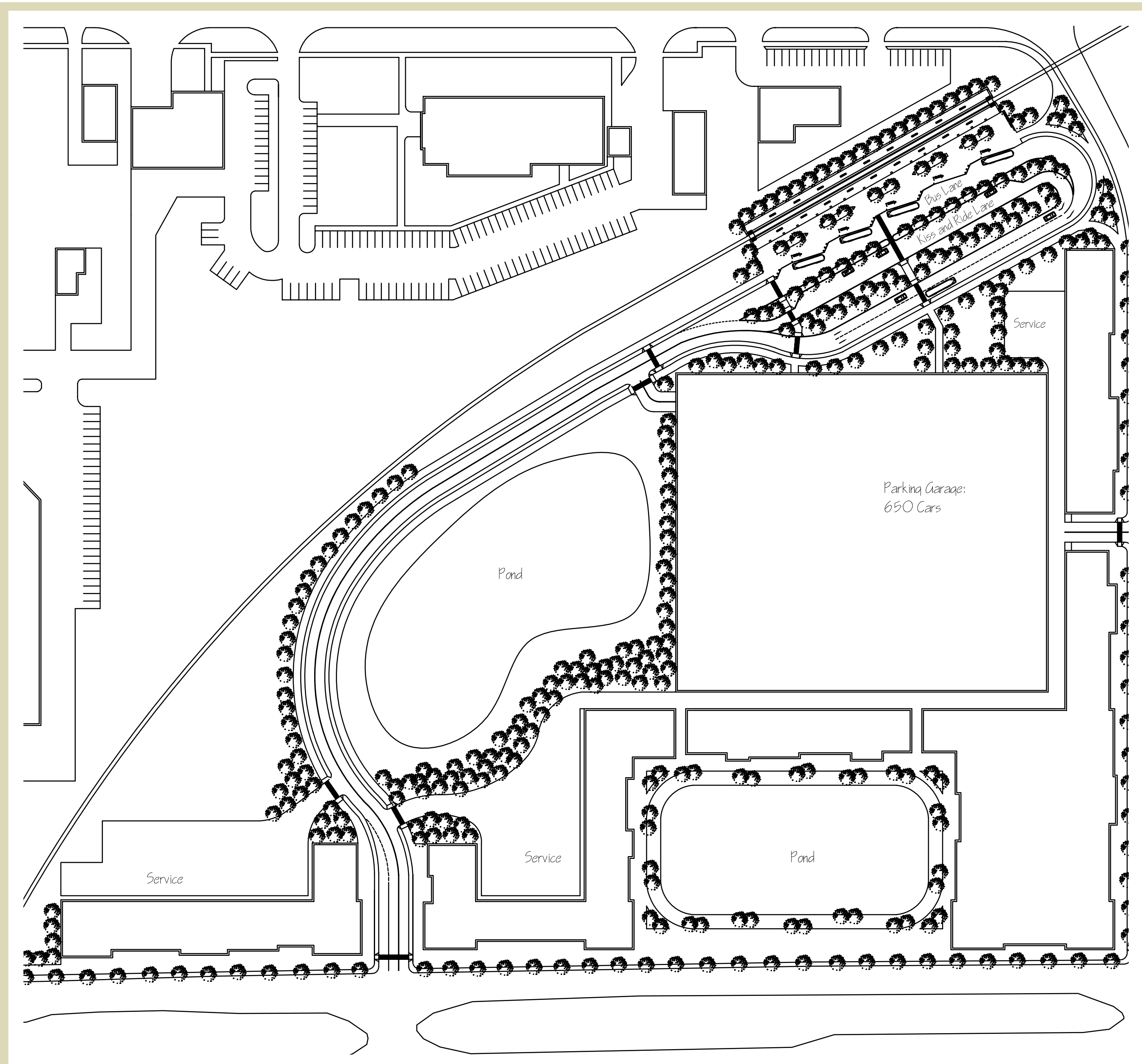


Figure 3.25 | Plan of a rail bus intermodal transit station in an activity center context.

FACILITY PROTOTYPES

development opportunities around each station. Figure 3.26 is a diagram showing the at-grade tracks and single platform connecting both modes of transit. [8]

There are three basic platform arrangements. They are central, side, and split platforms. Each is described below. [8]

Center Platform Stations

Center platform stations allow transit customers to be distributed for boarding light or heavy rail vehicles traveling in either direction from a single location. It is the most customer friendly and cost-effective platform configuration. Figure 3.27 shows a diagram of a central platform station.

Side Platform Stations

This configuration uses separate platforms to distribute passengers for each direction of travel. It accommodates large volumes of customers. Figure 3.28 shows a diagram for a side platform station.

Split Platform Stations

This station also has two platforms, arranged as side platforms servicing each direction. It is typically used at the intersection of streets with medians. This configuration minimizes the right of way necessary for the station, by locating platforms opposite of left turn lanes.[8] Figure 3.29 shows a diagram of split platform stations.

Approximate Site Area

One quarter to one half acre without parking.
Sixteen acres with parking.

continued on page 88

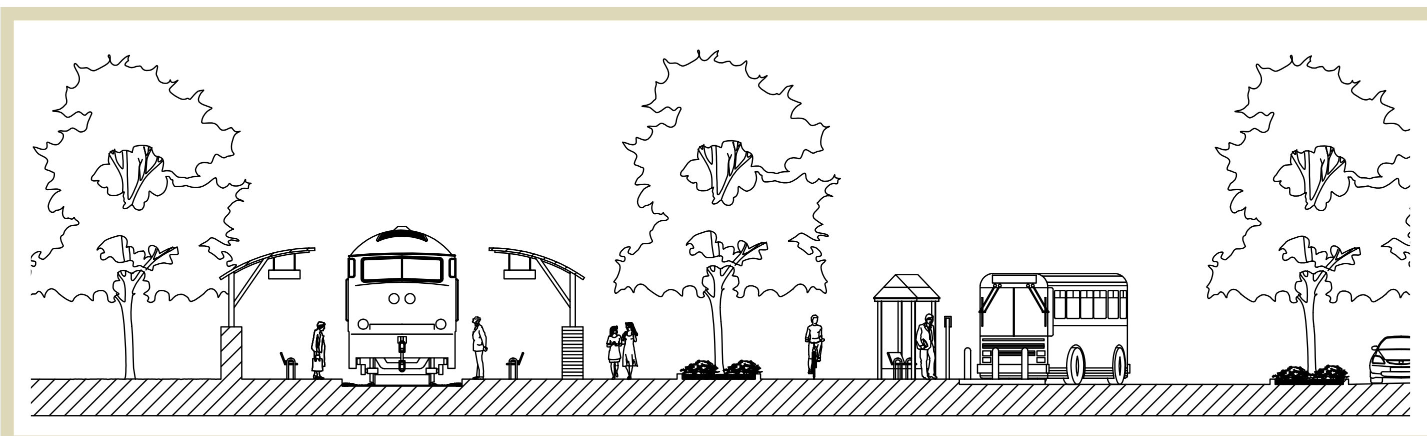


Figure 3.26 | Section showing at-grade tracks and single platform connecting both modes of transit.

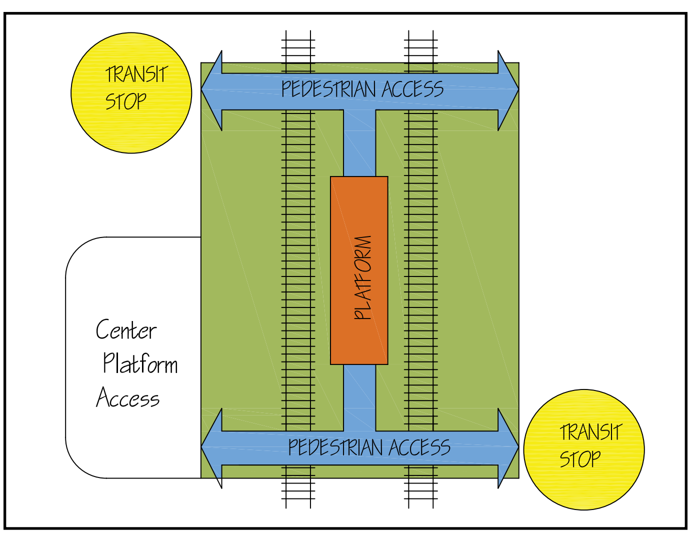


Figure 3.27 | Diagram of a central platform station.

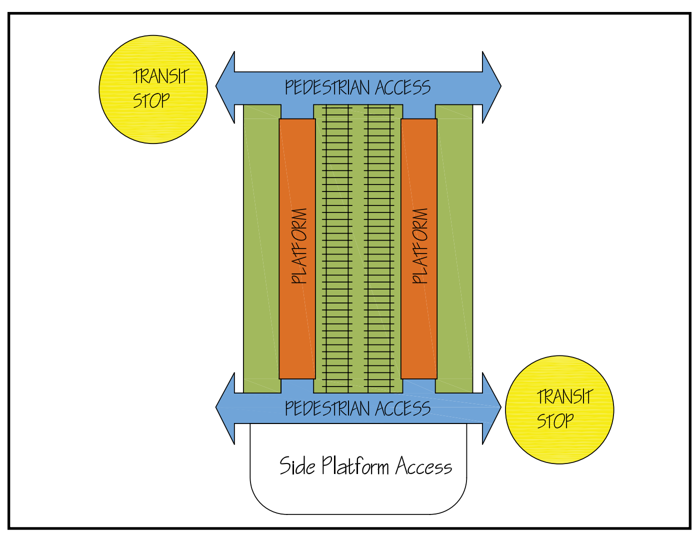


Figure 3.28 | Diagram of a side platform station.

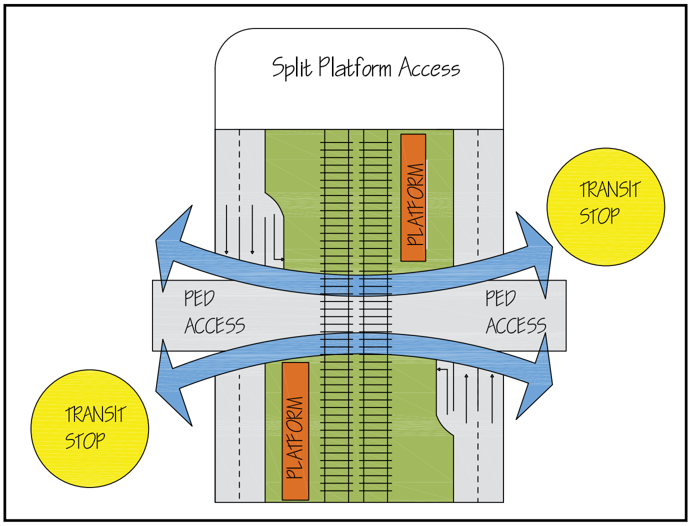


Figure 3.29 | Diagram of a split platform station.

Adjacent Land Use

Mixed uses in transit-oriented development.

Street Characteristics

Along major arterial streets.

Bus-side Elements

Dedicated busway with half-sawtooth bus bays.

Rail-side Elements

Designated area to cross at-grade tracks.

Curb-side Elements

Benches with shelter, trash receptacles, way-finding devices, electronic ticketing machines, public phones, and bike racks.

Pedestrian Connection

A single platform provides area for transition between bus and rail, crosswalks to designated parking, and sidewalks to surrounding transit-oriented development. Each station should facilitate safe and convenient pedestrian access to the rail system. Quality pedestrian connections facilitate future transit-oriented development around each station.

Bicycle Connection

Bicycle-friendly routes from stations and bicycle storage opportunities in stations will strengthen bicycle travel as a feeder travel option to transit stations.

3.9 Bus Rapid Transit (BRT)

BRT is a bus-based rapid transit service consisting of dedicated right of way with on-line stops. It combines the quality of rail transit with the flexibility of buses.

This service is often integrated with other regional transportation systems, enhancing mobility and promoting intermodal connectivity, thereby minimizing walking distances between trip origins and destinations. Headways are generally short, sometimes eliminating the need for passengers to consult a schedule. BRT works well in physically constrained environments where hills, tunnels, and water crossings result in frequent congestion and make freeway construction costly, difficult, or impractical.[9] The number of customers using a BRT station is typically higher than that at local bus stops. As a result, passenger facilities often resemble those provided at fixed-route surface transit stations.[5]

Adjacent Land Use

BRT is most successful in areas where the urban pattern is characterized as follows:

- Intensely developed downtowns and other business districts with limited on-street parking and costly off street parking. [5]
- Other areas with high population (more than 1 million) and employment (75,000 jobs).[9]
- High commercial and residential densities 5,000-10,000 of persons per square mile which can support a rapid transit system's high service frequencies. [9]
- Heavy utilization of conventional buses and possibility of dedicated bus lanes.

Approximate Site Area

The site area for a BRT passenger facility depends on the size of the BRT system. Generally the station spacing and station areas are as per Table 3.1.

Street Characteristics

BRT vehicles, often articulated buses, operate primarily within easily identifiable travel lanes exclusively used by buses. Dedicated bus lanes can take many forms depending on traffic conditions, the characteristics of corridor development, and availability of the right of way.[5] The most common lane configurations include:

- Mixed operation
  Buses operate in regular traffic but are given preferential treatment at intersections.

FACILITY PROTOTYPES

Table 3.1 | Station Spacing

By Primary Arrival Mode	
Walking	0.25-0.33*
Bus	0.50-1.00
Car	2.0
By Station Location	
CBD	0.25-0.50
Suburb	1.00-2.00
*Distance in miles	

- Median bus lanes
  Bus-only lanes are provided in the center of the road or along the center of medians.

- High occupancy vehicle (HOV) lanes
  HOV lanes are dedicated to the exclusive travel of buses or other high occupancy vehicles (typically three or more occupants).

- High occupancy toll (HOT) lanes
  These roads operate similarly to, and are designed to replace HOV lanes. Low occupancy vehicles may have to pay tolls for the privilege of using HOV lanes.

- Concurrent flow bus lanes
  Concurrent flow bus lanes are common bus priority lanes that segregate buses from other types of traffic. They run along bus curbs or beside parking near the curb.

- Contra-flow bus lanes
  Contra-flow bus lanes are bus-only lanes operated on one way roads in the opposite direction of other traffic.

- Median arterial busway
  A median arterial busway physically separates busways and stations, locating them at the center of the street.

- Bus streets
  Bus streets are automobile-free streets used only by buses during fixed times of the day.

- Busways
  Busways are dedicated running ways which are often grade separated from traffic used for line-haul transit. These may be guided busways or retrofitted with LRT operations later.

A number of other street design and transit variables also effect the level of BRT services. Signal prioritization, queue jumping, and other technologies can also be used to increase speed and enhance service when vehicles are operating in general traffic.

Regarding system configuration, routes should be simple to understand and should be depicted on an easy-to-read map. "Feeder" lines can be used to link into "express" service, combining the convenience of close-to-home stops with the speed of service. Direct, one-seat trips to multiple destinations are desirable. The major four route alignments are as follows. See Figure 3.30. [5]

- Single route
  In this type of alignment, one linear route provides service to the CBD. Neighborhood routes provide service to the BRT station.

- Commuter route
  Park-and-ride facility users who go to the CBD mainly use this type of BRT service.

- Multiple route
  This system provides feeder services by regular local bus service. Patrons can transfer between BRT lines.

- Integrated route
  In this system, BRT routes are fully integrated with local bus service. Regular local bus service provides both feeder and all-stop services along the BRT corridor. [5]

Bus-side Elements

Stations
BRT systems serve high-demand corridors and have a limited number of stops. They should provide a full range of passenger amenities, including shelters, passenger information, telephones, lighting, and security provisions depending on bus station type. They should provide a unified design theme; there should be a consistent pattern of station location, configuration, and design. BRT station designs should integrate bus, traffic, and pedestrian movements and separate them as appropriate.[9] They should enhance travel time, encourage intermodal connectivity, and minimize boarding and dwell times, thus helping people reach their destination more quickly. Stations should be integrated into

continued on page 90

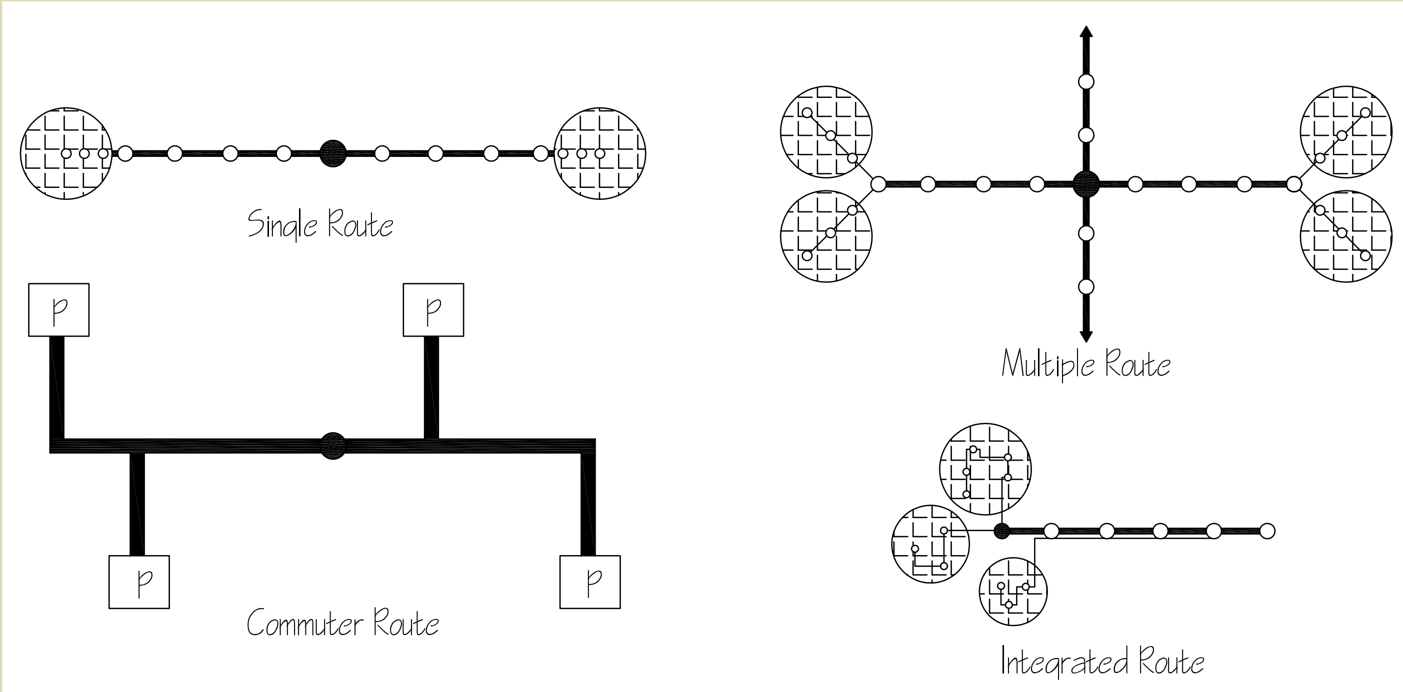


Figure 3.30 | Typical BRT route alignments.

the community and should be an urban design asset. Unique and attractively designed stations are a high priority for any BRT operation.

BRT stations should be generally more pronounced in terms of visibility and aesthetic appeal in order to provide the customer with information on where to access the system and routing. These features increase ridership in a competitive, consumer-oriented society. Stations should be typically located on the outside of the roadway along arterial medians and busways, but should be placed curb-side when buses operate in mixed traffic. Amenities and facilities of each bus station may vary with the station location. Refer to Table 3.2. Figure 3.31 shows a typical view of BRT station.

BRT station types also vary in cost and complexity. The criterion for selecting a particular type of stop is the amount of travel demand and passenger utilization at any particular station location. Factors influencing the design of BRT stations include service demand, station layout, station length, and passenger amenities. [5]

Vehicles
BRT vehicles should be compatible with the speed, capacity, environmental friendliness, and comfort of the BRT system. They often employ branding distinct from other components of the transit system in order to be recognized by both patrons and non-patrons of the BRT system. Beyond branding, BRT vehicles should be designed to allow rapid boarding and alighting and comfortable movement within the vehicle itself, and they should also include enhancements to the exterior and interior of the vehicle.

Nevertheless, bus vehicle designs may vary, and lane width should consider the design of the specific vehicle features such as mirror width, bumper design, and turning radii.

Curb-side Elements

Station platforms are an important curb-side element of a BRT system. BRT allows for a variety of options in platform design and layout.

Berth Design
Linear parallel berths are desirable for most BRT stations. However, shallow saw-tooth berths are used in terminal areas where independent entry and exit is essential. Each berth should be at least 45 to 50 feet long for a 40-foot bus and at least 65 to 70 feet long for a 60-foot articulated bus. Berths should be at least 11 feet wide. Additional distance is needed for independent entry and exit. [5]

continued on page 92

FACILITY PROTOTYPES

Table 3.2 | BRT Bus station types and features

Feature	BRT Curb-side Bus Stop		BRT Median Arterial Busway		BRT Busway		
	Typical	**Major**	**Typical**	**Major**	**Typical**	**Major**	**Intermodal center**
Conventional shelter [1]	X						
Unique BRT shelter	X	X	X	X	X	X	X
Illumination	X	X	X	X	X	X	X
Telephone / security phone		X	X	X	X	X	X
Temperature control			X	X[2]	X[2]	X	X
Passenger Amenities							
Seating		X	X	X	X	X	X
Trash containers		X	X	X	X	X	X
Restrooms							X
Public address / automated passenger information system		X	X	X	X	X	X
Passenger Services							
Vending machines, newsstands		X	X	X	X	X	X
Shops						X	X
Special services						X	X

1 Conventional shelter is a minimum treatment that should not be used for a BRT system.

2 In some environments major stations should be provided at interchanging transit lines, large park-and-ride lots, and important passenger generators.

Source: Danaher, A. (2006). *Cost and effectiveness of selected bus rapid transit components* (Transit Cooperative Research Program Report A-23A). as cited in Kittelson & Associates Inc. (2007). *Bus rapid transit practitioner's guide* (Transit Cooperative Research Program Report 118).[9]

FACILITY PROTOTYPES

The number of berths should be sufficient to accommodate anticipated peak hour bus flows without frequent spillback. For busways and median arterial busways, a minimum of two berths should be provided in each direction of travel.[9] Platform layouts vary depending on the berth design in terms of single vehicle length platform, extended platform with unassigned berth and extended platform with assigned berth.

Platforms Location
There are two basic options for BRT platform configuration: side platforms and center platforms.

Side platform configurations are common along streets and busways. They adapt to the right-hand curb-side of door arrangements in the United States and Canada. Far-side stations and near-side left-turn lanes can share the same envelope along median arterial busways. Side platforms should be about 10 to 12 feet wide.[5]

Center platform configurations allow more efficient and economical station design where buses have doors on both sides. Otherwise, they may limit operations in mixed traffic. A 20- to 25-foot width is desirable for center platforms.[5]

Side platform configurations are recommended over center platforms because the doors on most buses require boarding from the right-side of the vehicle. Custom-made buses may be necessary for center platforms. Such buses are very expensive. However, in bus contra-flow situations center street platforms can be employed without custom-made buses as typical bus doors will face the platform.

Platform Height
Platform heights should be coordinated with vehicle design and fare collection methods. Platforms may be the height of a standard curb or raised above that height. "Level" platforms are typically 14 inches high.

Standard curbs are typically 6 inches above the street level. They are also known as low floor platforms. There is about 8 inches from the platform to the base of the vehicle. These can only be served by low floor buses. Low floor buses are especially helpful to the elderly, children, and disabled.[5]

"Raised curbs" are typically 9 to 10 inches above the street level, leaving about 5 inches between the platform and the floor of the vehicle. Raised curbs and level platforms allow for faster boarding and alighting.[5] Raised curbs are exceedingly rare in Florida. They are not a standard FDOT curb type and are likely to be found only in a few downtown blocks of cities laid out in the 18th century.

Fare Collection
Fare collection systems can be located either on or off the vehicle.

"Smart card" and other advanced technologies allow fares to be collected quickly and efficiently, often before the boarding process, thus reducing the boarding time. See Figure 3.32.

Figure 3.31 | A typical view of BRT station

Figure 3.32 | Automatic fare collection machine in Los Angeles, CA.

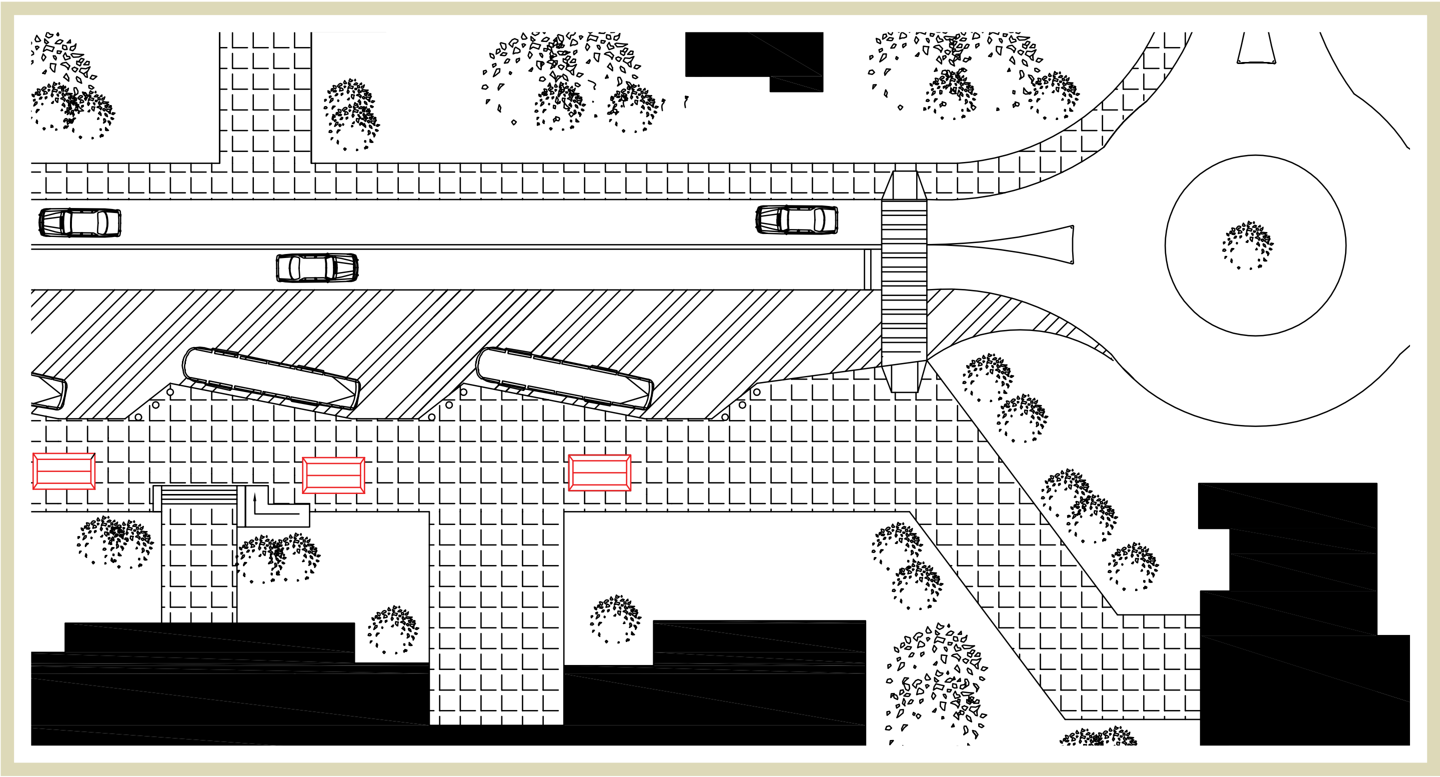


Figure 3.33 | A site plan for a university transfer center.

3.10 University Transfer Center

Many universities collaborate with local and regional transit authorities or, in fewer cases, run their own transit systems in the absence of city and regional transit systems.[10,11] Universities often invest in the passenger facility infrastructure necessary to support transit by providing bus shelters, transfer facilities, real time displays, and dedicated bus lanes.[11]

University transfer centers allow students and other riders to connect to several regional, local or campus bus transit systems. Locating such facilities near academic buildings, a destination for most transit riders, is often preferred. [12]

Within university campuses or adjacent to them, stops should be located in order to integrate the bus system campus circulator network, transfer facilities, parking, pedestrian access, bicycle access, and bicycle storage facilities. See Figures 3.33 and 3.34 for a site plan and a typical university transfer center. When it is not possible to have shelters for every stop at or adjacent to a university, the shelters should be located in areas where there is the highest ridership, where weather exposure is likely to make patrons uncomfortable, and in areas with adequate sidewalk width, visibility and surveillance.

Adjacent Land Uses

Stations and stops should be located in proximity to key academic facilities (including classroom buildings and the campus' core buildings), student housing, and other locations equidistant from these and other activity centers.

Approximate Site Area

One and a quarter acres

Street Characteristics

Campus and city service routes can be located on secondary and primary collector roads that provide access into and through the campus. These routes can be served by bus shelters and pull-out bus bays.

Bus-side Elements

Vehicle right of ways should be kept well defined and conflict free, with each mode provided with its own distinct right

continued on page 94

of way. Dedicated transit lanes may allow vehicle access to core campus areas that are otherwise accessible only to pedestrians, cyclists, and service vehicles.[11] The University of Colorado at Boulder, for instance, has brightly painted routes to make them easily recognizable.[11] Ample room needs to be provided for maneuvering buses, with turning movements based on turning radii of full size vehicles. Roadways in loading bays should be no less than 12 feet in width and are preferably separated by waiting islands.[13]

Curb-side Elements

The uniqueness of the campus community should be reflected in the design of transit facilities. Accessories, materials, facility logos, and vehicle colors (whether off the shelf or custom designed) all should be consistent with and limited to those that maintain a cohesive campus design.[14] Facilities should be located so that they can be seen and identified from a distance.

All public walks should be at least 48 inches wide and continuous and should have a gradient not greater than five percent.[13] Because many campuses are pedestrian-oriented and park-once destinations, and because of the pulse nature of class schedules, sidewalks may need to be very wide to accommodate high pedestrian numbers. Site accessories include such elements as benches, bollards, kiosks, bicycle racks, light poles, trash containers, and signs. Providing bicycle storage at stops can make it easier for users to combine bicycling and transit use.[11] Restrooms, telephones, coin operated machinery, and newspaper stands, or other amenities which may also be provided at transfer stations or points and other large passenger facilities.

Stations and stops should be designed with handicapped persons in mind.

Parking lots should have spaces for ADA compliant accessible parking located close to university transfer facility entrances. Although many university transit centers are located within historical campus settings, with ranging degrees of accessibility, wheelchair access should be provided to not fewer than one and as many points as feasible. Other amenities should include handrails, platform edge strips, telephones and stairs. Lighting and design should facilitate surveillance and deter crime. High levels of lighting should be maintained and electronic surveillance should be integrated with security systems of adjacent university activity centers (including "blue light trails") whenever possible. The design of shelters should consider climate and weather patterns

Figure 3.34 | A view of a university transfer center.

(providing protection from wind, rain, and uncomfortable direct sunlight).

Waiting areas should have adequate drainage to remain clear of standing water and mud. High quality material should be used and sufficient area should be landscaped for keeping the facility attractive and maintained over a long period of time. Rain can be redirected onto the landscape using native plants. There should be a barrier free environment with seating for 30 percent of peak ridership.[13]

Bicycle and Pedestrian Connections

Stops and shelters should be placed where they are easily accessible by both bicyclists and pedestrians and are near to campus pedestrian paths and streets where high numbers of potential passengers are found.[11,15]

Access to transit facilities should be provided from parking spaces and for pedestrians, bicyclists and the handicapped.

Signage

Signage should provide clear concise directions, be consistent in design, and provide some type of identity for the system using colors, logos and lettering connected to those of the university. Signage should be constructed with low maintenance material. Signage posts can be made of recycled plastic. University facilities should provide proper signage for clear understanding, including those unfamiliar with the English language, by all local standards for advertising and provide bus route, fare and schedule information.[13]

Text References

(Endnotes)

1 Florida Department of Transportation. (2008, May 20). *Project development and environment manual.* Retrieved June 9, 2008, from http://www.dot.state.fl.us/emo/pubs/pdeman/pdeman.htm

2 Florida Department of Transportation. (2008, January 1). *Plans preparation manual.* Retrieved June 9, 2008, from http://www.dot.state.fl.us/rddesign/PPMManual/2008/PPM2008.htm

3 Florida Department of Transportation. (2001.) *State park& ride lot program planning manual.* Updates of the report on Chapter 3, 4, and 6 by Chu, X., Land, L. & Pendyala, R. Retrieved June 11, 2008, from link http://www.dot.state.fl.us/research%2Dcenter/Completed_Proj/Summary_PTO/FDOT_BC137_13_rpt.pdf

4 U.S. Architectural and Transportation Barriers Compliance Board (Access Board). (2002, September). *Americans with Disabilities Act: Accessibility guidelines for buildings and facilities (ADAAG)*, Section 10 Transportation facilities. Retrieved June 9, 2008, from http://www.access-board.gov/adaag/html/adaag.htm#tranfac

5 Florida Department of Transportation Districts One and Seven. (2007). *Transit facility handbook*. Retrieved June 10, 2008, from http://www.dot.state.fl.us/transit/Pages/FDOT_D1_D7_Transit_Facility_Handbook.pdf

6 Federal Highway Administration, U.S. Department of Transportation. (2003). *Manual on Uniform Traffic Control Devices* (MUTCD). Retrieved June 5, 2008, from http://mutcd.fhwa.dot.gov/index.htm

7 City of Portland. (2003). *Draft report of the Alternative Paving Materials Subcommittee of the Sustainable Infrastructure Committee*. Retrieved June 9, 2008, from http://www.portlandonline.com/shared/cfm/image.cfm?id=82898

8 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida rail design manual*. Orlando, FL: Central Florida Regional Transportation Authority.

9 Kittelson & Associates Inc., Herbert S. Levinson Transportation Consultants & Dmjm+ Harris (2007). *Bus rapid transit practitioner's guide* (Transit Cooperative Research Program Report 118). Retrieved on June 9, 2008 from http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_118.pdf

10 University of California, Berkeley. (n.d.). *New century plan: Access initiatives*. Retrieved June 9, 2008, from http://www.cp.berkeley.edu/ncp/goals/accessinitiatives.html

11 Toor, W., & Havlick, S.W. (2004). *Transportation and sustainable campus communities: Issues, examples, solutions.* Washington, DC: Island Press.

12 University of British Columbia. (2003, June). *Campus transit plan.* Retrieved June 9, 2008, from http://www.planning.ubc.ca/corebus/pdfs/CampusTransitPlan2003-summary-web.pdf

13 U.S. Department of Transportation. (1989, February). *Market based transit facility design, final report* (Report No. DOT-T-89-12). Retrieved June 9, 2008, from http://ntl.bts.gov/lib/7000/7000/7061/824.pdf

14 University of Colorado at Boulder. (2001, March). *Campus master plan: Section IV-C-7. Site accessories.* Retrieved June 9, 2008, from http://www.colorado.edu/masterplan/plan/plan.cgi?4&3&7&1

15 *Campus design plans.* (n.d.). Retrieved June 9, 2008, from http://www.ncsu.edu/facilities/physical_master_plan/book/pdfs/3e%20NC%20State%20Master%20Plan.pdf#search=%22campus%20design%20%2B%20books%20%2B%20transit%22

Image credits for images by others

3.15 Images and caption retrieved from http://www.metrostlouis.org/InsideMetro/CapitalProjects/images/buscenters/civiccenter02.jpg on April 15, 2008.

3.20 Images and caption retrieved from <http://lehmanandlehman.blogspot.com/2007/06/forest-park-aquatics-parking-lot.html > on April 15, 2008.

3.27 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida rail design manual.* Orlando, FL: Central Florida Regional Transportation Authority.

3.28 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida rail design manual.* Orlando, FL: Central Florida Regional Transportation Authority.

3.29 Gladding Jackson Kercher Anglin Lopez Rinehart, Inc. (1994). *Central Florida rail design manual.* Orlando, FL: Central Florida Regional Transportation Authority.

3.30 Florida Department of Transportation Districts One and Seven. (2007). Transit facility handbook. Retrieved June 10, 2008, from http://www.dot.state.fl.us/transit/Pages/FDOT_D1_D7_Transit_Facility_Handbook.pdf

Text References

(Endnotes)

3.32 Images and caption retrieved from http://content.answers.com/main/content/wp/en/thumb/d/de/250px-TicketMachine.jpg on April 15, 2008.

CHAPTER FOUR

LAND USE GUIDELINES

This page left intentionally blank

CHAPTER FOUR: LAND USE GUIDELINES

4.1 Introduction

Certain land use configurations and site designs make public transit an attractive travel mode. This portion of the handbook focuses on the land use planning and site design elements that are most likely to encourage transit patronage. The goal is to assist transit agency planners, their colleagues in land use planning, and growth management agencies to direct private development in order to make the built environment more accessible to transit passengers and to transit vehicles.

Transit accessibility and pedestrian accessibility are closely linked. Development that supports various kinds of accessibility balances the infrastructure needs of transit users, pedestrians, bicyclists, motorists, and freight haulers. Although individual development projects have limited effect on transit use throughout a network, the cumulative effect of projects over time has important implications for transportation modes and their associated infrastructure. Many transit planners are aware of problems associated with right of way of limited width and finding appropriately sized lots for transit facilities in areas where substantial urban development has already taken place. Given the limited supply of land and funds for capital improvements, it is critical for transportation planners to understand the land use, site design, and development approval processes and their impacts on transit. Figures 4.1 and 4.2 depict examples of typical development patterns oriented to transit provision.

Transit-oriented development (TOD) attempts to manage growth and to improve the quality of life in Florida and elsewhere. Transit-oriented design (also TOD) is the set of urban design principles that attempts to provide communities with an alternative to low-density suburban sprawl and automobile-dependent land use patterns by aligning transit investments with development, creating livable mixed-use, denser, walkable "transit villages." Table 4.1 summarizes the benefits of TOD. [1] A successful TOD reinforces both the community and the transit system. Appendix D provides a checklist for TOD. Appendix I provides recommendations on transit-supportive language and policies for local government planning documents.

Figure 4.1 | Transit Mall Station is on 1st St. between Pine and Pacific, Los Angeles, California.

Figure 4.2 | Shelter designs are distinctive, signature features of the Transit Mall in Portland, Oregon.

LAND USE GUIDELINES

Table 4.1 | Benefits of TOD

1. Providing mobility choices
By creating "activity nodes" linked by transit, TOD provides much needed mobility choices, including options for young people, the elderly, and people who do not own cars or prefer not to drive.
2. Increasing public safety
By creating active places that are busy through the day and evening, TOD helps increase safety for pedestrians, transit users, and many others by providing "eyes on the street."
3. Increasing transit ridership
TOD improves the efficiency and effectiveness of transit service investments by increasing the use of transit near stations by 20 to 40 percent, and up to five percent overall at the regional level.
4. Reducing rates of vehicle miles traveled (VMT)
Vehicle travel has been increasing faster than population growth. TOD can lower annual household rates of driving by 20 to 40 percent for those living, working and/or shopping within transit station areas. Recent research shows that automobile ownership in TOD is approximately one half the national average.
5. Increasing disposable household income
Housing and transportation are the first and second largest household expenses, respectively. TOD can effectively increase disposable income by reducing the need for more than one car and reducing driving costs, saving households $3,000-4,000 per year.
6. Reducing air pollution and energy consumption rates
By providing safe and easy pedestrian access to transit, TOD can lower rates of air pollution and energy consumption. TOD can also reduce rates of greenhouse gas emissions by 2.5 to 3.7 tons per year per household.
7. Helping protect existing single-family neighborhoods
TOD directs higher density development to appropriate areas near transit, thereby reducing pressure to build higher density development adjacent to existing single-family neighborhoods.
8. Playing a role in economic development
TOD is increasingly used as a tool to help revitalize aging downtowns and declining urban neighborhoods, and to enhance tax revenues for local jurisdictions.
9. Contributing to more affordable housing
TOD can add to the supply of affordable housing by providing lower-cost, accessible housing, and by reducing household transportation expenditures. It was recently estimated that housing costs for land and structures can be significantly reduced through more compact growth patterns.
10. Decreasing local infrastructure costs
Depending on local circumstances, TOD can help reduce infrastructure costs (such as for water, sewage, and roads) to local governments and property owners by up to 25 percent through more compact and infill development.
11. Preserving open space and farmland
TOD promotes compact, mixed use development that preserves open space and farmland.
12. Improves social interaction
Walking environments improve social interactions, initiating community involvement.
13. Increase saleable floor space and business
Increase saleable floor space through compact growth patterns and lower parking requirements. Retail activity also increases due to increased foot traffic and more "on the way" shopping activities.
14. Increase revenues
Increased revenues from joint and co-developments through air rights and ground leases.

Source: Florida Department of Transportation Districts One and Seven. (2007). *Transit facility handbook.*

4.2 Key Land Use and Site Design Principles

Density and Intensity of Use

Along transit corridors or within ¼ mile of transit transfer or intermodal centers, land uses and development densities should support transit usage. Ideal land uses include medium to high density residential development, mixed use development, multi-family and small-lot single family residential projects, small to medium block lengths, offices and medium intensity employment centers, institutions, and smaller retail centers. Development requiring large areas of land for parking, generating many vehicle trips, and characterized by low rates of employment or low residential densities should be discouraged from locating there.

Land Uses

Certain land uses are better suited for TODs. Such land uses do not have to rely completely on automobile users for patronage. Table 4.2 lists these kinds of land uses in comparison to other, more auto-oriented land uses. A mix of uses generating pedestrian traffic concentrated within walking distance (¼ to ½ mile) of transit transfer points may also be beneficial.[1] Dense street corners should be developed with transit supportive commercial uses such as convenience stores, fast food restaurants, and services (such as banks) along with transit stops. These sorts of uses make it easier for the transit users to conduct their daily business activities without using an automobile. And they can do more activities during a single trip.

While auto oriented uses should be limited near transit, when those uses are already present and accompanied by concentrated commercial parking (as is the case with shopping malls), that parking may serve as a park-and-ride facility.[1] Refer to Section 3.6 for more details. Appendix E provides information on Zoning Review.

Network Continuity

Once they disembark from buses, passengers require continuous pedestrian infrastructure that links transit stops with off-site origins and destinations in a manner that minimizes the number of cross-traffic conflicts. Pedestrian routes to origins and destinations should be as direct as possible and closely spaced, based on relatively small blocks. Buildings not directly on the right of way should be linked to the right of way by visible and convenient walkways. Additionally, pedestrian crosswalks should be clearly demarcated. Functional street crossings should be provided with appropriate traffic buffering. If crosswalk striping is provided, it should be maintained, especially in areas of high auto use.

Building Orientation

Buildings should be oriented to provide pedestrians and transit passengers with easy access and a visually interesting environment that reduces perceived travel distances and increases the legibility of pedestrian networks.[2] Building entrances should be oriented to the pedestrian and transit networks. Non-residential buildings should be placed as close as possible to the pedestrian network and no more than 15 feet from the sidewalk. Building uses of interest to sidewalk traffic (like shops and commercial services) should be located along the sidewalk, and structured parking should be placed behind the building (or, if inside the building structure, below ground or behind its street front).[2]

Building Design

The design of building façades should be oriented to the transit route and pedestrian networks in order to realize the benefits of the elements discussed above. The building line should be varied to the degree necessary to enhance visual interest. First story windows should be considered in non-residential buildings, and uses should be "active" and oriented to serve pedestrians, and multiple compatible uses should be permitted within buildings near transit.[2] Awnings and arcades along building frontages, when provided, offer pedestrians with weather protection. Other design elements, like large, uninterrupted walls that are visually monotonous or that may create wind tunnels or perceptions of unsafe environments, should be avoided. Residential projects should have distinguishable front yards for privacy but should also engage the street with windows and porches.

Landscaping

Landscape buffers along rights of way enhance the comfort and safety of pedestrians and waiting transit passengers. Separating transit passengers and pedestrians from moving transit also shields them from dust, vehicle exhaust, and splashing storm water. Landscaping with plants of varying heights, sizes, textures, and colors can also increase visual interest along the right of way and can break down the scale of large buildings or uninterrupted walls. Trees can also be used to provide a continuous shade canopy along pedestrian and transit routes. Defensible space is created by designing

continued on page 100

the landscaping along streets in a way that facilitates and promotes natural surveillance while waiting for the bus.

Near transit stops, a minimum 5- to 8-foot landscape buffer is preferred where street trees are included. This buffer can be reduced to 3 feet in constrained areas through the use of tree grates. Maintenance can be reduced by using native plants. Storm water recycling should be considered for landscaping (see Section 1.9).

Bicycle Facilities

Roadways serving transit and transit oriented development should be bicycle compatible, or bicycle lanes should be provided along transit station access roads. Parking areas should be designed as shared-street environments. Bicycle paths should also be provided around the edge of a parking area. Where right of way can be acquired, bicycle paths from neighboring communities should be constructed, providing separate and more direct access to neighborhood interiors. If separate paths can not be provided, neighborhood streets should be comfortable for bicycle use. Paths can provide key connections where streets fail to do so.

Transit station design should also accommodate bicycle parking/storage facilities, preferably near the transit vehicle loading zone. Bicycle parking or storage should be well lighted and protected from weather, and visible to defer theft.[3] Clearly visible signs should be provided using the bicycle symbol for bicycle routes and parking/storage facilities.

Pedestrian Movements

Along transit serving corridors, walkways should have interesting and varied facades. Shaded, wide, continuous walkways linking all probable pedestrian movements are the optimal configuration. Pedestrians' views of parking areas and other "blank" spaces should be minimized. Attention should be paid to sidewalk and crosswalk design. Textured, colored pavement and other features may be used to delineate pedestrian areas from automobile areas; and street trees, plantings, and on-street parking may buffer pedestrians from vehicular traffic. Comfortable and functional street furniture may be provided in covered areas to protect passengers from rainfall. Proper lighting provides a feeling of nighttime safety. Pedestrian way-finding signs should be pedestrian scaled, and traffic should be calmed in areas where pedestrians and vehicles interact.

LAND USE GUIDELINES

Table 4.2 | Transit supportiveness of selected land uses.

Land use	Transit Supportive	May be supportive with development standards	Not supportive
Residential			
Single family [a]			
Lots > 5000 sq ft		x	
Lots = or < 5000 sq ft	x		
Multi family	x		
Elderly residential	x		
Public and semi-public			
Cemeteries			x
Clubs and lodges		x	
Convalescent facilities			x
Cultural institutions	x		
Day care, general	x		
Government offices	x		
Hospitals, medical offices	x		
Parks and recreational facilities [b]		x	
Public safety facilities		x	
Residential care		x	
Schools and colleges		x	
Commercial uses			
Ambulance services			x
Animal sales and services		x	
Animal boarding			x
Banks and savings and loan with drive-up services	x		
Building materials and services		x	
Commercial recreation and entertainment [c]		x	
Eating and drinking establishments	x		
Fast-food or take out with drive-through services		x	
Bars and taverns	x		
Food and beverage sales		x	
Funeral and internment services			x
Laboratories [d]		x	
Maintenance and repair services [e]		x	
Garden nurseries, commercial			x

LAND USE GUIDELINES

Land use	Transit Supportive	May be supportive with development standards	Not supportive
Offices, business and professional	x		
Personal improvement services		x	
Personal services	x		
Research and development services		x	
Retail services	x		
Volume discount retail		x	
Travel services	x		
Vehicle equipment sales and services [f]			x
Automobile rentals		x	
Automobile washing			x
Commercial parking garage [g]			x
Commercial surface parking			x
Service stations			x
Service stations with convenience retail garages		x	
Vehicle equipment repair			x
Vehicle equipment sales / rental			x
Vehicle storage			x
Visitor accommodations		x	
Hotels	x		
Bed and breakfast inns	x		
Motels		x	
Industrial uses			
Includes truck stops, manufactured home sales, cold storage plants, junk yards, and solid waste facilities			x
Light industrial employment		x	

a= Small lots or attached single family housing is transit supportive.
b= Small parks are transit supportive; large facilities such as golf courses or multiple playing fields are not.
c= Indoor uses, such as cinemas and theatres, are transit supportive.
d= Small scale facilities, such as medical labs, are transit supportive.
e= Neighborhood oriented businesses are transit supportive if on site storage of vehicles is limited.
f= Garages can be transit supportive if on-site storage of vehicles is limited.
g= Garages can be transit supportive if active, non-parking uses are located at street level.

Source: Central Florida Commuter Rail. (2007, Summer). *Transit oriented development workshop sketchbook.*

4.3 Transit-discouraging Residential Development

Density and Intensity of Use

Traditional residential developments have a floor area ratio (the total area of building floor space per site area) of less than 0.25, developed at a rate of 1 to 8 units per acre.

Network Continuity

Conventional developments are characterized by cul-de-sacs that restrict traffic and lengthen trips by causing drivers to travel away from their destinations on some segments. They have limited access to transit stops and in settings that attempt to mimic rural character, sidewalks are rarely provided. All trips to and from such communities are made along arterial roadways at their periphery.

Block Orientation and Design

The large blocks in residential developments discourage transit usage. These developments often have direct access to arterials where commercial activities are located. Connections between complimentary buildings and destinations along the arterials are minimal. See Figure 4.3.

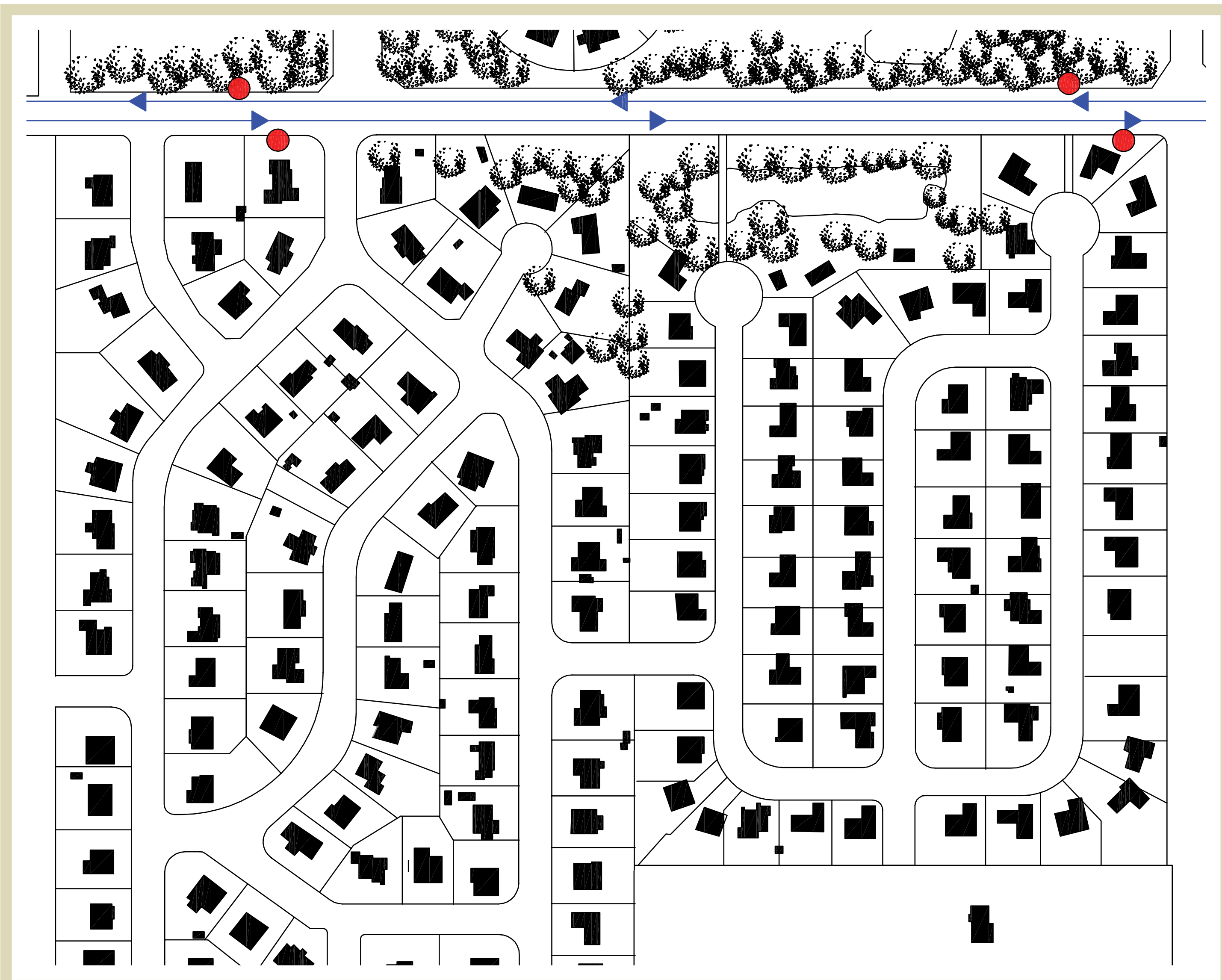


Figure 4.3 | Traditional single family residential development with cul-de-sacs. Bus stops are indicated in red dots in plan. Bus stop locations are indicated by red dots and bus routes are shown in blue.

4.4 Transit-oriented Residential Development

Density and Intensity of Use

Transit oriented residential developments should have a floor area ratio between 0.5 and 1, at a rate of no less than 12 to 16 units per acre.

Network Continuity

Well-connected continuous street networks minimize out of direction travel in cul-de-sacs, using traffic calming measures to prevent the negative effects of traffic on pedestrians. Collector and local roads also provide alternatives to arterials. Developments should be connected through collector streets that connect arterials and local roads.

Block Orientation and Design

Blocks should be at pedestrian scale, with a continuous sidewalk network to maximize accessibility to transit stops. See Figure 4.4.

Figure 4.4 | Transit friendly single family residential development. Bus stops are indicated in red dots in plan.

4.5 Transit-discouraging Multi-family Development

Density and Intensity of Use

In traditional multi-family developments, buildings are two stories and accommodate 22 to 24 dwelling units per acre.

Building Orientation

Ample parking is widely distributed throughout the development. Buildings are oriented to the parking in order to minimize trips between vehicles and dwelling units.

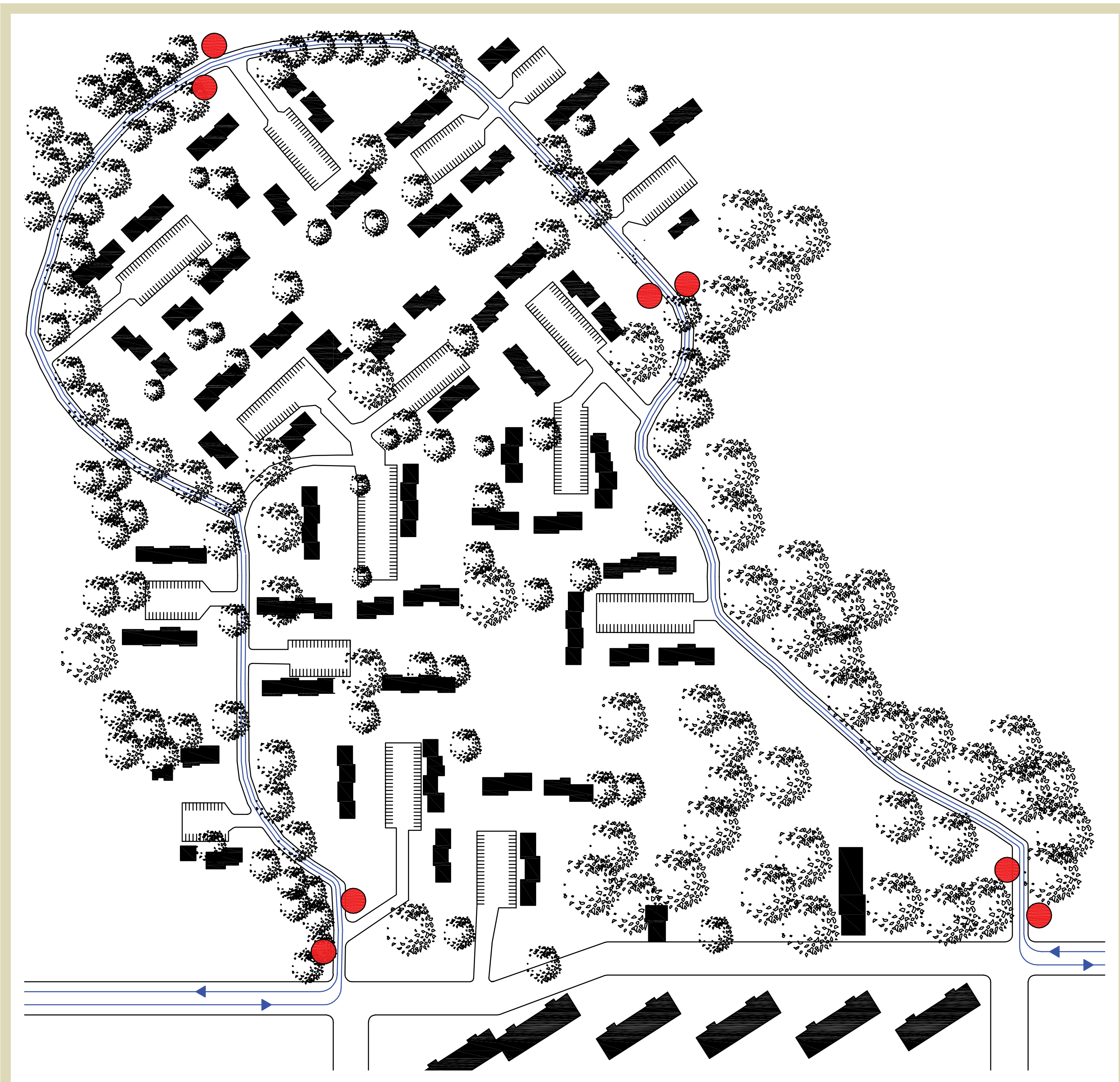


Figure 4.5 | Traditional multi-family residential development at Alumni Village in Tallahassee, Florida. Bus stops are indicated in red dots in plan.

4.6 Transit-oriented Multi-family Development

Density and Intensity of Use

Multiple buildings should be clustered together to minimize walking distances from transit stops.

Network Continuity

Transit stops should be located in places central to building clusters. See Figure 4.6.

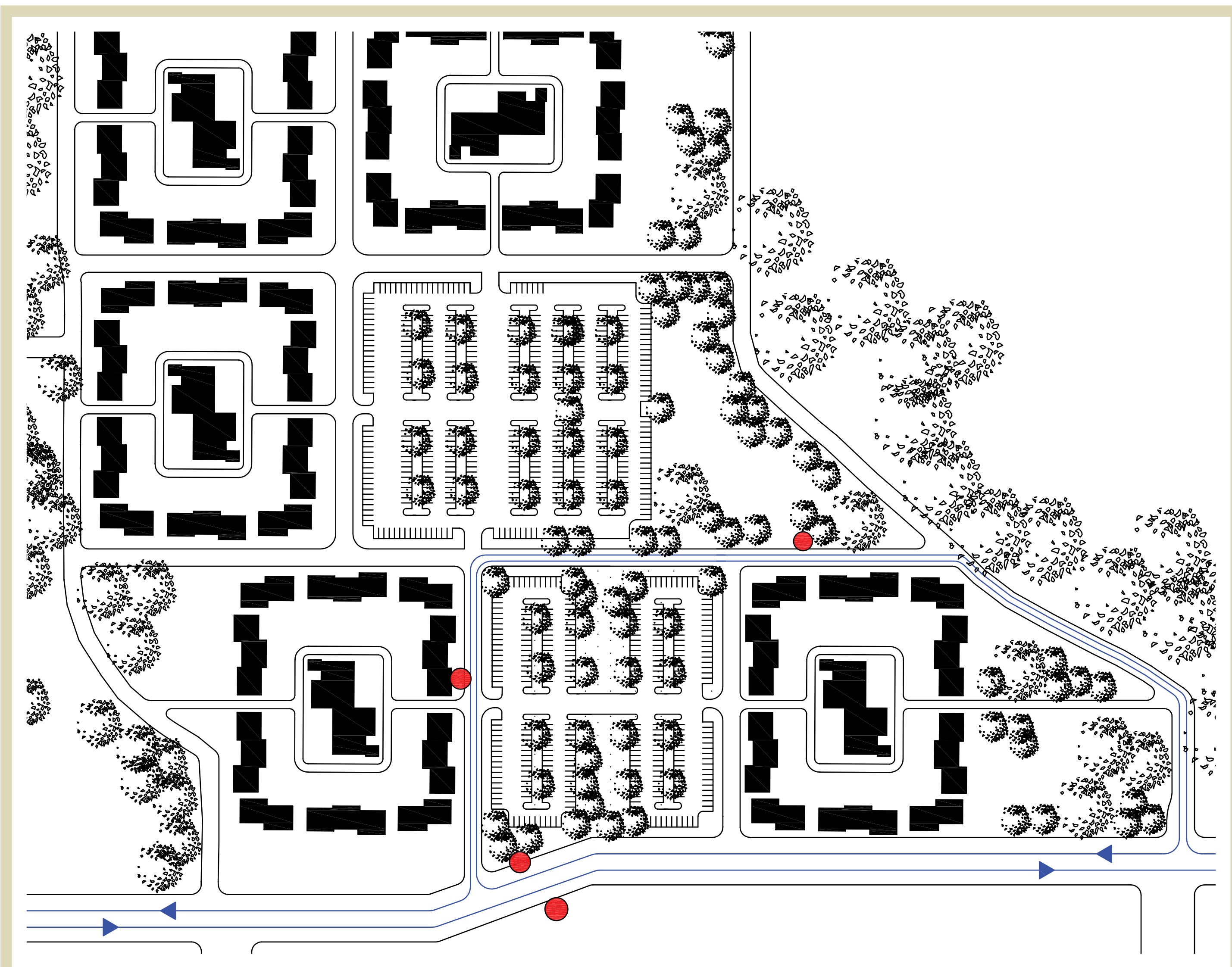


Figure 4.6 | Transit friendly multi-family residential units. Bus stops are indicated in red dots in plan.

4.7 Transit-discouraging Mixed-use District

Density and Intensity of Use

Auto-oriented mixed-use districts are characterized by a floor area ratio of less than .25 in commercial areas and multi-family housing developed at 6 to 8 units per acre.[1] See Figure 4.7.

Network Continuity

Cul-de-sacs maximize out-of-direction travel. Through traffic is restricted in such road networks and there is limited access to transit stops. Few connections are made between buildings or destinations. All trips are directed towards the arterial roadway. There is limited, sporadic sidewalk provision.

Block Orientation and Design

Blocks are very large. The average block perimeter is 2,000 to 3,000 feet. Each development has its own access from the arterial and is separated from adjacent developments.

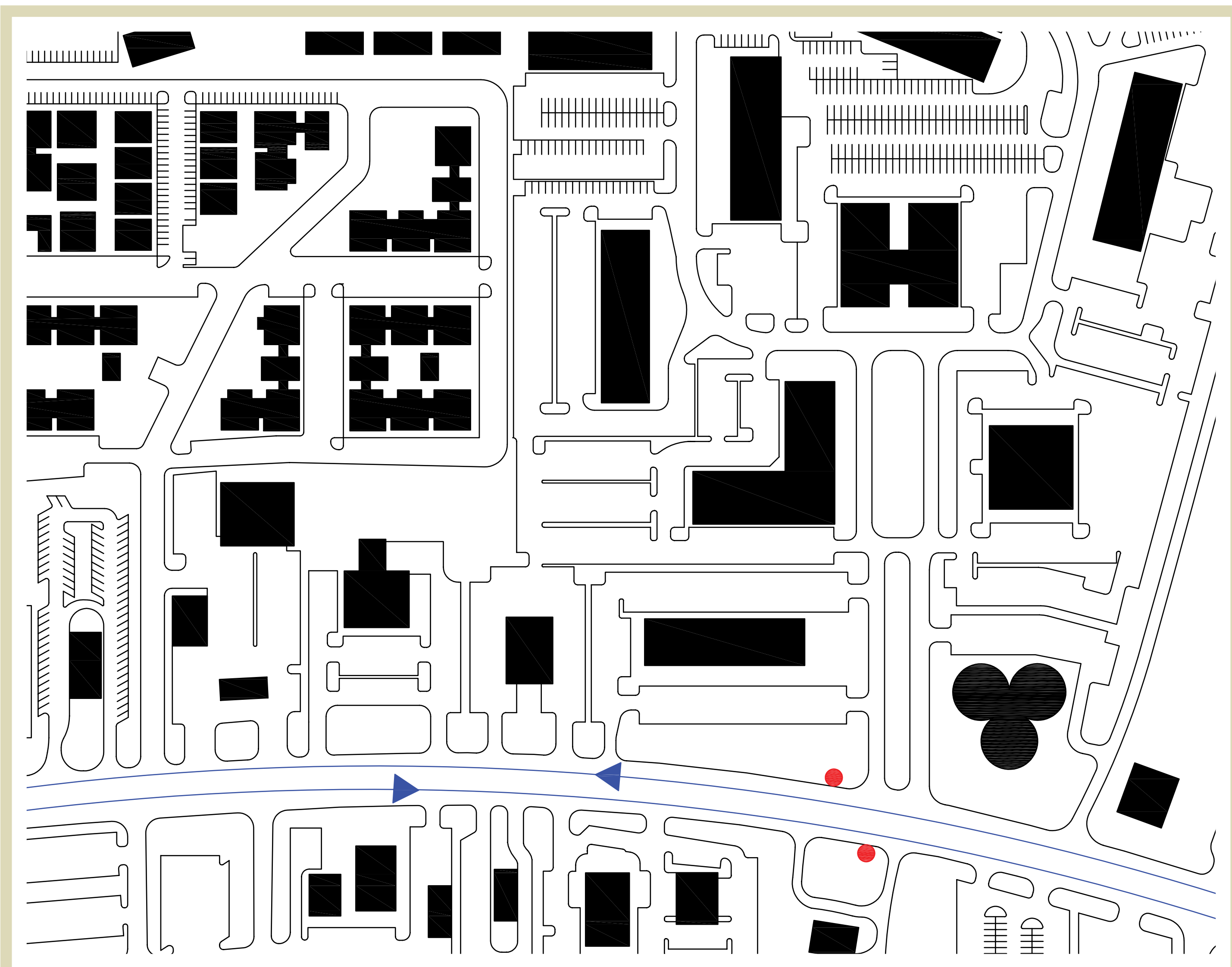


Figure 4.7 | Mixed use districts along many arterials are often characterized by multiple curb cuts, large block sizes, and poor connectivity between land uses, making them less accessible to both transit riders and pedestrians. Bus stop locations are indicated in red dots in plan.

4.8 Transit-oriented Mixed-use District

Density and Intensity of Use

Transit-oriented mixed-use districts are pedestrian friendly centers with a floor area ratio of no less than .25 in commercial areas but preferably in the range of .5 to 1. Multi-family housing is developed at no less than 6 to 8 units per acre but preferably approaching 12 to 16 units per acre.[2] See Figure 4.8. Bus stop locations are indicated in red and bus routes in blue.

Network Continuity

A continuous street network minimizes out-of-direction travel. The negative effects of through traffic are mitigated with traffic calming. Access to transit stops is provided by a continuous sidewalk network. Some trips are executed on collector and local roads, providing alternatives to the arterial roadway.

Block Orientation and Design

Blocks are scaled to pedestrian travel. The average block perimeter is 1,600 feet. Development is accessed through collector streets that connect with the arterial roadway and the local street network. [2]

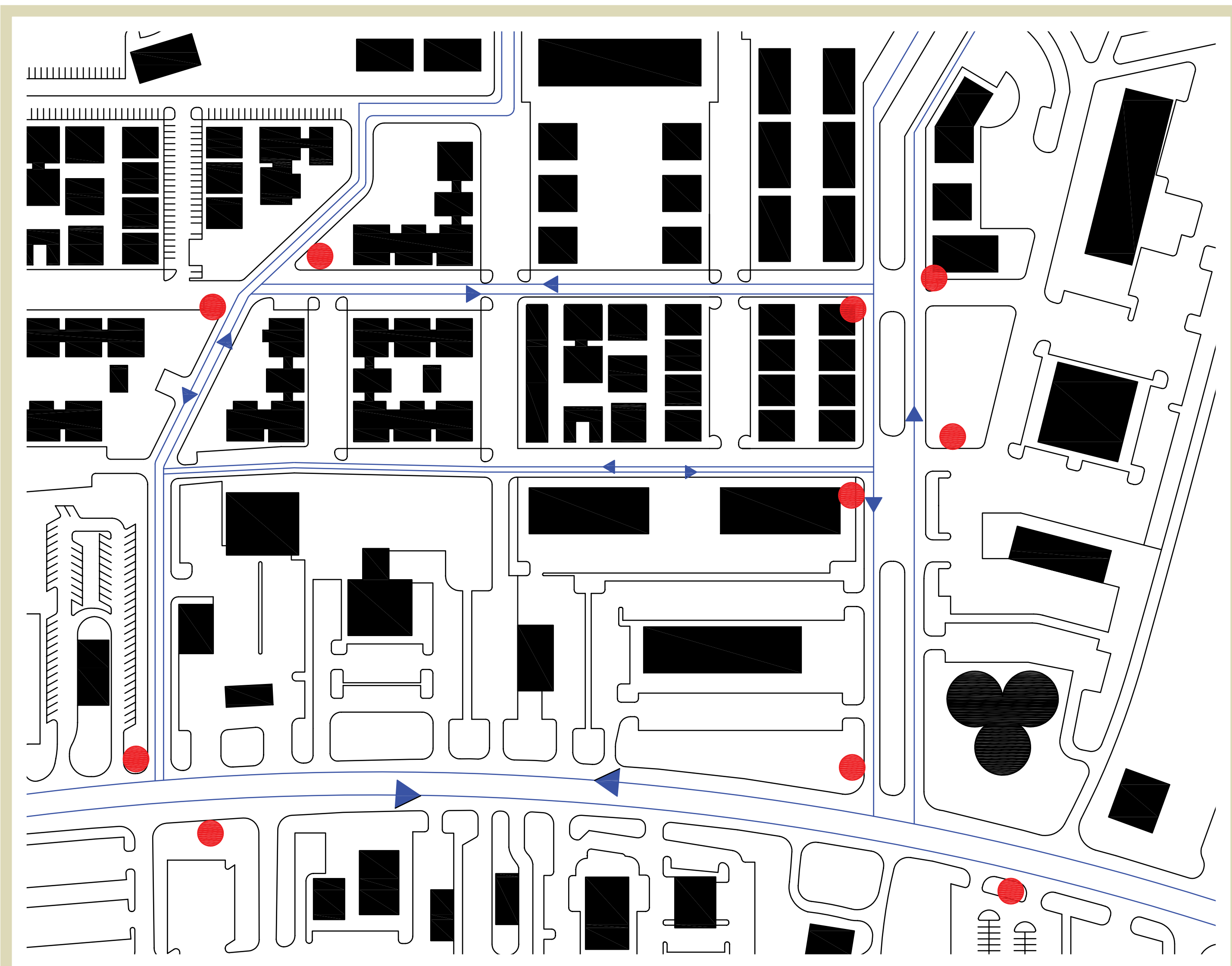


Figure 4.8 | Mixed use districts along arterials can be made more accessible to transit by reducing the block size and the need for out of direction travel. Bus stops are indicated in red dots in plan.

4.9 Transit-discouraging Retail Shopping Center

Density and Intensity of Use

Auto-oriented commercial centers have a floor area ratio of less than .25. [2] See Figure 4.9.

Network Continuity

Few connections are made to other buildings or destinations off-site. Connections between building entrances and pedestrian facilities in the public right of way are usually absent. This requires pedestrians to travel through parking lots and negotiate conflicts with vehicles more frequently and with vehicles traveling at often inappropriately high speeds. Large block perimeters and separation from nearby developments extend the length of walking trips.

Building Orientation

Building entrances may or may not be oriented to transit routes. Buildings are separated from surrounding uses by fences and are separated from transit routes and stops by large parking lots. Building entrances are often several hundred feet from the right of way.

Building Design

Many buildings have large blank walls. Weather protection is provided only at the entrances of buildings.

Landscaping

Perimeter sidewalks are usually not buffered from auto traffic. Low maintenance landscaping is limited to groundcover, shrubs, and isolated trees.

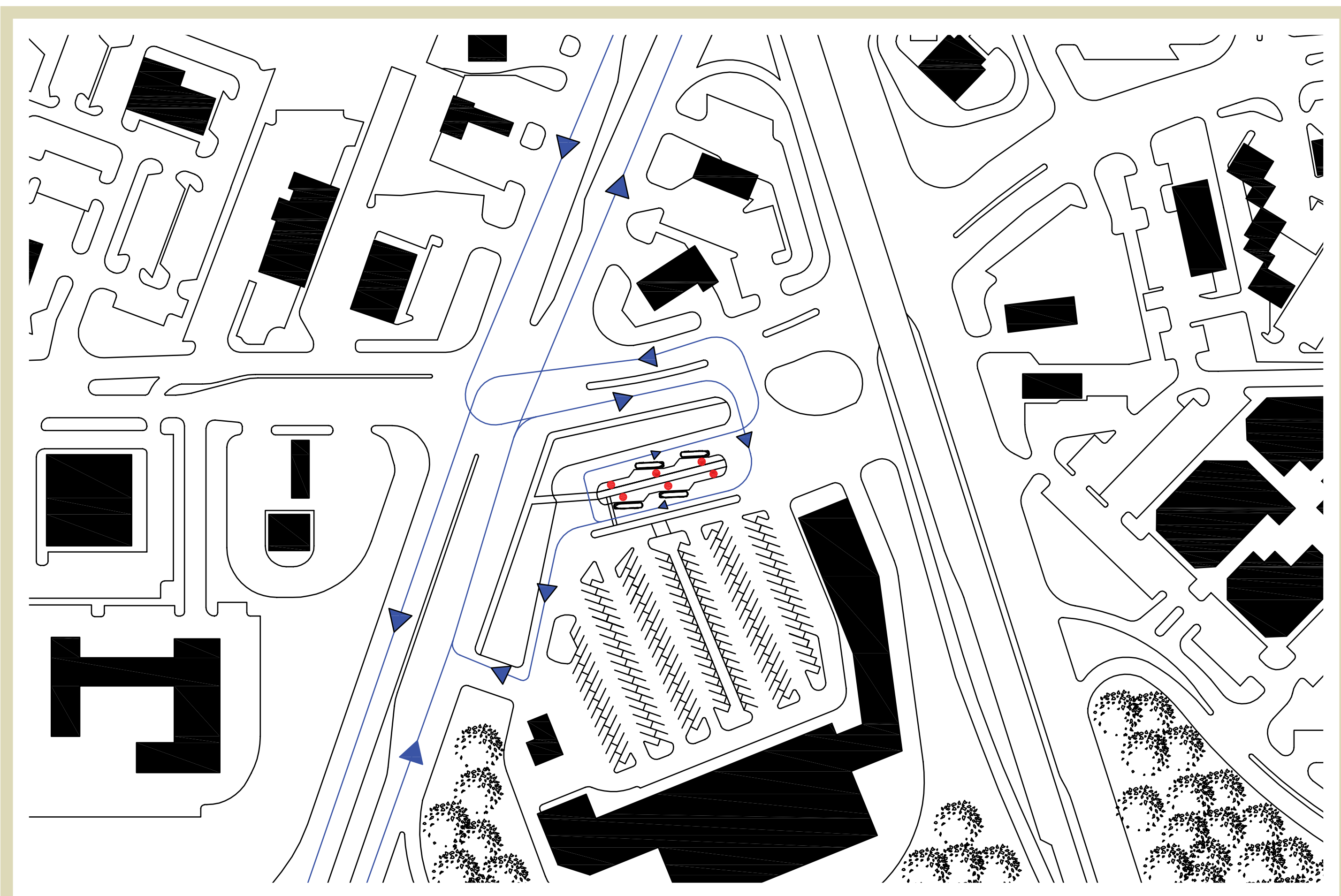


Figure 4.9 | Many shopping centers are separated from the street by large parking lots, causing transit riders and pedestrians to negotiate many conflicts with automobile traffic. Bus stops are indicated in red dots in plan.

4.10 Transit-oriented Retail Shopping Center

Density and Intensity of Use

Transit- and pedestrian-oriented commercial centers, if completely realized, should approach a floor area ratio of .5 in the suburban configuration illustrated below.[2] See Figure 4.10. While this configuration is typical of much of urbanized Florida, elsewhere floor area ratios of 1.0 or more are typical.

Network Continuity

Pedestrian crossings are provided between buildings, at intersections, and at access points on-site. Transit riders have safe and comfortable access to multiple destinations. Interior walkways connect to sidewalks at property boundaries. Transit facilities are taken into account and the roadway network may include a dedicated busway.

Building Orientation

Buildings are oriented to the street and to transit corridors. Building entrances are oriented to the pedestrian network. No parking should be provided between streets and building fronts; any parking garages built on street-bordering lot edges should incorporate retail or service commercial activities at the street level.

Building Design

All building façades facing the transit corridor and pedestrian network have windows or displays. Awnings and arcades along the pedestrian network provide protection from the weather.

Landscaping

Landscape buffers are provided as a transition between different land uses and plants of varying heights, sizes, textures, and colors can increase visual interest along the right of way. The use of public art may also give the community a feeling of ownership that tends to reduce vandalism.[4]

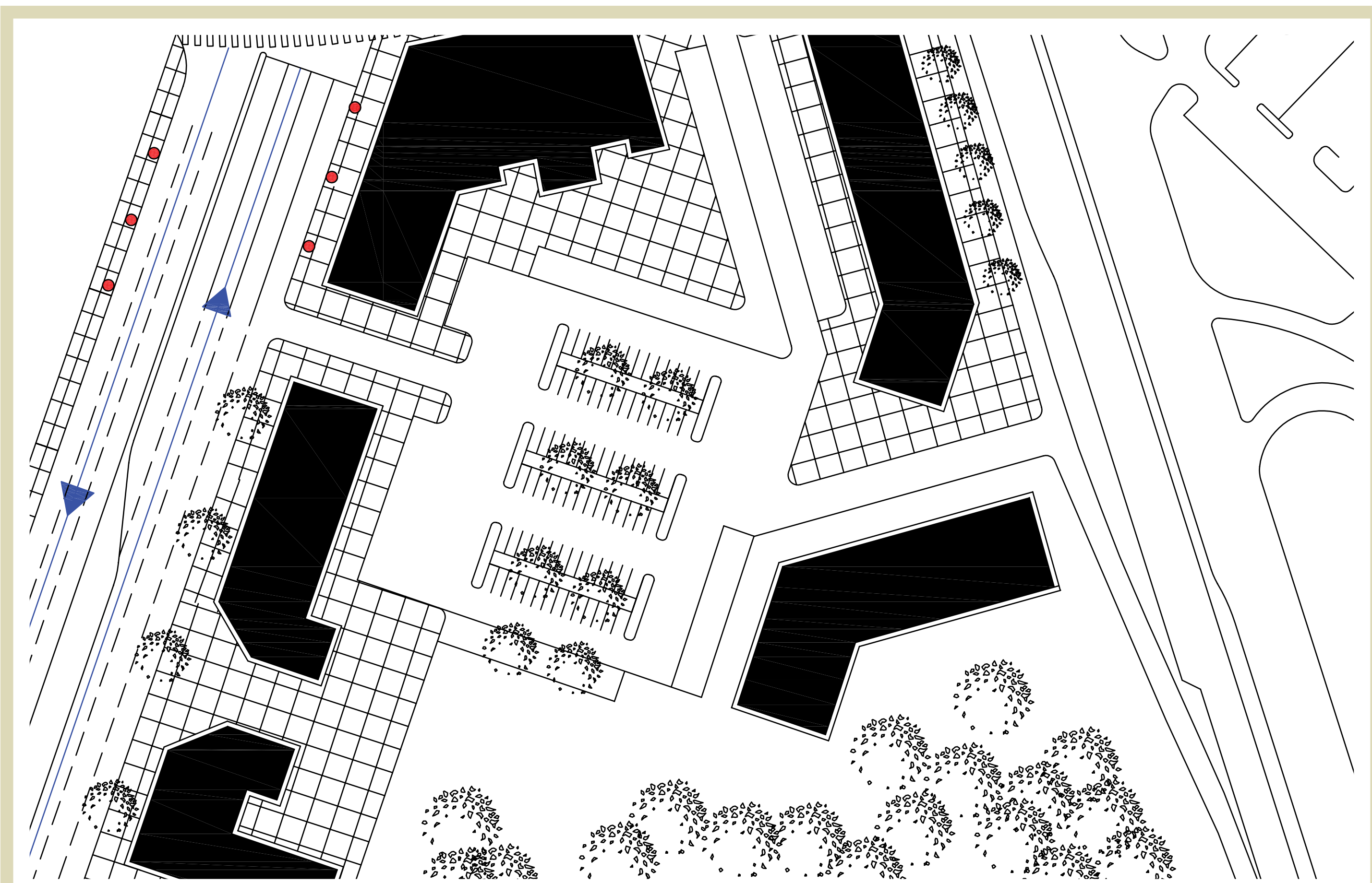


Figure 4.10 | Shopping centers can be made more accessible to transit riders and pedestrians by locating parking at the center and providing primary transit stops along high-traffic corridors.

4.11 Transit-discouraging Office Building

Density and Intensity of Use

Auto-oriented employment zones have floor area ratios of less than 0.25 and 4 to 5 parking spaces per 1,000 square feet of building. See Figure 4.11.

Network Continuity

Few connections are made to other buildings or destinations. On-site walkways do not extend to the perimeter pedestrian network beyond the boundaries of the property.

Building Orientation

Buildings are oriented to the parking lot.

Building Design

Entrances and structures are oriented to parking lots. Weather protection is provided only at the entrances of buildings.

Landscaping

Perimeter sidewalks may not be buffered from auto traffic. Parking lots are unshaded. Landscaping at auto entrances and building entrances may be of varied quality.

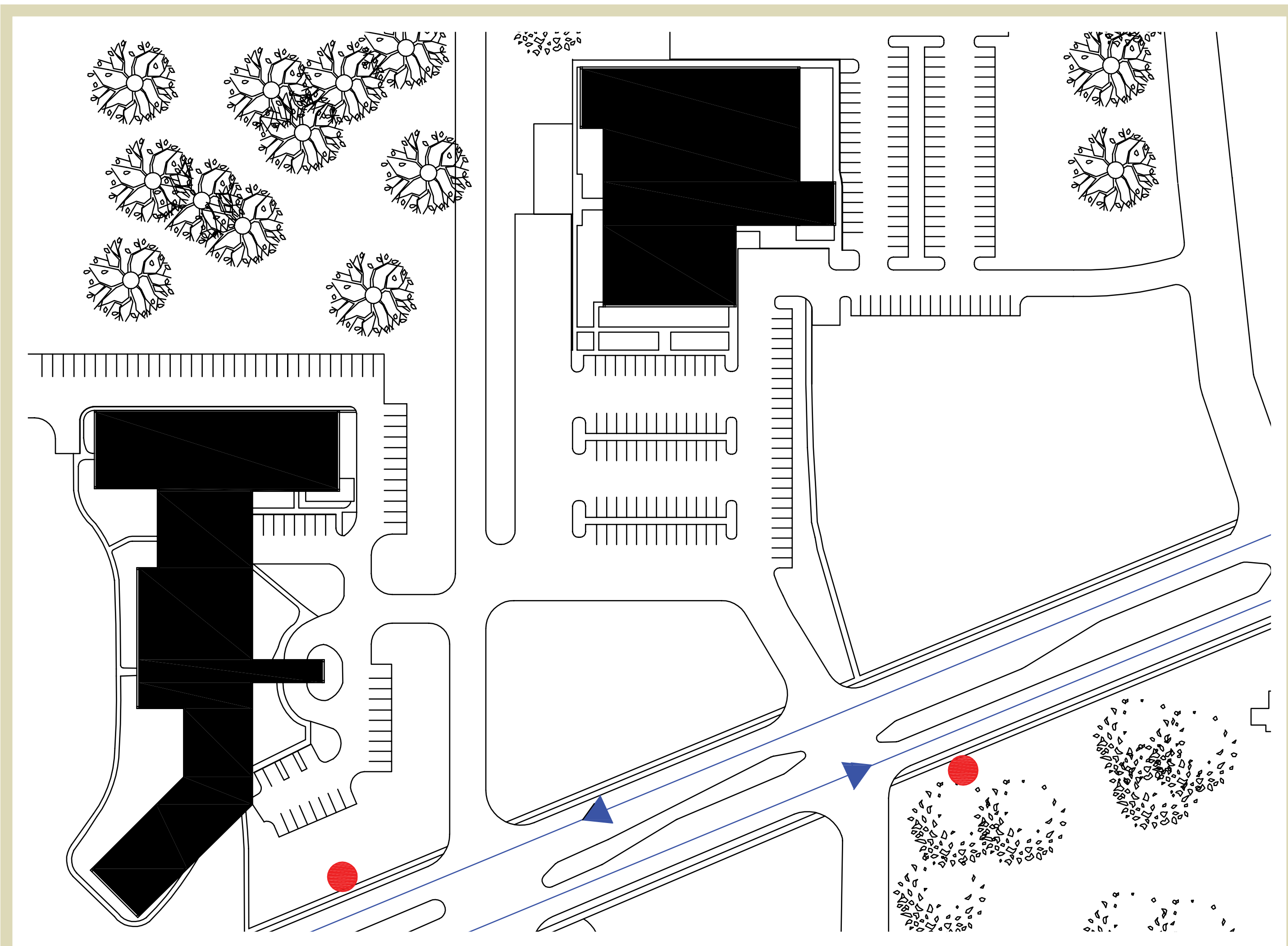


Figure 4.11 | Many office buildings are set back from the right of way, causing increased trip length and reduced accessibility for transit riders and pedestrians. Bus stops are indicated in red dots in plan.

4.12 Transit-oriented Office Building

Density and Intensity of Use

Transit- and pedestrian-oriented office buildings are designed to allow for the future intensification of development. See Figure 4.12.

Network Continuity

Sidewalks are provided around building perimeters and building locations enhance accessibility for pedestrians and transit patrons. Sidewalks are articulated across driveway aprons.

Building Orientation

Buildings are oriented to the street and to transit corridors. Building entrances are oriented to the pedestrian network.

Building Design

All building façades facing the transit corridor and pedestrian network have windows or displays. Awnings and arcades along the pedestrian network provide protection from the weather.

Landscaping

Landscape buffers are provided between transit routes and pedestrian paths. Trees provide a shade canopy along pedestrian and transit routes.

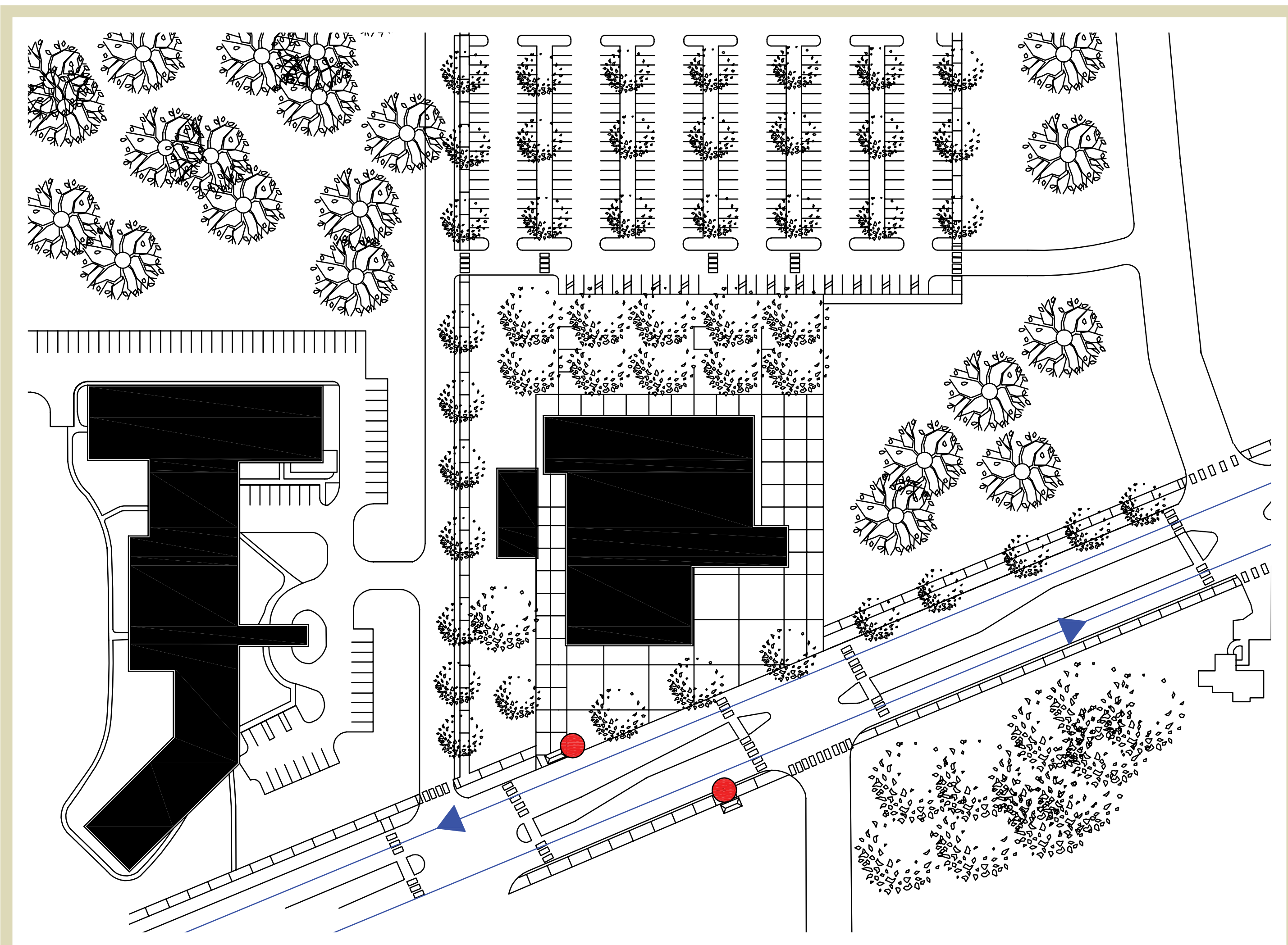


Figure 4.12 | Simply locating an office building closer to the right of way greatly enhances its accessibility to transit riders and pedestrians. Bus stops are highlighted in red.

Text References

(Endnotes)

1 Central Florida Commuter Rail. (2007, Summer). *Transit oriented development workshop sketchbook.* Retrieved June 13, 2008, from http://www.cfrail.com/Files/Brochures/TODSketchbook.pdf

2 Tri-County Metropolitan Transportation District of Oregon. (1995.) *Planning and design for transit handbook: Guidelines for implementing transit supportive development.* Portland, OR: Tri- County Metropolitan Transportation District of Oregon.

3 Florida Department of Transportation Districts 1 and 7. (2007). *Transit facility handbook.* Retrieved June 13, 2008, from http://www.dot.state.fl.us/transit/Pages/FDOT_D1_D7_Transit_Facility_Handbook.pdf

4 *Crime prevention through environmental design.* (n.d.). Retrieved June 13, 2008, from http://www.cpted-watch.com/

Images credited by others

4.1 Retrieved from Santa Monica Bus Photos http://www.transit-rider.com/ca.losangeles/ images/3540/3540-24.jpg on June 12, 2008

4.2 Retrieved from http://www.bobrichardson.com/transitmall/Shelter_6th_Courthouse_1_R.JPG on June 12, 2008

This page left intentionally blank

CHAPTER FIVE

SAFETY

This page left intentionally blank

CHAPTER FIVE: SAFETY

5.1 Introduction

The safety of patrons at bus stops should get top consideration from transit agencies. Crime and crashes at bus stops endanger transit agency personnel and customers, make them feel vulnerable and generate negative perceptions of transit that discourage ridership. Nevertheless there is much that can be done through the design of bus transit passenger facilities to ensure passenger safety.

This chapter covers issues related to traffic safety, security, and crime prevention at transit facilities. While the policing of crime is beyond the scope of transit agency missions, transit agencies can use design to limit passengers' exposure both to criminal activity and to traffic safety hazards.

Crime prevention through environmental design, or CPTED, concepts seek to reduce vulnerability to crime.[1] Other techniques, outside of CPTED, can also be implemented to reduce passenger exposure to accident and injury. Like CPTED, the focus of the injury-prevention section of this chapter is on simple and unobtrusive design solutions and facility maintenance.

5.2. Environmental Factors Related to Crime at Bus Passenger Facilities

Table 5.1 below summarizes some of the findings from recent research focusing on bus stop crime. [2] Bus passenger facilities that are poorly maintained, especially where litter is allowed to accumulate, may be associated with higher rates of crime. The presence of litter may convey the impression that no one owns or takes responsibility for the bus stop, turning it into a "no-man's land." On the other hand, a clean bus stop indicates that regular maintenance is performed and that the transit agency cares about its facilities and its passengers. Well-maintained facilities may lead people to feel safer and more comfortable waiting for the bus and may increase pedestrian travel. See Figure 5.1.

Pedestrian presence and visibility are, in fact, the two environmental factors most often associated with lower rates of crime. In other words, a high pedestrian presence and high transit stop visibility may correlate with lower crime rates at bus passenger facilities. Increased pedestrian presence in the vicinity of a bus stop provides more surveillance of the environment. Visibility, the absence of visual obstruction, allows passers-by, local businesspeople, passing motorists and others to keep an eye on the bus stop and eliminates places in which it is easy to hide, lurk or loiter without notice. Figure 5.2 illustrates a facility that offers poor visibility.

Table 5.1 | Environmental variables related to bus stop crime.

Variables Associated with Higher Crime Rates	Variables Associated with Lower Crime Rates
Total Crime Rates	
Level of litter Liquor stores and other undesirable establishments Vacant buildings and lots Rundown buildings	Pedestrian presence Visibility Large front/closed commercial Bus shelters Street traffic
Violent Crime Rates	
Vacant lots Rundown buildings	Large front/closed commercial Visibility Pedestrian presence

Source: Liggett, R., Loukaitou-Sideris, A., & Hiroyuki, I. (2001). *Bus stop-environmental connection: Do characteristics of the built environment correlate with bus stop crime?* (UCTC Report No. 613)

5.3. Crime Prevention Through Environmental Design (CPTED)

Research has shown that of all transit-related crime, about 46 percent occurs on the bus, 32 percent occurs at the bus stop, and the other 22 percent occurs when passengers travel to and from the transit passenger facility.[3] In general, non-transit riders are three times more likely than transit riders to perceive bus passenger facilities as dangerous because of crime.[3] Because there is a strong correlation between perceptions of personal security and willingness to ride the bus, transit agencies seeking to lure more "choice riders" to transit should convey to the wider public that bus passenger facilities are safe, secure, and crime-free.

There are several strategies transit agencies can employ to increase the perceptions of safety at bus passenger facilities. First, every effort should be made to site bus stops in front of establishments that offer opportunities for natural surveillance and away from desolate spaces, empty lots, and vacant buildings. Additionally, the placement of bus stops in the immediate vicinity of establishments that attract crime (liquor stores, bars, adult bookstores and movie theaters) as well as facilities that favor many cash transactions (pawn shops or check cashing establishments), should be avoided. It is important to install and maintain sufficient lighting (see Section 1.8 for lighting standards), especially at stops served by night routes, if streetlights do not provide ample illumination. Agencies should consider installing LED lighting that is both resistant to tampering and energy-efficient or solar lighting. Regular maintenance of landscaping around and near bus stops and transit facilities should also be performed. Overgrown bushes potentially present a security hazard and obstruct the approach on the sidewalk and landing area to the bus stop.

Transit agencies should strive to keep the bus stop environment clean from graffiti and litter, thus sending the message that the bus stop environment is actively looked after and kept in order. Transit facilities should be clean, well-kept environments in order to increase perceptions of safety and dissuade potential perpetrators of crime. Any opportunities to store explosive or other harmful objects in and around transit facilities should be eliminated by installing bomb-proof trash cans (see Section 1.11) and by ensuring that bus shelter partitions can be seen in, around, and through.

Figure 5.1 | A clean, well-maintained bus stop indicates that regular maintenance is performed and that the transit agency cares for its bus stops and its passengers.

Figure 5.2 | Even temporary low visibility can create places where it is easy to hide, lurk, or loiter without notice.

Finally, agencies should consider hiring transit police or engaging local police and sheriff's departments to cope with any crime that may occur on the buses and at bus stops.

For bus stops that are used by students, the following additional considerations are important. Bus stops near schools should be located in the vicinity of clearly established and defined school property lines. Any opportunity to collocate bus passenger facilities with blue security lights having direct phone connection to police should be realized. See Figure 5.3. Depending on their priorities, transit agencies

Figure 5.3 | Stops at educational facilities should have blue security lights with direct phone connection to police.

Figure 5.4 | A bus stop with highly visible bike racks.

should consider installing closed-circuit video cameras to monitor sites. Finally, bike racks should be installed in high-visibility areas. If fenced, fencing should be chain-link; if by a building, the rack should be near a window. Figure 5.4 illustrates highly visible bike racks installed near a bus stop.

Figure 5.5 | Bus bays allow buses to safely re-enter traffic.

5.4. Passenger Injury

Bus passenger injuries generally fall into two large categories: injuries from traffic collisions and other injuries (the most common of which are falls). Bus stops at mid-block locations, as opposed to those near street intersections, are often accompanied by specific hazards. See Section 2.8 for more information on design standards for facilities at mid-block locations.

Passenger injuries resulting from vehicle collision often require emergency medical treatment.[4] Specific crashes are difficult to predict and, thus, to prevent. Crashes involving buses and passengers should be addressed through driver training and, where possible, transit vehicle design.

Automobile-pedestrian crashes near bus stops often occur as buses re-enter the traffic flow. Bus-automobile crashes also often take place under the same circumstances. Where practicable, agencies should consider installing bus bays (see Figure 5.5) and signal controls to allow the bus safe re-entry into traffic flow. Primary consideration should be on routes experiencing frequent congestion. In areas where bus-automobile crashes have occurred, agencies should consider installing informational signage reminding motorists of state law which grant right of way to buses entering traffic and requesting increased traffic enforcement by police.[4] See Figures 5.6, 5.7 and 5.8 for examples of informational signage. At signalized crosswalks near transit stops, pedestrian signals

continued on page 118

should be installed to enhance the safety both of pedestrians and cyclists.[4] See Figure 5.9.

Although a significant amount of automobile-pedestrian crashes do occur at bus stops, research suggests that the reasons for the majority of passenger injuries are unrelated to automobile traffic.[5] Most of these injuries appear to be preventable, as through ensuring that bus shelter design does not create any optical barrier that obstructs the view of the bus stop from the surrounding establishments.

Additionally, it is important to install and maintain ADA-required infrastructure such as landing pads. ADA-mandated landing pads should be kept free of obstruction and debris.[3] Agencies should ensure that all surfaces on which passengers stand are non-slip. For example, the use of stone aggregate that can be slippery for wheelchair users should be avoided. Unevenness of pedestrian surfaces at bus stops should not exceed ADAAG maximums for surface discontinuities or cross slopes.

The slope of the landing pad should be steeper than 1:50, but not steeper than the ADA standard to prevent water accumulation.[6] The accumulation of water in the busway or travel lane can become a hazard. Therefore, water flow should be directed towards the landscaping. Buses entering and leaving stop areas may splash passengers when puddling is present.[3] Efforts should be made to shield passenger waiting areas from the rain.

Again, regular maintenance should be performed to ensure that sidewalks and other pedestrian routes remain accessible and free of obstacles. All hazardous objects such as broken street furniture should be repaired and replaced.[3] Bus shelters and their appurtenances should be constructed of materials unlikely to develop jagged edges.

Adequate pedestrian infrastructure should be provided so that passengers are not required to use the travel lane of the roadway with moving vehicles. It is safe to use the sidewalk. Way-finding devices accessible by all, especially the mobility-, vision-, and hearing-impaired should be installed as is appropriate.

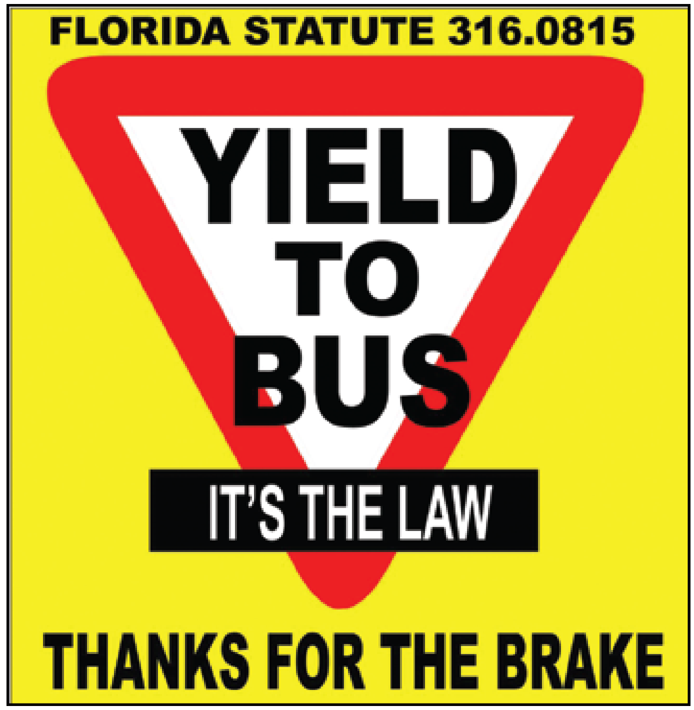


Figure 5.6 | Yield-to-bus decal tested on StarMetro vehicles in Tallahassee, Florida.

Figure 5.7 | StarMetro test decal placement.

Figure 5.8 | "Yield to Bus" roadway signs in Lee County, Florida.

Figure 5.9 | Pedestrian traffic controls provide safety of both pedestrians and cyclists at crosswalk.

Text References

(Endnotes)

1 Newman, O. (1996). *Creating defensible space.* Retrieved June 13, 2008, from http://www.defensiblespace.com/book.htm

2 Liggett, R., Loukaitou-Sideris, A., & Hiroyuki, I. (2001). *Bus stop-environmental connection: Do characteristics of the built environment correlate with bus stop crime?* (UCTC Report No. 613). Berkeley, CA: University of California, Transportation Center.

3 Florida Department of Transportation Districts 1 and 7. (2007). *Transit facility handbook.* Retrieved June 13, 2008, from http://www.dot.state.fl.us/transit/Pages/FDOT_D1_D7_Transit_Facility_Handbook.pdf

4 Zhou, H., & Bromfield, S.A. (2007). *Moving the bus back into traffic safely: Signage and lighting configuration phase 1* (NCTR 77610-00). Tampa, FL: National Center for Transit Research. Retrieved on June 16, 2008 from http://www.nctr.usf.edu/pdf/77610.pdf.

5 Bird, R., & Quigley, C. (1999). *Assessment of passenger safety in local service PSV's: Final report.* Retrieved June 13, 2008, from http://dspace.lboro.ac.uk/dspace/bitstream/2134/525/1/AR2089.pdf

6 Lynch, Kevin and Hack, G. (1984). *Site planning.* Cambridge: MIT Press.

Image credits for images by others

5.6 Zhou, H., & Bromfield, S.A. (2007). *Moving the bus back into traffic safely: Signage and lighting configuration phase 1* (NCTR 77610-00). Tampa, FL: National Center for Transit Research. Retrieved on June 16, 2008 from http://www.nctr.usf.edu/pdf/77610.pdf.

5.7 Zhou, H., & Bromfield, S.A. (2007). *Moving the bus back into traffic safely: Signage and lighting configuration phase 1* (NCTR 77610-00). Tampa, FL: National Center for Transit Research. Retrieved on June 16, 2008 from http://www.nctr.usf.edu/pdf/77610.pdf.

5.8 Zhou, H., & Bromfield, S.A. (2007). *Moving the bus back into traffic safely: Signage and lighting configuration phase 1* (NCTR 77610-00). Tampa, FL: National Center for Transit Research. Retrieved on June 16, 2008 from http://www.nctr.usf.edu/pdf/77610.pdf.

5.9 Image and caption retrieved on June 16, 2008 from http://ops.fhwa.dot.gov/aboutus/one_pagers/images/049_MUTCD_peds_h.jpg

APPENDIX A

Glossary[1]

A

AASHTO – American Association of State Highway and Transportation Officials; see *organizations, American Association of State Highway and Transportation Officials.*

ADA –Americans with Disabilities Act of 1990; see *legislation, Americans with Disabilities Act of 1990.*

ADAAG – Americans with Disabilities Act Accessibility Guidelines.

APTA – American Public Transit Association; see *organizations, American Public Transit Association.*

APM – Automated People Movers.

access, limited (controlled access) – In transportation, to have entry and exit limited to predetermined points, as with rail rapid transit or freeways.

accessibility – **1.** A measure of the ability or ease of all people to travel among various origins and destinations. **2.** In transportation modeling and planning, the sum of the travel times from one zone to all other zones in a region, weighted by the relative attractiveness of the destination zones involved. **3.** In traffic assignment, a measure of the relative access of an area or zone to population, employment opportunities, community services, and utilities.

accessibility, handicapped (full accessibility) – The extent to which facilities are free of barriers and usable by mobile handicapped people, including wheelchair users.

accessible transportation facilities – Transportation facilities that are barrier-free, allowing their use by all travelers, including the mobile physically handicapped, elderly, and transportation disadvantaged.

accessway – A paved connection, preferably non-slip concrete or asphalt, that connects the bus stop waiting pad with the back face of the curb.

advertising shelter – A bus shelter that is installed by an advertising agency for the purpose of obtaining a high visibility location for advertisements. By agreement, the bus shelter conforms to the transit agency specifications but is maintained by the advertising company.

alight – To get off or out of a transportation vehicle.

alignment – In transportation, the horizontal and vertical ground plan of a roadway, railroad, transit route, or other facility as it would appear in plan and profile. The alignment is usually described on the plans by the use of technical data, such as grades, coordinates, bearings, and horizontal and vertical curves, see also *roadbed*.

amenities – Features that provide or increase comfort or convenience.

area, coverage – In transit operations, the geographical area that a transit system is considered to serve, normally based on acceptable walking distances (e.g., ¼ mile, 0.4 km) from loading points. For suburban rail transit that depends on automobile access (park and ride or kiss and ride), coverage may extend several kilometers. See also *area, service.*

area, service – **1.** The jurisdiction in which the transit property operates. **2.** The geographic region in which a transit system provides service or that a transit system is required to serve. See also *area, coverage.*

area, urbanized (UA) – As defined by the Bureau of the Census, a population concentration of at least 50,000 inhabitants, generally consisting of a central city and the surrounding, closely settled, contiguous territory *(suburbs)*. The boundary is based primarily on a population density of 1,000 people/mi^2 but also includes some less densely settled areas, as well as such areas as industrial parks and railroad yards, if they are within areas of dense urban development. The boundaries of UAs, the specific criteria used to determine UAs, or both may change in subsequent censuses. It should be noted that some publications abbreviate urbanized area *UZA*.

articulated bus or articulated trolleybus – An extra-long, high-capacity bus or trolleybus that has the rear body section or sections flexibly but permanently connected to the forward section. The arrangement allows the vehicle to bend in curves and yet have no interior barrier to movement between the two parts. The puller type features a powered center axle while the pusher type features a powered rear axle. Articulated buses with powered center and rear axles exist but are not common. Typically, an articulated bus is 16-18 m (54-60 ft) long with a passenger seating capacity of 60 to 80 and a total capacity of 100 to 140.

automatic vehicle location system (AVL) – A system that determines the location of vehicles carrying special electronic equipment that communicates a signal back to a central control facility. AVLs are used for detecting irregularity in service and are often combined with a computer-aided dispatch system.

APPENDIX A

B

barrier-free – Containing no obstacles that would prevent use by a mobile, physically handicapped or any other person.

bicycle locker – A lockable, enclosed container used for storing a bicycle. Typically provided at major transit stops and stations and rented on a monthly basis.

bicycle rack – **1.** A fixed post or framework to which bicycles may be secured and locked, typically provided on a first-come, first-served basis. **2.** A device mounted to a transit vehicle that allows bicycles to be transported outside the passenger compartment. Typically provided on a first-come, first-served basis; many transit operators require that passengers obtain a permit to use them.

BOB – Bike on bus.

bollard - An upright fixed block (usually concrete) used to prevent the unauthorized or unintended entry of vehicles into an area.

BRT – Bus Rapid Transit. See *transit system, bus rapid.*

BSP – Bus Signal Priority.

bus – A self-propelled, rubber-tired road vehicle designed to carry a substantial number of passengers (at least 16, various legal definitions may differ slightly as to minimum capacity), commonly operated on streets and highways. A bus has enough headroom to allow passengers to stand upright after entering. Propulsion may be by internal combustion engine, electric motors or hybrid. Smaller capacity road transit vehicles, often without full headroom, are termed vans.

bus, low floor – A bus without steps at entrances and exits. The low floor may extend throughout the bus or may use a ramp or steps to access the raised rear portion over a conventional axle and drive train. Wheelchair access is provided by a retracting ramp.

bus, small – Bus that is less than 6 m (20 ft) long.

bus, standard urban (transit coach, urban transit bus) – A bus for use in frequent-stop service with front and (usually) center doors, normally with a rear-mounted engine and lowback seating. Typically 10-12 m (35-40 ft) long.

bus bay – **1.** A branch from or widening of a road that permits buses to stop, without obstructing traffic, while laying over or while passengers board and alight; also known as a blister, bus duckout, bus turnout, pull-off or lay-by. As reentry of the bus into the traffic stream can be difficult, many agencies discourage their construction. **2.** A specially designed or designated location at a transit stop, station, terminal, or transfer center at which a bus stops to allow passengers to board and alight; also known as a *bus dock* or *bus berth*. **3.** A lane for parking or storing buses in a garage facility, often for maintenance purposes.

bus bay, sawtooth - A bus bay design where the curb is indented in a sawtooth pattern, allowing buses to enter and exit bus bays independently of other buses. Often used at transit centers.

bus bulb (curb extension) – An extension of the sidewalk into the roadway for passenger loading without the bus pulling into the curb; gives priority to buses and eases reentry into traffic; often landscaped and fitted with bus shelter and other passenger amenities.

bus stop spacing – The distance between consecutive stops.

bus stop zone length – The length of a roadway marked or signed as available for use by a bus loading or unloading passengers.

busway – A special roadway designed for exclusive use by buses. It may be constructed at, above, or below grade and may be located in separate rights of way or within highway corridors.

C

CBD – Central Business District. *See central business district.*

CPTED – Crime prevention through environmental design.

CUTR – Center for Urban Transportation Research.

capacity, design – **1.** For highways, the maximum number of vehicles that can pass over a given section of a lane or roadway in one or both directions during a given time period under prevailing environmental (e.g., weather, light), roadway, and traffic conditions. **2.** for transit, the maximum number of passengers that can be transported over a given section of a transit line in one direction during a given time period (usually 1 hr.) under prevailing traffic conditions and design comfort standards. **3.** for vehicles, the total number of spaces or people a vehicle can accommodate.

capital costs – Nonrecurring or infrequently recurring costs of long-term assets, such as land, guideways, stations, buildings, and vehicles. These costs often include related expenses, for example, depreciation and property taxes.

central business district (CBD) – Defined by the Bureau of the Census, an area of high land valuation characterized by a high concentration of retail businesses, service businesses, offices, hotels, and theaters, as well as by a high traffic flow. A CBD follows census tract boundaries; that is, it consists of one or more whole census tracts. CBDs are identified only in central cities of MSAs and other cities with populations of 50,000 or more.

central city – As defined by the Bureau of the Census, the largest city, or one of the largest cities.

corridor – In planning, a broad geographical band that follows a general directional flow or connects major sources of trips. It may contain a number of streets and highways and transit lines and routes.

curb-side factors – Factors that are located off the roadway that affect transit patron comfort, convenience, and safety.

curb-side stop – A bus stop in the travel lane immediately adjacent to the curb.

D

DOT – Department of Transportation; see *organizations, department of transportation;* and *U.S. Government, Department of Transportation.*

deceleration, retardation, braking rate – Decrease in velocity per unit time; in transit practice, often measured in m/s^2 (ft/s^2) or, in the United States, mph/s.

defensible space – A concept in architecture and urban design that precludes designs resulting in dark alleys, corners, or spaces where visibility and openness to other people is severely limited.

destination – **1.** The point at which a trip terminates. **2.** In planning, the zone in which a trip ends.

discharge – In transit operations, to let passengers exit the vehicle.

disincentive – Something that discourages people from acting in a certain way. For example, high parking fees or tolls are disincentives to automobile use.

downstream – In the direction of traffic.

drop curb – A concrete traffic curbing that allows vehicles to be driven over.

dwell time – See *time, dwell*.

E

EMS Access – Emergency Medical Services Access.

elderly and handicapped (E&H) – People who may have special needs for services such as transportation. Transportation especially provided for their benefit is called *elderly and handicapped (E&H) transportation*. Transit operations may provide discounted *E&H* fares or include *E&H* in a more general concession fare. Minimum age varies by program — 55+, 60+, 65+. See also *handicapped.*

F

FAC – Florida Administrative Code.

FAR – Floor Area Ratio. It is the ratio of the building area of all floors to the site area.

FHWA – Federal Highway Administration; see *U.S. Government, Federal Highway Administration*.

FTA – Federal Transit Administration; see *U.S. Government, Federal Transit Administration*.

freeway – A divided highway for through traffic that has full access control and grade separations at all intersections. In some countries, it is also known as a motorway.

H

HART – Hillsborough Area Regional Transit Authority.

HCM – Highway Capacity Manual.

HOV – High Occupancy Vehicle; see *vehicle, high occupancy.*

HOV lane – High Occupancy Vehicle lane; see *lane, high occupancy vehicle.*

HOT lane – High Occupancy Toll lanes.

handicapped – People who have physical or mental impairments that substantially limit one or more major life activities. In the context of transportation, the term usually refers to people for whom the use of conventional transit facilities would be impossible or would create a hardship. These people are also known as transportation handicapped, as people who have a public transportation disability and transportation disadvantages, or more currently, also are physically or mentally challenged.

headway – The time interval between the passing of the front ends of successive transit units (vehicles or trains) moving along the same lane or track (or other guideway) in the same direction, usually expressed in minutes; see also *service frequency*.

hub (timed transfer focal point) – Transit center or interchange for connections or transfers between modes and/or routes. Connections are usually timed in clock-headway pulses and allow convenient transfer between local routes and to express routes. The express routes can connect to the city center and to other hubs, thus offering better suburb to suburb trips than possible with a radial route system. Hubs are best located at activity centers such as shopping malls, suburban town centers and campuses.

I

ISTEA – Intermodal Surface Transportation Efficiency Act of 1991.

interchange – **1.** Facility for passenger transfers or connection between routes or modes, see *hub*. **2.** The system of interconnecting ramps between two or more intersecting travel ways (highways, transit guideways, etc.) that are grade separated.

intermodal – Those issues or activities which involve or affect more than one mode of transportation, including transportation connections, choices, cooperation and coordination of various modes.

J

jaywalk – To cross a street illegally in the middle of the block or against a pedestrian signal.

K

Kiss-and-ride (kiss 'n' ride, K&R) – An access mode to transit whereby passengers (usually commuters) are driven to a transit stop and left to board a transit unit and then met after their return trip. Transit stations, usually rail, often provide a designated area for dropping off and picking up such passengers.

L

LED – Light emitting diodes ; a small area light source that emits narrow-spectrum light. LEDs are more efficient in terms of producing light per watt than incandescent bulbs. This is also useful in battery powered or energy-saving devices. Depending on composition and condition of the semiconducting material used, the color of the emitted light can be infrared, visible, or ultraviolet. [2,3]

LOS – Level of service. *See level of service.*

lane, bus (bus priority lane, preferential bus lane, priority bus lane) – A highway or street lane reserved primarily for buses, either all day or during specified periods. It may be used by other traffic under certain circumstances, such as making a right or left turn, or by taxis, motorcycles, or carpools that meet specific requirements described in the traffic laws of the specific jurisdiction.

lane, carpool – A highway or street lane intended primarily for carpools, vanpools, and other high occupancy vehicles, including buses, either all day or during specified periods. It may be used by other traffic under certain circumstances, such as while making a right turn. Minimum occupancy is contentious; many requirements for a minimum of three passengers have been reduced to two through political pressure or legal action.

lane, diamond – A high occupancy vehicle lane physically marked by diamonds painted on the pavement and often indicated by diamond-shaped signs as well. Often used synonymously with high occupancy vehicle lane.

lane, exclusive carpool – A highway or street lane reserved for carpools and vanpools.

lane, exclusive transit (reserved transit lane) – A highway or street lane reserved for buses, light rail vehicles, or both.

lane, high occupancy-vehicle (HOV lane) – A highway or street lane reserved for the use of high occupancy vehicles (HOVs), see *lane, carpool*.

lane, priority – A highway or street lane reserved (generally during specified hours) for one or more specified categories of vehicles; for example, buses, carpools, vanpools.
layover, vehicle – See *time, layover.*

layover time – See *time, layover.*

layover zone – A designated stopover location for a transit vehicle at or near the end of the route or line or at a turnback point.

APPENDIX A

legislation, Americans with Disabilities Act of 1990 (ADA) – Federal civil law which assures people with disabilities equal opportunity to participate fully in society, the ability to live independently, and the ability to be economically sufficient.

legislation, Federal Transit Act of 1964 – Federal legislation enacted in 1964 that established the federal mass transportation program. Formerly known as the Urban Mass Transportation Act of 1964. Repealed in 1994 and reenacted as chapter 53 of title 49, United States Code.

legislation, Intermodal Surface Transportation Efficiency Act (ISTEA) – Signed into federal law on December 18, 1991, it provided authorizations for highways, highway safety and mass transit for six years and serves as the basis of federal surface transportation programs. Renewed and amended in 1998 for six years as TEA-21; see *legislation, TEA-21*.

legislation, TEA-21 – 1998 Transportation Efficiency Act for the 21st Century, provides authorizations for highways, highway safety and mass transit expenditures for six years and is the basis of federal surface transportation programs. Replaces ISTEA.

level of service (LOS) – **1.** A set of characteristics that indicate the quality and quantity of transportation service provided, including characteristics that are quantifiable (system performance, e.g., frequency, travel time, travel cost, number of transfers, safety) and those that are difficult to quantify (service quality, e.g., availability, comfort, convenience, modal image). **2.** For highway systems, a qualitative rating of the effectiveness of a highway or highway facility in serving traffic, in terms of operating conditions. The *Highway Capacity Manual* identifies operating conditions ranging from A, for best operation (low volume, high speed), to F, for worst conditions. **3.** For paratransit, a variety of measures meant to denote the quality of service provided, generally in terms of total travel time or a specific component of total travel time. **4.** For pedestrians, sets of area occupancy classifications to connect the design of pedestrian facilities with levels of service (A for best through F for worst). **5.** The amount of transit service provided.

levels of service (transit) – Six designated ranges of values for a particular service measure, graded from "A" (best) to "F" (worst) based on a transit passenger's perception of a particular aspect of transit service. LOS for transit relates to frequency of service, pedestrian access, obstacles to stops and bus span of service. See "FDOT Quality / Level of Service Handbook" for more details on all LOS issues.

line-haul - Movement of freight between cities, excluding pickup and delivery service.

loading island - **1.** A pedestrian refuge within the right of way and traffic lanes of a highway or street. It is provided at designated transit stops for the protection of passengers from traffic while they wait for and board or alight from transit vehicles; also known as a pedestrian refuge or boarding island. **2.** A protected spot for the loading and unloading of passengers. It may be located within a rail transit or bus station. **3.** On street car and light rail systems a passengers loading platform in the middle of the street, level with the street or more usually raised to curb height, often protected with a bollard facing traffic; also known as a safety island.

M

MUTCD – *Manual on Uniform Traffic Control Device.*

mass transit, mass transportation – Urban public transport by bus, rail, or other conveyance, either publicly or privately owned, providing general or special service to the public on a regular and continuing basis (not including school bus, charter, or sightseeing service). The term has developed a negative connotation and its use is discouraged in favor of urban transport, transit, public transit, public transport or public transportation.

mid-block stop – see *stop, mid-block.*

mixed traffic operations – The operation of transit vehicles on nonexclusive right of way with non-transit vehicles.

mode – **1.** A transport category characterized by specific right of way, technological and operational features, **2.** A particular form of travel; for example, walking, traveling by automobile, traveling by bus, traveling by train.

mode, transit – A category of transit systems characterized by common characteristics of technology, right of way, and type of operation. Examples of different transit modes are regular bus service, express bus service, light rail transit, rail rapid transit, and commuter rail.

N

NCTR – National Center for Transit Research; a program of the Center for Urban Transportation Research at the University of South Florida. It researches the public transportation and alternative forms of transportation. [4]

NTSB – National Transportation Safety Board; see *U.S. Government, National Transportation Safety Board.*

near-side stop – see *stop, near-side.*

network, radial – In transit operations, a service pattern in which most routes converge into and diverge from a central hub or activity center (e.g., central business district), like the spokes of a wheel. The hub may serve as a major transfer point.

nub – A stop where the sidewalk is extended into the parking lane, which allows the bus to pick up passengers without leaving the travel lane; also known as *bus bulbs* or curb extensions.

O

operations, mixed traffic – see *mixed traffic operations.*

organizations, American Association of State Highway and Transportation Officials (AASHTO) – Membership includes state and territorial highway and transportation departments and agencies and the U.S. Department of Transportation. Its goal is to develop and improve methods of administration, design, construction, operation, and maintenance of a nationwide integrated transportation system. It studies transportation problems, advises Congress on legislation, and develops standards and policies.

organizations, American Public Transit Association (APTA) – A nonprofit international industry association made up of transit systems and other organizations and institutions connected to or concerned with the transit industry. It performs a variety of services for the industry, and its objectives include promotion of transit interests, information exchange, research, and policy development.

organizations, department of transportation (DOT) – A municipal, county, state, or federal agency responsible for transportation; see also *U.S. Government, Department of Transportation.*

organizations, Transportation Research Board – A unit of the National Research Council, operating under the corporate authority of the private and nonprofit National Academy of Sciences. The purpose of TRB is to advance knowledge concerning the nature and performance of transportation systems by stimulating research and disseminating the information derived there from. Its affiliates and participants include transportation professionals in government, academia, and industry.

P

PD & E Manual – *Project Development and Environment Manual*; provides information to project analysts and project managers about compliance of project with all Federal and state laws and be uniform in their quality and exactness. It is generally used by FDOT to ensure quality in project development. [5]

PPM – *Plans Preparation Manual;* Two volumes provide guidelines on geometric and other design criteria, and as well as procedures, and requirements for the preparation and assembly of contract plans, for Florida Department of Transportation (FDOT) projects. It is applicable to the preparation of contract plans for roadways and structures on the state roads. [6,7]

paratransit – Forms of transportation services that are more flexible and personalized than conventional fixed route, fixed schedule service but not including such exclusory services as charter bus trips. The vehicles are usually low- or medium-capacity highway vehicles, and the service offered is adjustable in various degrees to individual users' desires. Its categories are public, which is available to any user who pays a predetermined fare (e.g., taxi, jitney, dial-a-ride), and semipublic, which is available only to people of a certain group, such as the elderly, employees of a company, or residents of a neighborhood (e.g., vanpools, subscription buses).

park-and-ride (park 'n' ride, P&R) – An access mode to transit in which patrons drive private automobiles or ride bicycles to a transit station, stop, and park the vehicle in the area provided for that purpose (park-and-ride lot, park-and-pool lot, commuter parking lot, bicycle rack or locker). They then ride the transit system or take a car or vanpool to their destinations.

parking facility – An area which may be enclosed or open, attended or unattended, in which automobiles may be left, with or without payment of a fee, while the occupants of the automobiles are using other facilities or services.

passenger amenity - An object or facility (such as a shelter, telephone, or information display) intended to enhance passenger comfort or transit usability.

peak (peak period, rush hours) – **1.** The period during which the maximum amount of travel occurs. It may be specified as the morning (a.m.), afternoon or evening (p.m.) peak. **2.** The period when demand for transportation service is heaviest.

pedestrian refuge – A space designed for the use and protection of pedestrians, including both the safety zone and the area at the approach that is usually outlined by protective deflecting or warning devices; see also *loading island*.

platform – The front portion of a bus or streetcar where passengers board.

platform, passenger – That portion of a transit facility directly adjacent to the tracks or roadway at which transit units (vehicles or trains) stop to load and unload passengers. Within stations, it is often called a station platform.

platform, high – A platform at or near the floor elevation of the transit unit (vehicle or train), eliminating the need for steps on the transit unit.

platform, low – A platform at or near the top of the running surface of the transit unit (vehicle or train), requiring the passenger to use steps to board and alight.

public transit – Passenger transportation service, usually local in scope, that is available to any person who pays a prescribed fare. It operates on established schedules along designated routes or lines with specific stops and is designed to move relatively large numbers of people at one time. Examples include bus, light rail, rapid transit.

public way – Any public street, road, boulevard, alley, lane, or highway, including those portions of any public place that have been designated for use by pedestrians, bicycles, and motor vehicles.

Q

queue – A line of vehicles or people waiting to be served by the system in which the rate of flow from the front of the line determines the average speed within the line. Slowly moving vehicles or people joining the rear of the queue are usually considered a part of the queue.

queue jumper – **1.** A short section of exclusive or preferential lane that enables specified vehicles to bypass an automobile queue or a congested section of traffic. A queue jumper is often used at signal-controlled freeway on-ramps in congested urban areas to allow high occupancy vehicles preference. It is also known as a bypass lane or queue bypass. **2.** A person who violates passenger controls.

queue jumper bus bay – A bus bay designed to provide priority treatment for buses, allowing them to use right-turn lanes to bypass queued traffic at congested intersections and access a far-side open bus bay.

queue jumper lane – Right-turn lane upstream of an intersection that a bus can use to bypass queued traffic at a signal.

R

right of way (ROW) – **1.** A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes. For transit, right of way may be categorized by degree of their separation: fully controlled without grade crossings, also known as grade separated, *exclusive,* or private ROW*;* longitudinally physically separated from other traffic (by curbs, barriers, grade separation, etc.) but with grade crossings; or surface streets with mixed traffic, although transit may have preferential treatment. **2.** The precedence accorded to one vehicle or person over another.

right of way, controlled access – Lanes restricted for at least a portion of the day for use by transit vehicles and/or other high occupancy vehicles. Use of controlled access lanes may also be permitted for vehicles preparing to turn. The restriction must be sufficiently enforced so that 95 percent of vehicles using the lanes during the restricted period are authorized to use them.

right of way, exclusive – Roadway or other right of way reserved at all times for transit use and/or other high occupancy vehicles.

right of way, exclusive transit – A right of way that is fully grade separated or access controlled and is used exclusively by transit.

right of way, segregated – Roadway or right of way reserved for transit use, but which permits other modes to cross at defined locations such as grade crossings.

right of way, shared – Roadway or right of way which permits other traffic to mix with transit vehicles, as is the case with most streetcar and bus lines.

roadbed – **1.** In railroad construction, the foundation on which the ballast and track rest. **2.** In highway construction, the graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulder.

roadway – That portion of a highway built, designed, or ordinarily used for vehicular travel, except the berm or shoulder. If a highway includes two or more separate roadways, the term means any such roadway separately but not all such roadways collectively.

APPENDIX A

roadway geometry – The proportioning of the physical elements of a roadway, such as vertical and horizontal curves, lane widths, cross sections, and bus bays.

route – **1.** The geographical path followed by a vehicle or traveler from start to finish of a given trip. **2.** A designated, specified path to which a transit unit (vehicle or train) is assigned. Several routes may traverse a single portion of road or line. **3.** In traffic assignments, a continuous group of links that connects two centroids, normally the path that requires the minimum time to traverse. **4.** In rail operations, a determined succession of contiguous blocks between two controlled interlocked signals.

S

service, community – Short feeder or loop route serving a local community, often operated with smaller buses.

service, express bus – Bus service with a limited number of stops, either from a collector area directly to a specific destination or in a particular corridor with stops en route at major transfer points or activity centers. Express bus service usually uses freeways or busways where they are available.

service, feeder – **1.** Local transportation service that provides passengers with connections with a major transportation service. **2.** Local transit service that provides passengers with connections to main-line arterial service; an express transit service station; a rail rapid transit, commuter rail, or intercity rail station; or an express bus stop or terminal, see also *service, community.*

service, shuttle – **1.** Service provided by vehicles that travel back and forth over a particular route, especially a short one, or one that connects two transportation systems or centers, or one that acts as a feeder to a longer route. Shuttle services usually offer frequent service, often without a published timetable.

service frequency – The number of transit units (vehicles or trains) on a given route or line, moving in the same direction, that pass a given point within a specified interval of time, usually 1 hr. See also *headway*.

shelter – see *transit shelter.*

shoulder – The edge or border running along either side of a roadway, generally kept clear of all traffic, and used in the event of a breakdown, for evasive action, for use by emergency vehicles, or by cyclists when a bicycle lane is not present.

sight distance – The portion of the highway environment visible to the driver.

splitter island - A traffic island located in the leg of a roundabout. It is used to separate or split the entering and exiting traffic. It also directs the entering traffic in the right direction.[8]

station – An off-street facility where passengers wait for, board, alight, or transfer between transit units (vehicles or trains). A station usually provides information and a waiting area and may have boarding and alighting platforms, ticket or farecard sales, fare collection, and other related facilities; also known as a passenger station.

station, off-line – A station at which a transit unit (vehicle or train) stops outside the main track or travel lane so that other units can pass while passengers board and alight, rare but found on a few automated guideway transit systems and busways.

station, on-line – A station in which transit units (vehicles or trains) stop on the main track or travel lane. This is the common design, and the term is used only to distinguish this station from off-line stations.

stop, far-side – A transit stop located beyond an intersection. It requires that transit units (vehicles or trains) cross the intersection before stopping to serve passengers.

stop, mid-block – A transit stop located at a point away from intersections.

stop, near-side – A transit stop located on the approach side of an intersection. The transit units (vehicles or trains) stop to serve passengers before crossing the intersection.

stop, transit – An area where passengers wait for, board, alight, and transfer between transit vehicles. In the case of bus, it is usually indicated by distinctive signs and by curb or pavement markings and may provide service information, shelter, seating, or any combination of these. Stops are often designated by transit mode, for example: bus stop for bus transit or trolley stop for trolleys.

street, transit – A street reserved for transit vehicles only.

street–side factors – Factors associated with the roadway that influence bus operations.

system planning – In transportation, a procedure for developing an integrated means of providing adequate facilities for the movement of people and goods, involving regional analysis of transportation needs and the identification of transportation corridors involved.

APPENDIX A

T

TCP – Traffic Control Plan; allows the contractor to work within the public right of way efficiently and effectively, while maintaining a safe, uniform flow of traffic during construction. Equal considerations are given to both construction work and the public in such plan. Equal attention must be given to all modes of travel through the work zone: i.e., vehicular, bicycle, and pedestrian. [9]

TCRP – Transit Cooperative Research Program. *See transit cooperative research program.*

terminal – The end station or stop on a transit line or route, regardless of whether special facilities exist for reversing the vehicle or handling passengers; also known as a terminus.

time, dwell – The time a transit unit (vehicle or train) spends at a station or stop, measured as the interval between its stopping and starting.

time, layover (recovery time, relay time, spot time, turnaround time) – Time built into a schedule between arrivals and departures, used for the recovery of delays and preparation for the return trip. The term may refer to transit units (also known as *vehicle layover*) or operators. Note that the layover time may include recovery time and operator rest time as two specific components.

timetable – **1.** Usually refers to a printed schedule for the public. **2.** A listing of the times at which transit units (vehicles or trains) are due at specified time points; also known as a schedule. **3.** In railroad operations, the authority for the movement of regular trains subject to the rules. It contains classified schedules with special instructions for the movement of trains and locomotives.

transfer – **l.** A passenger's change from one transit unit (vehicle or train) or mode to another transit unit or mode. **2.** A slip of paper, card, or other instrument issued to passengers (either free or with a transfer fee) that gives the right to change from one transit unit or mode to another according to certain rules that may limit the direction of travel or the time in which the change may be made.

transfer, timed – **1.** A transfer that is valid only for a specified time. **2.** The scheduling of intersecting transit routes so that they are due to arrive at a transfer point simultaneously, eliminating waiting time for transfer passengers; also known as a timed connection. See also *timed transfer system.*

transit center – A transit stop or station at the meeting point of several routes or lines or of different modes of transportation. It is located on or off the street and is designed to handle the movement of transit units (vehicles or trains) and the boarding, alighting, and transferring of passengers between routes or lines (in which case it is also known as a transfer center) or different modes (also known as a modal interchange center, intermodal transfer facility or an hub).

Transit Cooperative Research Program – A major transit research program provided for in the *Intermodal Surface Transportation Efficiency Act of 1991* and established by the Federal Transit Administration in 1992. The program is administered by the Transportation Research Board on behalf of the Federal Transit Administration and the American Public Transit Association. The program emphasizes the distribution of research information for practical use.

transit shelter – A building or other structure constructed at a transit stop. It may be designated by the mode offering service, for example, bus shelter. A transit shelter provides protection from the weather and may provide seating or schedule information or both for the convenience of waiting passengers.

transit system – The facilities, equipment, personnel, and procedures needed to provide and maintain public transit service.

transit system, accessible – A transit system that can transport any mobile person, including elderly and people with disabilities, and in which the vehicles and stops or stations are designed to accommodate patrons who are confined to wheelchairs or visually and hearing impaired.

transit system, bus rapid – An inexact term describing a bus operation that is generally characterized by operation on an exclusive or reserved right of way that permits higher speeds. It may include reverse lane operations on limited access roads.

transportation disadvantaged (low-mobility group) – People whose range of transportation alternatives is limited, especially in the availability of relatively easy-to-use and inexpensive alternatives for the trip making. Examples include the young, the elderly, the poor, the handicapped, and those who do not have automobiles. Also known as transit dependent; rider, captive; and rider, captive transit.

Transportation Research Board – see *organizations, Transportation Research Board*.

transportation system, urban – The system of transportation elements (both private and public) that provides for the movement of people and goods in an urban area. The components include transit systems, paratransit services, and highway or road systems, including private vehicles and pedestrians.

travel way - A designated path to be used by a specific mode of the transportation system.[10]

trip – **1.** A one-way movement of a person or vehicle between two points for a specific purpose; sometimes called a one-way trip to distinguish it from a round trip. **2.** In rail operations, a mechanical lever or block signal that, when in the upright position, activates a train's emergency braking system. **3.** The movement of a transit unit (vehicle or train) in one direction from the beginning of a route to the end of it; also known as a run.

trip generation – In planning, the determination or prediction of the number of trips produced by and attracted to each zone.

trip generator – A land use from which trips are produced, such as a dwelling unit, a store, a factory, or an office.

U

UA – Urbanized area; see *area, urbanized.*

UMTA – Urban Mass Transportation Administration; previous name for FTA; see *U.S. Government, Federal Transit Administration.*

universal design – A paradigm that calls for environments to be designed so as to be usable by all people, to the greatest extent possible, without the need for adaptation. The intent of the universal design concept is to simply life for everyone by making the built environment more usable by more people at little or no extra cost. The universal design concept targets people of all ages, sizes and abilities.

upstream – Toward the source of traffic.

U.S. DOT – U.S. Department of Transportation; see *U.S. Government, Department of Transportation.*

U.S. Government, Department of Transportation (DOT) – A cabinet-level Federal agency responsible for the planning, safety, and technology of the national transportation system, including highways, mass transit, air traffic, and shipping.

U.S. Government, Federal Highway Administration (FHWA) – A component of the U.S. Department of Transportation, established to ensure development of an effective national road and highway transportation system. It assists states in constructing highways and roads and provides financial aid at the local level, including joint administration with the Federal Transit Administration of the 49 USC Section 5311 (formerly Section 18 of the Federal Transit Act) program.

U.S. Government, Federal Transit Administration (FTA) – A component of the U.S. Department of Transportation, delegated by the Secretary of Transportation to administer the federal transit program under Chapter 53 of Title 49, United State Code and various other statutes. Formerly known as the Urban Mass Transportation Administration.

U.S. Government, National Transportation Safety Board (NTSB) – An independent agency of the federal government whose responsibilities include investigating transportation accidents and conducting studies, and making recommendations on transportation safety measures and practices to government agencies, the transportation industry, and others.

V

vehicle, high occupancy – Any passenger vehicle that meets or exceeds a certain predetermined minimum number of passengers, for example, more than two or three people per automobile. Buses, carpools, and vanpools are HOVs.

W

waiting or accessory pad – A paved area that is provided for bus patrons and may contain a bench or shelter.

wheelchair lift – A device used to raise and lower a platform that facilitates transit vehicle accessibility for wheelchair users and other handicapped individuals. Wheelchair lifts may be attached to or built into a transit vehicle or may be located on the station platform (wayside lifts).

APPENDIX B

Planning Procedure for Shelters Provided and Maintained by Others[11]

Procedure

1. Keep a master list of existing and derived bus shelter structure. As advertisers propose sites, reference their suggestions to the list and add proposed sites to it.

2. The advertising company and the transit agency staff will field-check each proposed site, preferably at the same time.

3. The advertising company will submit a site plan to the transit agency for staff review and comment. Review will include:
   - ADA accessibility of the shelter and pad to the bus
   - connectivity to land uses
   - safe and convenient boarding and alighting
   - safe bus operation within the existing lane geometry
   - FDOT, county, and municipal design criteria, such as setbacks based on posted speed.

4. If within a municipality, that jurisdiction will review and comment on the site plan after the transit agency staff review.

5. If there is no consensus to proceed, the referents will change the status on the master list to "rejected."

6. Notify adjacent property owners, follow the local jurisdiction's notification procedures for a neighborhood workshop, and then conduct a workshop.

7. If the consensus is to proceed, begin the formal permitting process. Notify the transit agency. The referents will change the status on the master list to "in progress."

8. The advertising company should provide a monthly progress report to the transit agency on permitting and construction. As each new shelter is completed, change the status on the master list to "completed."

APPENDIX C

Checklists[12]

Transit Community Checklist

Parking

Are parking requirements reduced or shared parking facilities provided for uses close to transit?

Is structured parking encouraged in higher-density areas?

Are surface parking lots encouraged to be located off main streets and away from front lot lines?

If high capacity transit systems exist, are large commercial uses encouraged to provide shuttle service when located beyond walking distance from the facility?

Density

Are relatively higher densities encouraged in activity centers or near transit facilities, with a gradual decrease in density away from these centers?

Do the densities required/allowed near activity centers or transit facilities support transit use? (Refer to table below.)

Are new developments located within already established areas as opposed to less dense greenfield areas?

Are specific regulations in place to address significant displacement and gentrification that may be caused by new development?

Land Use

Are active pedestrian-generating land uses encouraged to concentrate in activity centers or within walking distance of transit facilities?

Are active pedestrian-generating land uses accessible to the physically challenged?

Is a balanced and compatible mix of land uses encouraged within walking distance of activity centers or transit facilities? Mixes may take the form of first-floor retail with office and residential above, or may involve the integration of a variety of uses over a larger area.

Are large areas of single use zones discouraged, and are adjacent land uses compatible?

Site Planning and Design

Are continuous sidewalks and/or pathways radiating from your community's center to outlying districts required?

Can bicyclists travel and park their bicycles safely and conveniently at the site?

Are site designs with buildings clustered near activity centers or transit facilities encouraged, and are there incentives to promote this type of development?

In non-centers, are site designs that encourage buildings to cluster in centralized groupings, with parking to the back and the sides, encouraged?

In centers, are buildings encouraged to locate at the street line, thus defining and enclosing primary pedestrian paths and increasing ease of access to transit?

Are larger developments or redevelopments encouraged to conform to existing block patterns and provide multiple access points for pedestrians and bicyclists?

Are subdivisions encouraged to conform to either grid patterns without cul-de-sacs or dead ends, or cluster-style developments?

Are potential developers provided with a transit checklist regarding their proposals, and are transit-based reviews of site plans and development proposals conducted?

Residential Use	Commercial Use	Transportation Compatibility
1-6 units per acre	2+ employees per acre	Supports cars, carpools, and vanpools
7+ units per acre	40+ employees per acre	Supports local bus service
15-24+ units per acre	150+ employees per acre	Supports rail or other high capacity service

APPENDIX C

Institutional Tools

Does your community's Master Plan include goals and policy statements that encourage transit use and transit-compatible development at both the planning and implementation phases?

Are Special Districts, Overlay Zones, and Planned Unit Development – or other mechanisms that might encourage transit-compatible development or redevelopment – included in your municipal land use or zoning ordinance?

Are incentives (i.e., bonuses, parking reduction, etc.) offered to encourage transit-compatible development?

Joint Development

Are key development sites adjacent to a planned or existing transit facility designated for transit-compatible uses, densities, and designs?

Accessibility Checklist

The Americans with Disabilities Act

The Americans with Disabilities Act (ADA) requires that new and altered transit facilities be accessible. Title II of the ADA covers sidewalk and street construction and transit accessibility, referencing the ADA Accessibility Guidelines (ADAAG) or the Uniform Federal Accessibility Standards (UFAS) for new construction and alterations undertaken by or on behalf of a state or local government. United States Department of Justice (DOJ) Title II regulation specifically requires that curb ramps be provided when sidewalks or streets are newly constructed or altered.

Bus Stop Sites and Alterations

Are bus stop sites chosen such that, to the maximum extent practicable, the areas where lifts or ramps are to be deployed are on stable and firm surfaces?

Is there a clear length of at least 96 inches (measured from the curb or vehicle roadway) and a clear width of at least 60 inches (parallel to the roadway) provided to the maximum extent allowed by legal or site constraints?

Bus Stop Pad

If a bus stop pad has been newly constructed at a bus stop, bay or other area where a lift or ramp is to be deployed, does it have a surface that is stable?

Is there a clear length of at least 96 inches (measured from the curb or vehicle roadway) and a clear width of at least 60 inches (parallel to the roadway) provided to the maximum extent allowed by legal or site constraints?

Is the pad connected to streets, sidewalks or pedestrian paths by an accessible route?

Is the slope of the pad parallel to the roadway and, to the extent practicable, the same as that of the roadway?

Note: A maximum slope of 1:50 (2%) perpendicular to the roadway is allowed for water drainage.

Bus Shelter

Where provided, are new or replaced bus shelters installed or positioned in such a way that a wheelchair or mobility aid user can enter from the public way and reach a location having a minimum clear floor area of 30 inches by 48 inches, entirely within the perimeter of the shelter?

Are such shelters connected by an accessible route to the boarding area provided?

Signs

Do the characters and background on such signs have a non-glare finish?

Do the letters and numbers on such signs have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10?

Are the characters on such signs sized according to viewing distance, with characters on overhead signs at least 3 inches high?

Note: Signs that are sized to the maximum dimensions permitted under legitimate local, state or federal regulations or ordinances shall be considered in compliance.

Exceptions: Bus schedules, timetables, or maps that are posted at the bus stop or bus bay are not required to comply with this provision.

APPENDIX D

Zoning Review[13]

If you wish to develop a parcel of land in the municipality, you must have a permit. In order to obtain a permit, you must meet the minimum requirements recorded in the municipality Land Development Code (LDC).

Land Development Code

- Preserve and enhance the present advantages that exist in the municipality;
- Encourage the most appropriate use of land, water, and resources, consistent with the public interest;
- Overcome present handicaps;
- Deal effectively with future problems that may result from the use and the development of land within the total unincorporated area of the municipality;
- Preserve, promote, protect, and improve the public health, safety, comfort, good order, appearance, convenience, and general welfare of the municipality;
- Prevent the overcrowding of land and avoid undue concentration of population;
- Facilitate the adequate and efficient provision of transportation, water, sewerage, schools, parks, recreational facilities, housing and other requirements and services;
- Conserve, develop, utilize, and protect natural resources within the jurisdiction of the municipality;
- Maintain, through orderly growth and development, the character and stability of present and future land uses and development in the municipality.

The Local Government

- Publishes minimum standards for all the development within the unincorporated portions of the municipality;
- Prohibits such development prior to authorization consistent with the code;
- Provides authoritative, general guidelines, not specific detailed public transit, engineering, architectural, construction, legal or other information.

The Transit Agency

- Monitors the standards which pertain to accessibility by mass transit which serves developments, including handicap accessibility;
- Monitors mass transit standards, including rail and bus transit.
- Reviews all development and rezoning applications to the county for determination according to developers' thresholds and minimum standards
- Adjusts the information contained in the handbook to the site specific needs, constraints and applicable laws, regulations and codes.

Regulations

- Subdivision Regulations – the first thing to examine is the location of the property to be divided.
- Any subdivision, which meets the developer thresholds and is located on public transit corridors, is subject to the public transit facilities requirements.
- The public transit corridor: A public transit corridor is any route on which public transportation travels, including all bus routes.

Planned corridors are listed in the Long-Range Transportation Plan (LRT).

Development thresholds and required facilities:
The subdivision requirements are determined by
- The number of residential units;
- Number of residential, non-residential and mixed use developments;
- Total area in square feet.

APPENDIX E

Bus Stop Evaluation Program[14]

Scope of Services

Task 1: Develop, in consultation with municipality staff, a set of principles, guidelines and standards for bus stop design and performance criteria.

Task 2: Evaluate existing (approximately) bus stops within the municipality against the standard.

Task 3: Identify shortcomings and desired improvements with relation to safety, lighting, amenities, access to nearby origin/destinations and ADA (Americans with Disabilities Act) requirements. The report should include examples from other transit agencies.

Task 4: Design specific improvements for the 10% of stops needing the most improvement (such as: safety improvements; shelters/benches; tree trimming; relocation of stop; etc).

Task 5: Map the top 100 stops identified in Task 4 above. Include existing items such as signage, paper boxes, etc. in the drawings.

Task 6: Recommend an implementation plan and work with the appropriate municipal staff to prepare financial strategies and an action plan and schedule.

Task 7: Work with the municipal staff to recommend a plan for organizing multiple agencies to optimize cleaning of shelters, including recommended standards for frequency, and repairs, including emergency and routing maintenance, along with storm debris removal.

Task 8: Complete an evaluation of the advantages and disadvantages of contracting for shelter installation and maintenance in exchange for advertising space, including case studies of actual programs.

Task 9: Assist with creation of a GIS bus stop file. This would include providing a lap top computer for field work. Local government staff will load the GIS database into the computer.

Task 10: Complete file of digital pictures of each stop in an appropriate format. Pictures are to be entered into the lap top computer and GIS software program described in Task 9. The municipality will notify successful bidder as to which camera to purchase and use. Cost will be reimbursed separately, and municipality will retain the camera at the end of the contract.

Resources to be Provided to contractor

A survey was conducted to document data on bus stops with shelter in GIS by the local governments. Ridership data at the bus stop level will be made available to the contractor after award from the transit agency through the local government planning staff. A list of all stops, with amenities, will be provided in an electronic spreadsheet. A description of desired bus stop information delivery systems (sign holders, electronic information signs and kiosks, etc.) will be provided, along with the desired street furniture design and vendors. Safety and accident reports from the transit agency and the local government will be provided through the staff, as requested.

The municipality will act as intermediary to the transit agency and other sources of outside information that may be required for completion of this project. All requests shall be made to the municipality's Project Officer in writing.

The contractor shall purchase a laptop computer, digital camera and other necessary equipment as directed by the local government. These items will be reimbursed separately, and shall become municipality property at the end of the contract.

Deliverables

A. Reports shall be delivered to the municipality each month, during monthly meetings.

B. GIS database shall be updated, including an update of the inventory and photographs of bus stops.

C. Web page shall be designed to provide current information about the Bus Stop Study, and a procedure to handle email comments.

D. Technical Memorandum #1 shall include:

- A report of bus stops from another region or agency outside of the municipality metro area;
- Local and state requirements that affect bus stop design standards;

APPENDIX E

- Responses from driver interviews;
- Incorporation of marketing consultant's information delivery system recommendations;
- Recommended bus stop standards.

E. Technical Memorandum #2 shall include:
- Master list of identified shortcomings and recommendations on a stop-by-stop basis;
- Criteria for prioritizing bus stop improvements and ranking method, including (but not limited to) the items described in Task 4 above;
- List of the 10% of bus stop needing the most improvement, as identified using the prioritizing method above.

F. Specific improvements shall be drawn on Plan and Profile sheets (supplied by the local government) or produced using a computer program. Improvements to each of the top 10% of bus stops shall be also detailed in tabular and written format.

G. A plan to coordinate bus shelter maintenance with the local government, the transit agency and other involved parties.

H. An evaluation shall be done on providing shelter installation and maintenance through an advertising contract.

I. A final comprehensive report shall be prepared with executive summary that provides findings, conclusions and recommendations.

Time Line

1. The base term of this contract shall start upon award of the contact, and continue for seven (7) months, with 2 extension options of three (3) months each.

2. Monthly reports shall be due by the 10th of each month.

3. The draft of the final comprehensive report shall be due six (6) months from award of the contract, with the final report due one month after submittal of the draft, unless rescheduled during contract performance. This shall include designing the action plan and schedule with the local government planning staff.

4. The time line may be extended due to scheduling the Advisory Committee meetings to accommodate all members' availability to attend.

5. The contractor proposes the following time line below:

	Tasks	**Months after notice to proceed**						
		1	2	3	4	5	6	7
Task 1	Initiate Project, purchase equipment and obtain database		*					
Task 2	Develop bus stop design standards			* Technical Memorandum				
Task 3	Conduct field work							
Task 4	Assess bus stop improvement needs				*	Technical Memorandum		
Task 5	Design specific improvements for top 100 stops							
Task 6	Develop implementation plan							
Task 7	Develop shelter maintenance plan							
Task 8	Evaluate advantages and disadvantages of contracting							
Task 9	Provide technical assistance with updating GIS file							
Task 10	Write draft and final reports				Draft Final Report			
					Final Report			

APPENDIX F

Bus Passenger Facility Development Thresholds[15]

Developer Thresholds	Required Facilities	Not Required
Developments greater then 500,000 sq. ft. or 1,000 residential units.	• Sidewalks • ADA and paratransit access • Sheltered Park and Ride facility • Separate bus loading and unloading area • Bus staging area for passenger loading and unloading	If determined by the transit agency that the public transit facilities are not needed for a project, either in whole or in part, the Administrator may waive the public transit requirement.
Developments of 500 to 1,000 residential units, or Non-residential and mixed use developments of 200,000 - 500,000 sq. ft.	• Sidewalks • ADA and paratransit access • Bus bay • Transit accessory pad w/shelter, seating, trash receptacle and bicycle rack	
Non-residential developments of 100,000 -200,000 sq. ft.	• Sidewalks • ADA and paratransit access • Transit accessory pad w/shelter, seating, trash receptacle and bicycle rack	
Non-residential developments 50,000 -100,000 sq. ft.	• Sidewalks • ADA and paratransit access • Transit accessory pad w/shelter, seating, trash receptacle and bicycle rack	
Non-residential developments or single- or multi-tenant office buildings of less than 50,000 sq. ft.	• Sidewalks • ADA and paratransit access • Pedestrian and bicycle connections	

APPENDIX G

Pedestrian Improvement Thresholds[16]

Pedestrian Measures Guidelines Matrix

	Residential	Residential	Residential collector	Main Street CBD	Commercial >2 lanes	Minor Arterials	Arterials	Major Arterials
Volume (vehicles per day)	<1,200	1,200-2,000	2-5,000	<10,000	7-15,000	10-15,000	15-20,000	>20,000
Typical speeds (mph)	15-25	25	25-30	25-30	30-35	30-35	35-40	35-40
Intersection Nubs								
Colored/ Textured Crosswalks								
Mid-block Crossings								
Raised Pedestrian Crossings								
Pedestrian Islands								

Most appropriate	
Moderately appropriate	
May be appropriate with mitigating circumstances	

APPENDIX H

Recommended Transit-Supportive Language and Policies for Local Government Planning Documents

As an addendum to some Florida county's Transit Development Plan (2003-2007), the Center for Urban Transportation Research (CUTR) at the University of South Florida has developed recommended transit-supportive language to be used in the comprehensive plans and other planning-related documents in the county or its encompassing municipalities. This language represents a strengthening in policies and procedures to integrate transit into land use and development activities. The recommendations address a broad range of land use and transportation planning issues, including increasing density; mixed-use, pedestrian-oriented design; and most importantly, transit service. In general, transit-supportive development involves dense, mixed-use development designed for pedestrians and multimodal transportation.

Florida counties have an opportunity to strengthen their comprehensive plans and other planning related documents to ensure the integration of public transportation policies into the land use planning and development process. It is imperative that all local government entities consider how proposed developments and recommended land use changes can impact or will be impacted by public transit. County and municipal planning documents can be useful instruments in the development of a public transportation system.

However, local governments should be encouraged to adopt proactive policies rather than reactive ones so that they can be prepared for opportunities to enhance public transportation.

CUTR recommends that county staff consider the reasoning behind each recommendation and determine whether it is in keeping with the goals of the transit system and county government, as a whole. In addition, the language may be recommended to other local governments within the county to promote consistency. It is important to recognize that the absence of transit service to an area does not preclude the local government from establishing guidelines for the future.

Typically, transit-related policies and language can be found in the Future Land Use Element and Transportation Element (implemented through Capital Improvement Element). In addition, each local government's comprehensive plan or land development code may have other elements to which transit-related language is applicable. Presented below are recommended transit-supportive objectives and policies that might complement goals established in the Future Land Use and Transportation Elements of the county's plan. The county should ensure that the goals in those elements reflect support for a multimodal transportation system.

Future Land Use Element

The Future Land Use Element usually represents the "blueprint" for land development in the jurisdiction. The Future Land Use Element should include broad guidelines related to land use patterns and population densities that can be instrumental in implementing transit-supportive development projects.

Recommended language for the Future Land Use Element:

Objective: Promote an intensive mixture of employment, goods and services, and residential uses in activity centers and promote the use of public transit throughout major corridors of such activity centers.

Policy: Medium- and high-density multi-family residential development shall be encouraged near major employment centers with convenient access to transit routes.

Policy: Shopping centers shall be located in areas served by public transit along arterial roads, with secondary access on another collector or arterial streets, providing convenient access to surrounding residential areas as well as opportunity to facilitate return trips.

Policy: The county shall ensure that the public transit network serves major corridors and centers.

Policy: The county shall encourage the location of public and semipublic uses on the public transit network.

Objective: Encourage land use developments that generate pedestrian activity and transit ridership.

Policy: The county shall ensure that land development regulations address the requirement of sidewalks and appropriate pedestrian infrastructure.

Policy: The county shall encourage design development that reflects consideration of pedestrians, bicyclists, and transit users.

Policy: The county shall encourage streets designed to promote multi-modal use by ensuring safe connections between streets and sidewalks, as well as safe links to transit routes.

Policy: The county shall manage the growth of parking and encourage its efficient use.

APPENDIX H

Transportation Element

Often the Transportation Element of a comprehensive plan is reflective of goals, objectives, and policies that only relate to roads and the impact that development might have on them. However, it is imperative that mass transit be included in any discussions or policy considerations related to the transportation network.

Recommended language for the Transportation Element:

Objective: Provide a coordinated multimodal transportation system to serve current and future land uses and population needs.

Policy: The county shall coordinate with the Metropolitan Planning Organization (MPO) to ensure that the provision of public transportation is considered in lieu of or part of major transportation construction projects.

Policy: The county shall coordinate with the MPO to develop efficient and effective public transportation and other ridesharing programs.

Policy: The county shall establish public transportation to and from the airport for passengers, as well as employees.

Policy: The county shall coordinate with the MPO and the para-transit and transit provider to ensure that the transportation disadvantaged population is adequately served.

Policy: The county shall work to establish land use, site, and building design guidelines for development in exclusive public transportation corridors to assure the accessibility of new development to public transportation.

Objective: Promote alternate modes of transportation through the construction of bicycle facilities and pedestrian facilities, and the use of public transit.

Policy: New residential development shall provide sidewalks on both sides of minor collector streets and one side of every other street, except for cul-de-sacs which are less than six hundred feet in length.

Policy: The county shall integrate bicycle and pedestrian features (i.e., bicycle racks on buses, bicycle storage lockers, and park and ride lots) into transit planning.

Policy: The county shall designate all roads serviced by existing and/or proposed bus routes as "public transportation corridors."

Policy: The county shall work to develop a coordinated and consistent policy with the Future Land Use Element and implemented through Capital Improvement Element to encourage land uses that promote public transportation in designated public transportation corridors.

Policy: The county shall encourage the provision of cut-throughs in residential developments for pedestrian and bicycle access to public transportation.

Policy: New commercial, industrial, and residential developments shall provide bus stop improvements if located on an existing or proposed bus route and shall provide transit information to employees and/or residents.

Policy: The county shall request that all major employers consider implementing Transportation Demand Management (TDM) strategies such as flextime, parking policies, carpools, vanpools, monthly transit passes, or alternate work schedules for their employees to spread the peak travel times in the county.

Policy: The county shall incorporate into its Land Development Code appropriate project design standards to ensure that the needs of pedestrians and bicyclists are met.

Policy: The county shall coordinate with the MPO, transit provider, and all affected local municipalities to provide passenger amenities along major public transportation corridors based upon the established criteria.

Policy: The county shall coordinate with the MPO, transit provider, and all affected local municipalities to establish programs directed toward financing public transportation passenger amenities to enhance the attractiveness of public transportation usage.

Objective: Coordinate its transportation planning with the MPO, the transit provider, Florida Department of Transportation (FDOT), and other transportation agencies to the maximum extent feasible.

Policy: The county shall respond in writing to all requests for information from other agencies involved in transportation planning in the area.

Policy: The county shall work with the transit provider and local municipalities to improve the location of bus stops and to install benches, clearly marked signs, lights, and covered or enclosed waiting areas at selected bus stops (based on established criteria).

Policy: The county shall require applicants for development proposals to be consistent with all adopted transportation plans of the FDOT, the MPO, the county, and all affected municipalities.

Policy: The county shall work with the MPO and the transit provider to develop numerical indicators against which the achievement of the mobility goals of the community can be measured, such as: modal split, annual transit trips per capita, or an automobile occupancy rate.

Policy: The county shall continue to involve the citizens and those affected agencies within the county in the development and implementation of its Transit Development Plan. In accordance with Florida Statutes Chapter 163.3194 (b), "All land development regulations enacted or amended shall be consistent with the adopted comprehensive plan, or element or portion thereof, and any land development regulations existing at the time of adoption which are not consistent with the adopted comprehensive plan, or element or portion thereof, shall be amended so as to be consistent."

Land Development Code

In response, below are standards and guidelines that might be considered for the county's Land Development Code in support of the recommended language for the Comprehensive Plan. Specifically, site plan application requirements and public transit facilities standards are sections which might be included in the land development code to better achieve the inclusion of transit facilities in planned development projects.

I. Site Plan Application Requirements

The preliminary and final site development plans shall identify existing transit routes on abutting streets. A circulation plan map delineating the location, classification, names, and widths of all major public or private streets and rights of way, pedestrian paths, trails, bikeways, and transit routes within 1,500 feet of property boundaries shall be identified on the site development plans.

II. Public Transit Facilities

A. General - Public transit facilities including pedestrian circulation systems and pathways to public transit facilities shall be provided as established with each threshold listed below.

B. Location - Public transit facilities shall be provided on sites meeting the threshold requirements and located on public transit corridors or planned corridors as listed in the Long-Range Transportation Plan.

C. Development thresholds and required facilities -

1. Developments greater than 1,000 residential units and non-residential and mixed-use developments of greater than 500,000 square feet shall be required to provide the following:

    a. A circulation pattern with turning radii sufficient to accommodate bus movement.

    b. Bus staging areas segregated from automobile traffic with the number of bays or pull-ins to be decided by the developer and the county based upon the adopted MPO Long-Range Transportation Plan.

    c. Shelter protected space that is suitable for waiting out of inclement weather throughout the transit service provided as approved by the county.

    d. Park-and-Ride accommodation. The county and the developer shall decide on the location, timing, and construction of such a facility.

    e. At the sole discretion of the county, the developer may be allowed a reduction in required parking spaces based on a credited modal split for transit.

2. Developments of 500 to 1,000 residential units and non-residential and mixed-use developments of 200,000 square feet to 500,000 square feet shall provide pedestrian and bicycle connections.

3. Non-residential developments of 100,000 to 200,000 square feet shall provide a transit accessory pad including the following: shelter, seating, trash receptacle, and bicycle rack.

4. Non-residential developments of 50,000 to 100,000 square feet shall provide a transit accessory pad including the following: shelter, seating, trash receptacle, and bicycle rack.

5. Non-residential developments or single- or multi-tenant office buildings of less than 50,000 square feet shall provide a bus stop and pedestrian and bicycle connections.

D. Exceptions - If determined by the county that the public transit facilities are not needed for a project, either in whole or in part, the county may waive the public transit facilities requirement.

APPENDIX I

Passenger Amenities

Amenity	Advantages	Disadvantages
Shelters	• Provide comfort for waiting passengers • Provide protection from climate-related elements (sun, glare, wind, rain, snow) • Help identify the stop	• Require maintenance, trash collection • May be defaced by graffiti
Benches	• Provide comfort for waiting passengers • Help identify the stop • Cost less than shelters when compared to installing a shelter	• Require maintenance • May be defaced by graffiti • Sleeping place for vagrants
Vending Machines	• Provide reading material for waiting passengers	• Increase trash accumulation • May have poor visual appearance • Reduce circulation space • Can be vandalized
Lighting	• Increases visibility • Increases perceptions of comfort and security • Discourages "after hours" use of bus stop facilities by indigents	• Requires maintenance • May be defaced by graffiti
Trash Receptacles	• Provide place to discard trash • Keep bus stop clean	• May be costly to maintain • May have a bad odor
Telephones	• Are convenient for bus patrons • Provide access to transit information	• May encourage loitering at bus stop • May encourage illegal activities at bus stop
Route or Schedule Information	• Assists first-time riders • Helps identify bus stop • Can communicate general system information	• Must by maintained to provide current information • May be defaced by graffiti

APPENDIX J

Bus Shelter Manufacturers

The following is a sample list of firms that sell prefabricated transit shelters. This list is meant to be a helpful sample of firms to help transit agencies get started in the purchasing process. This list has not been approved by or pre-qualified by the Florida Department of Transportation or Florida State University. The Florida Department of Transportation, Florida State University and the authors of this guideline do not take responsibility for or accept liability for any of the products on this list or for the use of these products. This list is not meant to be complete, and due to the rapidly changing nature of commerce in the world today, it may be obsolete by the time the guidelines are printed. It is recommended that users of this guideline search for alternative firms on the internet or through equipment supplier catalogues or other sources to supplement this list.

Legend

■ Companies that build according to the Florida Building Code

◆ Companies that require post manufacturing alteration to meet the Florida Building Code

❖ No information available.

Architectural Products Co. ❖

P.O. Box 418
Monroe, WA 98272-0418
Telephone: 866-805-5159
Fax: 360-805-5258
http://www.architectural-products.com

Company Description: Manufacturer and distributor of architectural site furnishings and accessories, park benches, trash and ash receptacles, bike racks, bike lockers, structures, shelters, custom signage and directories, and architectural and ornamental fencing.

Austin Fabricating, Inc. ❖

2175 Beech Grove Place
Utica, NY 13501
Telephone: 315-793-9390
Fax: 315-793-9370

Company Description: Manufacturer of prefabricated aluminum booths, buildings, bus shelters and smoking shelters. Uses include guard houses, parking lots, security, service stations, shopping malls, ticket collection, film developing.

B.I.G. Enterprises, Inc. ❖

9702 T E. Rush St.
El Monte, CA 91733-1730
Telephone: 626-448-1449
Fax: 626-448-3598
http://www.bigbooth.com

Company Description: Manufacturer of shelters.

Brasco International, Inc. ■

1000 Mt. Elliott St.
Detroit, MI 48207
Telephone: 800-893-3665
Fax: 313-393-0499
http://www.brasco.com/

Company Description: Manufacturers of outdoor smoking shelters, covered walkways, bus stop shelters, advertising display shelters, and entrance way enclosures. Prefabricated aluminum structures are also used as guard booths, kiosks, bicycle shelters and platform shelters. A wide range of roofing styles and custom configurations are available.

CKC ❖

440 Wenger Drive
Ephrata, PA 17522
Telephone: 888-227-5672
http://www.ckckiosk.com

Company Description: Designer, manufacturer and distributor of custom designed kiosks and shelters. Uses include gas island kiosks, convenience stores, customs inspection stations, toll collection booths, parking security, smoking and transit shelters. Units arrive fully assembled and ready for hook-up. Variety of sizes and shapes; electrical, plumbing, and HVAC systems are available. Assortment of glass, door and hardware components is available. Complete selection of both exterior and interior finishes and colors, plus additional features. Operational components (cash drawers, safes, power windows, counters, and signage) can be added.

Columbia Equipment Co., Inc. ■

180-10-T 93rd Ave.
Jamaica, NY 11433-1408
Telephone: 888-768-2337
Fax: 718-526-4110
http://www.columbiaequipment.com

Company Description: Manufacturer of prefabricated bus and transit shelters, smoking shelters, advertising shelters, taxi stands, security guard booths, information kiosks, golf shelters, building entrance canopies and windbreaks, and benches.

APPENDIX J

Daytech Manufacturing, Inc. ■

227-T Thorn Ave.
Orchard Park, NY 14127
Telephone: 716-667-1702
Fax: 716-667-1709
http://www.daytechmfg.com/

Company Description: Manufacturer of shelters, kiosks, walkways, canopies, back-lit signs and displays, map frames, schedule holders, benches, and street furniture.

Design Dimensions ❖

7208 McNeil Dr., Suite 104
Austin, TX 78729
Telephone: 512-258-8596
Fax: 512-258-9108
http://www.designdimensions.com

Company Description: Full service of industrial product design, model building, and prototype development firm

Duo-Gard Industries Inc. ■

40442 Koppernick Dr.
Canton, MI 48187
Telephone: 734-207-9700
Fax: 734-207-7995
http://www.duo-gard.com

Company Description: Designer and manufacturer of smoking shelters, bus shelters, site shelters, walkway and entry canopies, skylights, plastic modular buildings, and translucent daylighting systems.

Handi-Hut, Inc. ■

3 Grunwald St.
Clifton, NJ 07013
Telephone: 800-603-6635
Fax: 973-614-8011
http://www.handi-hut.com

Company Description: Designer and manufacturer of glass and aluminum modular shelters.

Lacor Streetscape Inc. ❖

505 W. Dunlap, Suite 1A
Phoenix, AZ 85021
Telephone: 602-371-3110
Fax: 602-216-2772
http://www.lacorss.com

Company Description: Bus shelters, benches, trash receptacles, ash urns, advertising kiosks, and solar lighting.

Little Buildings, Inc. ❖

161 Shafer Dr.
Romeo, MI 48065
Telephone: 586-752-7100
Fax: 586-752-7108
http://www.littlebuildingsinc.com

Company Description: Bullet resisting security enclosures, cashier booths, and shelters.

NEC Architectural Metal Products ❖

1122 Lauder
Houston, TX 77039-2902
Telephone: 281-987-1144
Fax: 281-987-9443
http://www.neonelectric.net

Company Description: Manufacturer of shelters, furniture, benches, tables, trash receptacles, kiosks, and signs.

Par-Kut International, Inc. ■

40963 Production Dr.
Harrison Township,
MI 48045-1351
Telephone: 800-394-6599
Fax: 586-463-6059
http://www.parkut.com

Company Description: Manufacturer of custom and standard portable steel buildings which are built to specifications. Uses include guardhouses; parking cashier booths; turnpike, tunnel and bridge toll booths; weigh scale houses; in-plant offices; euipment shelters; and crane cabs. nts.

Porta-King Building Systems ❖

4133 Shoreline Dr.
Earth City, MO 63045-1211
Telephone: 866-867-0166
Fax: 314-291-2857
http://www.portaking.com

Company Description: Manufacturers of modular and preassembled building systems used by industry and institutional and government clients. Modular, site-assembled building systems are used for applications including; in-plant offices, team centers, guardhouses, smoking shelters, and bus shelters.

Tafco Corp. ❖

5024 Rose St.
Schiller Park, IL 60176-1099
Telephone: 847-678-8425
Fax: 847-678-8471
http://www.tafcocorp.com

Company Description: Manufacturer of transit and smoking shelters, kiosks, windscreens, and bollards.

Tolar Mfg. Co., Inc. ❖

258 Mariah Cir.
Corona, CA 92879
Telephone: 909-808-0081
Fax: 909-808-0041
http://www.tolarmfg.com/

Company Description: Manufacturer of bus and smoking shelters, street furniture, and site furnishings and amenities**.**

APPENDIX K

Costs

The following are estimates of construction costs for a range of facility elements described in this handbook. This information is provided for planning purposes only. Costs will vary depending on site conditions, facility location, design, specification, materials, purchasing processes, and the local market for construction services.

Curb-Side Facilities		
Facility	**Elements**	**Estimated cost[17]**
ADA Enhancements	Landing pads, wheelchairs ramps	Varies depending on type of project.
Lighting	Roadway lighting improvements	Varies depending on fixture type and service agreement with local utility. Solar lighting will cost more initially but will cost less in utility cost over time.
Landscaping	Suitable landscaping	Opportunities for funding landscaping are often more flexible than with major street changes. For example, the cost of the actual landscaping may be paid by neighborhood or business groups. Often, municipalities will pay for the initial installation and neighborhood residents or businesses agree to maintain anything more elaborate than basic street trees. Solar lighting will cost more initially but will cost less in utility cost over time.
Other	Bike racks, trash receptacles, shopping cart storage, bollards	Varies depending on the type of furniture and the material out of which it is constructed. Recycled materials are recommended.
Sidewalks	Sidewalks or walkways	The cost for concrete curb and sidewalk is approximately $15/linear foot for curbing and $11/square foot for walkways. Asphalt curbs and walkways are less costly but require more maintenance. Sidewalks made of recycled materials including rubber, costs approximately $20.00 per square foot installed and may realize maintenance cost savings.

APPENDIX K

Streetside Facilities		
Facility	**Elements**	**Estimated cost[17]**
Bus Bays	Specific paving treatments	Variable; materials requiring hand labor (cobblestones or pavers) have a higher cost.
Queue Jumper Bus Bays	Right–turn slip lanes or bus lanes	Approximately $50,000–$200,000 to reconfigure roadway, add striping and construct an island.
	Bus priorotization traffic signals	$30,000–$140,000.
Bus Bulbs	Curb extensions	$2,000–$20,000 per corner, depending on design and site conditions. Drainage is usually the most significant determinant of costs. If the curb extension area is large and special pavement and street furnishings and planting are included, costs will be higher. Costs can go up significantly if something major such as a traffic signal mast arm or controller box is moved.
Bike Lanes	Bicycle lanes	Approximately $5,000–$50,000 per mile, depending on the condition of the pavement, the extent of removing and repainting lane lines, the need to adjust signalization, and other factors. From a cost standpoint, the best time to create bicycle lanes is during regular street reconstruction, street resurfacing or at the time of original construction.
Pedestrian Crossings	Curb ramps	$800–$1,500 per curb ramp (new or retrofitted).
	Pedestrian signals	$30,000–$140,000.
	Recessed stop lines	Low cost. There is no extra cost when the recessed stop line is installed on new paving or as part of repaving projects. A stop sign can be used to supplement the recessed stop line.[8]
Intersection Nubs	Marked crosswalks and enhancements	$100 for a regular striped cross walk, $300 for a ladder crosswalk and $3,000 for a patterned concrete crosswalk.
	Pedestrian signal timing	Adjusting signal timing is very low cost and requires a few hours of staff time to accomplish. New signal equipment is approximately $20,000.

APPENDIX K

Streetside Facilities		
Facility	**Elements**	**Estimated cost**[17]
Raised Pedestrian Crossings	Raised intersections and raised pedestrian crossings	Raised crosswalks are approximately $5,000 - $7,000, depending on drainage conditions and materials used. The cost of a raised intersection is highly dependent on the size of the roads They can cost from $25,000–$70,000.
	Speed humps/tables	The cost for each speed hump is approximately $2,000. Speed tables are $5,000–$15,000, again depending on drainage conditions and materials used.
Pedestrian Islands	Pedestrian islands	Costs range from $6,000–$9,000 for an asphalt island or one without landscaping. The cost for installing a raised concrete pedestrian refuge island (with landscaping) is about $10,000–$30,000.
Medians	Raised medians	The cost for adding a raised median is approximately $15,000–$30,000 per 100 feet, depending on the design, site conditions, and whether the median can be added as part of a utility improvement or other street construction project.
	Intersection median barriers	$10,000–$20,000.
Parking	On-street parking	$30–$150 per sign. Curb paint and stall marks or striping costs are additional (optional).

APPENDIX K

Typical Transit Facilities		
Facility	**Elements**	**Estimated cost[18]**
On-line Bus Stops	Bus stop signs, benches, leaning rails, shelters, bus stop information and way-finding devices, shelter lighting	$1,000–$10,000, depending on type of improvements.[17]
Primary Stops	Shelters, bench seating, newspaper vending machines and trash receptacles, signs displaying the transit systems and the routes, bicycle storage area and pay telephone.	Approximately $15,000, exclusive of land costs.
Transfer Centers	Sawtooth bus bays, passenger shelters and seating, information kiosk, secure bicycle storage, trash receptacles, and public telephone.	Approximately $50,000, exclusive of land costs.
Park-and-ride	Parking spaces shared, parking lot lighting, signage	Approximately $30,000, exclusive of land costs. By using pervious pavement they may be able to reduce costs since they won't have to pay for storm water retention area.

NOTES

(Endnotes)

1 Unless otherwise noted, definitions are from Kittelson & Associates, Inc. (1999, January). *Transit capacity and quality of service manual* (TCRP Web Document 6, Part 6, Glossary). Retrieved October 20, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_6-e.pdf

2 Text retrieved on June 19, 2008 from http://planck.reduaz.mx/~imoreno/Publicaciones/IODC2006.pdf

3 Text retrieved on June 19, 2008 from http://www.netl.doe.gov/ssl/usingLeds/general_illumination_efficiency_comparison.htm

4 Text retrieved on June 19, 2008 from http://www.nctr.usf.edu/

5 Text retrieved on June 19, 2008 from http://www.dot.state.fl.us/emo/pubs/pdeman/PDE_p1c1_6-27-07.pdf

6 Text retrieved on June 19, 2008 from http://www.co.palm-beach.fl.us/mpo/library/fdot/pdf/2003PlansandPreparationManual.pdf

7 Text retrieved on June 19, 2008 from http://www.dot.state.fl.us/rddesign/PPMManual/2007/Volume2/zbV2Introduction.pdf

8 Text retrieved on June 25, 2008 from http://www.ltsa.govt.nz/roads/multi-lane-roundabouts.html

9 Text retrieved on June 19, 2008 from http://www.ci.vacaville.ca.us/departments/public_works/traffic.php

10 Text retrieved on June 25, 2008 from http://www.oregon.gov/ODOT/TD/asset_mgmt/AssetMgmtTermsAndDefinitions.shtml#S___T

11 Sarasota County Area Transit. (n.d.). *Planning procedures for Lamar shelters.* Sarasota, FL: Sarasota County Area Transit.

12 Metropolitan Area Planning Council. (n.d.). *Checklist: Does your community support transit?* Retrieved January 10, 2008 from http://www.mapc.org/transportation/trans_alternatives/transit_PDFs/3a_Transit_Friendly_Communities_draft.pdf

13 Hillsborough Area Regional Transit Authority. (n.d.). *Zoning review*. Tampa, FL: Hillsborough Area Regional Transit Authority.

14 Hillsborough Area Regional Transit Authority. (n.d.). *Bus stop evaluation program.* Tampa, FL: Hillsborough Area Regional Transit Authority.

15 Hillsborough Area Regional Transit Authority. (1995). *Transit friendly planning and design handbook and technical manual.* Tampa, FL: Hillsborough Area Regional Transit Authority.

16 San Diego Association of Governments. (2002). *Planning and designing for pedestrians: Model guidelines for the San Diego region.* San Diego, CA: San Diego Association of Governments.

17 Federal Highway Administration, U.S. Department of Transportation. (2003). *Safer journey: Interactive pedestrian safety awareness (*Publication No. FHWA-SA-03-014, Version 2.0). Washington, DC: U.S. Department of Transportation.

18 Land, L., & Foreman, C. (2001). *Neighborhood intermodal transfer facilities* (Report No. NCTR-392-16). Tampa, FL: University of South Florida, Center for Urban Transportation Research, National Center for Transit Research.