METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY

TRANSIT DESIGN GUIDELINES

January 2023

TRANSIT DESIGN GUIDELINES

Acknowledgments

METRO Transit Design Standards Committee (MTDSC) Members

Mohammed Boukhriss
Director of Safety

Rachael Die, AICP
Program Manager

Randy Frazier
Chief Technology Officer

Juan Garza - MTDSC Vice Co-Chair
Sr. Safety Officer - Bus

Clint Harbert
Vice President - Systems & Capitol Planning

Auturo Jackson - MTDSC Vice Co-Chair
Senior Director - Contracted, Paratransit, Vanpool, and Micro Transit Services

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Vice President - Marketing and Corporate Communications

Kurt Luhrsen
Vice President - Bus Operations

Yuhayna Mahmud, AICP - MTDSC Chair, Sr. Program Manager
System and Capital Planning

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Director - Universal Accessibility

Santiago Osorio
Chief Safety Officer

Aubin Pickens, AICP
Sr. Transit Planner

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Chief Engineering

Sydney Scardino
Director - Marketing

Andrew Skabowski
Former Chief Operating Officer

Bridgette Towns, P.E.
Vice President - Project Management & Engineering

Vera Bumpers
Chief of Police

Miguel Zavala
Director - Public Facilities

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1 INTRODUCTION

INTRODUCTION

The Metropolitan Transit Authority of Harris County (METRO) provides safe, clean, reliable, accessible, and friendly public transportation services to the Houston region. METRO provides service through local bus service, Park & Rides, METRORail, Vanpool, and METROLift. The Transit Design Guidelines document defines how METRO designs and operates its services throughout the Houston region. The document provides an overview of existing METRO standards and guidelines and updates them, when necessary. Updates are made with nationwide best practice guidance to establish recommended guidelines that will allow METRO to safely and efficiently operate their services and coordinate with other public agencies, METRO consultants, partners, and staff.

A Purpose Statement

METRO supports a multi-modal transportation system and strives to safely and efficiently interface with automobile, pedestrian, and bicycle traffic. METRO aims to obtain safety and efficient through the application of a variety of design standards and criteria by delineating space for automobile, truck, bus, light rail, and people who walk or bike at bus stops and transit facilities. This compilation of design guidelines and criteria for designing and building bus stops, transit centers, and Park & Rides has been updated to reflect current best practices and serves as a single source for all METRO projects and an all-inclusive approach to mobility and access.

The purpose of this document is to consolidate all of METRO's standards and guidelines in a single document to accomplish the following goals:

- Improve safety by holistically defining the interaction of transportation modes at bus stops.
- Enhance access to transit services with improved accessibility and comfort.
- Promote transit use through safe and secure METRO stops and facilities.
- Design bus stops and facilities to accommodate aesthetic and environmental elements proposed in the Urban Design guidelines.
- Provide a one-stop reference for designers and builders of METRO facilities and wherever construction affects METRO stops and stations.
- Design Context-Sensitive stops and facilities for optimal functionality.

This document will be periodically reviewed and amended to include relevant information and adopt current Best Practices. The update will coincide with the City of Houston (COH) Infrastructure Design Manual (IDM) update that occurs in July so that updates can be mirrored in both the IDM and this document as needed.

The METRO Transit Design Guidelines is broken out into the following chapters.

Introduction

The Introduction chapter outlines the purpose of this document, defines key terms, as well as local, statewide, and national standards and best practice materials used to develop the standards outlined in the following chapters. It provides an overview for how to use this document during the development review process.

Transit System Characteristics

The Transit System Characteristics chapter provides an overview of METRO's existing and planned service types and the areas that METRO serves. It covers METRO's vehicles to provide and maintain that service and their operating characteristics, the on-board and off-board transit technologies that METRO uses to efficiently operate their service, and the safety and security systems that are utilized along routes and within METRO facilities.

Transit Service Guidelines

The Transit Service Guidelines chapter outlines how METRO provides high quality transit service in an effective and efficient manner. The service guidelines aid in achieving a balance between quality and the cost-effective use of limited public resources. These guidelines enable METRO's staff and Board to make informed decisions, set expectations for customers, and provide a structure for evaluating existing services and for developing new services. This section provides a detailed overview of the types of transit service METRO employs, route design guidelines, schedule design guidelines, capital facility guidelines, details how to evaluate route performance, and defines Bus Operation Optimized System Treatments (BOOST) standards.

Street-Side Guidelines

The Street-Side Guidelines chapter defines METRO-recommended operations along COH and other area roadways and the types of interaction that may occur with METRO vehicles. It provides an overview of the general placement of transit stops in the near-side, mid-block, or far-side locations along roadways, including key considerations, applications, spacing, and dimensional requirements from driveways and intersections. It also defines how stops are configured along roadways considering the varying types of potential interactions with vehicles, pedestrians, and bicyclists. This section highlights COH Standards, including the IDM, Standard Detail and Code of Ordinances, applicable to the operation of transit vehicles. It identifies opportunities for METRO and the COH to coordinate to provide safe and efficient transit operations. In addition, this chapter looks at how transit interacts with other modes of transportation at intersections and at pedestrian crossings.

Curb-Side Guidelines

The Curb-Side Guidelines chapter includes recommended guidelines for transit facilities and access to those facilities outside of the roadway. Transit facilities are where users first interact with the METRO system, so facility design and accessibility are of the utmost importance. This chapter includes standards and guidelines for providing transit stops and facilities that are accessible, comfortable, and connected to the pedestrian system; an overview of facility types, elements, and design standards; and an overview of transit stop amenities that enhance user interaction.

Design Criteria for METRO Park and Ride Facilities and Transit Centers

The Design Criteria for METRO Park & Ride Facilities and Transit Centers chapter outlines the design criteria that specify the requirements for the performance of professional design and engineering services for METRO Park & Ride facilities and transit centers. The Chapter is excerpted from Design Criteria for Park & Rides and Transit Centers. The document is currently under review during the development of this Transit Design Guidelines document. Potential edits include language and elements to improve pedestrian and bicycle design and amenities at METRO facilities.

Transit Environment Design Resources

The contents of the Transit Environment Design Resources chapter were developed by METRO's Urban Design Division and include information and design criteria related to design elements at METRO facilities, including bus stops, shelters, and transit facilities. In addition, the section and referenced documents include several checklists and design review processes to guide the development of METRO facilities. METRO's Urban Design Division strives to promote equity in access and amenities at all transit facilities.

B Transit Definitions/Glossary

ADA/Accessible

Refers to standards for design that uphold the 1990 Americans with Disabilities Act (ADA) and all amendments since.

Armadillo Hump

Cycle lane physical delineator used along protected bike lane.

Best Practices

Refers to standards, guidance, or codes that reflect the most up to date or ideal application of a specified project or outcome.

Buffered Bike Lane

Conventional bicycle lane paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

Bus Lane Configurations

Special roadway configurations that dedicate lanes/space to specific modes of transportation.

Barrier-Separated Dedicated Guideway

Referring to lanes where Bus Rapid Transit (BRT) operates; an area that is physically separated for specific use of buses to travel freely, with minimal delay from roadway traffic.

Bus and Bike Shared Lane

Roadway lanes dedicated to bicycles and bus transit, ideal for low speed, low traffic roadways. Bicycles only leave the lane when necessary to pass bus traffic.

Business Access Transit (BAT) Lane

A business access transit (BAT) lane is a curbside lane designated for transit vehicles but allows other vehicles to share the lane under specific circumstances, such as right-turns. BAT lanes may be flexible and dynamic depending on needs. For example, the lane may allow right turning auto vehicle traffic at intersections or curbside driveway access for important destinations. They may also be flexible depending on time of day or day of the week.

Bus Turn Radii

The space required for bus turning movements at intersections or driveways. Varies based on vehicle typology. Buses generally require larger spaces for turning. This factor must be considered when designing intersections and station/stop areas that transit vehicles will be frequenting as well as the route alignment along roadways.

Mixing Zone

A zone, typically found at a turning point in an intersection or at transit stops/stations, where different modes of transportation cross over lane space. Larger modes (automobiles and buses) are required to yield to cyclists before crossing over. Mixing zones are often indicated with visual cues, such as signage or pavement markings in a dashed or checkered pattern.

HOV Lanes

High Occupancy Vehicle Lanes are restricted for the use of vehicles with a driver and one or more passengers and for the use of motorcycles.

High Occupancy Toll (HOT) (Express) Lanes

HOT (Express) Lanes take advantage of the HOV Lane system by allowing single occupant vehicles access to the lane for a small toll.

Diamond Lanes

Diamond Lanes occur in downtown Houston where only transit vehicles or right turning traffic is allowed. Some lanes may have time restrictions such as Monday-Friday or during peak travel hours. Diamond lanes differ from HOT (Express)/HOV in that Diamond Lanes have no physical separation from other travel lanes. This necessitates greater education and enforcement.

Bus/Bike Conflict Zone

The bus/bike conflict zone is where a bike facility passes through a bus merge zone.

Commuter Service

Transit service that travels directly to or from a major employment activity center with single or limited passenger pickup locations. Often services major Park & Ride or transit center facilities.

Context-Sensitive Design

The process of designing a facility in which the characteristics of the community, surrounding built environment, or future conditions impact the outcome of the project.

Cross Traffic

Roadway users which travel in a direction perpendicular to the lane of traffic being referred.

Curb Extension/Bulbouts

Curb extensions, also known as bulbouts, shorten the distance for pedestrians to cross at intersections. These also help reduce vehicular speeds in areas with high pedestrian activity.

Curb Ramp

A section along a curb where pedestrian use necessitates a reduction in curb height to meet roadway level. The slope of this reduction is referred to as a ramp and connects the sidewalk surface to the adjoining street. Curb ramps are required to follow ADA standards.

Curbside vs Off-Set

Refers to the placement of transit lane. Curbside lanes run directly along the curb in the rightmost lane, while off-set lanes allow for parking along the curb, bikeways, or other curbside activity.

Dedicated Rail Transitway

Dedicated rail transitways are lanes or travel ways dedicated exclusively to rail travel and physically separated from vehicular traffic.

Ballasted Track

Track structure consisting of rail, tie plates or fastenings, crossties, and the ballast/ sub ballast bed supported on a prepared subgrade.

Direct Fixation Track

Direct fixation track is a “ballastless” track structure in which the rail is mounted on direct fixation fasteners that are attached to a concrete deck, slab, or invert.

Embedded Track

Embedded track can be described as a track structure that is completely covered, except for the top of the rails-within pavement.

Dedicated Transit Lane

Lanes where bus or rail travel is allowed. Typically delineated by colored paint or vertical barriers. May also serve as a right-turn lane when applicable.

Design Minimum

Refers to lowest dimensional standard that must be met to comply with established design standards. Generally, these are measurements of numbers, width, or height.

Driveway/Curb Cut

Any section along the curb where curb height declines to meet roadway. These are used to access residential, commercial, or any other property outside of the right-of-way (ROW).

Fixed-Route Service

Fixed-route services operate on a predetermined, fixed-time schedule over a prescribed route using specified streets. The consistency of fixed-route service allows the distribution of timetables and route maps.

HAWK beacon

A High-Intensity Activated Crosswalk (HAWK) beacon is a traffic control device specifically designed for pedestrian crossings. These beacons are actuated by pedestrians waiting to cross at mid-block crossings and require vehicular traffic to stop.

Lane Width

Refers to the width of a roadway travel lane.

Texas Manual on Uniform Traffic Control Devices (TMUTCD)

A Texas Department of Transportation (TxDOT) document that guides the installation and use of traffic control devices on public roadways.

Median Refuge/Safety Island

A median refuge island is a brief protected stop or protected area in the middle of an intersection for pedestrians and cyclists. It allows a safe stopping point across wide roadways or intersections that might be difficult to cross. May be implemented in conjunction with a mid-block crossing when appropriate.

Near-Level Boarding/Near-Level Platforms

Bus stops or platforms where the curb height is placed between 8 to 11 inches. Near-level stations allow faster boarding, are compatible with the existing METRO fleet, and facilitate access to riders using mobility devices or pushing strollers.

On-Street Parking

Spaces reserved for vehicles to park on the roadway.

Pedestrian Clear Zone

The primary, accessible area along a roadway where pedestrian travel is prioritized. Additional pedestrian clear zone widths are required within transit areas.

Pedestrian Hybrid Beacon (PHB)

A traffic control device to increase motorist's awareness of pedestrian crossings at uncontrolled marked crosswalk locations. The beacon consists of two red lights above a single yellow light. It remains unlit until activated by a pedestrian when needed.

Pedestrian Mall

Area reserved for the exclusive use of pedestrians, which often refers to streets that may be closed to motor vehicle traffic.

Pedestrian Realm

Dedicated space along a roadway for pedestrian activity. 15' from curb to property line is the desired minimum (COH IDM Ch. 10). This includes sidewalks, sidewalk buffers, tree plantings, furniture zone, and transit stop amenities.

Preferred Treatment

Refers to the ideal application of roadway/curbside modifications or treatments, such as paint, thermoplastic, or physical barriers to achieve a desired outcome.

Public Art

Physical visual enhancements to enhance the built environment in public areas including near transit facilities.

Public Transit

Any form of publicly provided passenger transportation using fixed/non-fixed routes and an established fare system.

Bus Transit

A form of public transit that uses bus fleets to provide fixed-route and non-fixed-route service. This includes Express Service from METRO Park & Rides.

Bus Rapid Transit (BRT)

High capacity bus service, METRORapid, with dedicated lanes and upgraded stations that provides users with a comfortable and efficient transit experience. BRT systems are characterized by several of the following components: exclusive transitways, enhanced stations, easily identified vehicles, high frequency all-day service, simple route structures, simplified fare collection, and Intelligent Transportation Systems (ITS) technologies.

METROLift

METROLift provides demand response paratransit service in accordance with the ADA. Service is provided for those who are unable to, without assistance, board, navigate, ride or leave an accessible local fixed route bus.

METRO STAR Vanpool & Carpool

STAR Van/Carpooling is a service of METRO for those in the eight county service area who wish to save time and money during their commute. It uses a commuter matching system and takes advantage of the HOV Lane system to transport from five to fifteen people.

Bus Operation Optimized System Treatments (BOOST) - (In Development)

Network of METRO bus routes and optimized stops which use technologies such as transit signal priority, queue jumps, and bus-only lanes to prioritize transit travel and improve speed and frequency on roadways. BOOST routes also contain enhancements such as upgraded shelters and access improvements to stations /stops.

Light Rail Transit (LRT)

A metropolitan railway system characterized by its ability to operate single cars or short trains along exclusive ROW at ground level, on aerial structures, in subways, or occasionally, in streets.

Signature Service - (In Development)

Service that serves select limited stops that have high connectivity and ridership on existing local service routes. The service operates with reduced headways and higher speeds than the existing local service route. METRO currently operates one Signature Service routes branded as the 402 Quickline.

Raised Crosswalk

Refers to a cross walk which is raised to meet curb height from origin to terminus. Often used to enhance pedestrian visibility and slow oncoming traffic.

Rapid-Flashing Beacon (RFB)

Also known as rectangular rapid-flashing beacon (RRFB), an RFB is a "pedestrian actuated conspicuity enhancement" to increase motorists' awareness of crossing pedestrians.

Real-Time Arrival Information

Provides waiting passengers with the most up-to-date and accurate route information through digital messaging systems.

Road User Conflict

Refers to conflicts between different types of roadway users while sharing space in the roadway, such as bike, bus, and/or automobile conflicts.

Separated Bike Lane

Conventional bicycle lanes paired with physical separator from adjacent motor vehicle travel lane or parking lane. Physical separators often include; planters, flexible delineators, medians or concrete structures.

Shared Auto/Transit Lane

A travel lane that accommodates transit and vehicular travel. Most lanes may see transit travel based on vehicle routing, but the curbside lane is typical.

Sidewalk Buffer

Refers to the space between the roadway and edge of sidewalk.

Stop Bar

Pavement marking generally placed at intersections to mark where vehicles are required to stop in order to maintain the functional mobility of the intersection or shared space for other roadway users.

Stop Optimization

Stop optimization is an approach to improve the transit system by balancing stops in a manner that reflects the travel patterns of the service market to benefit the transit system and its passengers.

Stop Placement

Refers to the location of a transit stop which usually occur at the near-side or far-side.

Stop Spacing

Stop spacing refers to the distance between individual stops in a transit network or along a roadway.

Transit Corridor Street

ROW or easement that METRO has proposed as a route for a guided rapid transit or fixed guideway transit system and that is included on the COH's major thoroughfare and freeway plan (MTFP). Further information related to Transit Corridor Streets can be found in Chapter 42 of the COH Code of Ordinances.

Transit Facility

A permanent facility owned by METRO designed to serve as a point of access to METRO's transit infrastructure.

Transit Friendly Intersection Design

Treatments and improvements at intersections where transit operates to improve safety, transit travel time, and service reliability. Treatments may include physical interventions such as bypass lanes or technological improvements such as transit signal priority (TSP).

Transit Oriented Development (TOD)

Includes a mix of commercial, residential, office, and entertainment anchored around or located near a transit station or center.

Transit Signal Priority (TSP)

The adjustment of traffic signal phasing to prioritize transit vehicle movement through intersections. This can be implemented through passive or active signal priority.

Bypass Lane

A bypass lane is a transit intersection enhancement that allocates a dedicated transit lane before and after an intersection allowing the transit vehicle to circumvent queues.

Queue Jump Lane

A queue jump is a transit priority intersection treatment that provides preference to transit by allowing buses to skip the queue using a center-running or curbside dedicated transit lane. These lanes are used in conjunction with either a leading transit interval or active signal priority that allow the bus to enter the intersection ahead of other traffic.

Transit Station/Stop

A designated location for boarding/alighting of a transit vehicle. Stations/stops may also provide transit users shelter and other amenities to wait for vehicles. A transit station is a passenger loading or unloading facility of a route for a guided rapid transit or fixed guideway transit system owned and operated by METRO.

Bus Stop

Any location designated as a safe boarding/alighting zone, per METRO requirements, within a bus transit route.

Far Side Stop

A transit stop located beyond an intersection. It requires that transit vehicles cross the intersection before stopping to serve passengers.

Mid-Block Stop

A bus stop located between two intersections when necessary due to long block lengths or major mid-block destinations. Traditionally, these stops are located next to a mid-block pedestrian crossing for safe crossing.

Near Side Stop

A transit stop located on the approach side of an intersection. The transit vehicle stops to serve passengers before crossing the intersection.

Bus Boarding Pad (Stop Pad)

A rectangular slip resistant concrete pad that is connected to adjacent sidewalks and sidewalk ramps that provides access to transit vehicles. ADA requirements stipulate a 5′ x 8′ pad to ensure safe maneuverability and access to transit vehicles (COH IDM Ch. 10, can be referenced).

Transit Shelter

Infrastructure installed at transit stop and station locations to provide protection from the weather.

Bus Pullout

A dedicated space adjacent to a road that allows buses to stop, without obstructing traffic, while passengers board or alight. Not recommended for streets with moderate-to-high traffic volumes.

Floating Bus Stop

A bus stop whose specific layout allows pedestrian and bicycle ROW to locate behind the bus boarding pad, safely separating different modes of transportation. Generally used when a dedicated/protected bike lane travels through a bus stop area.

BRT Station

A transit station for METRORapid and its passengers. Typically includes enhanced features and amenities.

Light Rail Station

Typically an off-street facility where passengers wait for, board, alight, or transfer between light rail vehicles (LRV) and other transit vehicles. A light rail station usually provides information and a waiting area and will have boarding and alighting platforms, ticket or fare card sales, fare collection, and other related facilities. Rail stations can be both at-grade or grade separated (for elevated guideways).

Universal Accessibility Transit Stop Improvements

Refers to Universal Design concepts that go beyond ADA accessibility requirements to provide access to transit for all ages and abilities at transit stop locations. Improvements include interventions such as voice activated ticket vending machines, removal of barriers in walkways, or large print schedules.

Universal Design

Universal Design is a concept that goes beyond minimum ADA accessibility requirements by encouraging transit stop design that is safe, comfortable, accessible, and convenient for users of all ages and abilities. Universal Design utilizes best practices rather than requiring minimum standards.

Utility Cabinet

A collection of electronic equipment that operates traffic signals, transit station technologies, and amenities or pedestrian crossing beacons. Can be located below or above surface and are typically enclosed in aluminum casing.

C Endorsed Design Standards

The following design standards and document were utilized in the creation of this Transit Design Guidelines document.

METRO Standards/Documents

Where any of these standards conflict with this document, this document is the most recent and supersedes these documents.

- METRO Bus Shelter Guidelines
- METRO Design Criteria for Park & Ride and Transit Center Facilities
- METRO Locative Survey, Scope of Service for Bus Shelter Program
- METRO Bus Stop Placement Guidelines
- METRO Service Standards
- METRO Bus Stop Design Checklist
- METRO Transit Center Design Checklist
- METRO Urban Design Manual

Local Standards/Documents

- COH Code of Ordinances
- COH Major Thoroughfare and Freeway Plan
- COH Infrastructure Design Manual (including all documents referenced in this manual)
- COH Bike Plan

Industry/National Documents

- National Association of City Transportation Officials (NACTO) – Transit Street Design Guidelines
- NACTO Urban Bikeway Design Guide
- NACTO Urban Street Design Guide
- Texas Accessibility Standards
- American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets
- AASHTO Guide for the Development of Bicycle Facilities
- Texas Manual on Uniform Traffic Control Devices (TMUTCD)
- Americans with Disabilities Act (ADA) Standards
- Title VI Circular

D METRO Development Review Guidelines and Process

This document was developed to serve as a guide for designing and implementing METRO infrastructure and supporting METRO operations. These Transit Design Guidelines do not represent strict standards as METRO service and its facilities are implemented using a context-sensitive approach that is tied to the built environment of the specific location. It is important to note that current METRO facilities may not meet the guidelines or recommended standards of this document.

Potential projects that may require specific consultation of these Transit Design Guidelines include a new development or land use that may affect METRO service, the relocation of a bus stop, modifications or alterations to fixed-route service, and/or construction projects that may require the replacement or placement of a METRO transit facility or supporting infrastructure.

Document Usage

This document should be consulted in coordination with the Transit Environment Design Checklists (Bus Stop Design and Transit Center Design) during the appropriate phases of the METRO design review process. The METRO Design Review Process for projects that involve the METRO Service Area will follow the METRO Design Review Process intended to aid developers in the programming, design, construction and maintenance and operations of a project. The Design Review Process encompasses six stages:

1. Programming
2. Design 0-15%
3. Design 15%-30%
4. Design 30%-60%
5. Design 60%-100%
6. Construction
7. Operations & Maintenance

For a more detailed breakdown of what specific steps/actions each stage requires, please see the Transit Environment Design Checklists developed by the METRO Urban Design Division.

METRO has outlined specific actions and steps to consider during each phase of the Design Review Process. In addition to outlining specific actions and considerations, the Design Checklists include critical design considerations for METRO facilities and references the design standards in this document and other METRO design standards documents, such as the METRO Passenger Shelter Program. The METRO Transit Design Guidelines should be consulted and recommended standards and guidelines should be considered during each stage of this process.

Coordination

The planning, programming and implementation of project that affect METRO facilities may require ongoing and collaborative discussions internally between METRO divisions and with other agencies and jurisdictions that are impacted by the project. These guidelines align closely with standards outlined in the COH IDM. As such, continued coordination between developers, the City of Houston, and METRO is essential for the successful implementation of facilities that serve and support METRO service.

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2 TRANSIT SYSTEM CHARACTERISTICS

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The Transit System Characteristics section provides an overview of METRO's existing and planned service types and the area that METRO serves, the vehicles it uses to provide and maintain that service and their operating characteristics, the on-board and off-board transit technologies that METRO uses to efficiently operate their service, and the safety and security systems that are utilized along routes and within METRO facilities.

A Existing System Overview and Types of Service

The METRO service area is 1,309 square miles encompassing most of Harris County and portions of Fort Bend and Waller Counties. It includes the City of Houston and 14 incorporated communities within or adjacent to the COH. METRO operates 1,259 buses on 117 routes and carries nearly 7.5 million passengers a month. METRO's bus service includes local and express routes with one Signature Service Line, the 402 Bellaire Quickline that offers a special branded service in one of Houston's busiest corridors. METRO operates special commuter service from 27 Park & Rides in over 100 miles of High-Occupancy Vehicle (HOV) lanes. METRO also operates over 22 miles of light rail, called METRORail, with a fleet of 76 vehicles.

Additionally, METRO operates 21 transit centers in the service area that provide a "hub" to connect to multiple locations via transit. Some locations have limited parking and METRORail availability.

METROLift and METRO STAR Vanpooling also provide additional means of transit service. METROLift provides complementary paratransit service for individuals who are not able to use local bus service and meet eligibility requirements. METROLift operates required ADA service within a 557 square mile area, which encompasses areas within three quarters of a mile from fixed route bus service. Non-required service also extends to an additional 215 square mile area, during a shorter period of time.

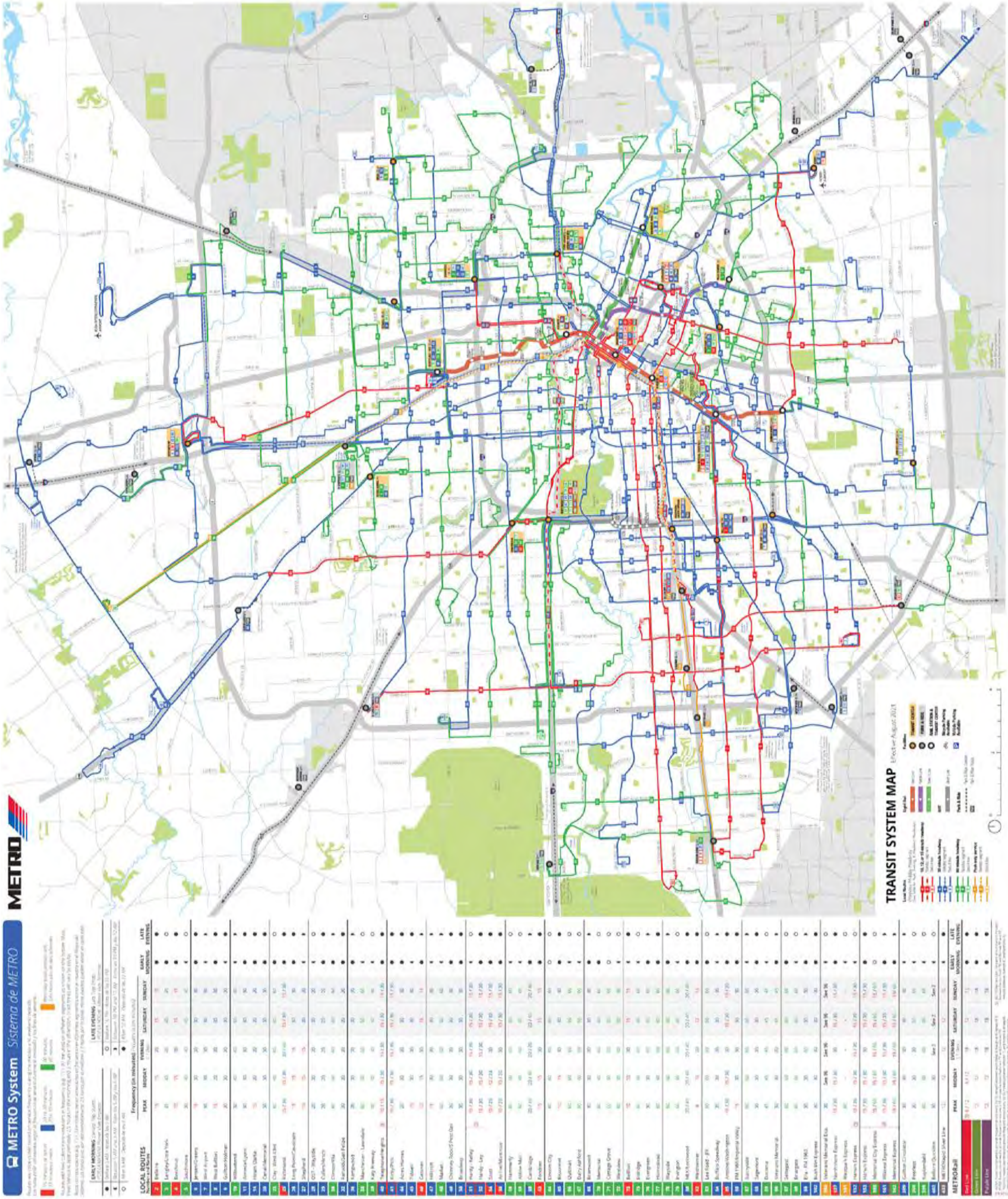
Those living in suburban areas can utilize the METRO STAR Vanpooling program. Five to fifteen people with similar travel patterns share commuting costs using METRO vans and ride matching services.

B METRO Service Area Characteristics

The METRO service area is composed of all varieties of land uses from highly urbanized to extremely rural. The central business district (CBD) is the most densely developed area of the service area with over 150,000 employees, approximately 30 percent of whom use transit to get to work. While the density of the service generally decreases farther from the CBD, the Houston area has several activity centers that function as mini business districts and have their own set of commuters and travel patterns. These activity centers serve to de-centralize many of the primary destinations for travelers and present an opportunity to leverage transit as part of a multimodal approach to regional mobility.

The farthest extents of the service area are highly suburban and rural. Transit service is composed primarily of Park & Ride service in these areas. The COH and Harris County have bikeways throughout the service area. The region's bayou and drainage network are being used to establish an extensive bikeway network; however, there are still many miles of bike lanes and bike routes along the roadway network.

Figure 2.1: Houston METRO System Map - August 23, 2020



C Operational Characteristics

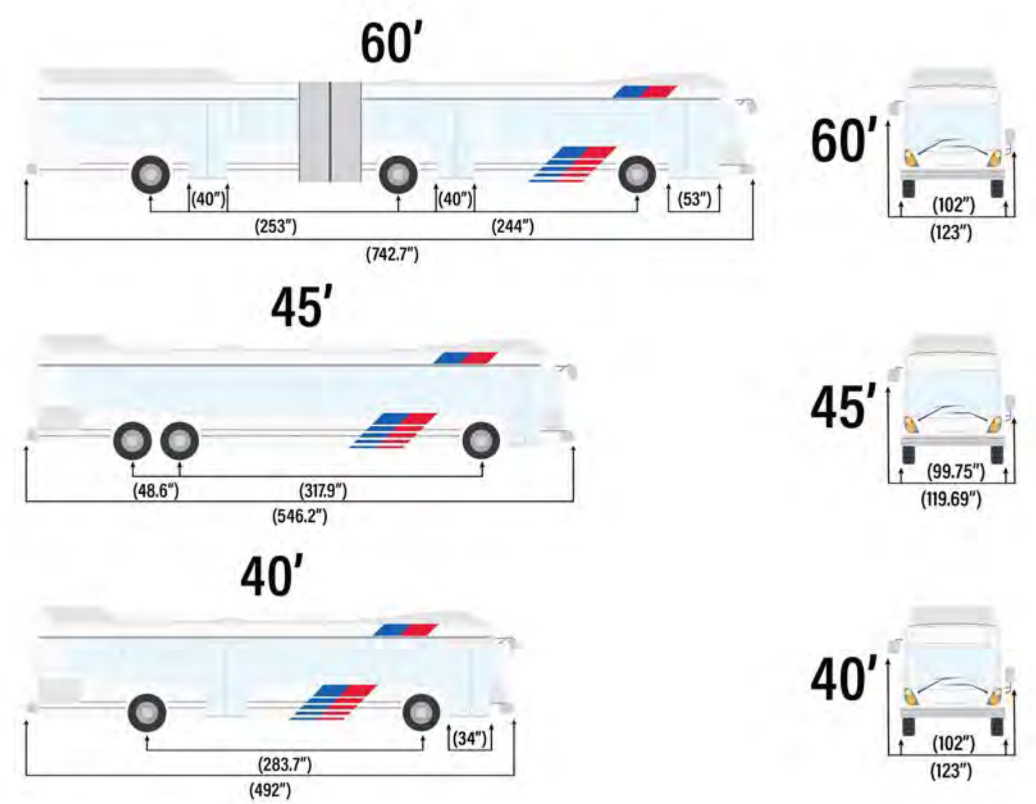
The foundation of METRO's service are the local routes, which make up most of the routes and provide the greatest coverage. The local service provides the greatest coverage and carries the majority of the riders. Local routes operate primarily on major thoroughfares and stop approximately every quarter-mile. Express routes are a combination of local service with portions of the route either on freeways or major arterials with limited to no stops. Suburban routes, also known as commuter routes, travel from Park & Ride lots on the outer extents of the service area directly to major employment centers.

METRO also operates light rail primarily within IH-610 and serves the concentrated core of the COH. The METRORail light rail system links major activity centers such as the CBD, Texas Medical Center (TMC), University of Houston, and Texas Southern University. Station spacing ranges from 1,000' in the CBD to approximately one-half mile farther out.

D Vehicle Typologies and Standard Dimensions

METRO operates three primary bus types: 40' and 60' local buses and a 45' commuter bus. METRO also has seven 29' cutaways used on METRO curb2curb routes, as of 2019. The local buses are low floor and have a seated and standing capacity of 135 percent, with 100 percent representing all seated passengers. The capacity amounts to 54 passengers on the 40'vehicle and 80 on the 60' vehicle. Commuter coaches have a capacity of 55 seated passengers. Standing is permitted on freeway running routes, but due to the length of the trip and the speeds obtained, it is not encouraged.

Figure 2.2: METRO Bus Diagram



E Other Fleet Characteristics

In addition to buses, METRO operates 76 light rail vehicles (LRV) on the METRORail lines. All METRORail vehicles operate through an electric overhead catenary system on standard tracks, but three different types of LRVs compose the METRORail fleet. The different models range from 89'-94' in length and have slightly different interior configurations. All are 70 percent low floor to allow for level boarding with the platform.

F Operations and Maintenance Vehicles

METRO supports the bus and rail operations with a fleet of service and maintenance vehicles. Pool cars are available for administrative staff to use as needed and heavy tow trucks for buses and rail vehicles.

G System Safety and Security

System Safety and Security is currently under development and will be included in the next iteration of these Transit Design Guidelines.

H Transit Technology

The majority of METRO buses operate on ultra-low sulfur diesel (ULSD) fuel. Of the 1,259 buses in the METRO fleet, 397 are diesel-electric hybrids and ten are CNG powered. METRO has been exploring the potential for fully electric vehicles, but as of 2019, only has researched the retrofitting infrastructure required to implement electric vehicles.

METRO has participated with the Houston-Galveston Area Council (H-GAC) to launch a demonstration program for an electric autonomous vehicle on the Texas Southern University campus. The vehicle is an EasyMile Shared Autonomous Vehicle (SAV) that holds 12 passengers: six seated and six standing.

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3 TRANSIT SERVICE GUIDELINES

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The Transit Service Guidelines chapter outlines how METRO provides high quality transit service in an effective and efficient manner. The service guidelines aid in achieving a balance between quality and the cost-effective use of limited public resources. These guidelines enable METRO's staff and Board to make informed decisions, set expectations for customers, and provide a structure for evaluating existing services and for developing new services.

A Overview of Service Guidelines

This chapter provides a brief overview of the types of transit service METRO employs, route design guidelines, schedule design guidelines, and capital facility standards, details how to evaluate route performance, and defines BOOST standards. A full copy of METRO's Service Standards document that describes the transit services and programs presently offered by METRO can be found in Appendix A.

B Types of Transit Service

METRO has two basic classifications of bus service, Fixed Route Bus Service and other transportation services. In addition to bus service, the light rail service known as METRORail is also included. The service standards document focuses on fixed route service; however, some aspects of light rail service are also covered. Although infrequent, METRO may provide emergency/evacuation and charter services under certain circumstances.

Fixed Route Bus Service

Fixed route services operate on a predetermined, fixed-time schedule over a prescribed route using specified streets. The consistency of fixed-(or regular) route service allows the printing and distribution of timetables and route maps. Fixed route service is operated by buses generally with 38 or more seats and constitutes the majority of METRO's bus service. Fixed route service is further classified into three major types: Local Service, Signature Service, and Commuter Service.

Local Service

Local bus service is transit service that picks up and discharges passengers all along the route and, consequently, operates at a relatively low average speed. Local service provides the greatest concentrated geographic coverage of the METRO Service Area.

Signature Service

Signature service serves select limited stops that have high connectivity and ridership on existing local service routes. The service operates with reduced headways and higher speeds than the existing local service route. METRO currently operates one Signature Service route branded as the 402 Quickline.

Commuter Service

Commuter service is transit service that travels directly to or from a major employment activity center with single or limited passenger pickup locations. Commuter service is offered by METRO's Park & Ride routes. Commuter Service also takes advantage of the HOV/HOT (Express) Lanes system to provide efficient transportation for riders.

Other Transportation Services

METROLift

METROLift is a complementary paratransit service, in accordance with the 1990 Americans with Disabilities Act (ADA). METROLift provides transportation for persons with disabilities who cannot board, ride or disembark from a regular METRO fixed route bus, even if that bus is equipped with a wheelchair lift or ramp.

METROLift Service Plus (MSP)

Operated by several taxicab companies, this METRO service allows riders to call the taxi vendor directly for service. The service is a direct-to-the-public paratransit taxi, offered as demand response curb-to-curb.

Guaranteed Ride Home

A service that uses the METROLift Service Plus (MSP) contract for taxi transportation providing users of METRO's commuter service with a free ride home in the middle of the workday, should they have an emergency and there is no midday bus service on their route.

METRO STAR

METRO sponsors a regional vanpool service for commuters who do not have access to convenient transit services. METRO STAR offers hundreds of scheduled vanpool routes serving the 8-county Houston-Galveston Transportation Management Area, including the counties of Harris, Brazoria, Chambers, Fort Bend, Galveston, Liberty, Montgomery, and Waller.

METRO curb2curb: Missouri City, Acres Homes & Kashmere/Trinity Gardens

Service provided by METRO serving Missouri City, Acres Homes and Kashmere/Trinity Gardens communities. Rides are scheduled by calling dispatch for service within each respective zone, and all buses are wheelchair accessible. Rides are also given from two (2) anchor points in either zone. Both services tie into other local bus routes.

Light Rail (METRORail)

METRORail consists of three light-rail lines: the Red Line (North), Green Line (East) and the Purple Line (Southeast), totaling 22 miles of rail with 44 stations. The METRORail fleet consists of 76 light-rail vehicles. The Red Line opened in 2004 as the 7.5-mile Main Street Line and after an expansion in 2013 is currently 12.6 miles long. The Purple Line (6.7 miles) and the Green Line (3.2 miles) opened in May 2015.

Charter Services

Federal Regulations 49 CFR Part 604, Charter Service; 73 FR 2326 Final Rule 4/30/08 prohibits all public transit agencies from providing Charter Services unless certain exceptions are met. The Federal Transit Administration (FTA) requires METRO to provide a quarterly report for all transit service exceptions.

Emergency/Evacuation Services

Local Area Assistance

METRO has transportation services and other available resources that may be requested by the cities, counties, school districts, and organizations within METRO's service area or the Houston/Galveston region before, during, and after an emergency.

As a standard practice, METRO's resources should be used first to provide public transportation service for METRO passengers as "Top Priority." To the extent that resources become available, METRO will consider requests for assisting in programs that save lives, protect property or the environment, help stabilize an emergency, or restore services to any affected community.

The METRO Emergency Management Plan provides general guidance to METRO management and employees who are responsible for the mitigation, preparation, response, and recovery from any disaster. The Plans developed for Local Area Assistance have been designed to support the intent of the Authority's Emergency Management Plan.

C BOOST (Bus Operations Optimized System Treatments)

The Bus Operations Optimized System Treatments (BOOST) program aims to holistically improve the transit experience for METRO's customers with a focus on a network of the busiest bus routes across the system. The BOOST program delivers benefits to many thousands of existing riders and positions the corridors to attract new ridership in the future Through a coordinated set of capital, operating, and service improvements, the BOOST program provides existing and prospective bus riders with an enhanced experience on all aspects of their trip: a better walk, a better stop, and a better ride. The BOOST program creates transit corridors that are safer, more comfortable, and more accessible for METRO riders and all people traveling along the corridor. These improvements also deliver faster, more reliable, and more frequent service.

Principles of BOOST

A transit trip encompasses more than just the time a customer spends on a bus or train. It begins when the customer leaves their starting point, such as their home or workplace, and includes travel to their stop or station. Trips include the time and experience waiting at the stop for the next bus to arrive, time on the transit vehicle, and travel from the stop to the destination. BOOST aims to improve each of the elements by focusing on three key components of a trip.

A Better Walk

The BOOST program makes improvements to the sidewalk and bikeway networks adjacent and connecting to project corridors so more people can safely access transit service. These improvements benefit all people who are traveling along these corridors, not just transit riders.

Focus areas for BOOST access improvements include:

1. **Better sidewalks** – New, wider sidewalks and accessible curb ramps connecting the bus stop to nearby intersections and destinations. These make reaching a bus stop easier for all types of transit users, including people using wheelchairs and people traveling with strollers, carts, or suitcases. METRO will also work with partners such as the COH, other member cities, and Harris County to facilitate the completion or repair of sidewalks along and connecting to BOOST corridors.
2. **Safer street crossings** – Where high-ridership bus stops on BOOST corridors are located far from existing safe street crossing locations like traffic signals and four-way stops, appropriate crossing treatments will be identified and implemented.
3. **First- and last-mile connections to major destinations** – BOOST corridor projects can include high-value sidewalks to key destinations such as schools, public facilities, and parks. The BOOST program can also help implement elements of the Houston Bike Plan that provide meaningful connectivity to existing or programmed bikeways or destinations.

A Better Stop

While the BOOST program aims to provide more frequent and reliable service for METRO customers to simply "show up and go," a portion of the trip will continue to be spent waiting at the bus stop. Well-placed and well-designed bus stops can make the wait more pleasant and can even make it seem shorter, a critical component to improving the overall transit experience.

Focus areas for BOOST improvements at bus stops include:

1. **New shelters and crossings** – BOOST corridors will be planned to have improved shelters at every bus stop, providing shade and protection from the elements. Quality seating will be included to make the experience more comfortable. Shelters will have integrated lighting to improve safety, security and visibility for waiting passengers.
2. **Improved passenger information** – Passenger information is important toward maximizing rider understanding of the transit system and communicating service conditions. Enhanced stops on BOOST corridors will provide real-time bus arrival and status updates. Improved signage and wayfinding maps will provide schedule data, key information, and wayfinding to destinations from the transit stop.
3. **Easier boarding platforms and safe all-door access** – To improve access to the bus and help improve bus speeds, stops will be designed to include near-level accessible platforms. This allows customers, particularly those with mobility challenges, to board buses faster and more seamlessly.
4. **Bus Stop Enhancements** – Well-designed bus stops can be centers of activity and help improve the visual appeal and the sense of community along a BOOST project corridor. Where space allows, they can include enhancement spaces that can be tailored to include trees for shade, space for local art, plantings, or room for bicycle parking.

A Better Ride

Transit riders seek quality service that safely and comfortably brings them to their destination as quickly and reliably as possible. The BOOST program improvements support faster service with buses that arrive frequently on each corridor. Therefore, more time for customers to devote to other important activities in their life and less time spent waiting and riding the bus.

Focus areas for BOOST improvements to improve speed and reliability include:

1. **Faster service** – BOOST corridor improvements aim to improve transit travel times by at least 10 to 15 percent, helping people reach their destinations faster. Optimized stop placement and better designs mean buses make fewer, faster stops, allowing buses to pick up and maintain speed in between. Riders spend less time waiting at red lights because the bus communicates its location and expected arrival time to traffic signals as it approaches an intersection.
2. **Reliable service** – The same treatments that improve bus speed help with reliability, so METRO's customers can depend on arriving at their destination on time. When buses arrive every 12 to 30 minutes, riders can expect fewer late buses and can trust the service will take them to their destinations on schedule. When service is very frequent (every 10 minutes or less), headways are actively managed so buses maintain consistent spacing, allowing customers to know they will never wait long for the next bus to arrive.
3. **More frequent service to key destinations** – Faster, more reliable bus service is great for customers and has the additional benefit of lowering the cost to operate each bus route. When there are cost savings, METRO may reinvest in more service.
4. **More trips when people ride most** – Travel time savings and simplified service patterns allow METRO to more effectively tailor bus schedules to match customer demand. This means more frequent service at the busiest times of day and less crowded buses with room for everyone to sit.

D Route Design Guidelines

Bus Route Design Guidelines are established to ensure that METRO bus routes provide service to major activity centers or other passenger destinations with the highest level of accessibility and service coverage possible, while making the most efficient and productive use of METRO's available financial, physical, and labor resources.

Network Connectivity (Route Spacing) includes the distance between parallel routes. To enhance the attractiveness of transit usage, service should provide all segments of the region with good access from residential areas to concentrations of employment, essential services, and other passenger destinations. Under BOOST guidelines, optimization plans should also consider opportunities to improve connectivity between individual routes and within the overall transit network. Examples of this include route extensions, realignments, frequency changes, and/or span adjustments to bus routes intersecting a high frequency transit corridor. While opportunities to improve the transit network are important, BOOST route development should not go to the extent that BOOST service becomes degraded or strays from core BOOST principles.

Route Variations are sometimes more efficient to providing service to a certain area with one route having several branches than to operate several different routes. In addition, some bus trips on a route may not go to the end of the line due to very low ridership in that area at a particular time of day. This is called a "turnback" trip and is used only under certain circumstances.

Directness of Travel minimizes passenger travel time. Routes shall operate on major arterial streets as much as possible. However, there may be situations in which a route may deviate from the shortest, most direct routing. Such situations include a mid-route deviation to serve a particular trip generator or other high potential passenger area that does not have service, at the end of the line terminal loop, or for a route serving a small geographical area. Under BOOST guidelines, optimization plans should consider options for creating faster, more direct routes by removing deviations from the primary corridor that add travel time but do not serve major origins and destinations, provide connections to other routes, or generate strong ridership. To preserve coverage, plans should assess opportunities to maintain service on the removed segments with alternative services, such as METRO curb2curb, or by improvements to first/last mile access to existing stops.

Bus Stop Spacing and Positioning are determined according to two (2) main criteria: accessibility and travel speed. Close spacing of stops increases patron accessibility but increases transit trip time and may reduce carrying capacity. Therefore, a balance must be made between these two criteria.

Two other important factors examined are consistency in stop spacing and the impact on adjacent land use and development. As a general rule, METRO bus stops have been located on the nearside of intersections; however, on certain routes with high ridership along busy streets and where TSP is applicable, far-side stops may be more practical. Many factors, notably safety, indicate where the stop is the most desirable in the majority of circumstances. Chapter 4 addresses street side designs and explores bus stop placement, the advantages and disadvantages of each type, and how the stop should interface with parking, pedestrians, and bicycles.

Bus Stop Amenities such as passenger shelters, benches and seats, curb cuts and wheelchair ramps, signs and posts, info panels and info posts along with maps, can increase the use of transit services by making the system safer and easier to use. The thresholds for the types and level of amenities required are determined through a combination of daily boardings/alightings, route type, surrounding land use, and available right-of-way. Chapter 5 provides guidance on bus stop amenities and preferred dimensions behind the curb.

At a minimum all bus stop signs shall have the route number, route name and METRO's information phone number, 713-635-4000, on the sign. All bus stop signs are also numbered for reference in case of an emergency.

Service Detours and Interruptions caused by construction or other route obstructions shall be made to move routes to the closest adjacent street. If the affected area is in the CBD or another area with many one-way streets, then the detour shall be a maximum of two (2) blocks from the current routing, if possible. Signs informing passengers of long-term detours shall be placed at all regular bus stops several days prior to scheduled events. Temporary bus stop signage shall be installed at the new stop locations the day prior to the change. In the case of unplanned events; temporary signage shall be provided at the new stops as soon as possible if the detour is going to last more than 24-hours. All efforts shall be made to return service to the streets that are identified on the public timetables within 24-48 hours by the next day after the disruption is over or removed.

Strong Endpoints help encourage healthy ridership through the entirety of a transit route. Under BOOST guidelines, optimization plans for high frequency service should consider route extensions that extend frequent and high-ridership local bus corridors to strong endpoints—i.e., major origins and destinations, and connection points that provide opportunities to transfer to other METRO services. Wherever possible, service optimization plans should terminate routes at safe, functional layover locations with ample room for multiple buses and restroom access for operators or provide recommendations for coordination and/or capital improvements to accommodate layovers at locations that do not meet these criteria.

Service Interruptions

To maintain a seamless service, the Authority must establish a service recovery plan to assist with any scheduled or unscheduled service interruptions to the network.

The Authority must also maintain an operational strategy for providing service for scheduled or unscheduled rail service interruptions. This strategy must consist of the use of a "single track rail operation," bus bridge operation or existing fixed route service.

E Schedule Design Guidelines

Schedule design guidelines are established to ensure that the level of service offered by METRO will be adequate to attract new riders to the system and to maintain present riders. Service reliability, measured as schedule adherence, is critical in keeping customers who must rely on METRO's service or who may not have alternate means of transportation. A standard for adherence to the printed schedules is necessary to ensure that this crucial aspect of our service is regularly reviewed and addressed.

These guidelines are also essential to establish criteria for the scheduled interval between buses, as well as the hours during which a route will operate. In addition, standards for the number of passengers on a bus and the type of bus on a route are vital in ensuring that these patrons have a comfortable trip that will encourage them to continue to utilize the service. Key factors that fed into scheduling bus service include the following:

Schedule Adherence

Passengers depend on buses being on time. The on-time-performance goals are 75 percent for local routes, 76 percent for Park & Ride routes, for a weighted average of 69 percent.

Span of Service

The hours a route operates is determined by passenger need. As passenger loads shift, the additional runs may be necessary to provide the necessary service. On many corridors, customers will benefit from a longer span of service—i.e., trips that begin earlier in the morning or end later at night, especially if strong ridership is observed on either end of the service span. Schedules of important connecting services like rail lines should also be considered. Wherever possible, a consistent span should be provided seven days a week. Maintaining the same early morning and late evening trip times across the week, especially after midnight, can make them easier for riders to remember and reduce confusion about which schedule applies.

Service Frequency

The time between buses on a particular route is the frequency, or headway. Headways are determined by passenger demand as well as the necessary span of service. Longer headways during off-peak hours ensure service while allocating resources more efficiently. Customers will also benefit from additional trips that create more frequent service when people ride most. When designing BOOST service, optimized schedules will gradually transition between early morning, peak hour, midday, and evening frequencies, ramping up and scaling back in step with demand throughout the day. To the extent possible, optimized schedules will improve frequency at times when the median seating utilization exceeds 75 percent in the existing system to provide capacity for ridership growth and to accommodate minor service disruptions. Frequency decreases will be considered at times when median seating utilization falls below 25 percent while maintaining the span of frequent service defined by METRO's service standards. Clockface schedules, i.e., headways that divide evenly into 60 minutes, are strongly preferred whenever headways are 10 minutes or greater and should be considered on a case-by-case basis as to prevent excessive layover.

Headway Management

One of the chief benefits of frequent service is that passengers can "show up and go" and do not need to plan their trips around transit timetables. When buses arrive sufficiently frequently, customers can depend on getting to and from their destinations knowing they will likely not have to wait more than a few minutes for the next bus, no matter what time they arrive at the bus stop. However, achieving consistent headways on frequent service is operationally challenging, as even a small delay on one trip can spur bus bunching and long service gaps.

Headway management helps address these challenges to deliver more reliable frequent service. Under headway management, operators focus on maintaining consistent spacing between buses, rather than adhering to a specific schedule. Transitioning from a schedule-based operating practice to headway management requires additional displays on board buses to indicate to drivers their headway-based performance. METRO may explore headway management for BOOST routes in the future.

Passenger Load Factors

The capacity of the vehicles combined with the passenger demand are taken into account in developing a bus schedule. Achieving a balance between passenger safety and comfort, while maintaining operating efficiency is a scheduling challenge.

Equipment Assignments

METRO owns a variety of bus models for different purposes. Distributing the appropriate vehicles to the right route optimizes operating cost, load capacity, and passenger comfort and safety.

Title VI Requirements

METRO is committed to a policy of non-discrimination in the conduct of its business, including its responsibility to deliver equitable and accessible transportation services to all people.

F Capital Facility Guidelines

METRO has Transit Center and Park & Ride facilities that serve both bus and rail together or bus alone. METRO also operates a Bus Operating Facilities (BOF), METRORail Storage and Inspection facilities (S&I), and the DeLibero Rail Operation Center (ROC) for the storage and maintenance of the vehicles:

Transit Centers serve as connecting hubs for bus routes and sometimes rail lines. There are 21 transit centers that provide an off-street location for multiple bus routes to stop around a common platform; allowing passengers to board or alight without having to walk very far or cross a busy street. They provide a secure, sheltered location for passengers to sit, purchase tickets, and plan their trips with route maps and schedules posted at the transit center.

Park & Rides are located on the periphery of the service area and offer commuter service to suburbanites. Commuters can use the 27 Park & Ride lots to park their car for the day and ride the bus directly into either the CBD, The Texas Medical Center (TMC), or Greenway Plaza. Some Park & Ride routes stop at a transit center along the way to either pick up additional passengers or allow transfers to another bus if passengers are not headed to the ultimate Park & Ride destinations.

Bus and Rail Operating Facilities are located throughout the service area and serve as storage and maintenance centers for the METRO bus and rail fleet. Operators also gather at the facilities to await their route assignments and/or enjoy down time between runs.

G Evaluation of Route Performance

METRO ranks routes based on four key indicators. The overall performance of the route is evaluated relative to other routes. Poor-performing routes are either discontinued or modified to encourage better performance, if possible. Routes that have not been operational long enough to assess are called Maturing and allowed with some scrutiny.

The development of the four indicators requires the calculation of several pieces of data on a route level basis. The specific definitions for each indicator are:

Passenger Boardings / Revenue Mile

The number of average daily boardings per route divided by the daily number of revenue miles of service supplied on the route (total miles less "deadhead" miles, or the miles to and from the garage).

Passenger Boardings / Revenue Hour

The same information as the previous indicator except using revenue service hours instead of miles.

Operating Ratio

The operating ratio calculates the percentage of operating costs covered by that route's revenue.

Total Subsidy / Passenger Boarding

The net cost (total cost less revenue) of operating a route divided by the number of passengers. At METRO, total cost is determined by allocating all service-related expenses over three cost factors:

5. **Total Miles:** Revenue miles plus deadhead miles.
6. **Total Hours:** Revenue hours plus deadhead hours.
7. **Peak Vehicles:** The number of peak weekday vehicles required on the route. The number of buses required to operate weekday service far exceeds weekend services resulting in bus procurements to meet weekday demand. Since buses are already available for use on weekends, no peak vehicle costs are allocated to weekend services.

The cumulative score of these indicators is used to rank routes for assessment.

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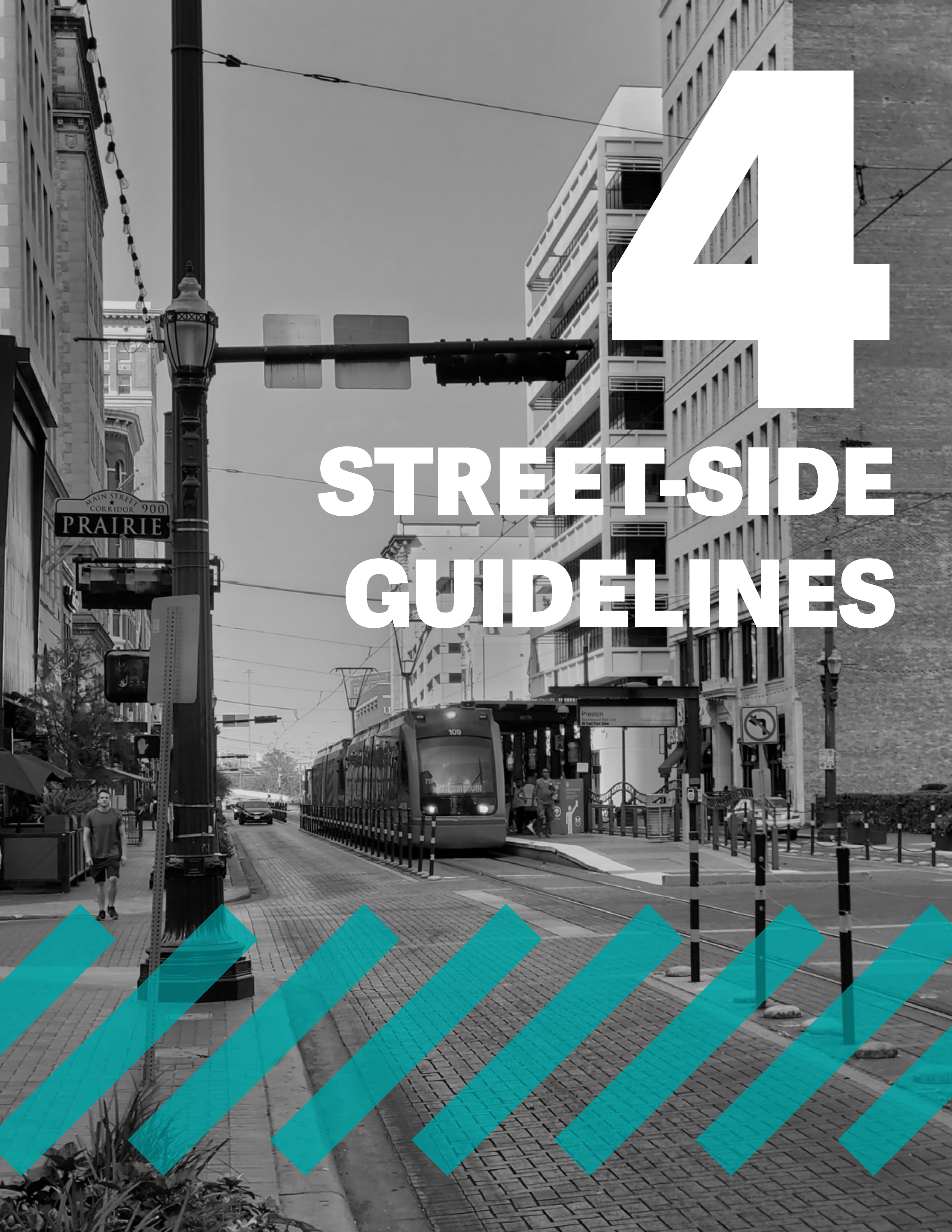
4 STREET-SIDE GUIDELINES



STREET-SIDE GUIDELINES

A Transitways

Transitways are the physical space in which a transit service operates its routes. There are several different types of transitways, ranging from mixed-mode space (transit, automobiles, and bicycles) to fully dedicated transit space. Due to the physical nature of these spaces, transitway design can influence and is impacted by other physical elements of the transportation and land use environment; as such, a suite of considerations and choices that will determine the most appropriate type of transitway for each unique situation and location inherently accompanies transitway design. Note that the design considerations and standard dimensions outlined in this chapter do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for safe transit service. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

A METRO bus using High Occupancy Vehicle (HOV) Lanes.

General Considerations

Right-of-Way (ROW)

ROW availability often determines what type of transitway fits a street or corridor. It is highly recommended to consider retrofitting underutilized auto vehicle lanes or on-street parking lanes to allocate space for transit lanes. High traffic volume corridors can also see benefits when vehicular lanes are reallocated for high-frequency transit vehicles.

Transit Demand & Future Growth

Potential transitways should consider current and future transit system needs and context. Allocating more ROW to transit often leads to better system efficiencies and increased ridership. Future growth along the transit roadway may also induce a higher demand for transit.

Transit Friendly Intersection Design

Transit Friendly Intersection Design is a set of tools and techniques used to improve transit service efficiency, reliability, and on-time performance, generally at intersections. Implementing a range of transit friendly intersection design tools at signalized intersections along transitways greatly improves reliability and travel times.

Turning Traffic

Transitways must consider turning traffic patterns at intersections. Right- and left-turn bays, street markings, signage, and TSP should be considered to minimize service delays and conflicts due to right- and left-turning vehicles.

Encroachment

Lanes designated for transit are often subject to illegal encroachment due to double-parking, deliveries, and passenger loading. Visible signage and enforcement are critical for deterring violations that can affect transit travel speeds and system reliability.

Signage and Pavement Markings

Lanes should be delineated by specific street markings, signage, and physical barriers to ensure road-user legibility. These are integral elements for maintaining system efficiency and safety.

Bicycle Facilities

Special attention must be given to bike lanes when present on or aligned with bus lanes. Bikes and bus lanes often share space and therefore need specific street markings and signage to delineate use and ensure safety and comfort.

Roadway Condition

Where areas of high wear are anticipated on transitways, especially where high capacity transit operates, concrete slabs may be thickened by 3" to minimize the deterioration of roadway due to the operation of transit vehicles. Generally this will occur at transit stops, intersections where transit vehicles accelerate from a stopping point, or other areas where frequent stops or acceleration are made.

Shared Auto/Transit Lanes

Definition

A shared auto/transit lane is a travel lane that accommodates transit and vehicular travel.

Application

These lanes are most appropriate for neighborhood streets or narrower streets that lack the ROW necessary to allocate a transit-dedicated lane. Best suited for lower-traffic corridors where transit vehicles are not as affected by congestion. May be used along a corridor in conjunction with transit-dedicated lanes where ROW constraints exist.

Advantages

Does not require additional ROW or eliminating existing auto travel lanes. Does not require extensive signage or pavement markings to designate lane.

Disadvantages

Inherent to having both vehicular traffic and transit vehicles using the same lane is the potential for unreliable transit service, a key contributor to unsatisfied passengers and lower transit use. Additionally, mixed traffic may also lead to more conflicts between vehicular traffic and transit vehicles.

Design Considerations

Lane Width

METRO preferred lane width for bus operation is 12'. Minimum lane width is 11'. A context-sensitive approach shall be used when determining lane widths and METRO Engineering shall be consulted to consider variables such as travel speeds, or geometry, etc.

Placement

Shared automobile transit lanes should be designated to the farthest right travel lane. May be curbside or offset if on-street parking is present.

Business Access Transit (BAT) Lanes

Shared auto transit lanes used in conjunction with BAT lanes where ROW space is not available. See Section 4.A.3. for further guidance on BAT lanes.

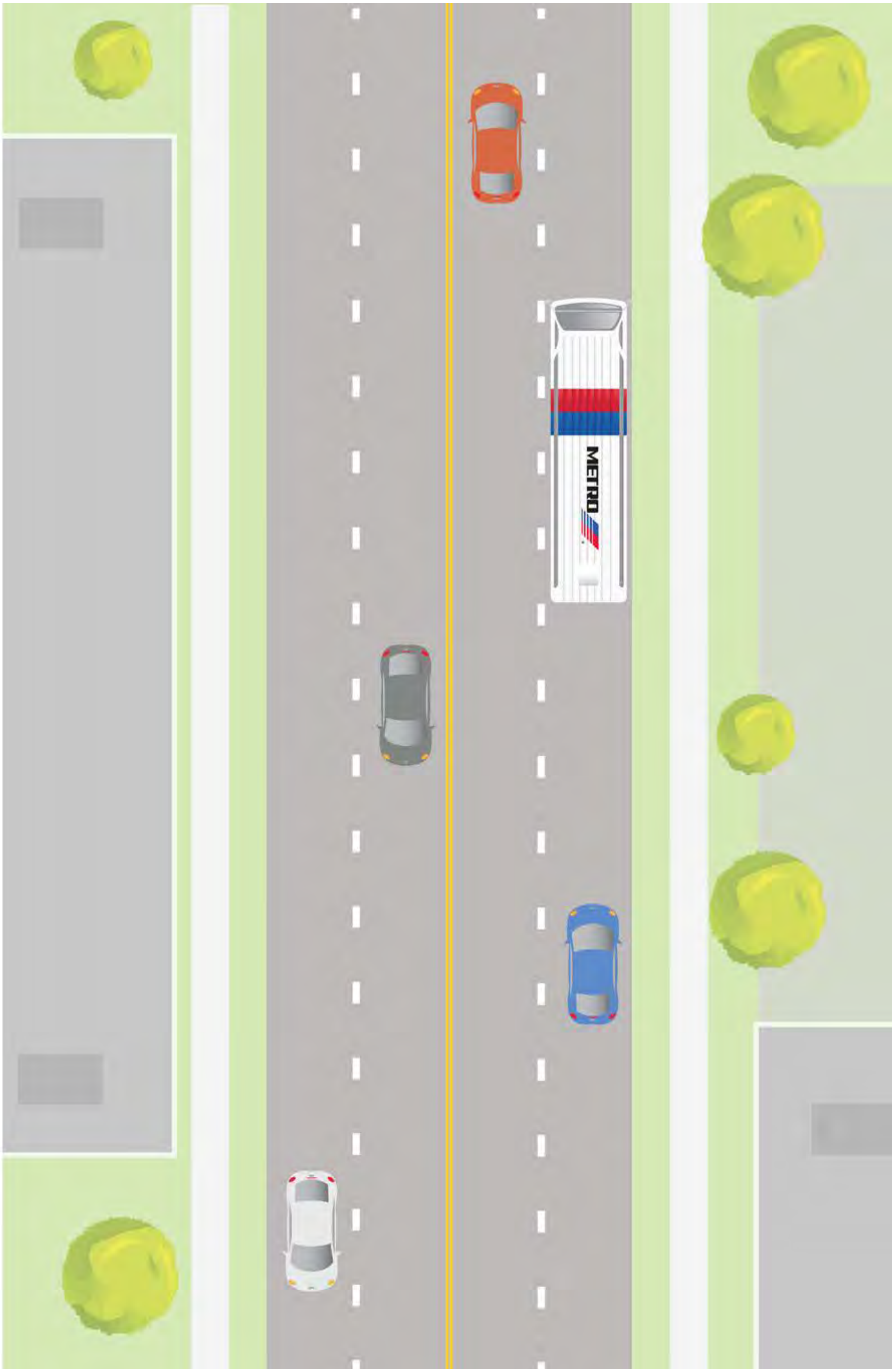
Parking

If on-street parking is present, the parking lane must terminate before and resume after the bus stop to allow adequate merging space for all transit vehicles serving that stop. Where parking along a bus route exists, coordination with COH Parking is recommended. See Section 4.D. Transit Stop Roadway Configuration for further guidance in required dimensions to operate buses safely to the curbside.

Bike Facilities

Buffered or separated bike lanes are recommended to run parallel to the lane. They provide extra space and operating comfort over a standard bike lane. Special attention to bike and bus conflict zones is critical. See Section 4.D. Transit Stop Roadway Configuration and Section 4.E. Pavement Markings and Signage for further design guidance. If bike lanes are not provided, cyclists are likely to use the shared bus/auto lane or a sidewalk if no other parallel facility exists.

Figure 4.1: Shared Auto/Transit Lanes



Business Access Transit (BAT) Lanes

Definition

A BAT lane is a curbside lane designated for transit vehicles but allows auto vehicles to share the lane under specific circumstances. BAT lanes may be flexible and dynamic depending on needs. For example, the lane may allow right turning auto vehicle traffic at intersections or curbside driveway access for destinations. They may also be flexible depending on time of day or day of the week.

Application

A BAT lane is beneficial along corridors with intersections that have a high volume of right turning vehicles or need for access to curbside driveways where a dedicated lane is not feasible. A BAT lane is also applicable for corridors with underutilized parking or vehicle traffic lanes that can be re-designated. These lanes are appropriate for rapid transit routes due to the separation from most vehicular traffic.

Advantages

These lanes are more advantageous to the transit system than mixed traffic lanes as they may lessen the potential for transit delays. BAT lanes restrict auto vehicle traffic leading to better on-time performance and system reliability. BAT lanes may limit or reduce potential conflicts with auto vehicle traffic compared to shared lanes.

Disadvantages

While appropriate signage and markings may lessen turning conflicts, they are still likely to occur when using BAT lanes. BAT lanes may be a problem for service or delivery vehicles. The advantages inherent to BAT lanes are dependent upon strategic enforcement of traffic rules. These lanes require additional ROW or the elimination of a general purpose or parking lane.

Design Considerations

Lane Width

METRO preferred lane width is 12′. Minimum lane width is 11′.

Placement

BAT lanes should be designated to the farthest right travel lane. They may run curbside or offset.

Signage and Markings

Specific signage and markings are critical for user legibility and eliminating conflicts with other road users. If lanes are dynamic depending on time of day or day of the week, signage must be highly visible for all road users. Lanes should be distinguished by a solid single or double white line with the option of red colored pavement on the inside of the lane. "BUS ONLY" and a right turn arrow should be painted in the lane with associated signage where it applies. All markings and associated signage should be highly visible where vehicles are allowed. See Section 4.E. Pavement Markings and Signage for further design guidance.

Note: Colored pavement treatments are not currently a COH standard and therefore will not be maintained by COH.

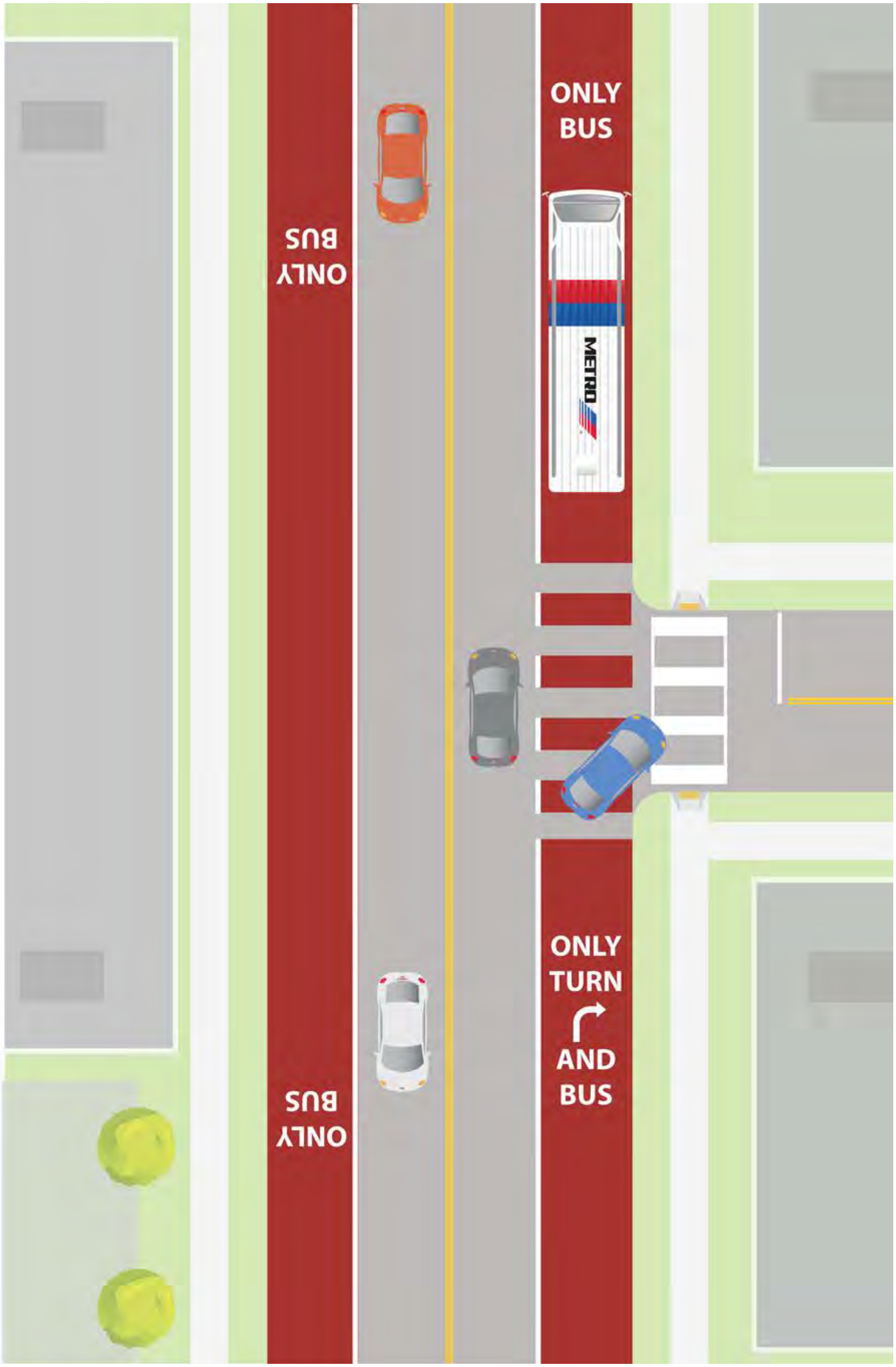
Parking

If on-street parking is present, bus stops will require a bulbout design or bus bay that is delineated with pavement markings. The parking lane must terminate before and resume after the bus stop. Where parking along a bus route exists, coordination with COH Parking is recommended. See Section 4.D. Transit Stop Roadway Configuration for further guidance.

Bicycle Facilities

Buffered or separated bike lanes running parallel to a BAT lane are highly recommended over a standard bike lane given that they provide extra space and operating comfort between riders and transit vehicles. Refer to Section 4.D. Transit Stop Roadway Configuration and Section 4.E. - Pavement Markings and Signage for further design guidance.

Figure 4.2: Business Access Transit (BAT) Lanes



Dedicated Transit Lanes

Definition

Dedicated transit lanes are designated for bus-only travel.

Application

Dedicated lanes best optimize transit routes with frequent headways or where traffic congestion significantly impacts transit reliability. By eliminating vehicular traffic from the travel lane, buses can maintain speeds and decrease delays. Dedicated transit lanes are appropriate to transit-oriented neighborhoods as well as higher-density commercial areas or where congestion impacts travel time and speed.

Advantages

Dedicated bus lanes best optimize system reliability and travel times by completely separating bus traffic from vehicular traffic.

Disadvantages

Dedicated bus lanes restrict vehicular turning movements that may not be able to be accommodated. If lanes are placed center-running, pedestrians are required to cross traffic to board. Dedicated lanes may be an issue for service and delivery vehicles. Similar to BAT lanes, the advantages inherent to dedicated lanes are dependent on strategic traffic enforcement if physical separation is not present. These lanes require additional ROW or the elimination of a general-purpose or parking lane traffic lane.

Design Considerations

Lane Width

METRO preferred lane width is 12′. Minimum lane width is 11′. If center-running, 12′ METRO preferred with an additional 1′ minimum buffer, 2′ buffer preferred that includes vertical separation such as turtle humps.

Placement

Dedicated lanes may run curb-side, off-set, or center-running.

Signage and Markings

Specific signage and markings are critical for user legibility and eliminating conflicts with other road users. Lanes should be distinguished by a solid single or double white line with the option of red colored pavement on the inside of the lane. “BUS ONLY” should be painted in the lane with associated signage. See Section 4.E. Pavement Markings and Signage for further design guidance.

Note: Colored pavement treatments are not currently a COH standard and therefore will not be maintained by COH.

Physical Separation

Dedicated transit lanes are most advantageous when separated from traffic using physical barriers.

Parking

If on-street parking is present and transit lane is offset, bus stops will require a bulbout design. The parking lane must terminate before and resume after the bus stop. Where parking along a bus route exists, coordination with City of Houston Parking is recommended. See Section 4.D. Transit Stop Roadway Configuration for further guidance.

Bicycle Facilities

Buffered or separated bike lanes are highly recommended over a standard bike lane given that they provide extra space and operating comfort between riders and transit vehicles. Refer to Section 4.D. Transit Stop Roadway Configuration and Section 4.E for further guidance.

Figure 4.3: Dedicated Transit Lanes

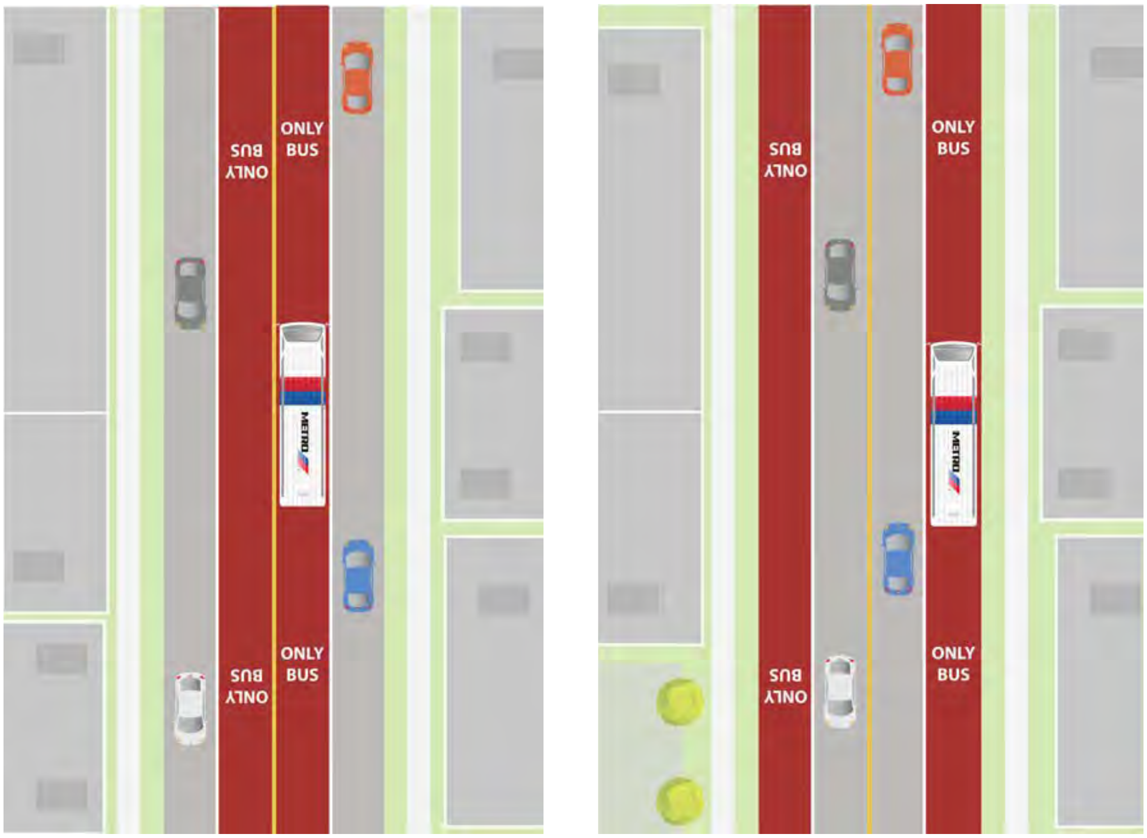
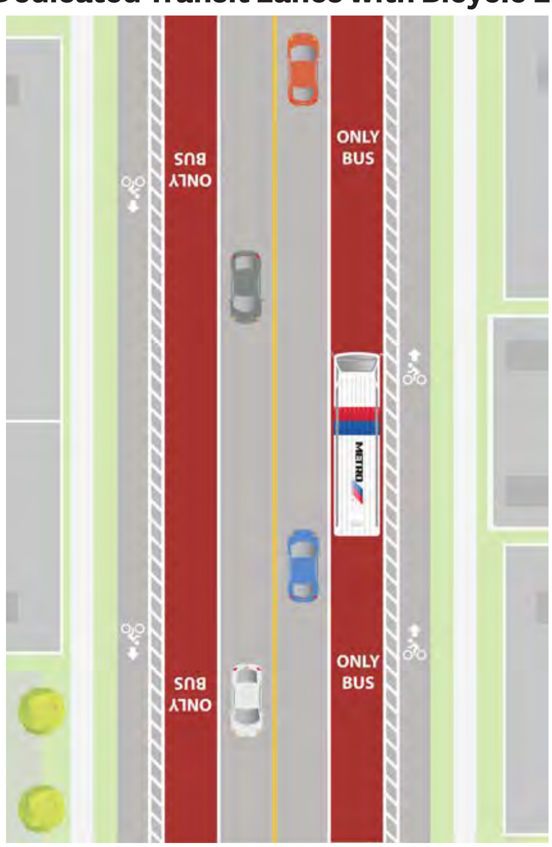


Figure 4.4: Dedicated Transit Lanes with Bicycle Lanes



Dedicated Rail Transitways

Definition

Dedicated rail transitways are lanes or travel ways separated from vehicular traffic.

Application

Dedicated rail transitways are most appropriate along corridors with high demand for transit and where transit travel speeds are relatively low. Dedicated rail transitways are suitable along streets with high levels of automobile traffic and demand for many users including transit riders, cyclists, and pedestrians. Dedicated rail transitways allow transit service to operate with fewer direct conflicts with vehicles or other street activities. Buses may use dedicated rail transitways if no other option exists.

Advantages

This type of transit guideway provides increased safety, efficiency, and reliability because these transitways are physically separated from other modes of transportation. Separation may reduce conflicts between other vehicles and increase reliability. Dedicated rail guideways are also ideal configurations for coordinating with active signal priority.

Disadvantages

Dedicated rail transitways are the most restrictive concerning vehicular turning movements. Physical barriers when present prevent vehicular traffic from encroaching the transitway. This type of transit infrastructure is more costly than the other types of transit lanes. Dedicated rail transitways require additional ROW or the elimination of a through traffic lanes.

Design Considerations

Lane Width

Desired transitway width is 32′. Minimum is 26′. If OCS poles are present, 27.5′ is the recommended minimum for center-running rail with bi-directional service.

Access

A context-sensitive approach should be used when determining suitability of dedicated rail transitways in certain locations. It is crucial to ensure that some form of access is provided to adjacent buildings for service and business purposes, as well as for emergencies. For example, it would be important to determine whether the placement of a dedicated rail transitway would create a barrier to access in the only feasible locations for loading and service zones for buildings along the street, as well as for emergency access such as police, fire, and EMS.

Placement

Rail transitways may run curb-side, off-set, or center-running.

Signage and Markings

Specific signage and markings are critical for user legibility and eliminating conflicts with other road users. Rail transitways may be painted red for high visibility with a solid double or single white line on the outside lane. See Section 4.E. Pavement Markings for further design guidance.

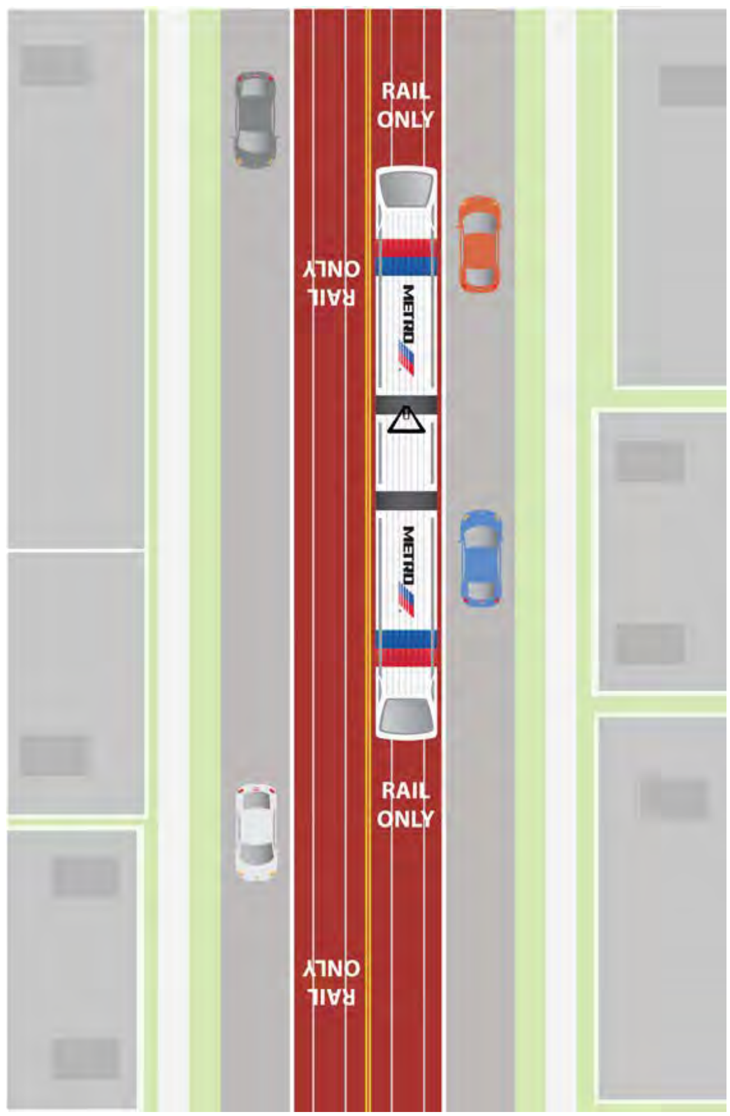
Physical Separation

The physical separation of rail transitways can be created in multiple ways, such as through side-fencing, bollards, or medians. A fence or barrier with sufficient height is recommended, however, requirements could be lowered based on context. Regardless of the separation method used, the transitway should be marked clearly to indicate to other modes of transportation that the transitway is exclusively used for rail transit and that other modes are not permitted access. This is especially important at intersections or other crossings where the transitway cannot fully bar all other forms of traffic. The use of vegetation only is not a suitable barrier for physical separation.

Track Types

Different types of rail trackage, such as ballasted, embedded, and direct fixation, are appropriate for various portions of a dedicated rail transitway. Ballasted track is lower cost but not appropriate at intersections. Embedded track is the most common track type and preferred at intersections and other vehicle/bicycle/pedestrian crossings. Direct fixation track is best for tunnels and bridges.

Figure 4.5: Dedicated Rail Transitways



B Bicycle Interaction

Bicycle interaction with the transit system is expected to occur throughout the City. Ensuring safe cohabitation of space is integral to operating transit along roadways. METRO has identified several preferred interaction treatments along roadways where transit operates. The preferred treatments described below should be implemented where possible as these treatments provide the most comfort and ease for cyclists, transit operators, and other road users. Providing high-comfort bicycle facilities along roadways where transit operates is important to providing transit service as it helps connect transit users to the bicycle network. When adequate ROW does not exist for the preferred bicycle treatment, please refer to other treatments noted in this section for the next best solution or consider parallel corridors. For specific details on the types of bicycle facilities planned along roadways where transit operates, please refer to the COH Bike Plan. Roadways where transit operates should adhere to the COH Bike Plan where applicable. For bicycle facility design specifications, please refer to the COH IDM, Chapter 17, Section D to ensure adherence. Note that the design considerations and standard dimensions outlined in this section do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for safe transit interactions with bicycle facilities. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

Preferred Bicycle Treatment

Bicycle facilities along roadways where transit operates should provide the greatest possible amount of protection and separation from the transit travel lane, transit stops, and intersections. This provides greater comfort for cyclists regardless of age and ability. In addition, greater separation from the transit travel lane, transit stops, and intersections makes it easier for transit operators to safely pass cyclists.

Bicycle Facility

Where ROW exists, the bicycle facility along the transit lane should provide the greatest possible separation from the outside transit lane. A buffered bike lane with vertical delineation (ex. bollards or armadillos) is preferred. If on-street parking is present, the buffered bike lane may be placed to the right of the parking to create greater separation from the transit lane. Per COH IDM specifications, the buffer should be at least 3' wide and bike lane should be at least 5' wide with a 6' width preferred. Refer to COH IDM Chapter 17 and COH Standard Design 01510-01 for further design specifications.

Transit Stops

Where bicycle facilities intersect with transit stops, separation from the transit stop and bicycle facility is highly recommended. A floating bus stop as shown in Figure 4.14 and Figure 4. 15 provides the greatest separation between the bicycle facility and transit stop. If a floating bus stop is not possible, conflict zones should be painted along the transit stop with green paint along the bike lane and a dashed white line (See Figure 4.13 for reference). Refer to COH IDM Chapter 17 and Standard Design 01510-01 for further design specifications.

Intersections

Intersections along transit roadways with bicycle facilities should incorporate high visibility markings to ensure road user legibility and added safety. The preferred bicycle intersection marking is painted green striping with white lines as shown in Figure 4.14 and Figure 4.15. Refer to COH IDM Chapter 17 and COH Standard Design 01510-01 for further design specifications.

Recommended Minimum Bicycle Treatment

Where roadway space is constrained and unable to accommodate the preferred bicycle treatments, the minimum bicycle facility treatments should be implemented. The minimum treatments define roadway space for bicycle users along transit roadways.

Bicycle Facility

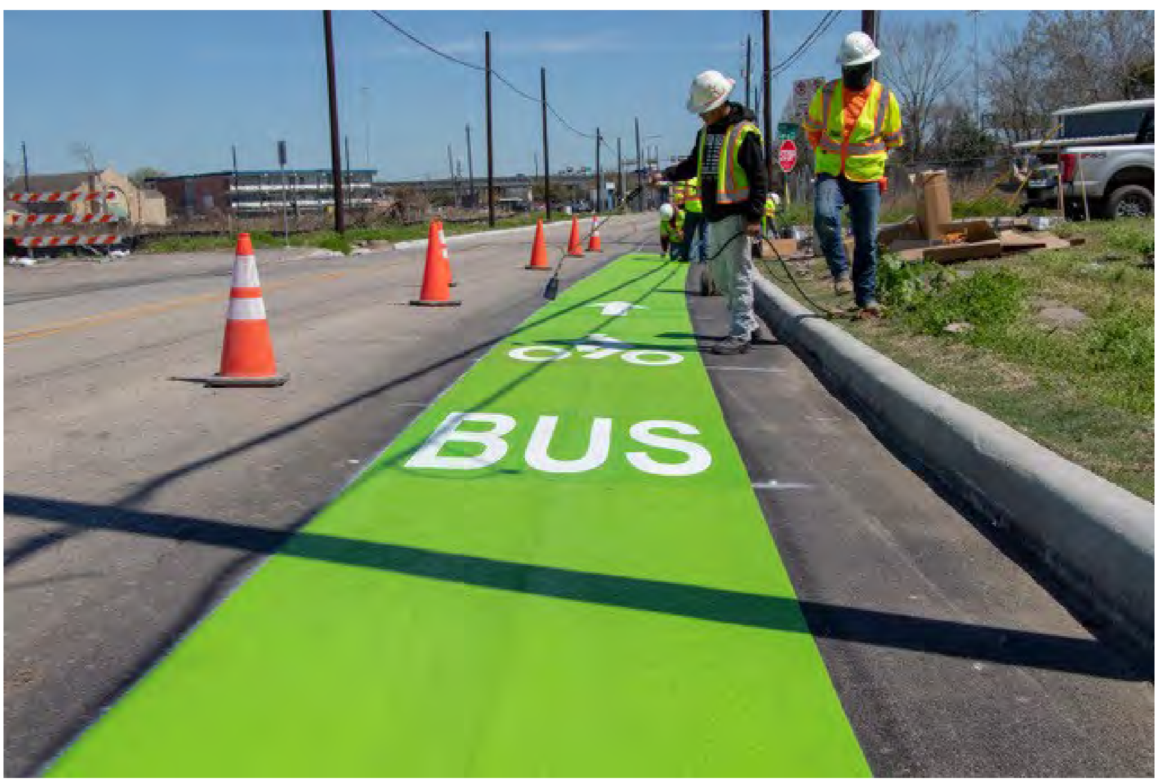
When ROW cannot accommodate a buffered bike lane, a standard bicycle lane should be implemented along transit roadways. Per recommendation by the COH IDM Chapter 17, standard bicycle lanes should include a painted white line with a minimum width of 5′ with a 6′ preferred width. Refer to COH IDM Chapter 17 and COH Standard Design 01510-01 for further design specifications.

Transit Stops

Where standard bike lanes intersect transit stops, conflict zones should be painted along the transit stop with green paint along the bike lane and a dashed white line (See Figure 4.12 for reference). Refer to COH IDM Chapter 17 and Standard Design 01510-01 for further design specifications.

Intersections

Intersections along transit roadways with bicycle facilities should incorporate high visibility markings to ensure road user legibility and added safety. The minimum intersection treatment along a transit roadway with a standard bike lane should be two parallel dashed white lines. Green bicycle boxes may also be implemented. See COH Standard Design 01510-01 for further design specifications.



Bus/Bicycle Mixing Zone Installation.

C Transit Stop Placement

Transit stops provide passengers with access to the METRO transit network. As such, placing stops at the best possible locations is a crucial factor in promoting safe, convenient, efficient, and well-utilized transit service. Stop distribution, integration with surroundings, and location in relation to the street network are major aspects governing best practices for stop placement. There are three general stop location types – far-side, near-side, and mid-block – used for bus stop placement. These location types designate where the bus stops are in relation to an intersection and have specific applications and guidelines. Note that design considerations and standard dimensions outlined in this section do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for safe placement of transit stops. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

Example of a bus stop placed mid-block along Almeda Rd. across from Hermann Park Ct.

General Considerations

A variety of factors and situations must be considered to ensure the most suitable bus stop placement. The following are key elements to evaluate when considering bus stop placement:

Safety

Bus stops should maximize passenger and operational safety.

Accessibility for All Passengers

Bus stop siting should consider pedestrian access and be convenient for passengers with disabilities and those using mobility devices. Per ADA requirements, a bus should stop/dwell parallel to a curb at all transit stop locations to ensure accessible boarding and alighting. See Chapter 5 for specific requirements.

Context-Sensitive Design

Each bus stop location has a unique set of built and environmental characteristics that should be considered in the siting process.

Operations

Bus stops should be placed in a manner that facilitates safe and efficient transit vehicle circulation and operation with consideration to maintenance needs.

Preservation of Infrastructure and Utility Services

Bus stop placement should minimize impacts and disturbances to the roadway, sidewalks, and nearby utility services. In addition, utilities should be placed as not to impact unobstructed access to all passengers.

Landscaping

The addition of trees and landscaping should be considered where possible as they may provide additional comfort from weather and add aesthetic appeal.

Bus Stop Length

If a bus stop is shared by more than one route or combined frequency at a stop is more than four (4) buses per peak hour, the bus stop bay length should be planned for two buses. Dimensions for dual bus bay length vary based on placement and can be found below.

Design Considerations

The following provides an overview of context-sensitive design factors that should be considered when determining bus stop locations.

1. Adjacent land use and activities
2. Bus route configuration (for example, is the bus turning at the intersection?)
3. Impact on intersection operations
4. Intersecting transit routes
5. Intersection geometry
6. Parking restrictions and requirements
7. Passenger origins and destinations
8. Physical roadside constraints (trees, poles, driveways, etc.)
9. Potential ridership
10. ROW availability

Stop Spacing

Stop spacing refers to the distance between individual stops in a transit network. Using appropriate stop spacing is important because it allows a transit system to maximize efficiency while still providing service to locations that need it. Locating stops too close together slows service down and provides an area with redundant coverage, which, in turn, impacts on-time performance and reliability, while spacing stops too far apart restricts opportunity for accessing the network. Where sidewalk and/or other pedestrian infrastructure is non-existent or where sidewalks and ramps are not accessible, it is not feasible to place bus stops.

Appropriate stop spacing should be based on factors such as the type of service provided along a route, the density of population and development along the route, and block length of the street network.

Table 4.1: Stop Spacing Standards (see footnote)

Service Type	Stop Spacing
***Frequent (Mixed-Flow Fixed Route)**	1,300' average; 1,300 - 2,600'
Standard (Mixed-Flow Fixed Route)	1,300' average; 1,300 - 2,600'
Quickline (Mixed-Flow Fixed Route)	2,500'
Coverage (Mixed-Flow Fixed Route)	1,300' average; 800' - 2,600'
"On Call" (METRO curb2curb) (Demand Response)	N/A
Park & Ride (Suburban Express)	Every two to four blocks (distribution)
Express (Mixed-Flow Fixed-Route; Suburban Express)	1,300' average; 1,300' - 2,600' (collection), every two to four blocks (distribution)
METRORail (Light Rail)	2,600'

Stop spacing standards recommended by METRO in 2015 Proposed Service Design Standards
Signature Service in development
**Stop spacing applies to BOOST*

Frequent = Red (15 min or better)
Standard = Blue (20-30 min)
Quickline = High Frequency & High Capacity Service
Coverage = Green (60 min)

Non-BOOST Stop Optimization

Bus stop optimization is an approach to improve the transit system by optimizing the spacing and placement of bus stops to enhance speed and reliability while maintaining access. As mentioned above, bus stop spacing must balance accessibility needs with passenger travel time. Travel times, system reliability, service comfort, accessibility, and stop facilities and amenities may all be improved by carefully considering bus stops. In addition, optimizing bus stops along a roadway can enhance travel time savings for users.

The bus stop spacing standards provide a basis for stop optimization. Other context-sensitive measures should also be considered to supplement spacing guidelines where appropriate. Factors to be considered during optimization include those in Table 4.2. The optimization process should ensure that stops are provided at transfer locations, controlled crossing locations and on both sides of major barriers such as highways and bayous.

A high level of public engagement and outreach is recommended in advance of stop optimization to ensure a smooth transition for riders.

Bus stop optimization, when possible, should be done along a corridor or an entire continuous segment of a roadway rather than in isolation. This helps maintain overall spacing for the entire route and helps the agency capture the maximum benefits.

Table 4.2: Stop Optimization Factors

Factors	Criteria
Ridership	Stops with less than 40% of the average ridership per stop on a route will be examined (Transit Centers, Park & Rides, and Downtown Bus Stops excluded from the examination)
Spacing / Accessibility	Stops within 1/8-mile of adjacent stops will be examined for discontinuation but may be relocated for improved route performance
Transfer Points	Stops at transfer locations will not be examined
Major Destination	Stops adjacent to major destinations will not be examined
Title VI	Staff will work to ensure that there are no disparate impacts or disproportionate burdens placed on any group or community resulting from an optimization plan

Distance from Driveways/Intersections

Bus stop placement in proximity to driveways should be avoided when possible. Bus stops placed near driveways present potential conflicts between transit vehicles, traffic, and transit passengers.

Bus stops should be placed at least 10' upstream of a driveway or where the rear of the bus is at least 5' beyond the driveway when stopped. At intersections along bus routes, driveways should be offset by 100' minimum (COH IDM, Chapter 15). When placing a stop near a driveway is unavoidable, the following guidelines are encouraged.

- Where possible, a bus stop should be placed far-side of the driveway where it will not impede entering and exiting traffic. This allows the best visibility for vehicles leaving the site and minimizes vehicle/bus conflict.
- If blocking a driveway is unavoidable, it is preferred that the bus fully block a driveway rather than partially block. This prevents vehicles from attempting to squeeze by the bus and causing an unsafe condition because of reduced sight distance.
- Placement should leave one exit and entrance driveway open for vehicles to access the site.
- Stop location should allow unobstructed site lines for vehicles exiting the driveway.

Sight Distance

Sight distance standards are referenced from METRO's Locative Survey Scope of Services Bus Shelter Program.

- For intersections without any traffic control provide a 45-foot right triangle for corner clearance unless jurisdictional authority allows exception.
- For intersections and driveways, the sight distance shall be 10 times the legal speed limit of on-coming traffic as viewed by motorist from vehicle at intersection or driveway, etc. (Drawing CEF-1003). A sight-distance calculation deliverable is required to be included in each site folder.

Far-Side

Definition

A far-side stop is a configuration where the bus stops immediately after passing through an intersection.

Application

Far-side should be considered the preferred location placement for bus stops. Far-side stops are best-suited for intersections with a high volume of right turns and complex intersections with multi-phase signals or dual turn lanes (See Figure 4.8). If a dedicated transit lane is present or the transit vehicle must make a turn, far-side stops are preferred.

Advantages & Disadvantages

Please refer to Table 4.3.

Transit Signal Priority (TSP)

Far-side stops are most advantageous for TSP technology. The inclusion of TSP may minimize the disadvantages inherent to far-side stops by improving intersection efficiency and safety.

Design Considerations

Stop Placement

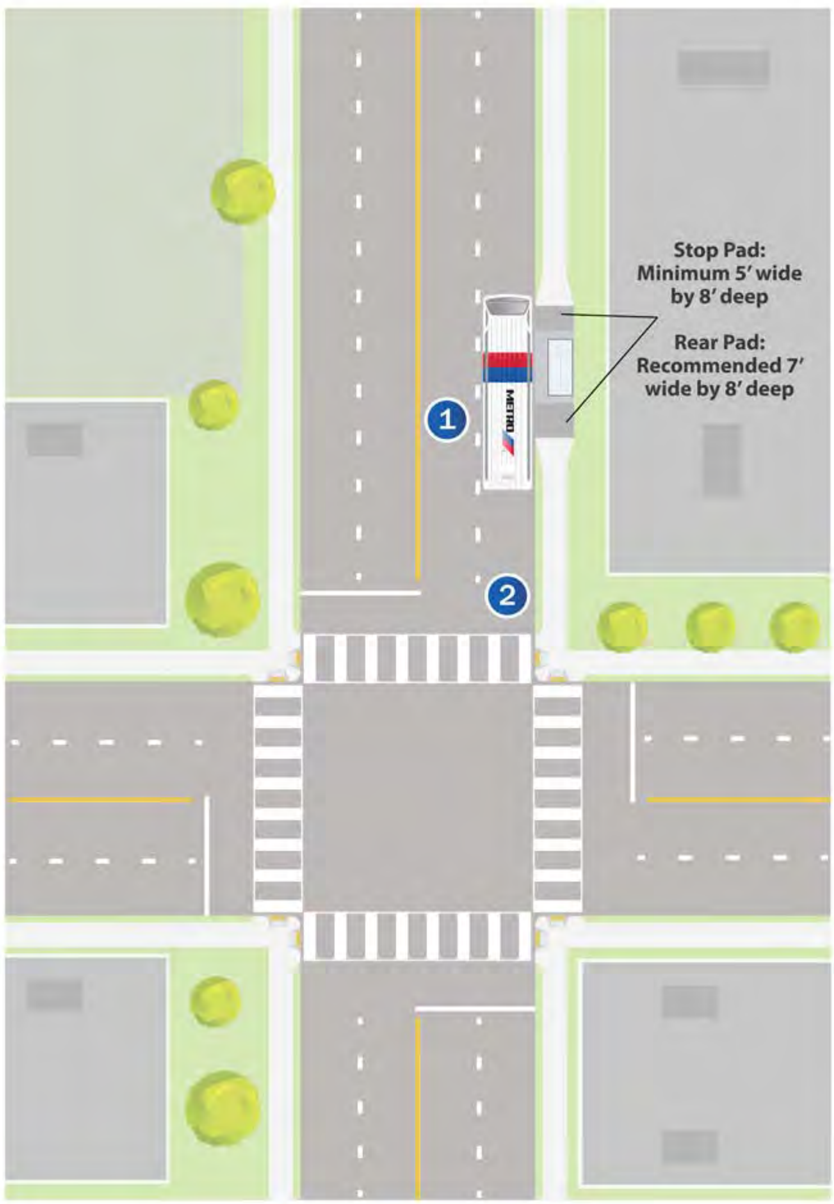
Far-side stops should be placed where the back of the bus clears the edge of the crosswalk by 20' or 30' from the intersection where no crosswalk exists. See Figure 4.6 for further guidance.

Table 4.3: Far-Side Stop Placement Advantages and Disadvantages

Advantages	Disadvantages
• Minimizes conflicts between right turning vehicles as the bus doesn't block turning vehicles • May increase safety by reducing the likelihood of conflicts between pedestrians and buses • Causes less interference where the cross street is a one-way street from left to right • May improve bus travel times as it can minimize double stopping prior to the intersection	• May introduce issues including queuing vehicles in the intersection • May cause additional stop after waiting for a red light that interferes with traffic flow • Potential for rear-end crashes • May obscure sight distance for crossing vehicles

Figure 4.6: Far-Side In-Lane Bus Stop Dimensions

Bus Length	Bus Dwell Zone (1)	Distance from Crosswalk (2)	Distance from Intersection
35′	35′	20′	30′
40′	40′	20′	30′
45′	45′	20′	30′
60′	60′	20′	30′
2 x 35′	75′	20′	30′
2 x 40′	85′	20′	30′
2 x 45′	95′	20′	30′
2 x 60′	125′	20′	30′



Near-Side

Definition

A near-side stop is a configuration where the bus pulls up to the stop immediately prior to an intersection.

Application

Best suited at intersections with a high volume of right-turning vehicles onto the transit roadway from a perpendicular street by making more space on the far-side (See Figure 4.8). Near-side stops are preferred if a near-side curb extension prevents automobiles from trying to turn right in front of the bus.

Advantages & Disadvantages

Please refer to Table 4.4.

Intersection Enhancements

If implemented with a queue jump lane and transit signal priority enhancements, the disadvantages concerning traffic flow will be minimized and may make the near-side stop applicable for high volume intersections.

Design Considerations

Stop Placement

Approximately 10′ from edge of crosswalk or 20′ from the intersection. See Figure 4.7 for further guidance. Near-side stops should not be placed along right-turn only lanes unless the bus is turning right. If right-turn lanes are present, the bus stop should be moved prior to the right-turn lane or placed on the far-side of the intersection.

Table 4.4: Near-Side Stop Placement Advantages and Disadvantages

Advantages	Disadvantages
• Encourages safety by providing the bus driver better opportunity to look for on-coming traffic and allowing passengers to board nearest to the crosswalk. • May minimize traffic delays by taking advantage of red lights to allow boarding. • Causes less interference where the cross street is a one-way street from right to left. • Causes less interference with traffic turning onto the bus route street from a side street.	• May introduce conflicts between vehicles trying to make right turns and obscure sight distance. • May cause sight distance problems for crossing pedestrians. • May cause delays if vehicles stopped at a red light back up far enough to prevent a bus from reaching the stop during the red light. • No preemption benefits • Potential for rear-end crashes • May result in bus loading/unloading if the above mentioned occurs. • High accident potential for cars trying to maneuver around dwelling bus to turn right as bus pulls away from stop

Figure 4.7: Near-Side In-Lane Bus Stop Dimensions

Bus Length	Bus Dwell Zone (1)	Distance from Crosswalk (2)	Distance from Intersection
35′	35′	10′	20′
40′	40′	10′	20′
45′	45′	10′	20′
60′	60′	10′	20′
2 x 35′	75′	10′	20′
2 x 40′	85′	10′	20′
2 x 45′	95′	10′	20′
2 x 60′	125′	10′	20′

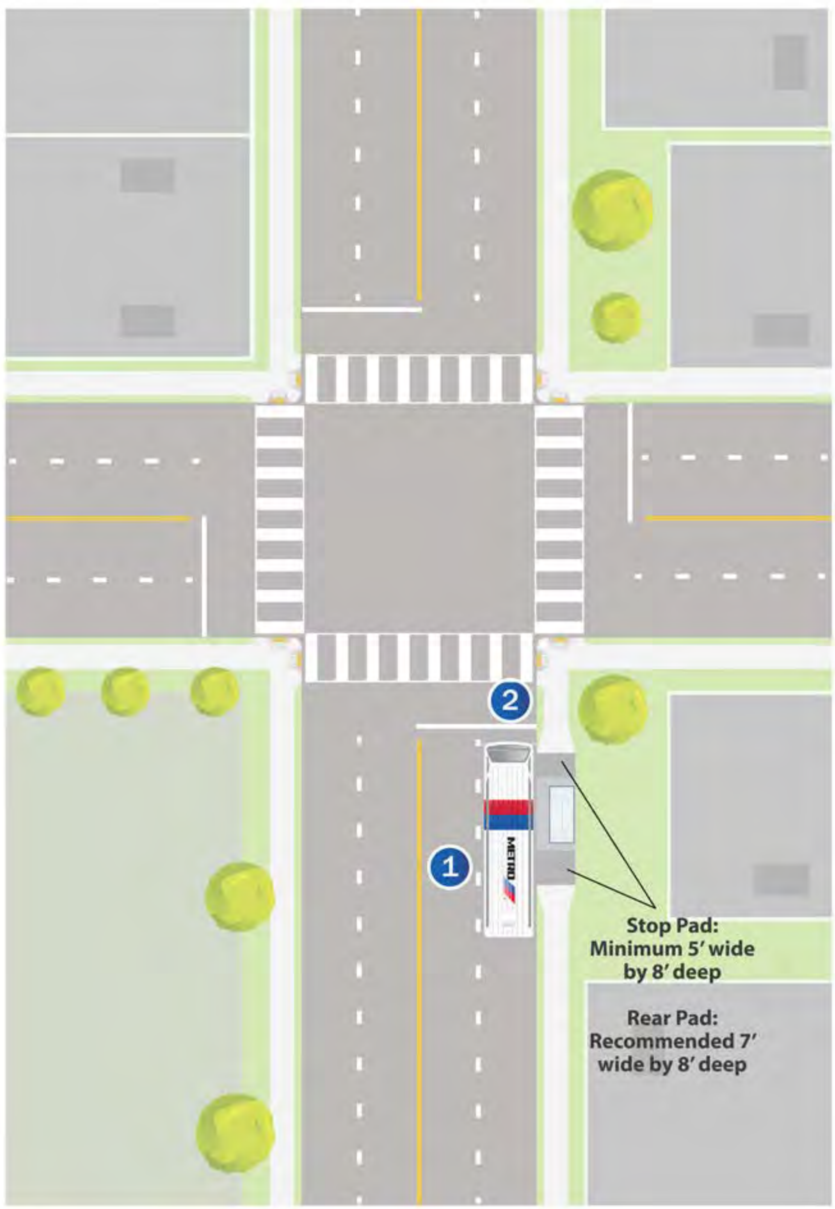
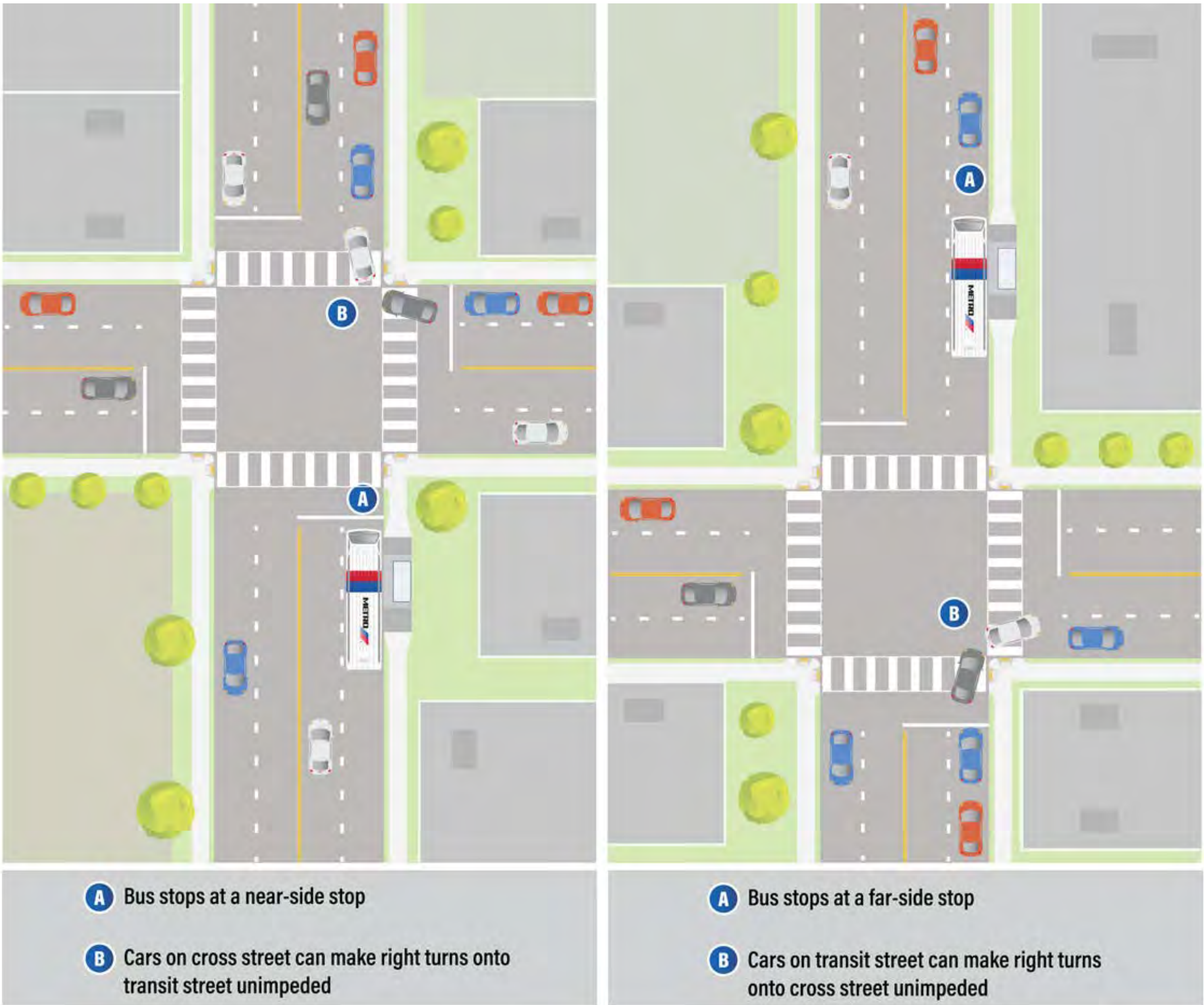


Figure 4.8: Bus Stop Location Turning Conflicts



Mid-Block

Definition

A mid-block stop is a configuration where the bus stop is somewhere near the middle of a block between two intersections. Near- or far-side stop locations are preferred to mid-block. Mid-block stops should only be implemented along very long blocks or where unavoidable.

Application

Near high passenger volume destinations or where traffic conditions are unsupportive of a stop at the intersection. This may be practical on longer blocks that can support a mid-block pedestrian crossing. Note that mid-block pedestrian crossings require coordination and approval from COH Public Works. Mid-block stops are less desirable than stops at intersections, but if far-side and near-side placements are unsuitable, the mid-block placement should be considered.

Advantages & Disadvantages

Please refer to Table 4.5.

Design Considerations

Stop Placement

Mid-block stops should be placed at a minimum of 200′ from an intersection. See Table 4.5 for further guidance. A high visibility pedestrian crosswalk should be installed in to ensure a safe and comfortable crossing for passengers at mid-block stops. The crosswalk should be placed where the rear end of the bus stops 20′ from the edge (far-side) of the crosswalk. See Figure 4.9 for guidance. Refer to COH Standard Detail 01510-01 and COH IDM, Ch. 17 for further details.

Median Refuge

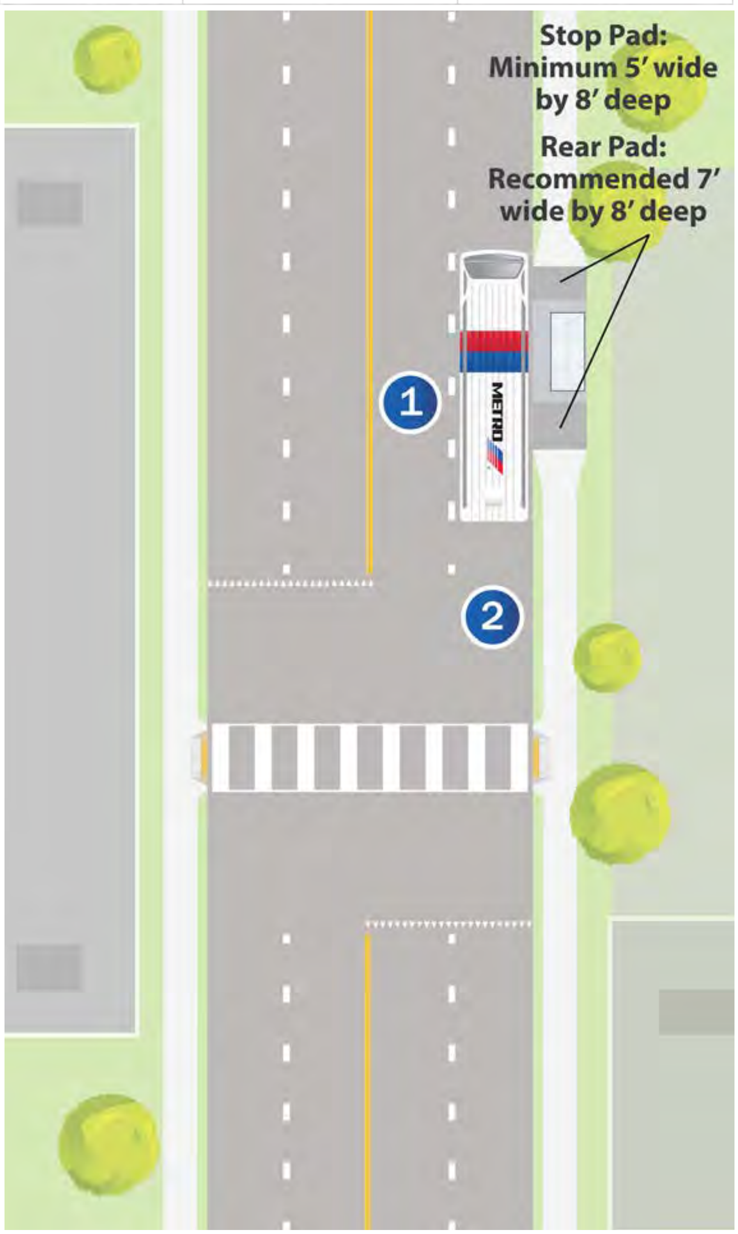
For roadways with three (3) or more travel lanes, a median refuge should be considered to shorten the crossing distance at mid-block crossing locations, particularly along roadways with high volumes/speeds and where yielding compliance is not expected to be high. Median refuges provide a safe place for pedestrians and make crossing wide roadways safer for users.

Table 4.5: Mid-Block Stop Placement Advantages and Disadvantages

Advantages	Disadvantages
• May allow for additional passenger waiting space which minimizes passenger congestion at high volume locations. • Minimizes sight distance problems for vehicles and pedestrians. • Allows for transit network access at high-demand destinations that aren't situated on intersections.	• May induce pedestrian issues including encouraging passengers to cross street at mid-block when there is no designated crossing rather than at an intersection. • May create conflicts with driveway access.

Figure 4.9: Mid-Block In-Lane Bus Stop Dimensions

Bus Length	Bus Dwell Zone (1)	Distance from Crosswalk (2)
35′	35′	20′
40′	40′	20′
45′	45′	20′
60′	60′	20′
2 x 35′	75′	20′
2 x 40′	85′	20′
2 x 45′	95′	20′
2 x 60′	125′	20′



D Transit Roadway Configurations

Demand for transit is often highest along roadways that are spatially constrained while also carrying the most diverse set of users. The following roadway configurations seek to best balance the needs of all road users including transit vehicles, general traffic, cyclists, and pedestrians. A context-sensitive approach is required when determining the applicable roadway configuration. Legible pavement markings and street signs are critical for ensuring safety, comfort, and reliability for all roadway users. Note that the design considerations and standard dimensions outlined in this section do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for the configuration of roadways where transit operates and at stop locations. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

Transit Stop Roadway Configuration

Considerations

Transit Lane Width

METRO preferred lane width of 12', 11' minimum.

Placement

Curb-side or off-set, if parking is present.

ROW

Mixed-traffic lanes may be implemented where ROW is restricted, and dedicated transit lanes are not an option. However, if higher traffic volumes and/or congestion are present, transit reliability and dependability may be hindered.

Dimensions

See Figure 4.10 and Table 4.6 for guidance.

Figure 4.10: Transit Roadway with No On-Street Parking

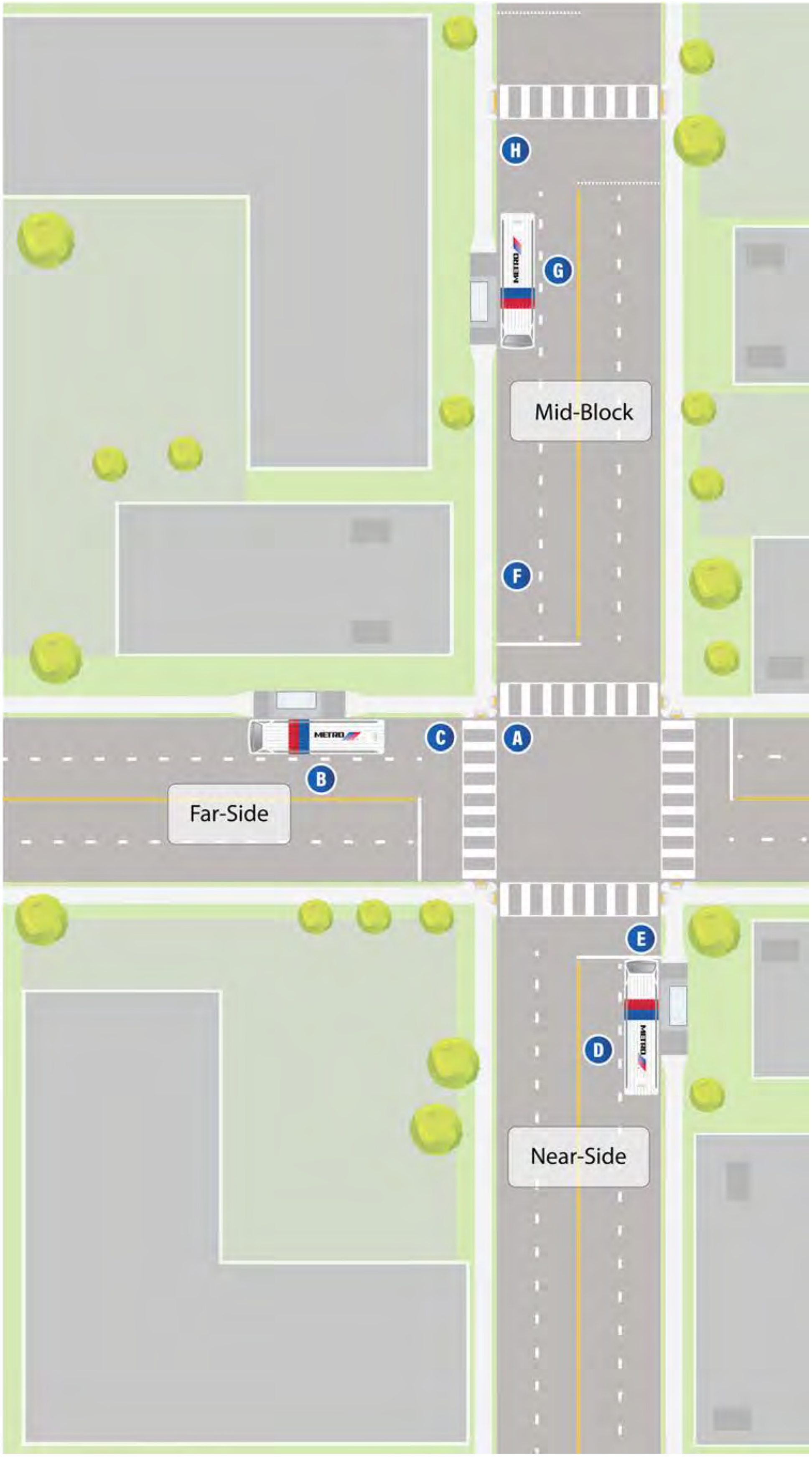


Table 4.6: Transit Roadway with No On-Street Parking Dimensions

Stop Configuration	Distance from Intersection	Bay Length	Distance from Crosswalk
Far-Side	A 30′ between the perpendicular street curb to the back of the bus bay.	B 40′ Bus – 40′ 2 x 40′ Bus – 85′ 45′ Bus – 45′ 2 x 45′ Bus – 95′ 60′ Bus – 60′ 2 x 60′ Bus – 125′	C Ensure back of bus clears crosswalk by at least 20′ if present.
Near-Side	See distance from crosswalk.	D 40′ Bus – 40′ 2 x 40′ Bus – 85′ 45′ Bus – 45′ 2 x 45′ Bus – 95′ 60′ Bus – 60′ 2 x 60′ Bus – 125′	E Bus should stop 10′ feet before crosswalk if present.
Mid-Block	F 200′ min between the bus bay and the perpendicular street curb at the nearest intersection.	G 40′ Bus – 40′ 2 x 40′ Bus – 85′ 45′ Bus – 45′ 2 x 45′ Bus – 95′ 60′ Bus – 60′ 2 x 60′ Bus – 125′	H Ensure back of bus clears crosswalk by at least 20′ if present.

Source: NACTO Transit Street Design Guide-2016, COH & METRO-2019

Transit Roadway with On-Street Parking

Considerations

Transit Lane Width

METRO preferred lane width of 12', 11' minimum.

Placement

When on-street parking is present, transit lanes may be placed curb-side or offset. A boarding bulbout is required if transit lanes are offset.

On-Street Parking

On-street parking lanes should be 8' wide (COH IDM, Ch.10; COH IDM, Ch. 17). Parking must terminate before bus merge zone and may resume immediately following. Highly visible pavement markings and signage clearly delineating a no parking zone must be implemented to ensure vehicles do not improperly park and block the bus merge zone. Where parking along a bus route exists, coordination with City of Houston Parking is recommended.

Bus Merge Zone

A bus merge zone is the space needed for transit vehicles to safely maneuver to and from a bus stop. Bus merge zone lengths differ depending on stop configuration. This dimension includes the bay length required for each stop configuration and bus type.

Pavement Marking

Clear "No Parking" signage and pavement markings are critical for ensuring vehicles do not block the bus merge zones and bus stops.

Dimensions

See Figure 4.11 and Table 4.7 for guidance.

Figure 4.11: Transit Roadway with On-Street Parking

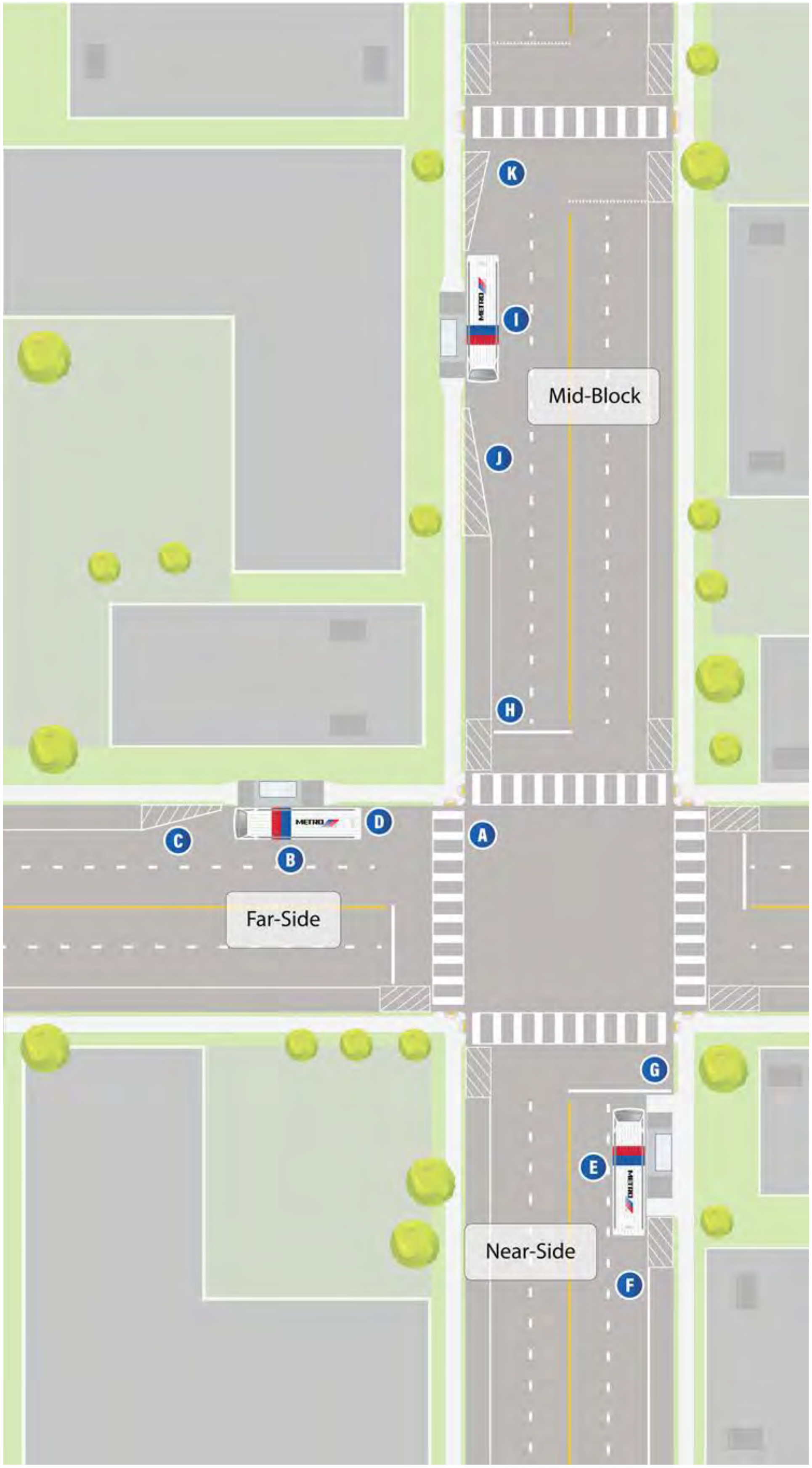


Table 4.7: Transit Roadway with On-Street Parking or Bike Lane Dimensions

Stop Configuration	Distance from Intersection	Bay Length	Bus Merge Zone	Distance from Crosswalk
Far-Side	A 30′ between the perpendicular street curb to the back of the bus bay.	B 40′ Bus – 40′ 2 x 40′ Bus – 85′ 45′ Bus – 45′ 2 x 45′ Bus – 95′ 60′ Bus – 60′ 2 x 60′ Bus – 125′	C 40′ Bus – 90′ 45′ Bus – 95′ 60′ Bus – 100′	D Ensure back of bus clears crosswalk by at least 20′ if present.
Near-Side	See distance from crosswalk.	E 40′ Bus – 40′ 2 x 40′ Bus – 85′ 45′ Bus – 45′ 2 x 45′ Bus – 95′ 60′ Bus – 60′ 2 x 60′ Bus – 125′	F 40′ Bus – 100′ 45′ Bus – 105′ 60′ Bus – 120′	G 10′ feet before crosswalk.
Mid-Block	H 200′ min between the bus bay and the parallel perpendicular street curb at the nearest intersection.	I 40′ Bus – 40′ 2 x 40′ Bus – 85′ 45′ Bus – 45′ 2 x 45′ Bus – 95′ 60′ Bus – 60′ 2 x 60′ Bus – 125′	J 40′ Bus – 120′ 45′ Bus – 125′ 60′ Bus – 145′	K Ensure back of bus clears crosswalk by at least 20′ if present.

Source: NACTO Transit Street Design Guide-2016, COH & METRO-2019

Transit Roadway with Standard Bike Lane

Considerations

Lane Width

METRO preferred lane width of 12'. 11' minimum.

Standard Bike Lane Width

6' preferred. 5' minimum. Refer to COH IDM, Ch. 17.

Bus Bike Conflict Zone

When standard bike lanes are present alongside a transit lane, the interaction between bus stops and bike lanes must be of heightened concern to ensure safety and comfort for all road users. The bus bike conflict zone is where a bike facility passes through a bus merge zone. Pavement markings and signage are critical to highlight this area of potential conflict. Upon approaching the bus merge zone, the solid white bike lane line should become a dashed white line. Dashed green striping or solid green paint along the bus bike conflict zone is suggested for heightened visibility.

Yield Responsibility

When buses encounter cyclists riding in the lane, buses should wait until it can safely pass the cyclists with 6' of space, per COH Code of Ordinances, Section 45-44. Non-commercial vehicles only require 3' to safely pass cyclists per COH Code of Ordinances Section 45-44. When cyclists approach a bus at a stop, they should yield to the bus. Buses should yield to bicycles until traffic in the adjacent travel lane allows the bus to safely maneuver around the bicyclist. Buses should wait until they can safely clear the bicyclists by 6' or more and where they will not have to stop abruptly once passing the bicyclists.

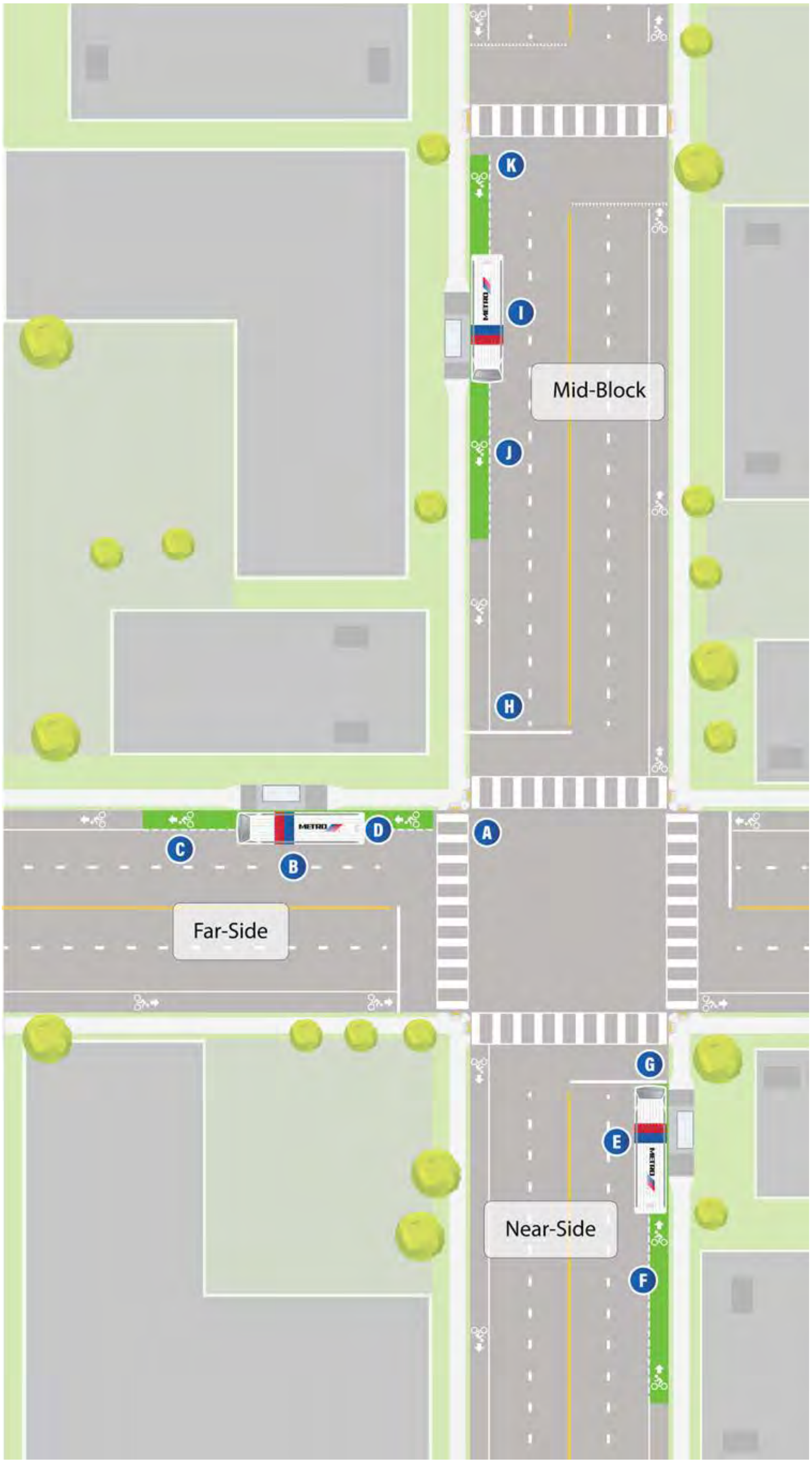
Other Considerations

If high frequency transit is present and ROW permits, buffered or separated bicycle facilities should be implemented over the standard lane to better ensure the safety and comfort of all road users.

Dimensions

See Figure 4.12 and Table 4.7 for guidance.

Figure 4.12: Transit Roadway with Standard Bike Lane



Transit Roadway with Buffered Bike Lane

Considerations

Lane Width

METRO preferred lane width is 12'. 11' minimum.

Buffered Bike Lane Width

8' minimum including bike lane and buffer. Bike lane minimum width is 5'. The buffer shall consist of two solid white lines and white hatching if buffer is 2' wide or over. If buffer is less than 3' wide, physical delineators within the buffer are suggested for increased comfort between vehicles and cyclists. Refer to COH IDM, Ch.17.

Bus Bike Conflict Zone

When buffered bike lanes are present alongside a transit lane, the interaction between bus stops and bike lanes must be of heightened concern to ensure safety and comfort for all road users. The bus bike conflict zone is where a bike facility passes through a bus merge zone. Pavement markings and signage are critical to highlight this area of potential conflict. Upon approaching the bus merge zone, the buffer should become a dashed white line. Solid green paint along the bus bike conflict zone is suggested for heightened visibility. However, if ROW exists, floating bus stops best alleviate the bus bike conflict by dedicating a separate bicycle facility that runs behind the bus stop. This interaction is shown below.

Yield Responsibility

Yielding responsibility should be clearly defined and designated through signage and pavement markings at approaches to bus merge zones, intersections, and pedestrian crossings.

Dimensions

See Figure 4.13 and Table 4.7 for guidance.

Figure 4.13: Transit Roadway with Buffered Bike Lane

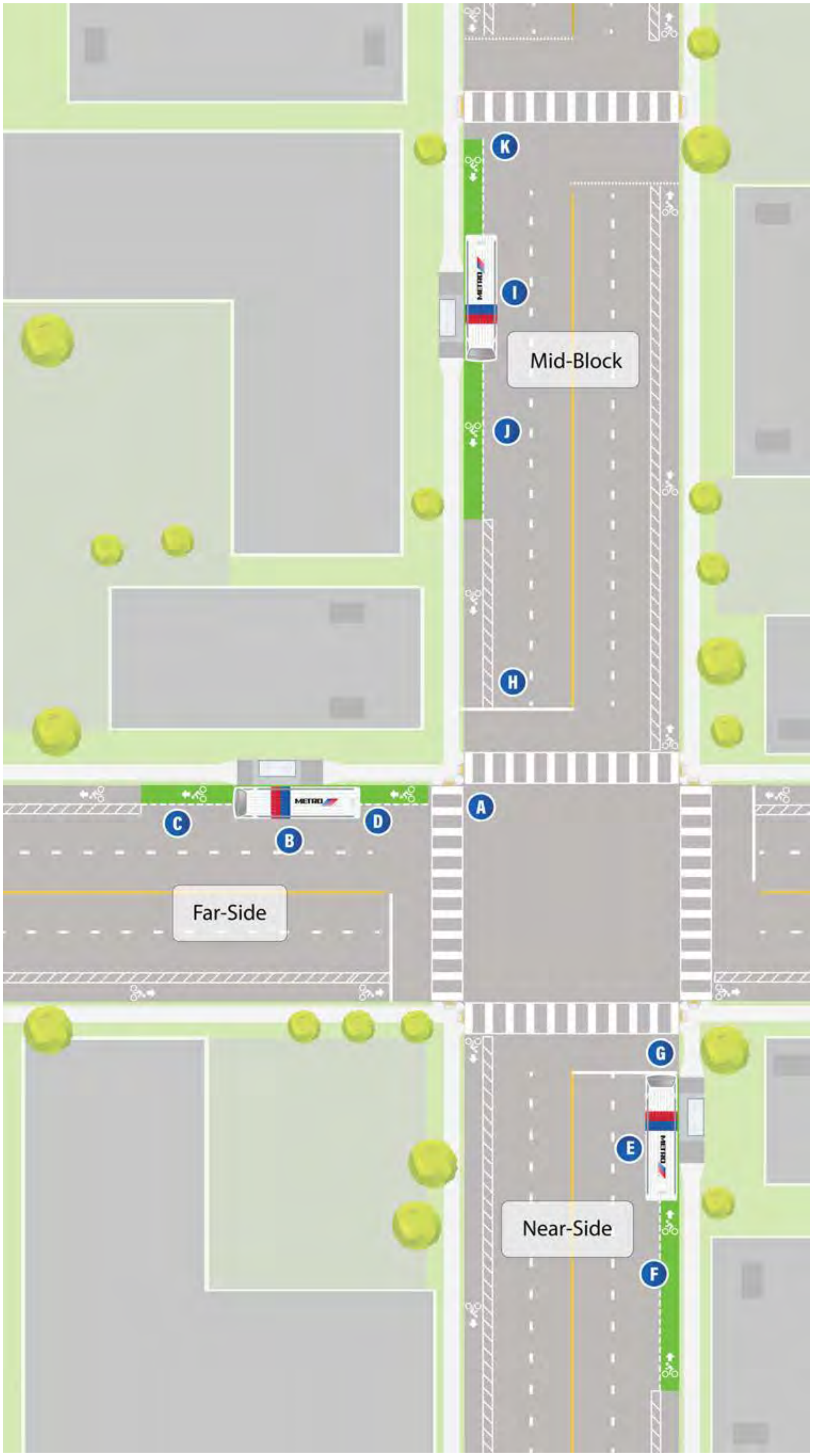


Figure 4.14: Floating Bus Stop with Parking

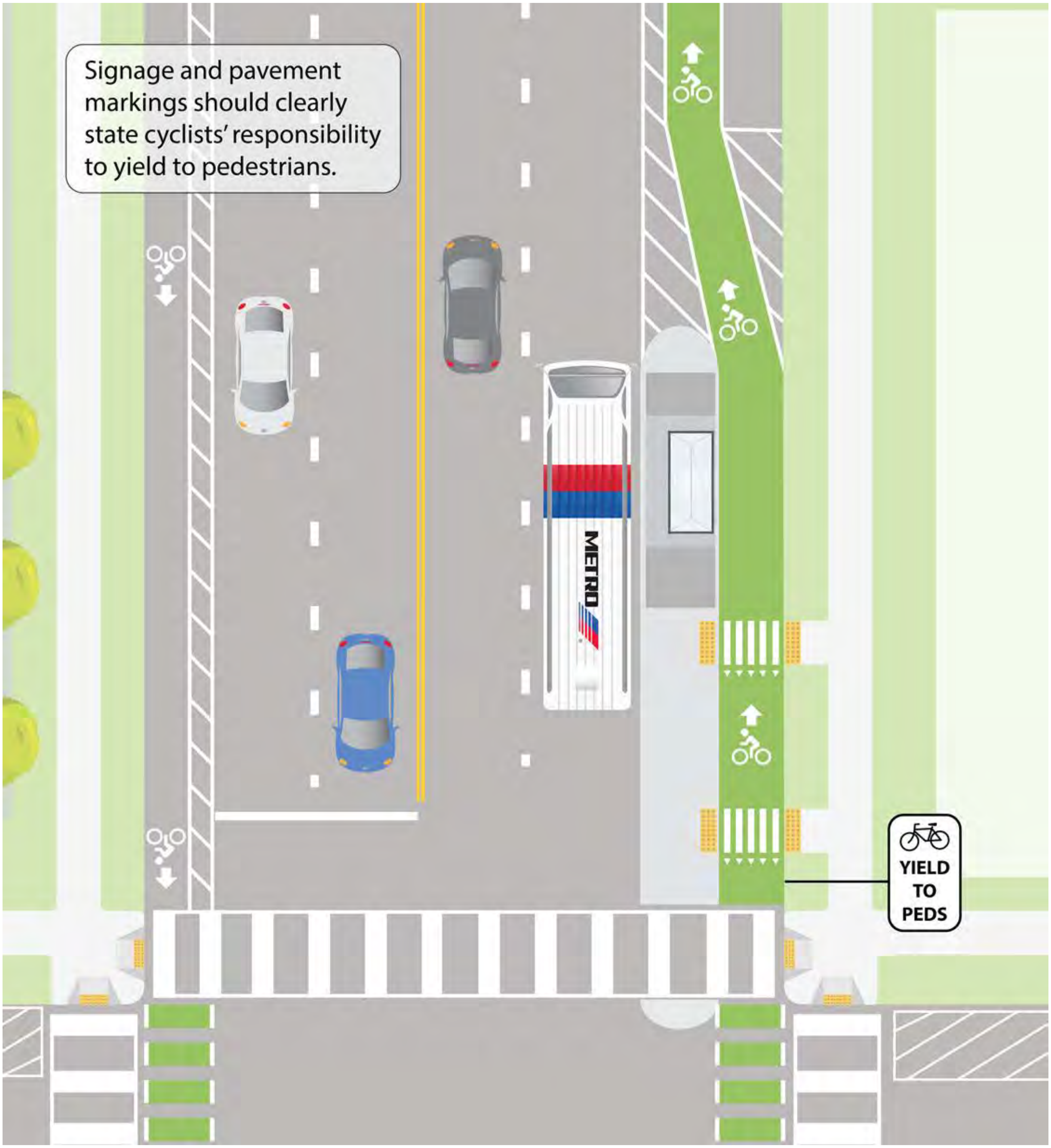
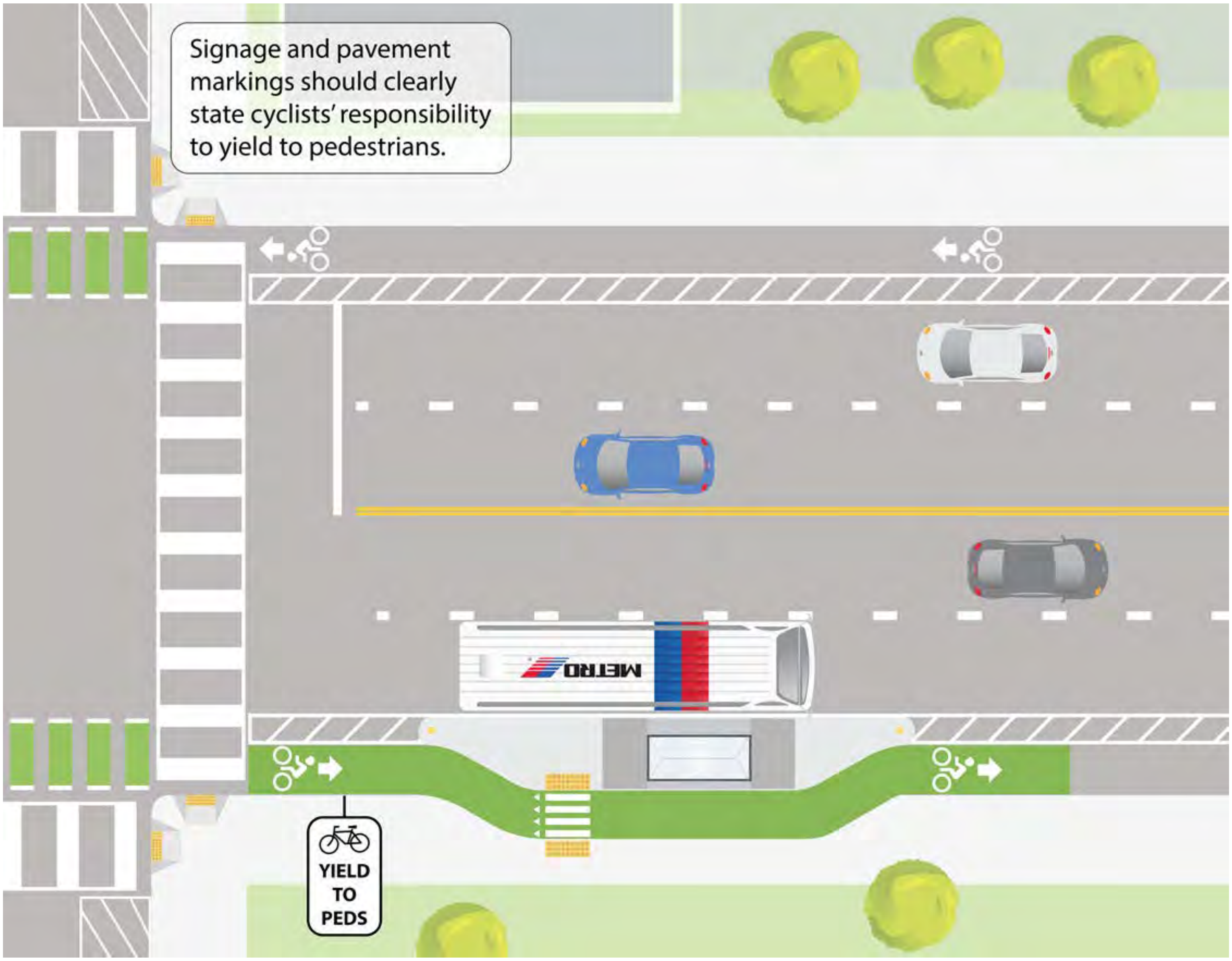
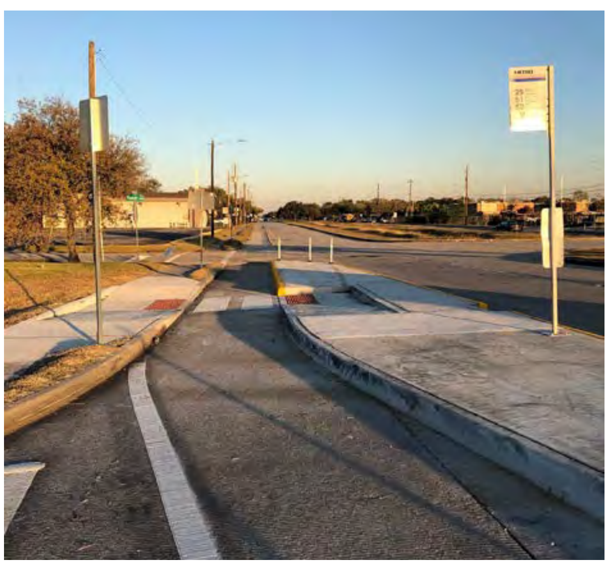


Figure 4.15: Floating Bus Stop without Parking





A floating bus stop at Kelley and Tuscon in Houston.

E Pavement Markings

Pavement markings provide essential directions to road users for how to navigate the roadway. Transit roadways often facilitate movement of many different road users including pedestrians, cyclists, bus drivers, and car drivers. Pavement markings allow road users to efficiently and safely navigate these roadway facilities. All pavement markings should align with guidance from the COH IDM, COH Standard Details, and the TMUTCD. Note that the design considerations and standard dimensions outlined in this section do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for pavement markings. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

Pavement marking and paint illustrating a bicycle lane in Houston, TX.

Dedicated Transit Lane Pavement Markings

Dedicated Transit Facility

Bus Only Marking

Dedicated bus lanes should use the pavement marking reading "BUS ONLY" to delineate use and assist user compliance. Spacing of these markings should consider travel speed, block lengths, distance from intersections, and other factors that affect clear communication to road users. TMUTCD suggests spacing between markings around 80' on city streets.

White Line

At minimum, a single solid white line should run along the length of the dedicated transit lane or a dedicated transit lane segment to discourage other vehicles from crossing into the line. A double solid white line may be used to reinforce where crossing is prohibited. See TMUTCD 3D.02 for further guidance.

Red Pavement

Red pavement may be used for dedicated transit lanes to heighten presence and discourage other vehicles from entering the transit lane. Red pavement for dedicated transit lanes is currently experimental and needs FHWA approval.

Intersection

Dotted White Line

The solid white line(s) designating the transit lane should turn into dashed white lines where other vehicles may enter. This may be applied where right turning movements are allowed.

Red Pavement

Solid red pavement may transition to hatched red pavement to designate where vehicles are allowed to enter the lane while still providing heightened attention to the transit lane. At this time, red pavement is not a standard treatment for the COH and therefore maintenance is not a COH responsibility.

Bicycle Facility Pavement Markings

Bicycle facilities placed along transit streets provide safe and comfortable space for cyclists, support a system-wide multi-modal network, and assist transit riders that may bike to bus stops. Bicycle facility pavement markings are critical for providing direction to cyclists using the facility while also ensuring other road users are aware of a potential cyclist's presence. All bicycle facility pavement markings should be in accordance with COH IDM, Chapter 17, COH Standard Detail 01510, and TMUTCD Section 9c.04.

Dedicated Bicycle Facility Standards

Standard Bike Lane

A 6" solid white stripe should define the bike lane from the adjacent vehicle lane. Standard bike lane preferred width is 6' (or 5' absolute minimum). A bicycle symbol and arrow marking shall also be used to define bike lanes. These should be placed at the beginning of a bike lane facility and the start of every block or at regular intervals as necessary. Refer to Standard Detail 01510-04 for pavement marking details.

Buffered Bike Lane

The bike lane buffer should consist of two 6" solid white lines with 6"diagonal white hatching if 3' in width or wider. Hatching spacing should be between 10 and 40' as determined by the engineer to increase motorist compliance. Lane and buffer width should be at least 8' wide. Where the buffer space is less than 2' between vehicles and the bike lane, a raised, physical delineator should be placed within the buffer. Refer to Standard Detail 01510-09 for further guidance.

Bus Stop Conflict Zone

Where bicycle facilities are present alongside a transit lane, the interaction between bus stops and bike facilities must be of heightened concern to ensure safety and comfort for all road users. Bus stops present "conflict zones" given the convergence of cyclists, pedestrians, and vehicles. Careful and considerate pavement markings ensure ease of use and safety of all users.

Dashed White Line

Upon approaching the bus merge zone, the 6" solid white bike line should become a dashed white line.

Dashed Green Striping or Green Lane

In addition to the dashed white line, solid green paint should be used to delineate and heighten visibility of the conflict zone. See Standard Detail 01510-09A for further design guidance.

Intersections

Similar to bus stops, pavement markings through intersections along transit streets should delineate and heighten visibility for bicycle facilities. While intersection pavement markings are not required, they should be considered for heightened visibility and direction.

Dashed White Line

Dashed white pavement markings aligned with the lateral extensions of the approaching bicycle facility may be used for heightened visibility through an intersection. See Standard Detail 01510-09A.

Dashed Green Striping

A combination of dashed white pavement markings and green bicycle pavement markings may be considered when additional guidance is needed to direct bicycles through the intersection or increased visibility is desired. See Standard Detail 01510-09A for further design guidance.

Green Pavement

Bicycle-green pavement markings may be considered when additional guidance is needed to direct bicyclists through the intersection or when increased visibility is desired.

Other Considerations

- Where a dedicated right-turn lane is present, the dedicated bicycle facility should be placed to the left of the turn lane. See COH IDM, Chapter 17 and Standard Detail 01510-09A for further guidance.
- Bicycle facilities should not terminate at intersections.
- Refer to Standard Detail 01510-09A and COH IDM, Chapter 17 to ensure pavement markings compliance.

Pedestrian Facility Pavement Markings

Crosswalk

White high visibility crosswalks are preferred at intersections along transit roadways. See Standard Detail 01510-09A for further design guidance.

Mid-Block Crossing

Where mid-block crossings are present, heightened visibility pavement markings are required to ensure pedestrian safety. See COH IDM, Chapter 17 for mid-block crosswalk criteria and design guidance.

Note: Mid-block crossings require coordination and approval from COH Public Works.

F Pedestrian Crossings

All transit trips start and end with pedestrian trips. Transit passengers need safe, predictable, and accessible crossings to reach transit stops, therefore pedestrian crossings should be considered critical components of the transit system. Note that the design considerations and standard dimensions outlined in this section do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for safe pedestrian crossings. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

An example of a mid-block crossing in Houston, TX.

General Considerations

- Pedestrian crossings at transit stops should always be considered as they improve safety regardless of traffic conditions.
- For near- and far-side stops, crossing should be constructed at the corresponding intersection. Where a mid-block transit stop is necessary, a mid-block crossing should be seriously considered in coordination with the stop. Note that mid-block crossings require coordination and approval from COH Public Works.
- A standalone crosswalk may not be sufficient for safety. The surrounding context, vehicular speeds, and roadway width may necessitate additional safety measures such as median refuge islands, pedestrian signals, or other traffic-calming features.
- Crosswalks should be present across all directions of a signalized intersection except where pedestrian crossings are not permitted. Crosswalks should be at least 10′ wide and should comply with COH IDM, Chapter 15 and City Standard Detail 01510-10 standards.
- Pedestrian countdown signals encourage pedestrian compliance and predictability. Countdowns should give adequate crossing time and be paired with shorter cycle lengths.
- Along transit roadways all sidewalks, ramps, and approaches must comply with ADA standards and Texas Accessibility Standards. Sidewalk widths should be 6′ wide along transit roadways but exceed the minimum if ROW is available (COH IDM, Ch. 10). Sidewalk buffers are highly recommended for sidewalks less than 10′ wide. Recommended buffer minimum width between the sidewalk and the curb is 4′.
- A Leading Pedestrian Interval (LPI) should be considered at signalized intersections along transit roadways. LPIs give pedestrians a head start to cross the intersection before vehicular traffic is given a green light. This simple pedestrian crossing enhancement increases safety by allowing pedestrians to establish themselves in the crosswalk before turning conflicts.
- Where pedestrian activity is high at signalized intersections, implementing a no turn on red can increase pedestrian safety.
- Maintenance and upkeep of crosswalks should be planned and implemented to ensure visibility and pedestrian safety.
- During the process of stop optimization, the stop pairs located more than 330 ft. from a controlled crossing and which meet one or more of the following three criteria are strong candidates for unsignalized crossing improvements:
  - » Expected to see a combined total of at least 20 daily boarding after stop optimization (Estimates of expected boarding should take into account existing ridership data as well as the new stop locations).
  - » Located directly adjacent to first- and last-mile connections identified for improvements.
  - » Located directly adjacent to key destinations such as schools, parks, services, or shopping.

Intersections

Description

Intersections are critical locations for pedestrian connectivity to the transit system. High visibility crosswalks encourage pedestrian safety and comfort, particularly where transit service is provided.

Advantages

Pedestrian crossings at intersections provide key access to most transit stops. High visibility crosswalks and other pedestrian-oriented design features help reduce vehicle-pedestrian incidents, particularly involving turning vehicles. These crossings are also critical to building a continuous and accessible pedestrian network across the city.

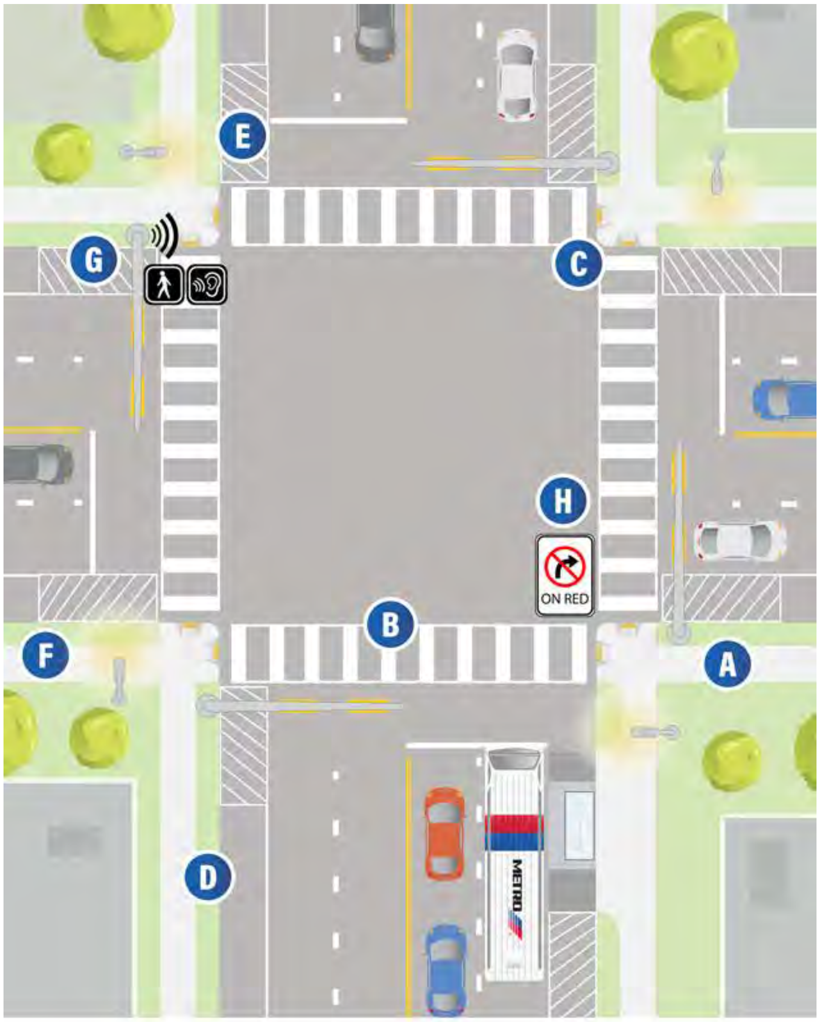
Disadvantages

Crosswalk markings require maintenance and upkeep for maximum performance.

Considerations

- The crosswalk should be striped no less than 10′ wide but may be wider to accommodate high pedestrian volume.
- All approaches to crosswalks must comply with ADA and Texas Accessibility Standards.
- All directions of the intersection should be striped with crosswalks unless there is no physical access on one side. Pedestrians will generally avoid three-step crossings as they expose the pedestrians to additional conflicts and time penalties.
- Intersection traffic signals should incorporate pedestrian signaling technologies. These technologies may include pedestrian pushbuttons, LPI, passive pedestrian detection, and Accessible Pedestrian Signals (APS). These technologies ensure safety and compliance at intersections.
    - Pedestrian pushbutton: A pedestrian pushbutton activates a pedestrian signal when pressed by a person waiting to cross an intersection. These should be easily within reach by all persons. Traffic signals should be programmed for quick response to the pushbutton. For specific requirements, see COH IDM, Ch. 15.
    - Passive pedestrian detection: Microwave or infrared pedestrian detection technology may be implemented at intersections. Such technology does not require pedestrians to activate the signal themselves, rather sends the signal when pedestrians are present.
    - LPI: Intersection signals may incorporate a LPI. These give pedestrians a head start to cross the intersection before vehicles are given a green light.
    - APS: APS technology communicates pedestrian signals in non-visual and non-verbal formats. “Walk” and “Don’t Walk” can be communicated by verbal tones and vibrations on the pushbutton.
- Pedestrian street lighting should be provided at each intersection.
- Crossing distances should be kept short as possible. Shorter crossing distances may be achieved using curb extensions, crossing islands, and medians.
- Stop bars should be 4′ minimum from the crosswalk per the COH Standard Detail 01510-09A. An advanced stop bar placed 10′ from the crosswalk may provide additional safety for pedestrians crossings at specific locations.
- Stop bars should be perpendicular to the travel lane.
- Right-turn-on-red restrictions can reduce conflicts between vehicles, cyclists, and pedestrians.

Figure 4.16: Intersection Considerations



- **A** Sidewalk Width 6' Minimum
  (CBD sidewalks should be greater than 6')
- **B** Crosswalk Width 10' Minimum
- **C** ADA Curb Ramp
- **D** Sidewalk Buffer Width 4' Minimum
- **E** Parking Terminates 30' from Crosswalk at Signalized Intersection
- **F** Street Lighting Provided at the Intersection
- **G** Pedestrian Passive Detection, Pushbutton, and Pedestrian Accessible Signals
- **H** No Right Turns on Red to Reduce Conflicts

Mid-Block

Description

Near- or far-side stop locations are preferred to mid-block. Mid-block stops should only be implemented along very long blocks or where unavoidable. While near- and far-side stops are highly encouraged, not all destinations can be served at intersections. Mid-block crossings at mid-block transit stops are required to ensure safe and predictable movement of people across the transit roadway as they go to and from the stop. Mid-block crossing design should be context-sensitive and considered on a case-by-case basis.

Note: Mid-block crossings require coordination and approval from COH Public Works.

Advantages

Mid-block crossings aid pedestrians to cross the roadway where a signalized intersection is not present. Key design measures at a mid-block crossing may increase pedestrian safety and predictability. Mid-block crossings placed at mid-block transit stops may also serve non-passenger pedestrian movements around the stop and increase neighborhood safety.

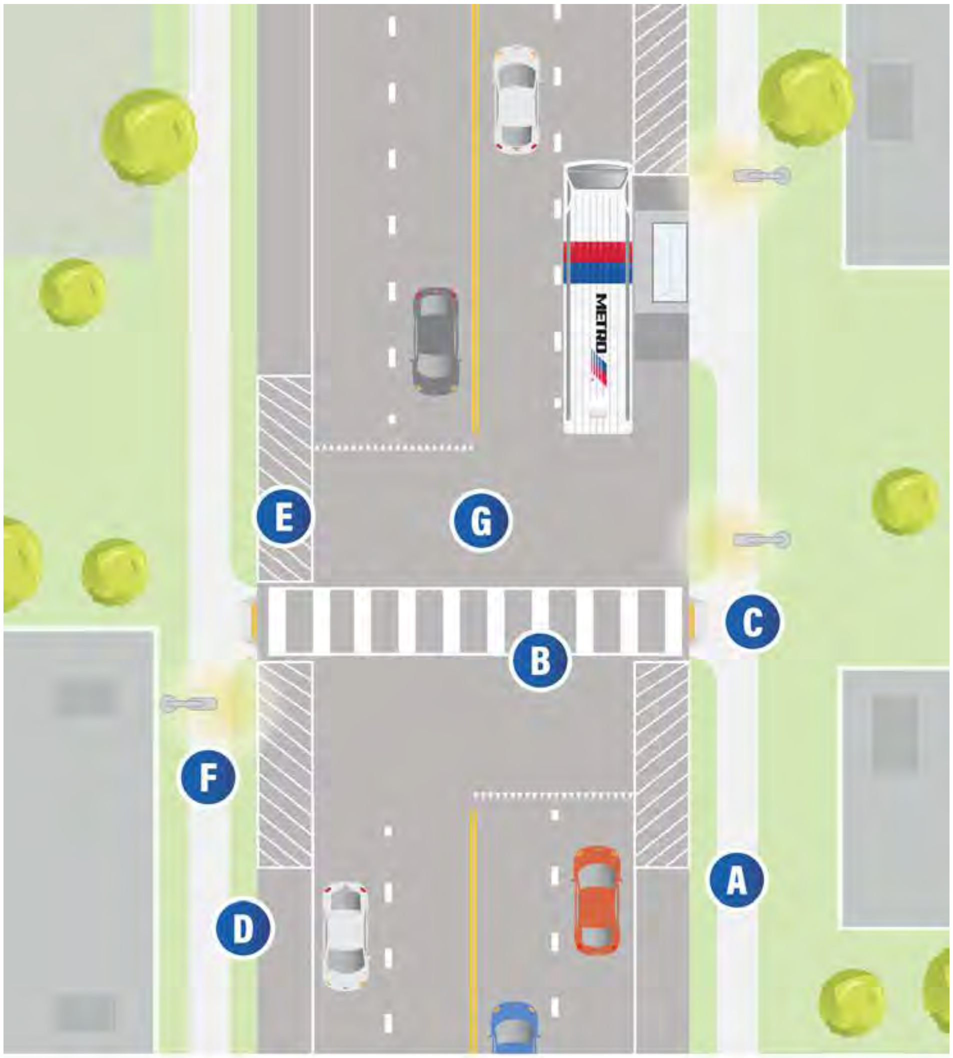
Disadvantages

Even when designed for visibility, mid-block crossings pose a potential conflict zone for crossing pedestrians. Vehicles may not anticipate or see crossing pedestrians.

Considerations

- At minimum, a mid-block crossing should include a 10' wide crosswalk with white high visibility crosswalk markings.
- Bus stops should be located on the far-side of the crosswalk.
- Yield lines should be placed 20-50' from the crossing to ensure pedestrians are visible to oncoming vehicles. For specific requirements, see COH Standard Detail 01510-09A. Yield lines should be used when the mid-block does not include the installation of a High-Intensity Activated Crosswalk (HAWK).
- Similar to mid-block bus stops, mid-block crossings should be placed a min of 100' from an intersection.
- HAWK beacons should be considered at mid-block crossing on major roadways.
- A raised crossing may be considered for enhanced visibility and safety. These are permitted on roadways with a design speed of 35 mph or less.
- Where on-street parking or excess pavement exists, curb extensions should be considered as a way to shorten crossing distance for pedestrians. Where parking along a bus route exists, coordination with COH Parking is recommended.
- Median refuge islands can shorten crossing distances for pedestrians and greatly improve safety and comfort.
- Enhancements are highly encouraged at unsignalized mid-block crossings. Enhancements may include additional warning signage up stream of crosswalk, actuated beacons, raised crossing, curb extensions, median refuge islands, and pedestrian lighting should all be considered. For specific requirements, see COH IDM, Ch. 17.

Figure 4.17: Mid-Block Considerations



- **A** Sidewalk Width 6' Minimum
- **B** Crosswalk Width 10' Minimum
- **C** ADA Curb Ramp
- **D** Sidewalk Buffer Width 4' Minimum
- **E** Parking Terminates 20' from Crosswalk, 30' at Signalized Intersection
- **F** Street Lighting Provided at the Crosswalk
- **G** Stop Bars & Bus Clear Crosswalk by 20'

HAWK

Description

A High-Intensity Activated Crosswalk (HAWK) beacon is a traffic control device specifically designed for pedestrian crossings. These beacons are actuated by pedestrians waiting to cross at mid-block crossings and stop road traffic when needed. For further detail, see COH IDM, Ch. 15.

Note: Mid-block crossings require coordination and approval from COH Public Works.

Advantages

HAWK beacons provide safer and more predictable pedestrian crossings by stopping traffic when pedestrians need to cross. These are particularly useful at mid-block crossings along major transit roadways as they assist passengers in safely crossing busy streets. These facilities encourage pedestrians to cross where present rather than attempting to cross outside of designated crossings. HAWK beacons greatly enhance crosswalk visibility for drivers which can lead to fewer vehicle-pedestrian conflicts.

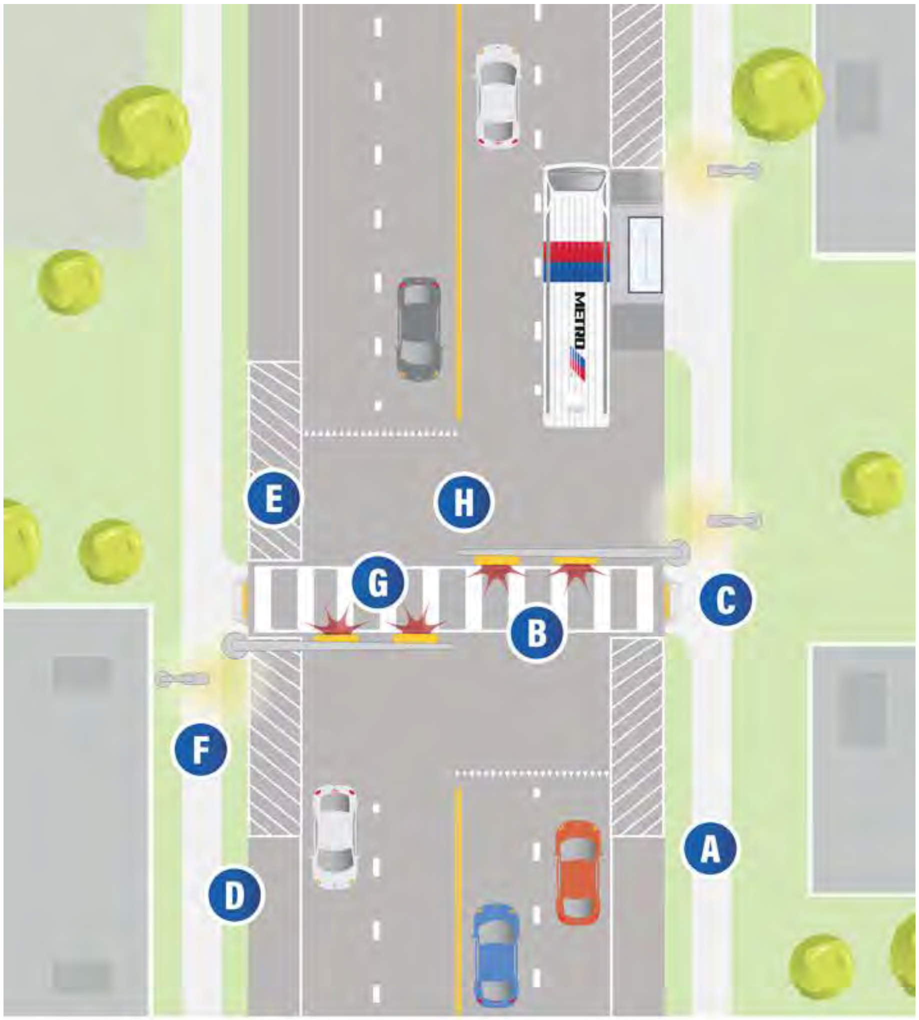
Disadvantages

HAWK beacons may distract or disorient oncoming drivers if appropriate signage and education is missing. The beacons are also subject to maintenance needs similar to standard traffic signals.

Considerations

- HAWK beacons should be installed where mid-block crossings are present along roads that are not comfortable or safe to cross as a pedestrian.
- All design considerations for mid-block crossings should be considered.
- Additional signage and pavement markings prompting drivers of approaching pedestrian crossings should be considered in tandem with the HAWK beacon.
- Site accommodations are highly recommended to increase pedestrian crossing visibility. Curb extensions are encouraged. Sight obstructions 100′ in advance of crosswalk should be prohibited.
- Rectangular Rapid Flash Beacon (RRFB): An alternative to the HAWK beacon, the RRFB is a pedestrian activated beacon that does not stop traffic but warns drivers that pedestrians are crossing.

Figure 4.18: HAWK Considerations



- **A** Sidewalk Width 6' Minimum
- **B** Crosswalk Width 10' Minimum
- **C** ADA Curb Ramp
- **D** Sidewalk Buffer Width 4' Minimum
- **E** Parking Terminates 30' from Crosswalk at Signalized Intersection
- **F** Street Lighting Provided at the Crosswalk
- **G** Pedestrian Hybrid Beacon
- **H** Stop Bars & Bus Clear Crosswalk by 20'

G Intersection Design

Intersections are where all road users converge. Safety and operations for all modes are the most critical concerns at intersections. These concerns can be balanced by implementing specific design features depending on need that support the converging demands. Note that the design considerations and standard dimensions outlined in this section do not reflect all operating conditions and roadway characteristics. A context-sensitive approach should be used to determine the most applicable design solution for safe intersection design where transit operates. Graphics and figures are for illustrative purposes and do not reflect all roadway characteristics.

An intersection involving light rail, automobile, bicycle, and pedestrian traffic.

Bicycle/Transit Interaction

Definition

Bicycle and transit facilities often interact along the same street. When facilities exist in tandem, they often converge in a way that requires special design attention to ensure safety for all road users including bicyclists, pedestrians, transit operators, and auto vehicle drivers. Bicycle and transit interactions vary depending on road configuration, turn movement volume, and facility types present.

Considerations

- Where ROW is available along transit roadways, bicycle facilities are highly encouraged. Dedicating space for each user minimizes conflicts and maximizes comfort and safety.
- Bicycle facilities should generally not terminate at intersections. Where facilities must end at an intersection, signage should be sufficient to provide bicyclists an opportunity to safely make necessary movements or transfer to a new facility.
- Bicycle facility conflict zone markings through intersections should be considered along transit roadways as they increase awareness and visibility of bicyclists activity. See Standard Detail 01510-10 for design guidance.
- At intersections with transit stops and on-street bicycle facilities, a floating bus stop with bicycle facilities deviating around should be considered. The bike facility may change grade to sidewalk level with slopes not exceeding 1:7.
- When bicycle facilities cannot be routed around a near-side bus stop and a right turn bay is not present, conflict zone markings should run throughout the bus merge zone to the stop bar. These markings should be dashed green stripes with white dashed lines. At a minimum, white dashed lines should be placed throughout the conflict zone. Bicycle facility conflict zone markings should be placed following the crosswalk and through the intersection. Refer to Standard Detail 01510-10 for design details.
- Dedicated right-turn lanes present crossing challenges for bicycle facilities and should be designed to highlight the crossing maneuver and prioritize bicyclists. This is also true for bypass and queue jump lanes.
- Bypass, queue jumps, and right turn bays on roadways with bicycle facilities are not ideal. When these cannot be avoided, an adjacent on-street bicycle facility should continue through to the intersection on the left side of the right-turn lane/bus bay. The conflict zone should be delineated with a combination of white and green dashed striping. The defined conflict zone should end 20 feet from the intersection. Within the section of the bike lane upstream of the conflict zone, the lane should be fully demarcated with green pavement and include a bike lane symbol and chevron pavement markings. See Standard Detail 01510-10 for further pavement marking details. See Section 4.G.3 Transit Priority Intersections for further guidance concerning bypass and queue jump lanes.
- Yielding responsibilities should be clearly defined among all users. Signage, markings, and education should be implemented to ensure safety and smooth operations.
- Intersection treatments for bicycles and pedestrians that encourage safe crossings range in design. Treatment examples are provided on the following pages.

Bike Box

Bike boxes allow for heightened cyclist visibility at intersections. May be painted with white striping with the addition of green fill paint.

Intersection Conflict Markings

Additional bicycle markings through the intersection heighten cyclist visibility across the intersection. Markings may vary depending on preference.

Two-Stage Queue Box

Two stage queue boxes allow for cyclists to safely make a left turn. Rather than crossing traffic before the intersection to make a left turn, the queue box encourages cyclists to cross the intersection first and then wait at the queue box in the intended direction of travel.

Median Refuge Island

A median refuge island is a brief protected stop in the middle of an intersection for pedestrians and cyclists. It allows a safe stopping point across wide intersections that might be difficult to cross.

Combined Bike Turn Lane

On streets with bike lanes at intersections with a right turn bay and tight ROW, the turn bay may act as a “shared” lane for cyclists. While a turn bay along roadways with bicycle facilities is not ideal, this heightens cyclist visibility and comfort in what is typically a high conflict zone.

Cycle Track Approach

Cycle tracks may begin, end, or continue at intersections. Appropriate signage and pavement markings help cyclists transition safely and comfortably.

Raised Crosswalks

Raised crosswalks heighten pedestrian visibility and comfort. This feature may also bring a human scale to streets that would otherwise feel unwelcome for pedestrians.

Curb Markings

Curb markings heighten pedestrian awareness at intersection crossings.

www.pedbikeimages.org, Laura Sandt

Bulb Outs

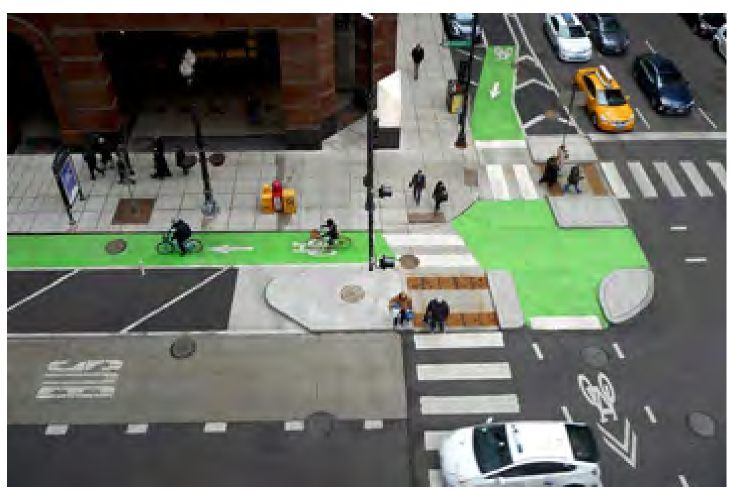
Curb extensions, also known as bulb outs, shorten the distance for pedestrians to cross at intersections. These also help reduce vehicular speeds in areas with high pedestrian activity.

Tactile Paving at Curb

A change of pavement texture adds an additional alert and heightens pedestrian awareness of the intersection approach.

Embedded Lighting

Lighting embedded into the curb or along the crosswalk adds additional pedestrian visibility and comfort, particularly for pedestrian activity at night.



Protected Intersection

A protected intersection includes physically protective barriers for both pedestrians and cyclists through traffic.

Turn Radii

For turn radii standards, refer to the Design Criteria for METRO Park & Ride and Transit Center Facilities Section 2.20-20 – Section 2.20-24. Intersections along transit streets should consider the additional turning space needed for transit vehicle. Typical bus turn radii range from 20'-40'.

Transit-Friendly Intersection Design

Prioritizing transit operations at intersections can reduce transit travel time delay and improve service reliability. Specific roadway design treatments (queue jumps and bypass lanes) and signal technology (transit signal priority, transit signal preemption) that prioritize transit operations at intersections allows transit vehicles to better navigate potentially congested intersections. Transit Signal Priority (TSP) utilizes signal timing to facilitate transit vehicle movement through the intersection. Intersection Treatments, such as queue jumps and bypass lanes are geometric roadway treatments specifically designed for transit movement through the intersection. Both queue jumps and bypass lane treatments may be paired with TSP and other intersection technologies/treatments to further enhance transit priority. Along with stop optimization, transit-friendly signal timing—in the form of transit signal priority or preemption—is critical to achieving fast, reliable service for riders on BOOST and high frequency service corridors systemwide.

Transit Signal Preemption

Definition

As defined by the TMUTCD, traffic signal preemption is the transfer of normal operation of a traffic control signal to a special control mode of operation. Often used by emergency vehicles, preemption is used to give the most important classification of roadway users ROW at and through intersections in a planned and managed fashion. In the same way, Preemption can also be used for transit vehicles.

Advantages

May result in increased efficiency and safety of transit vehicles who receive preemption through the intersection. Additionally, arrival time reliability can be improved.

Disadvantages

Can disrupt normal signal phasing and increase delays for vehicles, especially at cross streets. It may also shorten pedestrian crossing intervals resulting in difficulty at long crossings or extended wait times for the next crossing signal.

Considerations

Dedicated Lane

To reap the full benefits of Transit Signal Preemption, a dedicated transit lane is preferred to allow unencumbered movement of a transit vehicle through an intersection, bypassing any queues that may have accumulated in the primary travel lanes.

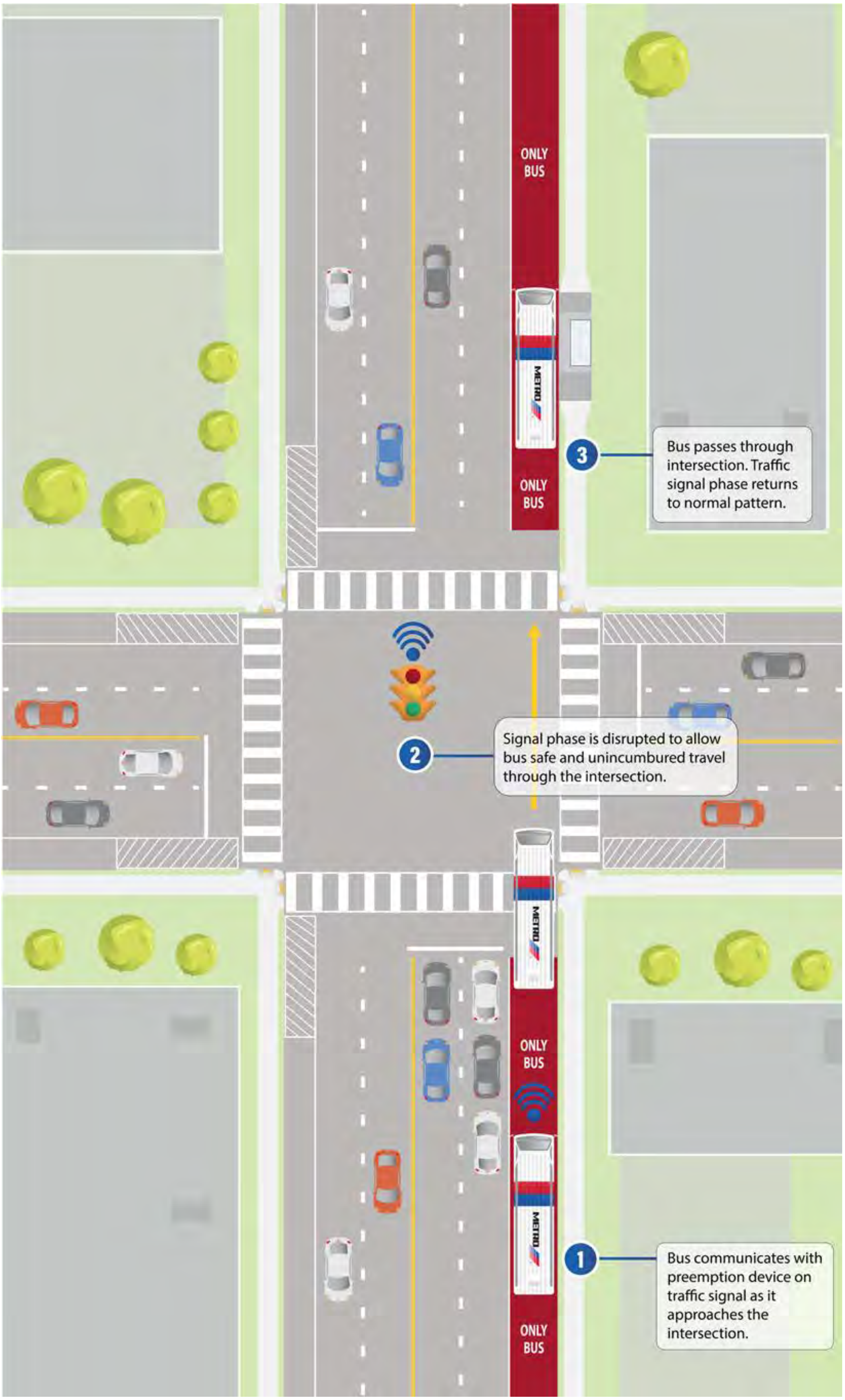
Coordination

As emergency vehicles, trains, or other preemptive vehicles may all use approach the same intersection at any give time, it is important to coordinate between all involved agencies to ensure a system is in place to mitigate those impacts.

Equipment

Preemptive equipment is often proprietary and may not function properly should competing preemptive signals be given. Coordination between all agencies that would use signal preemption should be carried out to ensure harmonious use of the system.

Figure 4.19: Transit Signal Preemption



Transit Signal Priority

Definition

Transit Signal Priority (TSP) is the adjustment of traffic signal phasing to prioritize transit vehicle movement through intersections. This can be implemented through passive or active signal priority. Passive priority is achieved through extending green signal phases or truncating red signal phases along a transit roadway whereas active priority incorporates technology to change the signal in real time.

Advantages

When implemented with other intersection enhancements such as queue jumps and bypass lanes, TSP minimizes person delay, reduces bus operating costs, and increases safety and reliability through the combination of signal enhancements and dedicated lanes.

Disadvantages

Enhancing timing for transit lanes may cause minor traffic congestion due to the altered signal timing. Coordination between all agencies and departments involved in traffic signaling is required.

Considerations

Context-Sensitive

TSP is most effective at signalized intersections operating under a Level of Service (LOS) D or E with a volume-to-capacity ratio between 0.80 and 1.00. Roadways that are relatively uncongested (LOS A to C) may not necessarily experience major bus travel time or reliability increases with TSP. Similarly, roadways with very high congestion (volume to capacity over 1.00) may inhibit buses from getting to the intersections in time to take advantage of TSP without majorly disrupting general traffic conditions.

Passive vs. Active

Passive TSP strategies implement pre-timed modifications to the signal system that occur whether or not a bus is present. Active TSP adjusts the signal timing after a bus is detected using a communication technology. See Table 4.8 for further descriptions of TSP treatments.

TSP Communication Technology

Active priority signaling requires the transit vehicle to communicate with a controller box as it approaches the intersection with the use of in-pavement induction loops, radio, GPS or light-based detection.

Along BOOST corridors, GPS- and cell-based TSP equipment is preferred over infrared or light-based technology, because GPS and cellular communication between buses and signals is less sensitive to environmental conditions and is more accurate. This helps the signal timing recover more quickly after a bus clears the intersection.

Coordination

A high level of coordination is required between the transit provider and any other agencies/departments involved in signal timing and traffic management. These groups must work together to effectively implement TSP based on overall goals for transit and signal timing, transit service scheduling, the mechanical/electronic capabilities of the signal system, and any phasing needed for TSP integration.

Cross Traffic

TSP may increase wait times for cross traffic. This is particularly important to note if two or more transit routes intersect as it can impact perpendicular route reliability. At places where transit routes intersect, signals may be programmed to receive TSP requests from multiple routes and serve these requests in order they are received.

Stop Configuration

Far-side stops best utilize TSP efficiencies as arrival can be anticipated more easily than dwell time.

BOOST Corridors

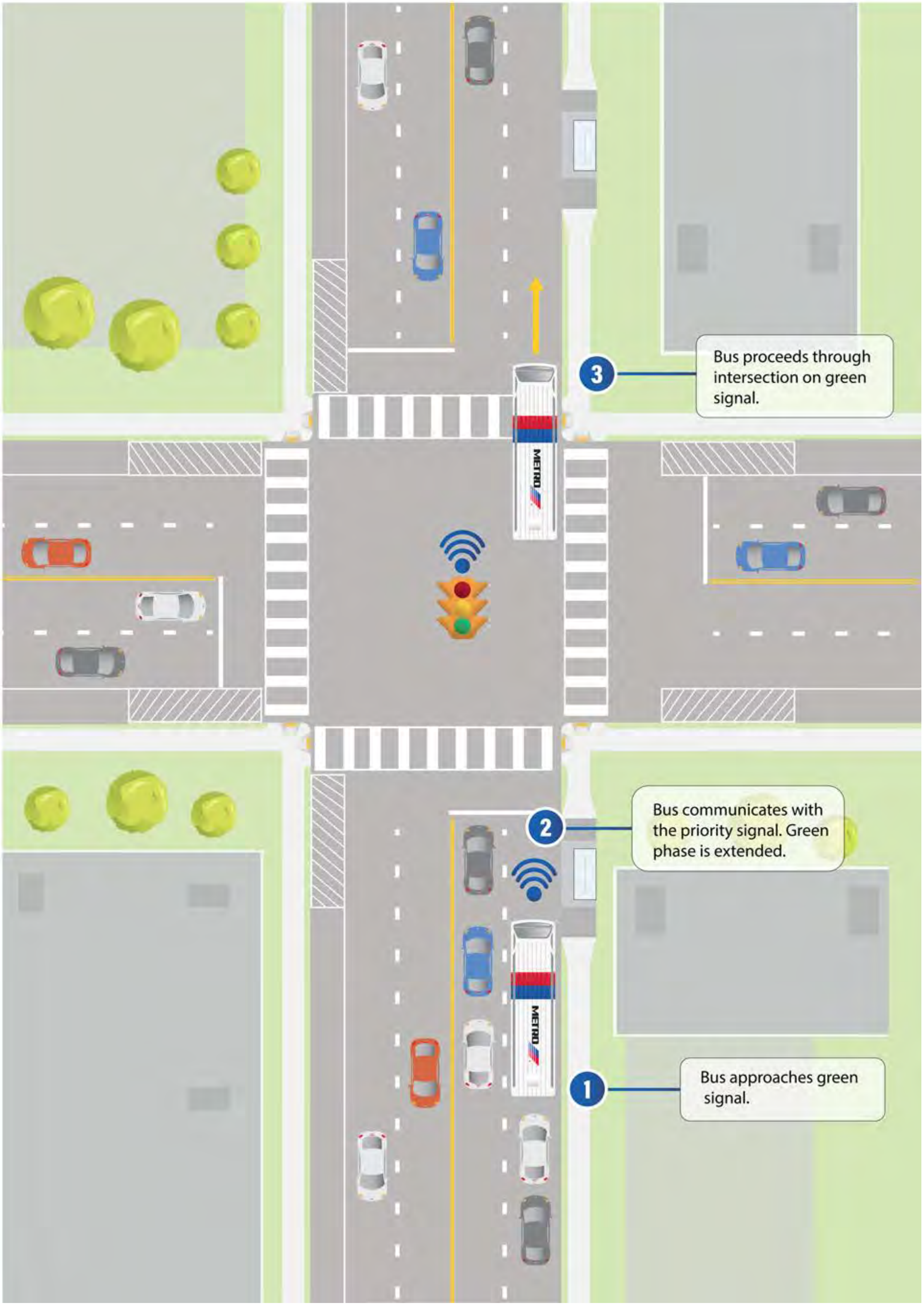
As a baseline, METRO's Operations team will pursue transit preemption at signals where a bus corridor intersects a minor street, and transit priority at signalized intersections with major streets. At major intersections, METRO will request extending the bus corridor's green phase and calling the opposing red early up to 10% of the cycle length. Implementing transit-friendly signal timing is especially beneficial to METRO at major intersections, because signal priority yields greater travel time savings at signals with longer cycles and where the bus corridor receives a green for a smaller share of the cycle.

Before and after implementing BOOST improvements, METRO will utilize data from IVOMS to assess travel time savings achieved through BOOST and will work with COH and other partner agencies to adjust transit signal priority and preemption parameters to ensure travel time reductions reach or exceed 15% corridor-wide. For more detailed information on Transit Signal Timing for BOOST corridors, refer to the BOOST Basis of Design in Appendix B.

Table 4.8: Passive and Active Priority Treatments

Passive TSP	
Treatment	**Description**
Adjust Cycle Length	Reduce cycle lengths at isolated intersections to benefit transit vehicles
Split Phases	Introduce special phases at intersection for transit vehicle movement
Areawide timing plans	Preferential progression for transit vehicles through signal offsets
Bypass metered signals	Transit vehicles use special reserved lanes, special signal phases, or are rerouted to non-metered signals
Adjust phase length	Increased green time for approaches with transit vehicles
Active TSP	
Treatment	**Description**
Green extension	Increase phase time for current bus phase
Early start (Red truncation)	Reduce other phase times to return to green for transit vehicles earlier
Special phase	Addition of a transit phase
Phase suppression	Skipped non-priority phases

Figure 4.20: Transit Signal Priority



Queue Jumps

Definition

A queue jump is a transit priority intersection treatment that provides preference to transit by allowing buses to skip the queue using a center-running or curbside dedicated transit lane. These lanes are used in conjunction with either a leading transit interval or active signal priority that allow the bus to enter the intersection ahead of other traffic.

Advantages

Queue jump enhancements in coordination with TSP have the potential to save time, money and ensure transit reliability and dependability for riders.

Disadvantages

High volumes of right turning movements may cause congestion in the queue jump. If a bike lane is present, a queue jump provides an additional conflict zone between bicyclists and buses when the bus merges across the bike lane into the queue jump. Implementation of a new queue jump lane may require eliminating on-street parking spaces if present near the intersection or additional ROW.

Considerations

Queue Bay Length

The length of the queue bay should consider how far potential vehicle queuing extends, so the bus is able to merge into the queue bay without having to wait behind stopped vehicles during the red-light phase. The length also depends on whether right turning vehicles are allowed. If right turning vehicles are allowed in the bay, length of the bay should allot space for queuing vehicles. Queue bay length should consider the potential for multiple buses using the space at one time.

Transit Signal Priority

A transit-only green light allows the transit vehicle in the queue jump to move through the intersection before the general traffic receives a green light.

Lane Width

METRO preferred lane width is 12'. 11' minimum.

Placement

May be placed curbside or between a through traffic lane and right turn bay.

Pavement Markings

The queue bay should be clearly distinguished to prevent other vehicles from using the lane unless otherwise permitted. "Bus Only" pavement markings, white line differentiation, red pavement coloring, and appropriate signage delineate the queue jump from a right turn bay.

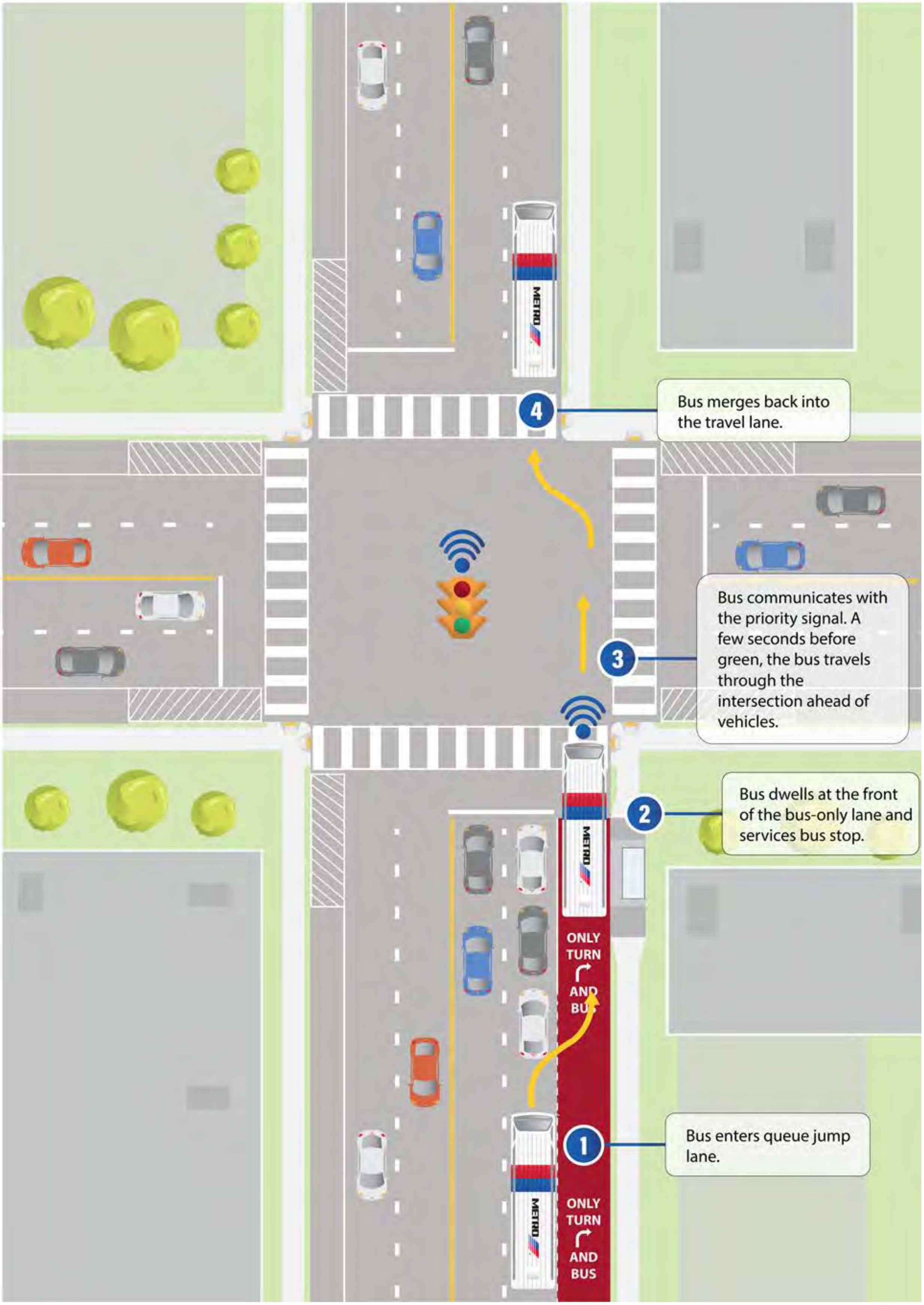
Bus Stop Configurations

When a queue jump is present along a transit route, near-side stops are optimal. A separate signal phase is triggered after the bus serves a stop. For near-side stops at queue jumps, right turns may be prohibited.

Right Turning Vehicles

Right turning vehicle movements must be considered when implementing a queue jump. Queue jumps may be transit-only or allow right turning vehicles to use the lane. However, allowing other vehicles may cause delays for the transit vehicle during congested periods or where cross street traffic volumes are high.

Figure 4.21: Queue Jumps



Bypass Lanes

Definition

A bypass lane is a transit intersection enhancement that allocates a dedicated transit lane before and after an intersection allowing the transit vehicle to circumvent queues.

Advantages

While only requiring 3-5 seconds of green light time allocated to specific transit vehicles, bypass lane enhancements have the potential to save time, money and ensure transit reliability and dependability for riders.

Disadvantages

Disadvantages to implementing bypass lanes are similar to those for queue jumps. High volumes of right turning movements may cause congestion in the near-side bypass lane. If a bike lane is present, a bypass lane provides an additional conflict zone between bicyclists and buses when the bus merges across the bike lane into and out of the bypass lane. May eliminate potential on-street parking space or require additional ROW.

Considerations

Bay Length

The bay length should consider how far potential vehicle queuing extends so the bus is able to merge into the queue bay without having to wait behind stopped vehicles during the red-light phase. The length also depends on whether right turning vehicles are allowed. If right turning vehicles are allowed, length of the bay should allot space for queuing vehicles.

Lane Width

METRO preferred lane width is 12'. 11' minimum.

Pavement Markings

The bypass lane should be clearly distinguished to prevent other vehicles from using the lane unless otherwise permitted. "Bus Only" pavement markings, white line differentiation, red pavement coloring, and appropriate signage delineate the bypass lane from a right turn bay.

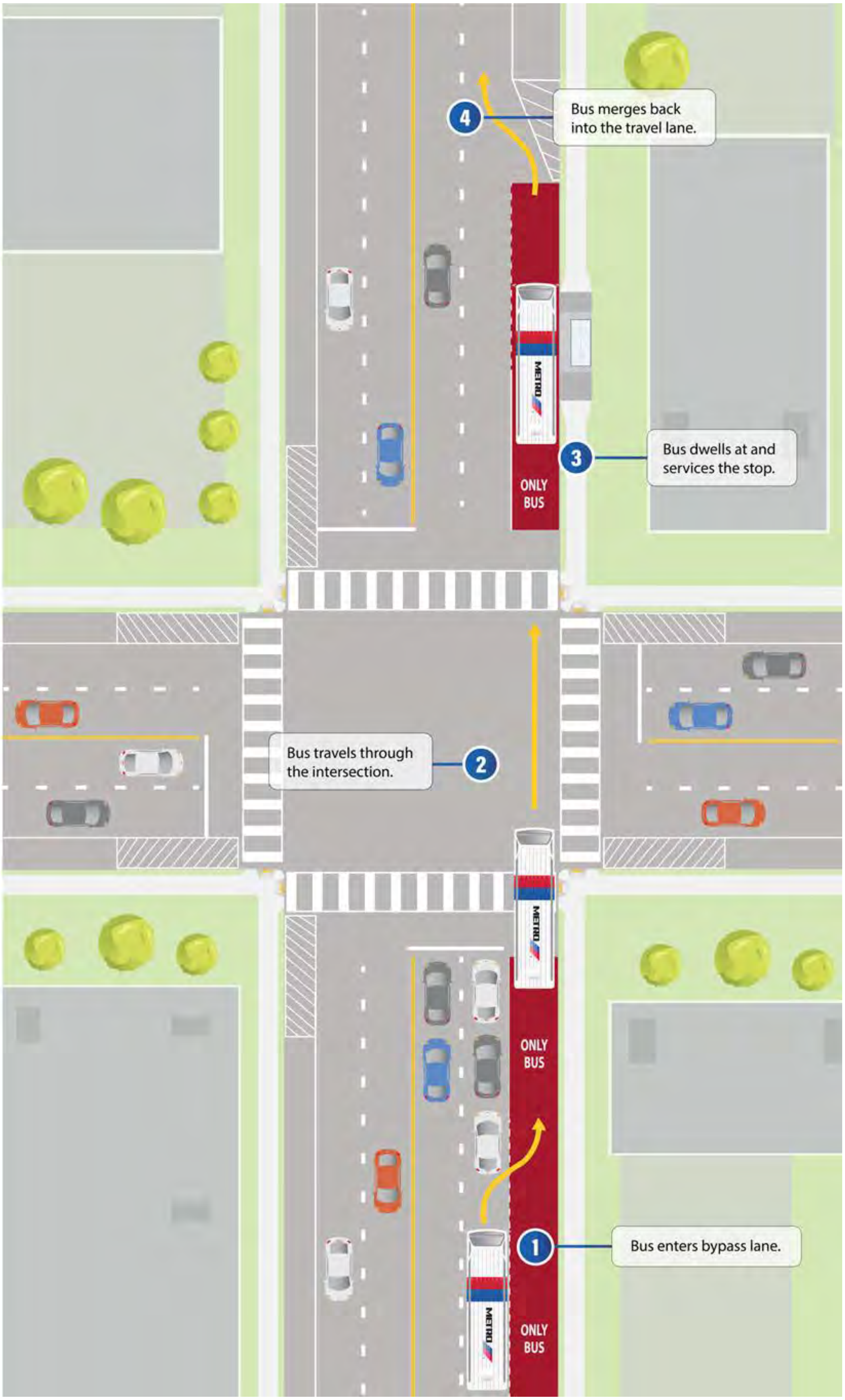
Bus Stop Configurations

A far-side stop best utilizes a bypass lane and avoids potential conflicts with right turning vehicles.

Right Turning Vehicles

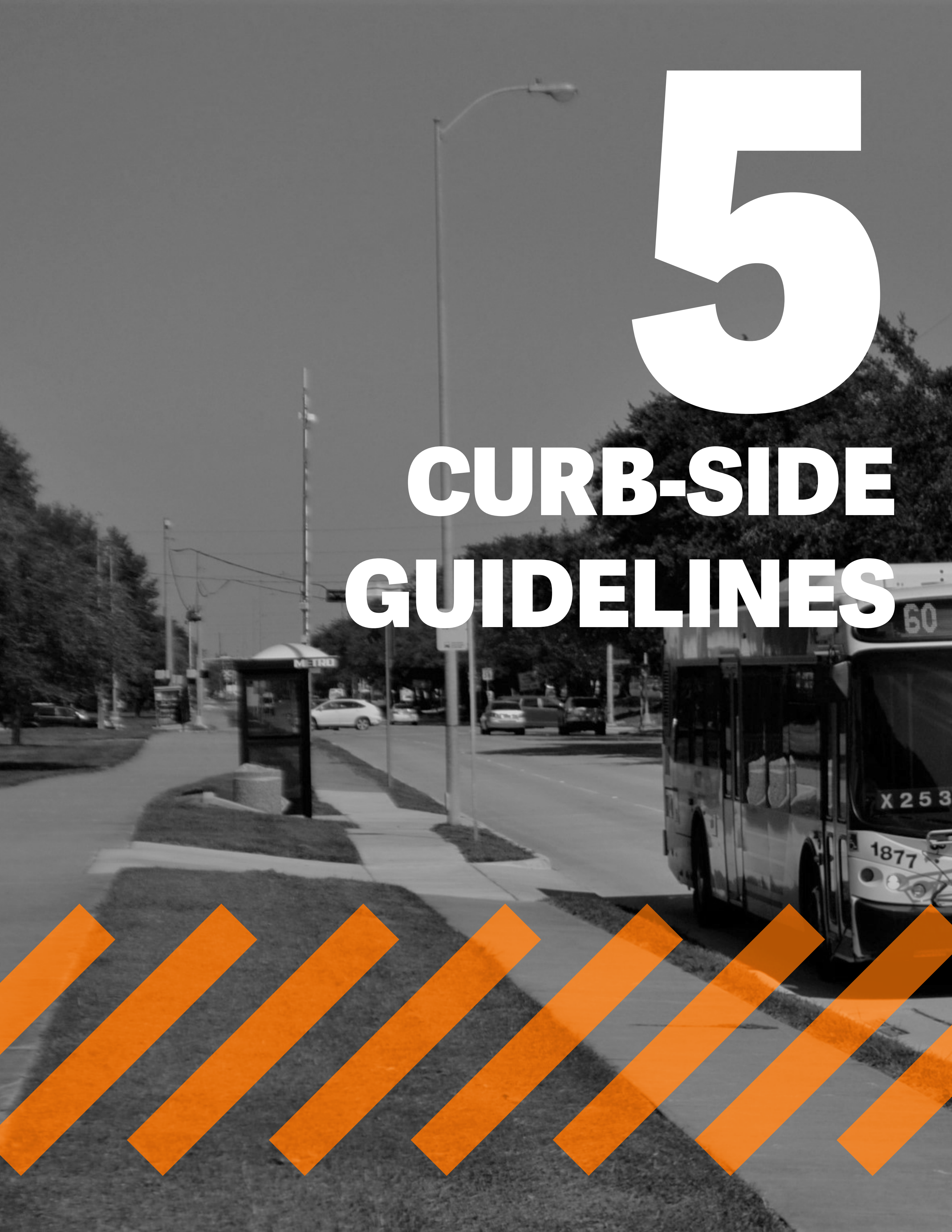
Right turning vehicle movements must be considered when implementing a bypass lane. A bypass lane may be transit-only or allow right turning vehicles to use the lane. However, allowing other vehicles may cause delays for the transit vehicle.

Figure 4.22: Bypass Lane



5

CURB-SIDE GUIDELINES



CURB-SIDE GUIDELINES

A Pedestrian System Connectivity

Description

Pedestrian System Connectivity refers to provision of physical connections between transit access points (stops and stations) and the rest of the pedestrian network.

Application

Transit stops should always be easily accessible to people using the pedestrian network. This applies not only to the direct connections between a bus stop and its adjacent pedestrian facility (typically a sidewalk), but also between the adjacent pedestrian facility and the rest of the surrounding pedestrian network. Pedestrian System Connectivity Guidelines should be integrated with Universal Access and ADA standards to optimize accessibility to transit stops.

Advantages

Building the necessary level of connectivity in the pedestrian system allows as many people as possible to reach transit access points like stops and stations. It also maintains a safer pedestrian environment by providing clear, accessible space. Good pedestrian connectivity shortens the amount of time it takes for people to arrive at a stop; this can help prevent riders from missing the bus/train, keep transit vehicles on schedule, and shorten the overall trip travel time for users. Good pedestrian connectivity can improve the perception of transit as an alternative mode of travel, and therefore may improve ridership.

Design Considerations

Minimum Sidewalk Width

6′ minimum along transit roadways (As defined in the COH IDM, Ch. 17, and Ch 10). Sidewalk width should exceed minimum where ROW exists.

Sidewalk Buffer

Desired minimum 4′. Buffers are desired where sidewalks are less than 10′ wide. Please refer to COH IDM Ch. 10 for further guidance.

Accessible Design

The pedestrian realm at transit stops should comply with ADA and Texas Accessibility Standards (TAS).

Pedestrian Realm

15′ from curb to property line is the desired minimum (COH IDM Ch. 10). This includes sidewalks, sidewalk buffers, tree plantings, furniture zone, and transit stop amenities.

Crosswalks

10′ width and placed at all approaches except where pedestrians are prohibited from crossing (COH IDM, Ch. 15). High visibility crosswalks should be used where identified as appropriate such as school crossings. Refer to COH Standard Detail 01510-10 for further guidance.

Curb Ramps

Curb ramp slope shall not exceed 1:12. Curb ramp width should be 36″ excluding flared sides and should fit entirely within crossing. Flared sides shall not exceed 1:10. Curb ramp cross slope should not exceed 1:50. There should be a 36″ - 48″ clear space at the end of ramp depending on landing type (diagonal or standard). See 2010 ADA Standards for Accessible Design.

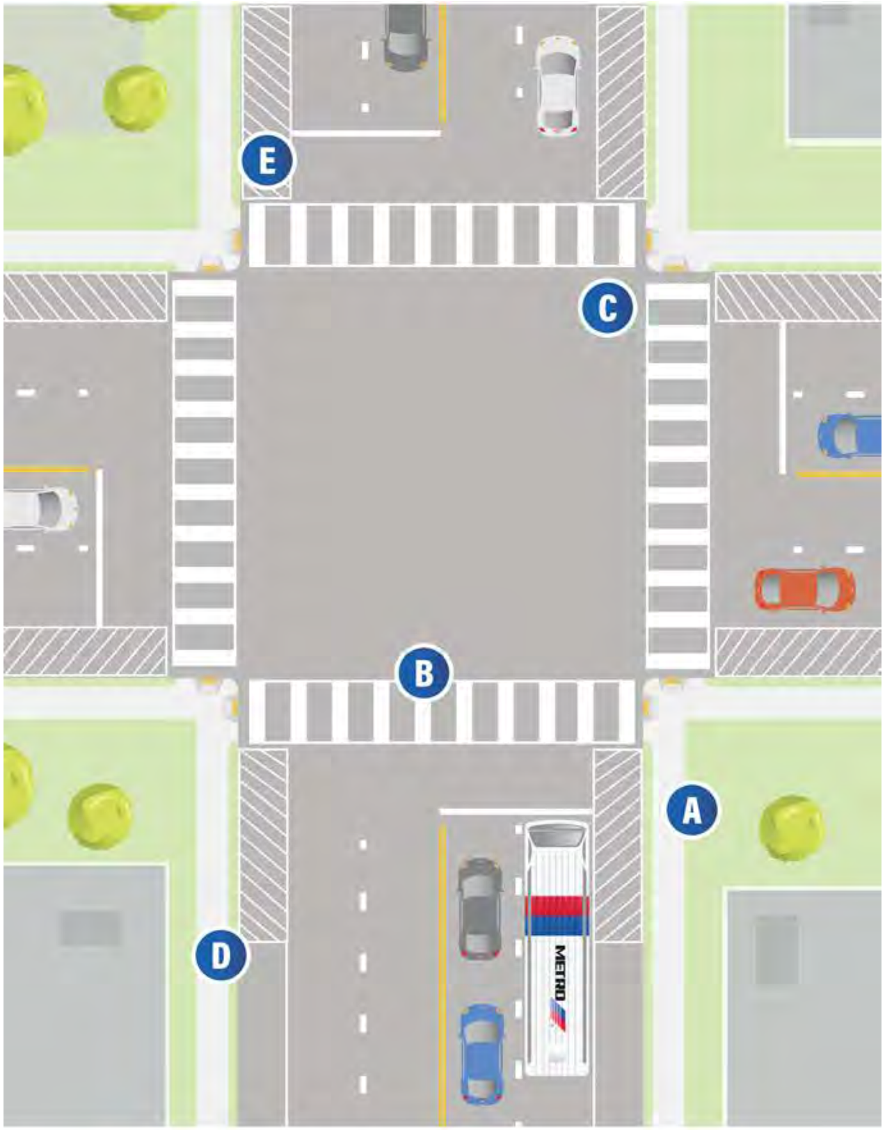
On-Street Parking

If on-street parking is present, parking lane should terminate 20′ from crosswalk to increase visibility. If the intersection is signalized, parking should terminate 30′ from the crosswalk.

Other Considerations

- Transit stops should not be placed in locations that do not have sidewalk facilities immediately adjacent, or an immediately adjacent sidewalk should be constructed if the stop placement is the ideal location based on other crucial placement factors.
- The transit stop should be directly connected to the adjacent sidewalk, either as an extension of the sidewalk or via paved paths.
- The sidewalk facility immediately adjacent to the transit stop should continue to each adjacent intersection so that it is directly connected to the rest of the surrounding pedestrian network.
- The intersections nearest to a transit stop should provide safe crossings at each corner of the intersection so that people crossing the street have continuous unobstructed access to the stop.
- The pedestrian network in the area surrounding the transit stop should be as complete as possible so people have direct pedestrian access to the stop when arriving from their origin and destination points. Sidewalks should line both sides of each street and continue the entirety of each block from intersection to intersection.
- Near- or far-side stop locations are preferred to mid-block. Mid-block stops should only be implemented along very long blocks or where unavoidable. Refer to COH IDM Ch. 17, for further details.
- Crime Prevention Through Environmental Design (CPTED) strategies should be incorporated in the design process of creating transit shelters and stations to mitigate the occurrence of undesirable behaviors, while maintaining an inviting aesthetic. Strategies such as natural surveillance, natural access control, territoriality, activity support and maintenance should be considered.

Figure 5.1: Pedestrian System Connectivity Considerations



- **A** Sidewalk Width 6' Minimum
- **B** Crosswalk Width 10' Minimum
- **C** ADA Curb Ramp
- **D** Sidewalk Buffer Width 4' Minimum
- **E** Parking Terminates 20' from Crosswalk, 30' at Signalized Intersection

B Universal Design and Accessibility

Definition

Universal Design is a concept that goes beyond minimum ADA accessibility requirements by encouraging transit stop design that is safe, comfortable, accessible, and convenient for users of all ages and abilities. Universal Design utilizes best practices rather than meeting minimums.

Application

Universal Design applies most prominently to the elements of a transit stop area but can also extend to safety and accessibility of the surrounding streetscape. Curbside design guidelines should strive to utilize Universal Design principles whenever feasible. Universal Design can be implemented in transit stop areas through choices about structural design, lighting, aesthetics, and visual, audible, and tactile amenities/cues (for wayfinding, transit service information, and safety/guidance equipment). Universal Design should create transit spaces that are equitable, flexible, simple to understand, and intuitive to use.

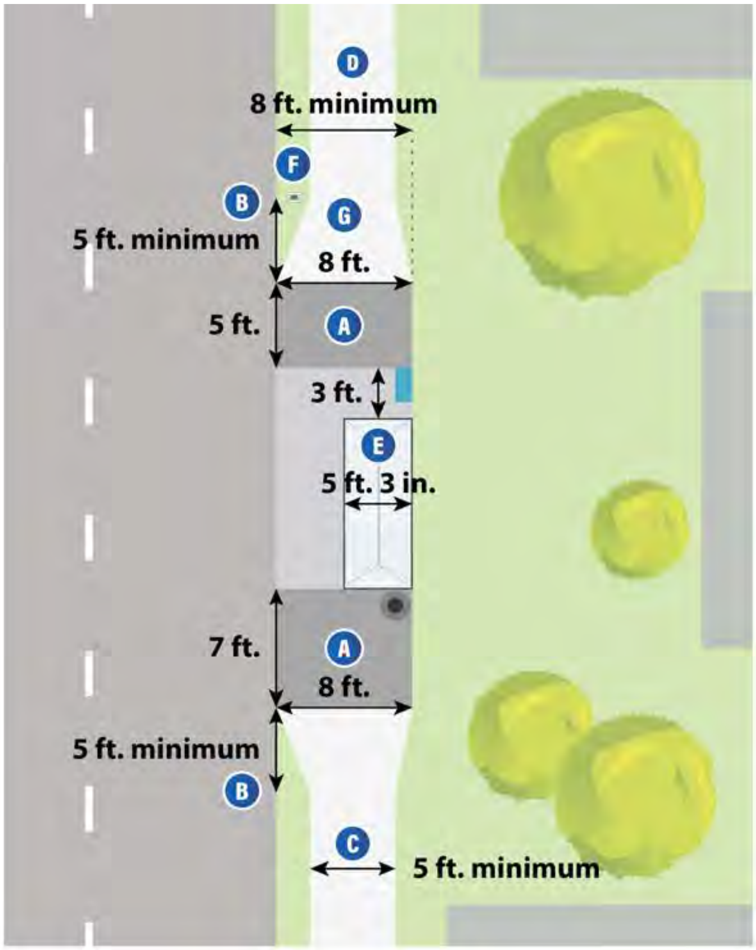
Advantages

Universal Design goes beyond minimum ADA requirements to create an environment that is even safer, more accessible, and more comfortable for transit users with disabilities. Universal Design also considers other types of users who are not always kept in mind during the design process for transit facilities, including users such as children, the elderly, pregnant women, parents with babies or small children, people traveling with luggage, and for the hearing or visually impaired.

Design Considerations

- The transit stop platform should stand on top of a slab of flat, hard material (e.g. concrete) to provide a smooth, safe surface for passengers waiting at the stop. Stops placed on natural ground or on another type of unstable/uneven surface may create safety hazards and may degrade the level of comfort and accessibility of the stop, particularly for people with disabilities. The platform should also allow for drainage so that standing liquids do not accumulate in the stop area.
- The platform area should be cleared of obstacles so that people moving into, out of, or through the stop area have a safe path. There should be a 6′ unobstructed sidewalk. Amenities such as trash bins, newspaper boxes, and planters/trees should be placed in areas where they will not create safety hazards or obstacles to movement. The stop pad by each door of the transit vehicle should be kept clear of obstacles such as utility poles and fire hydrants, as well as stop amenities.
- Paths for circulation leading to, from, or through the transit stop area should be designed to accommodate the expected level of pedestrian traffic, and busier stops should have circulation pathways that are wide enough to allow two persons in wheelchairs to pass each other going opposite directions.
- Transit stops should have shelter structures to protect waiting passengers from adverse weather conditions such as heavy precipitation, strong winds, and intense heat/sunlight. Shelters should also have enough space to accommodate persons in wheelchairs underneath the canopy.
- The context of the streetscape, surrounding land uses/attractions, and ridership levels should be considered when determining the most appropriate type and size of a transit stop area.
- It is preferable to avoid grade changes in the stop platform and circulation pathways. if possible. However, for all types of users, ADA-compliant ramps are required over staircases when changes in grade are present or necessary either in the station area or between the station area and the adjacent sidewalk facility.

Figure 5.2: Typical Standard Transit Stop



- **A** Stop Pad – 5′ x 8′ for front door and 7′ x 8′ for back door.
- **B** Minimum of 5′ transitional space from sidewalk to bus stop.
- **C** Sidewalk – 5′ minimum.
- **D** Minimum of 8′ from the curb to the back of the bus stop area.
- **E** Shelter – approx. 12′ wide x approx. 5′ deep with 3′ of space between the shelter and the front door stop pad.
- **F** Transit stop signage should be visible but not be an obstacle.
- **G** Stop should be connected to an adjacent pedestrian facility.

C Transit Stop Amenities

Description

Transit stop areas are a critical component of the transit system, as passenger boarding and alighting activity occurs in these areas. Transit stops should be comfortable and safe environments that improve the attractiveness and accessibility of the transit system. The following amenities provide improved user experience at stop locations.

Minimum Amenities

Sign and Post

At minimum, all METRO transit stops should have a sign and post that identify stop information, routes that serve that stop, and other system information.

Other Amenities

Bike Parking

Some transit users choose to ride a bicycle to and from transit stops, and not all passengers will want or need to take their bicycles with them on the bus all the way to their final destination. Bicycle racks provide a secure storage method for such passengers. Buses may also be equipped with bicycle racks to store bikes during travel. Covered bicycle parking provides an enhanced parking option for passengers. Covered bicycle parking may be made available to users for a daily or monthly fee.

Bicycle Repair Station

When transit users ride a bicycle to and from stops, they may encounter minor issues with the bicycles, such as flat tires or loose parts. Incorporating bicycle repair stations into the set of amenities at transit stops will allow users to conduct repairs without having to carry such repair equipment themselves and without having to go out of their way to find a shop. This added convenience can make combining bicycle and transit trips more attractive to potential users and can help to retain existing users who ride their bikes.

Free WiFi

WiFi at bus stops enables passengers to access the internet on their mobile devices (phones, tablets, laptops) for work and entertainment purposes while they wait for their bus. WiFi at transit stops requires additional technology infrastructure.

Bus Shelter Lighting

Pedestrian oriented lighting is critical to bus stop comfort. Lighting increases a sense of safety and provides visibility when service continues after sundown. Bus stops should include interior lighting for transit users.

Passenger Wayfinding

Passenger wayfinding signage allows passengers to gain an understanding of their surroundings and helps put their current location (the stop location) in context with the nearby environment. Wayfinding resources usually include maps that show their current location, nearby transit stops, the location of other destinations of interest, and how to reach those destinations.

Public Art

Public art gives a bus stops an elevated aesthetic and can increase the level of visual appeal. Public art at a stop can also bring a local placemaking component to the bus stop. This may increase the level of enjoyment passengers experience while waiting at the shop.

Real-Time Arrival Information

Real-time arrival signs provide waiting passengers with the most up-to-date and accurate route information. These signs are digital and receive updates directly from en-route buses that notify passengers of the expected arrival time for each bus. Real-time arrival information at transit stops improves passenger satisfaction, convenience and reduces perceived wait time.

Route and System Information

Transit service information is one of the most fundamental amenities that should be provided at stops. Even the most minimal of stops should provide service information at the route level, though ideally a stop would provide route and system-level information (e.g. stop locations, schedules, maps). Providing service information at transit stops is important for new users and for people who may not look up such information in advance of arriving at a stop. Providing system information allows transit users to successfully navigate the METRO transit system. Bus stop ID information should be present at stops and integrated with technology to help passengers to obtain stop information.

Seating

Seating is a critical amenity to providing comfort at transit stops. Placing the provided stop seating underneath the cover of a shelter structure encourages passengers to use the seating. If the seating is in an exposed area of the stop, people may choose to stand under the shelter instead of sitting on a bench or seating structure, particularly during adverse weather conditions.

Shelter

Shelters offer several benefits, including protecting people from weather conditions such as rain and sun exposure. Shelters can also protect other amenities at the stop from these same conditions. Though some of the minimal bus stops do not have a shelter structure, they are important to providing waiting passengers with a comfortable stop experience and help reassure the passenger that they are at an active bus stop. Shelters should include clear panels to ensure visibility to operators as they approach the stop area.

Trash Cans

Trash Cans are an essential amenity at bus stops as they help keep the bus stop area and surrounding property clean and pathways clear. They may also reduce maintenance costs and effort for the transit provider. Where ridership is high or the trash can is consistently overflowing, solar trash compactors should be considered.

Utility Cabinets

Certain technologies to operate service require utility cabinets. These should be placed inside or outside of the stop shelter but should not interfere with the pedestrian clear space and walkways.

Prioritizing Bus Stop Locations for Shelters

Houston METRO is updating the process for identifying new shelter sites throughout the METRO network. The overall goal is that each transit stop be equipped with a shelter, however financial, built environment and maintenance constraints may at times require the strategic use of funds to provide shelters. The Passenger Shelter Task Force is a team comprised of representatives from Planning, Engineering, Service Planning, and Maintenance, and their primary responsibility is to oversee the shelter-screening process. The task force will review multiple factors when deciding whether to place a shelter at a bus stop, and this section will be updated after the process is finalized.

Scoring Process (In Development)

The shelter scoring process is being updated by the Passenger Shelter Task Force and will be updated during the next revision of this document.

Figure 5.3: Houston METRO Shelter

D Transit Stop Design Elements - (In Development)

The Transit Stop Design Elements section is currently under development and any updates to Local or Commuter service will be included in the next iteration of these Transit Design Guidelines. Changes in this section will impact Appendix A.

Local Service (In Development)

Guidelines for Local Service are currently under development and will be included with a future update to this document.

BOOST Service Corridors

In order to improve the customer experience and reduce the perceived wait time at bus stops, METRO will implement spacious, accessible stops that accommodate wide sidewalks along with a range of amenities where right-of-way is available. The new standard for bus stops on BOOST corridors is also designed with an eye toward the objectives of faster, more reliable service and universal accessibility by employing treatments that reduce dwell time and help passengers with limited mobility safely navigate the stop and board and alight the bus. For more detailed information on the stop design for BOOST stops and for standard detail drawings of stops, reference the BOOST Basis of Design in Appendix B. The following sections detail the various dimensional requirements for BOOST stops.

Platform Height

To enable near-level boarding, BOOST platforms will be nine inches above street level, three inches above the standard six-inch curb height, which eliminates the need for buses to kneel. The extra height will require sufficient length parallel to the street to provide transition areas that meet ADA slope requirements and drainage needs. METRO will coordinate with the Houston Commission on Disabilities on BOOST stop designs and amenities to ensure they meet accessibility standards. A two-foot detectable warning surface along the length of the platform is proposed at all stops with nine-inch curbs.

Platform Depth

Spacious bus stops with at least 15 feet behind the curb are the standard for BOOST corridors. Stops with 15 feet behind the curb accommodate a cross-section consistent with the streetscape standards developed by the COH's Walkable Places Committee. Figure 5.4 shows the cross section of the standard BOOST stop with 15 feet behind the curb.

Platform Length

BOOST platforms will be designed to provide clear spaces for boarding and alighting at all doors of all vehicles likely to service the stops in the future. At a minimum, in all locations reasonably feasible, BOOST corridors will feature platforms with clear boarding/alighting zones at both doors of standard 40-foot buses; this requires a total platform length of 32 feet. Many BOOST corridors may benefit—either in the short term or the long term—from the extra capacity provided by 60-foot articulated buses and will therefore feature longer, 52-foot platforms. Platforms will be designed to accommodate 60-foot buses on corridors that meet one or more of the following criteria:

- 60-foot articulated buses currently operate on the corridor
- Existing route achieves weekday productivity of over 30 boardings per revenue hour
- Existing service runs every 10 minutes or better at peak times

Bus Stop Enhancements (BSE)

BOOST bus stops feature additional space that does not interfere with the shelter, the clear sidewalk, or the multiple boarding and alighting zones. These areas are flexible spaces that can accommodate a range of amenities, including street furniture, bike parking, landscaping, wayfinding, and public art. The BOOST Bus Stop Enhancements document in Appendix C of the BOOST Basis of Design describes the types of enhancements METRO has deemed appropriate.

Enhancements will be placed at stops depending on available space and funding/ maintenance partners and in the following order of priority:

1. Accommodate existing utilities and existing trees,
2. Plant new trees where there are no overhead utilities and soil requirements are met (as outlined in the BSE),
3. Bike parking, and
4. Plantings.

For more detailed information and visual examples of BOOST bus stop enhancements, reference the BOOST Basis of Design in Appendix B.

Stop Dimensions

BOOST corridors run through a variety of street conditions and development patterns, many of which make it challenging to build the safe, accessible, comfortable, and spacious bus stops that customers desire. The design team will work to overcome these constraints and to meet the following standards at all BOOST stops. In some cases, meeting these standards will require additional space behind the curb to comply. Reference the BOOST Basis of Design in Appendix B for further details on ROW acquisition along BOOST corridors. Table 5.2 - Table 5.4 display the dimensional measurements in feet for standard, constrained and unconstrained ROW stop elements. Figure 5.5 illustrates the standard BOOST stop at a location with 15 feet behind the curb. Final stop design should reference the standard detail drawings found in the BOOST Basis of Design in Appendix B.

Figure 5.4: Standard BOOST Stop Section

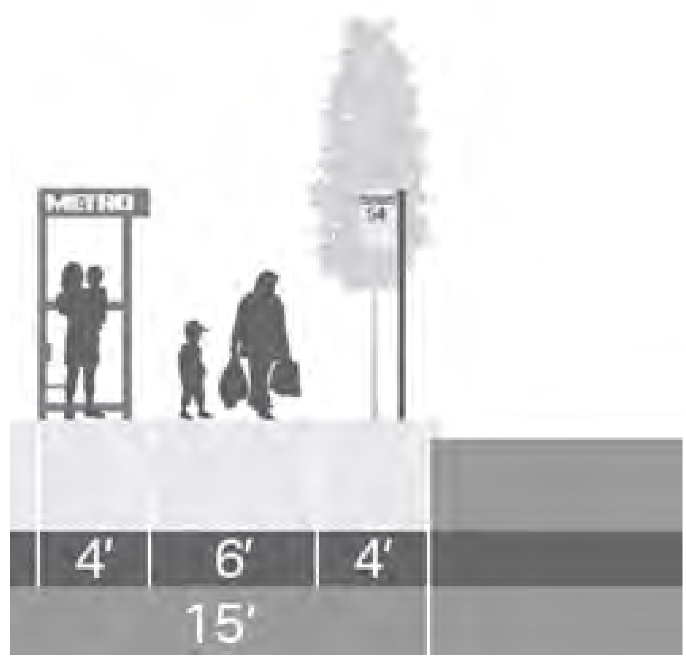


Figure 5.5: BOOST Bus Stop in Standard ROW

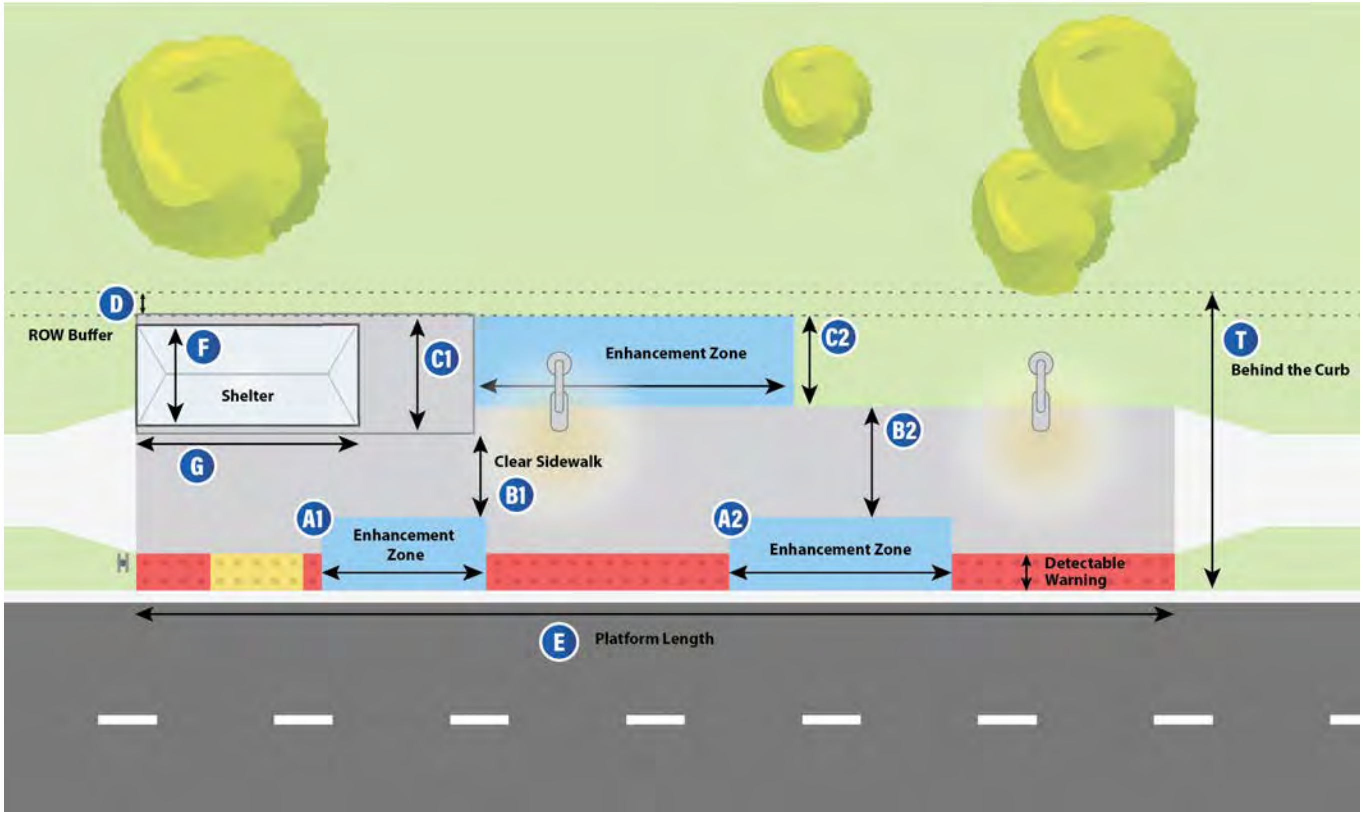


Table 5.2: Constrained ROW

Dimension (ft)	Label	Min	Standard	Signature
Total Back of Curb	**T**	**8**	**10**	**11**
Front Curbside Enhancement	A	2	2	2
Front Clear Sidewalk	B	4	5	6
Back of Platform Enhancement	C	2	3	3

Table 5.3: Standard ROW

Dimension		Label	Min	Standard	Signature	Max
Total Back of Curb		T	12	15	18	25
Front Curbside Enhancement		A1	2	4	4	6
Back Curbside Enhancement		A2	3	4	4	6
Front Clear Sidewalk		B1	4	5	6	11
Rear Clear Sidewalk		B2	6	6	7	10
Shelter Platform Depth		C1	6	6	7	7
Back of Platform Enhancement		C2	3	5	6	8
ROW Buffer		D	0	0	1	1
Platform and Shelter Dimensions						
Platform Length	60′ Bus	E	52	52	52	52
	40′ Bus		32	32	32	32
Shelter Dimensions	Depth	F	4	4	5	-
	Width	G	12	12	12	12

Table 5.4: Unconstrained ROW

Dimension (ft)	Label	Min	Standard	Signature
Total Back of Curb	T	20	23	25
Front Curbside Enhancement	A1	2	5	5
Back of Curbside Enhancement	A2	3	6	6
Front Clear Sidewalk	B	5	5	5
Shelter Platform Depth	C	6	6	6
Back of Platform Enhancement	D	4	4	4
Rear Clear Sidewalk	E	1	1	1
ROW Buffer	F	6	6	8

Commuter Service (In Development)

Guidelines for Commuter Service are currently under development and will be included with a future update to this document.

E Transit Stop/Facility Types - (In Development)

The Transit Stop and Facility Types section is currently under development and will be included in the next iteration of these Transit Design Guidelines. Changes in this section will impact Appendix A.

F Signage - (In Development)

The Signage section is currently under development and will be included in the next iteration of these Transit Design Guidelines. Changes in this section will impact Appendix A.

6

DESIGN CRITERIA FOR METRO PARK & RIDE AND TRANSIT CENTERS

DESIGN CRITERIA FOR METRO PARK & RIDE AND TRANSIT CENTERS

A Introduction

The Design Criteria for METRO Park & Ride and Transit Center Facilities document outlines the design criteria that specify the requirements for the performance of professional design and engineering services for METRO Park & Ride facilities and transit centers. (Excerpted from Design Criteria for Park & Rides and Transit Centers). The document is currently under review at the development of this Transit Design Guidelines document. Potential edits include language and elements to improve pedestrian and bicycle design and amenities at METRO facilities. Many of the suggested revisions include elements already being implemented at new METRO Park and Ride and Transit Center Facilities.

The entire Design Criteria for METRO Park & Ride and Transit Center Facilities is provided in Appendix C.

7 TRANSIT ENVIRONMENT DESIGN RESOURCES

TRANSIT ENVIRONMENT DESIGN RESOURCES

A Introduction

As part of METRO's urban design initiative to explore the role of designing transit infrastructure as public space, the transit environment design resources aim to strengthen the narrative of the transit experience and advance the physical condition of transit infrastructure. When thoughtfully designed, stations and stops, at every scale, become memorable and enjoyable civic spaces. Transit spaces will be designed as a gateway between origin and destination. The transit environment design documents include: project checklists for bus stop, park & ride, transit center, and landscape design; a programming catalogue of design typologies listed in the checklists, and a design manual. The design manual is the "go-to" resource that thoroughly explores design approaches to promote sustainability, advance design excellence, support local land use goals, and create safe transit environments.

Performance measures for project amenities are included in the transit environment design checklist to support the maintenance and relevancy of project amenities overtime. A clear understanding of the use, need, and purpose of purposed amenities should be clearly defined for future inspection, both for operational and rider use benefit.

At its core the transit environment design documents aim to encourage an ecological-based design approach at every stop and station -- pushing the status-quo of conventional transit infrastructure -- making them more porous and green, mimicking its natural environment. It is the intent of METRO that the transit environment design resources serve as a tool for accomplishing this goal.

Figure 7.1: Transit Environment

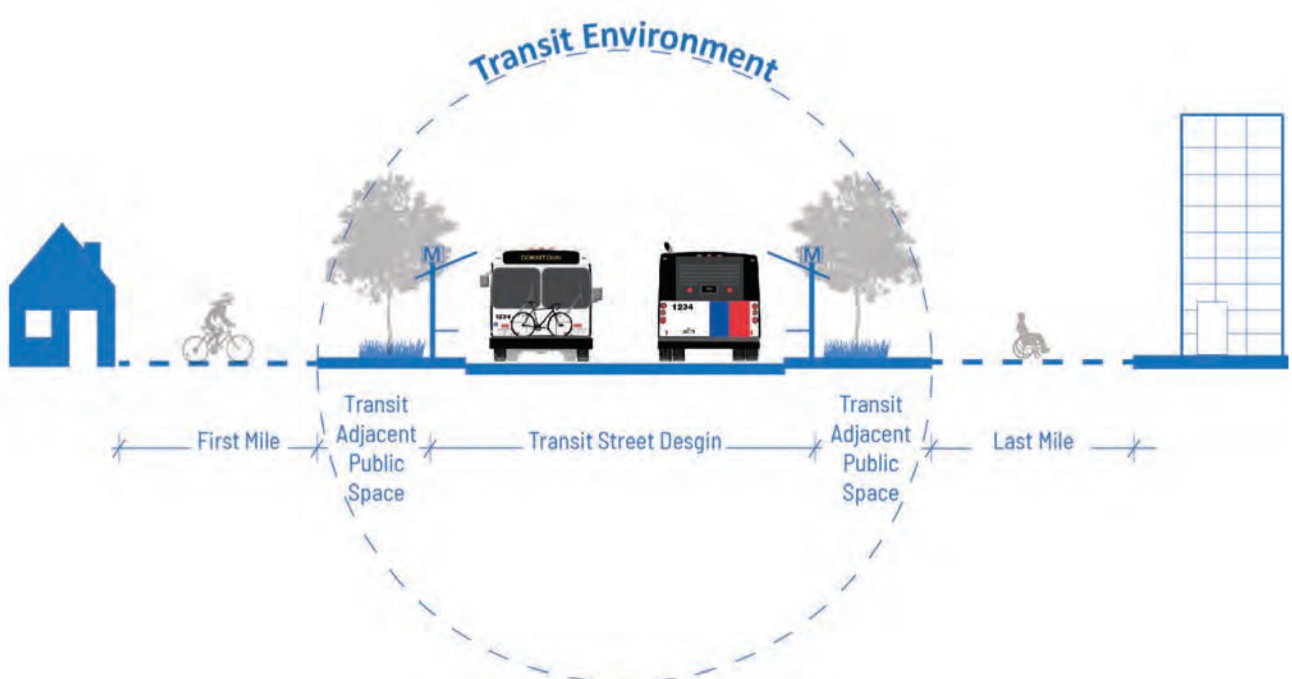


Figure 7.2: Before Image

Designing a civic network to act as the natural environment it replaces can be achieved through beneficial landscape methods.
The amenities listed in this chapter illustrate resources to reduce hardscape footprints, flooding, ponding, water runoff, and alternatives to grass.
By designing with nature transit infrastructure can celebrate and become a showcase for Houston's robust ecology.

Figure 7.3: After Image

Designing a civic network to act as the natural environment it replaces can be achieved through beneficial landscape methods. The amenities listed in this chapter illustrate resources to reduce hardscape footprints, flooding, ponding, water runoff, and alternatives to grass. By designing with nature transit infrastructure can celebrate and become a showcase for Houston's robust ecology.

B Transit Environment Design Checklists: Bus Stop, Transit Center, and Park & Ride Design

The intent of the checklist is to support the development of clear, well-thought out, and comprehensive spatial design report. With a clear spatial design report, planning and engineering teams are provided detailed strategies to develop project plans and a justified vision for intent and goal of conceptual design. As a tool-kit, teams should refer to the project checklists during the preliminary, in-progress, and final design report submittals to ensure recommended amenities identified in the programming phase are maintained throughout plan review and into construction.

The design checklists include the following eight categories:

Site

The layout responds to the connectivity of the site. It is formulated in the design process to best allocate space to balance the site's values. For each of our three scales (bus stop, park and ride, transit center), considerations of entry, multi-modal connectivity (bike or car parking), and exit will be informed by circulation in the surrounding area and the lot size itself. Features of the surrounding area, like a large tree for shade or proximity to a natural area should be a factor the design process uses to the facility's advantage.

Design for All

Understanding daily experiences for diverse riders is a primary consideration to inform station amenity selection. The structures should facilitate easy and feasible public transit journeys. These considerations will require observations of issues in safety and accessibility for all. These spaces can largely affect Houston's pedestrian comfort and providing holistic benefits such as improved connectivity from nearby sidewalks, bike paths, and highly visible socially secured environments.

Design for Comfort

METRO's public facilities should provide a feeling of wellbeing. Climate, long wait times, and crowded stops are eased and designed by thoughtful placemaking strategies. Designing for comfort is a vital contribution in supplementing METRO's First Mile-Last Mile initiative.

Amenities

Patrons and passersby should be able to recognize METRO's infrastructure unconsciously. Integration with the community and existing ecology develops unobtrusive and enhancing infrastructure. Though physically ending at the extent of METRO's ROW, our infrastructure should be designed as borderless, intentioned to seamlessly weave into the existing environment, providing utility and connectivity in a socially sensitive civic space.

Design for the Environment

Minimizing hardscape softens the utilitarian character of the station while further helping reduce the stormwater runoff problem caused by Houston's extensive impervious cover. Efforts to maintain and include green infrastructure in designs will functionally change the impacts of the space and provides local sustainability. In addition to ecological consideration, opportunities to integrate public health and promote active communities around transit is vital to creating resilient transit spaces. Relying on site specific public health and urban planning analysis to inform project design strategies will ensure the development of healthy transit environments for all.

Design for Safety

There is a direct correlation between hours spent on the road and traffic crashes in a city. Using public transit is a safe alternative to driving that METRO should maximize in its designs. Safety can mean protection from traffic for cyclists and clearly visible and well-lit stations.

Technology

Technology supports providing a sense of place to mobility hubs and account for an optimized transit experience. Next-time arrival guidance, charging stations, and other digital interactions helps transform transit infrastructure into places people love.

Project Maintenance

Include a thorough maintenance plan of proposed physical, cultural, and ecological amenities with project design spatial report to be used by facilities maintenance. Refer to the programming catalogue for preferred ecological amenities and landscape design checklist for maintenance strategies.

Each section is supported by design components in the form of questions that aim to consider best possible options to strengthen the design of the bus stop environment. Although the checklist aids the decision-making process, it should be recognized that each site is a unique location with different characteristics to be considered, Individual amenities are best designed as integral parts of the station and not added as an afterthought.

C Programming Catalogue

The programming catalogue is a robust manual listing placemaking typologies of urban ecology, street furniture, and cultural identity. It will feature lists of preferred amenities with graphics that illustrate the standard expected from these stations.

Ecological Amenities

Ecological amenities are low-impact development considerations to self-mitigate impervious impacts on the built environment. Features of METRO's infrastructure should be complementary to Houston's commitment to a green turnaround. Designing a civic network to act as the natural environment it replaces can be achieved through beneficial landscape methods. By designing transit environments with nature, transit infrastructure can act as a curator of ecological design.

Physical Amenities

Physical amenities are provided to enhance the waiting experience. They should work in conjunction with each other to create a safe, accessible, and comfortable place. Bike parking, waste bins, and wayfinding information are amenities that improve the user wait time and comfort of the transit facility.

Cultural Amenities

Cultural amenities are features that personalize and connect the transit environment with the community. Public art and branding features create a unique sense of place that serves the community beyond mobility.

D Urban Design Manual

The "go-to" resource to implement urban strategies.

Urban Design Guiding Principles

Safe for All

Clean, well-lit, active facilities support public safety and provides a sense of security for riders -- a reliable feeling of transit safety encourages pedestrians to use public transportation at all hours of operation.

Accessible for All

Urban design improves pedestrian access by partnering with public and private agencies to jointly support placement of accessible paths that are easy to move along, clear of obstructions, and accommodates all.

Provide a Sense of Place

Transit facilities that incorporate amenities such as retail and technology provide for an optimized transit experience. Creative use of materials and art in transit design reinforces a sense of place and ownership for transit riders and residents nearby.

Contribute to Sustainability

METRO will continue to look for and apply applicable best practices in transit design that contribute to sustainability. Specifically, transit facilities that are quick to recover from environmental challenges and support smart, healthy, livable, resilient, walkable communities.

Urban Design Guiding Process

Understand

Understand the Site. The urban design process is dependent on thorough (even empirical) analysis of a project site. For a bottom-up, data-based design approach, document the activity of the site at different times of day, experience different travel modes of accessing the site, and understand the people who use the site and connections to nearby amenities.

Engage

Engage the Rider. Create workshop exercises for public engagement meetings that are specific to users of the project site. The material should allow the audience to provide preferences on access and circulation routes, style of design, and type of preferred amenities. Documented material should be mapped into clear analysis and transformed into conceptual design.

Identify

Identity Project Scope and Need. After the initial project engagement meeting, the METRO team can identify scope and need of the project based on site documentation and data discovered during public review.

Designate

Establish Your Team. Select project consultants most appropriate [project-to-project] to designing facilities balanced in technical transit requirement and community need. Prompt critical questions about implementation, phasing, maintenance, and funding. How is this place going to be used over time, who is going to maintain it, and how will it impact the surrounding area over the coming years?

Create

The selected design team should first Develop a Clear Project Vision and Strategy to guide the big picture [goal] of the project. The developed strategy should be flexible but ensure project goal and community needs are maintained.

Design

Go Beyond Function. The purpose of an urban design process is to identify the most useful, vibrant opportunities of a project. The project should be thoughtfully integrated with surrounding amenities to support the vision of the project goal -- establishing a connected community project.

E Project Expectations and Design Submittals

Design teams should embark on a process of gathering, brainstorming, studying and developing ideas for project design. Key findings should be organized and documented to have an easy transition from conceptual design to design development. METRO intends to use concept designs developed out of the programming phase to showcase in-progress projects. A high-quality spatial design report is imperative in telling a complete story of projects before construction. Diagrams, renderings, site plans, sections, and elevations should all reflect high-quality and current design techniques. Please refer to project checklist for detailed method and expectation of the spatial design report.

F Urban Strategies

Envision your conceptual plan and design. Urban design provides design alternatives to bring your narrative to life. Insert the rider into your conceptual design plans by using the below urban strategies. Refer to facility type design checklist for detailed execution of the following methods:

Envisioning Exercises

Headlines from the Future

Headlines from the Future allow a rider to express future expectations of projects. The results help the designer understand how a rider currently feels compared to how they want to feel when arriving and waiting at a transit station or stop.

Character and Identity Mapping

Culture Mapping

Culture mapping is understanding the geographic and social context (parks, art, landmarks, unique community groups or businesses) of a transit station or stop location. The sites cultural fabric can be represented in the station design through branding and art design.

Station Character

The station character exercises identify riders preferred landscape style, station design, lighting style, and adjacent open space uses.

Station Amenities

The station amenities exercise identifies preferred amenities available at the stop and the amenity location.

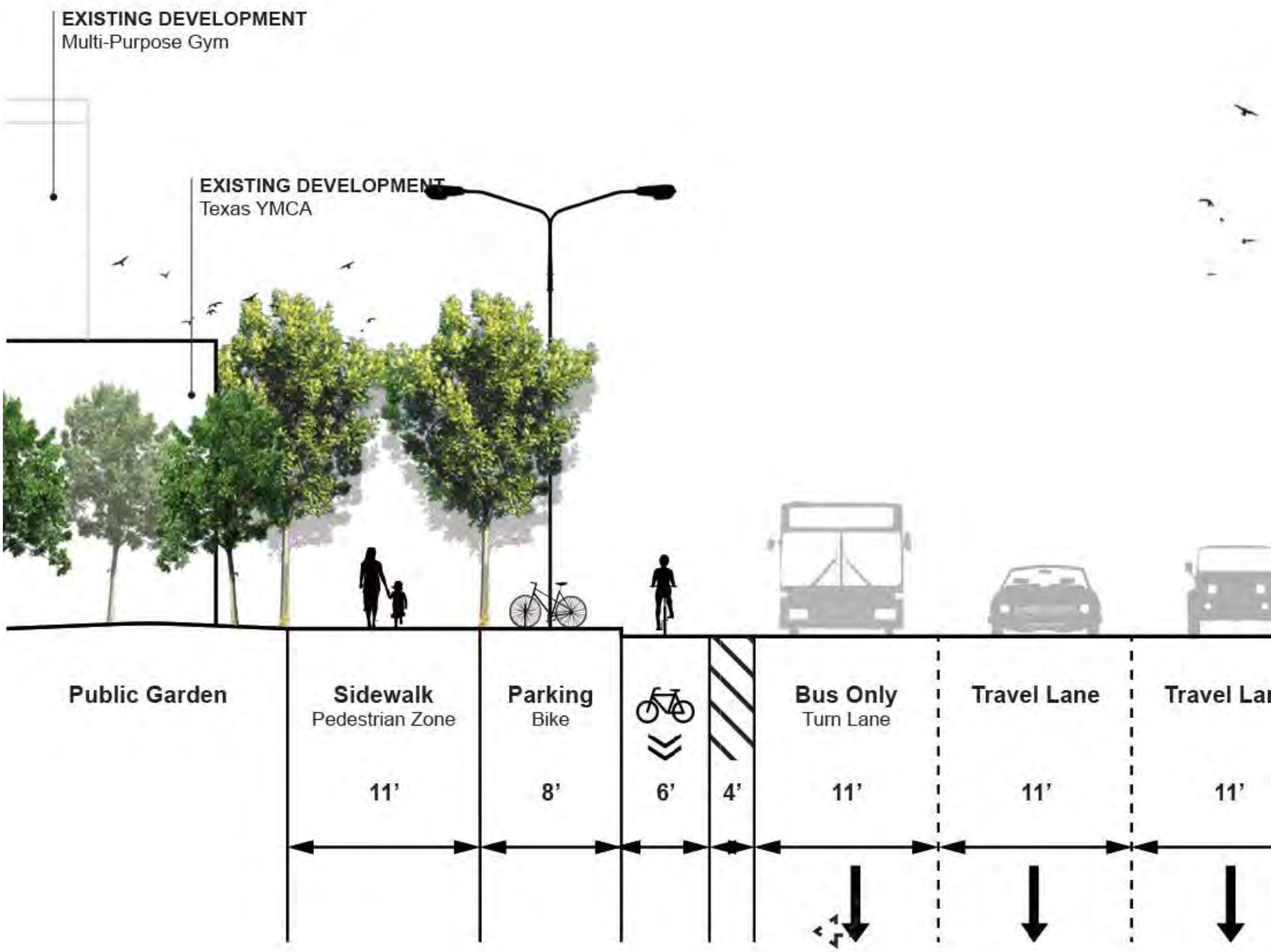
Illustrative Plans and Massing Design

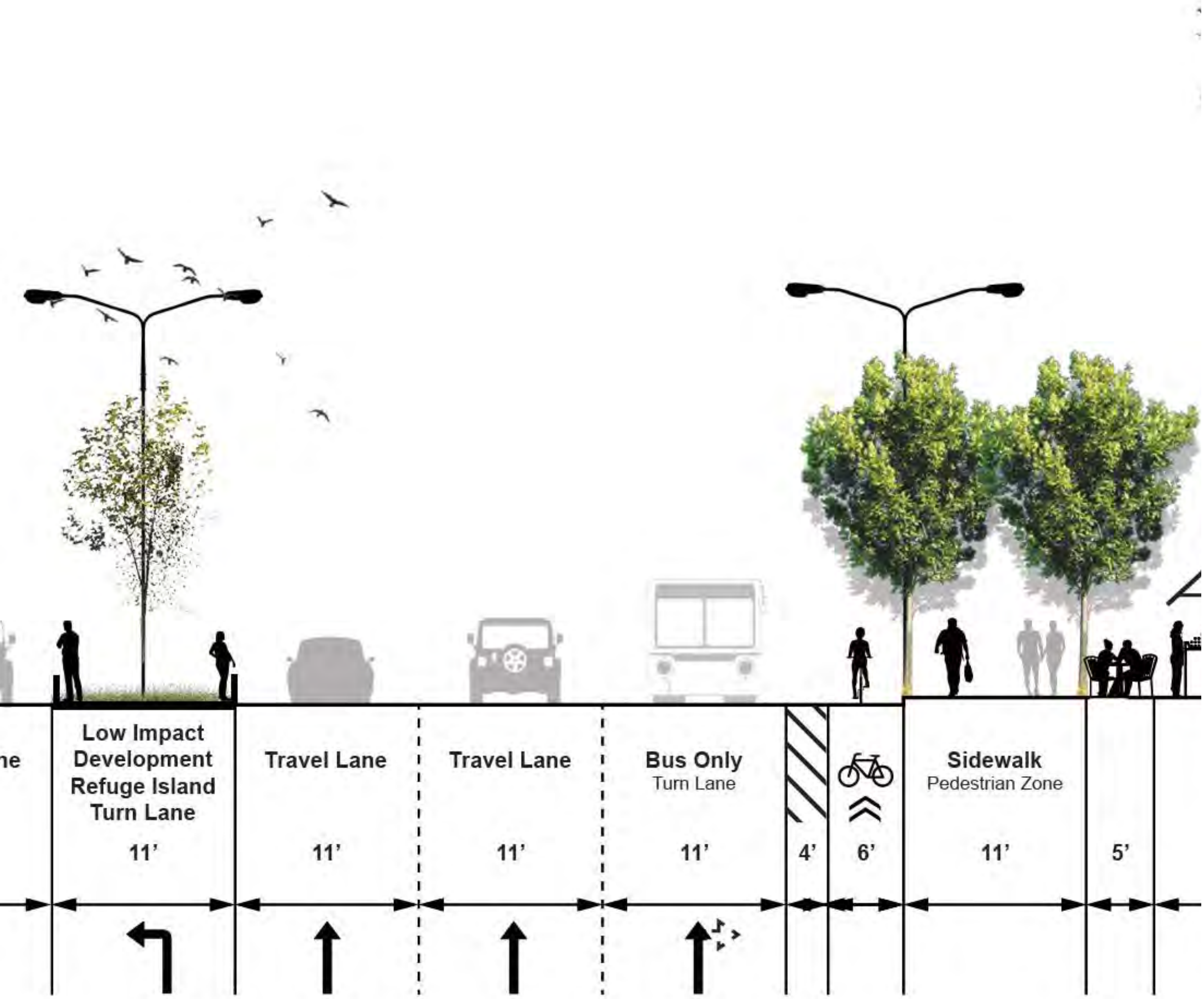
Illustrative master plans and massing models give virtual scale to large and complex infrastructure when trying to create a sense of place to large open spaces. Massing models also provide context to layout and circulation planning and design.

Diagramming

Diagrams help simplify complex research and elaborate narrative. For example, heat map diagrams help illustrate how people are moving throughout a site, where they stop and congregate. Create diagrams from mapped data to give justification to design proposals and conclusions extracted from envisioning key findings.

Figure 7.4: METRO Urban Design Transect




ne
Low Impact Development Refuge Island Turn Lane
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Travel Lane
11'
Travel Lane
11'
Bus Only
Turn Lane
11'
4'
6'
Sidewalk
Pedestrian Zone
11'
5'

Continued


RESIDENTIAL
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THE
MARKET
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Pedestrian
Alley
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Sidewa
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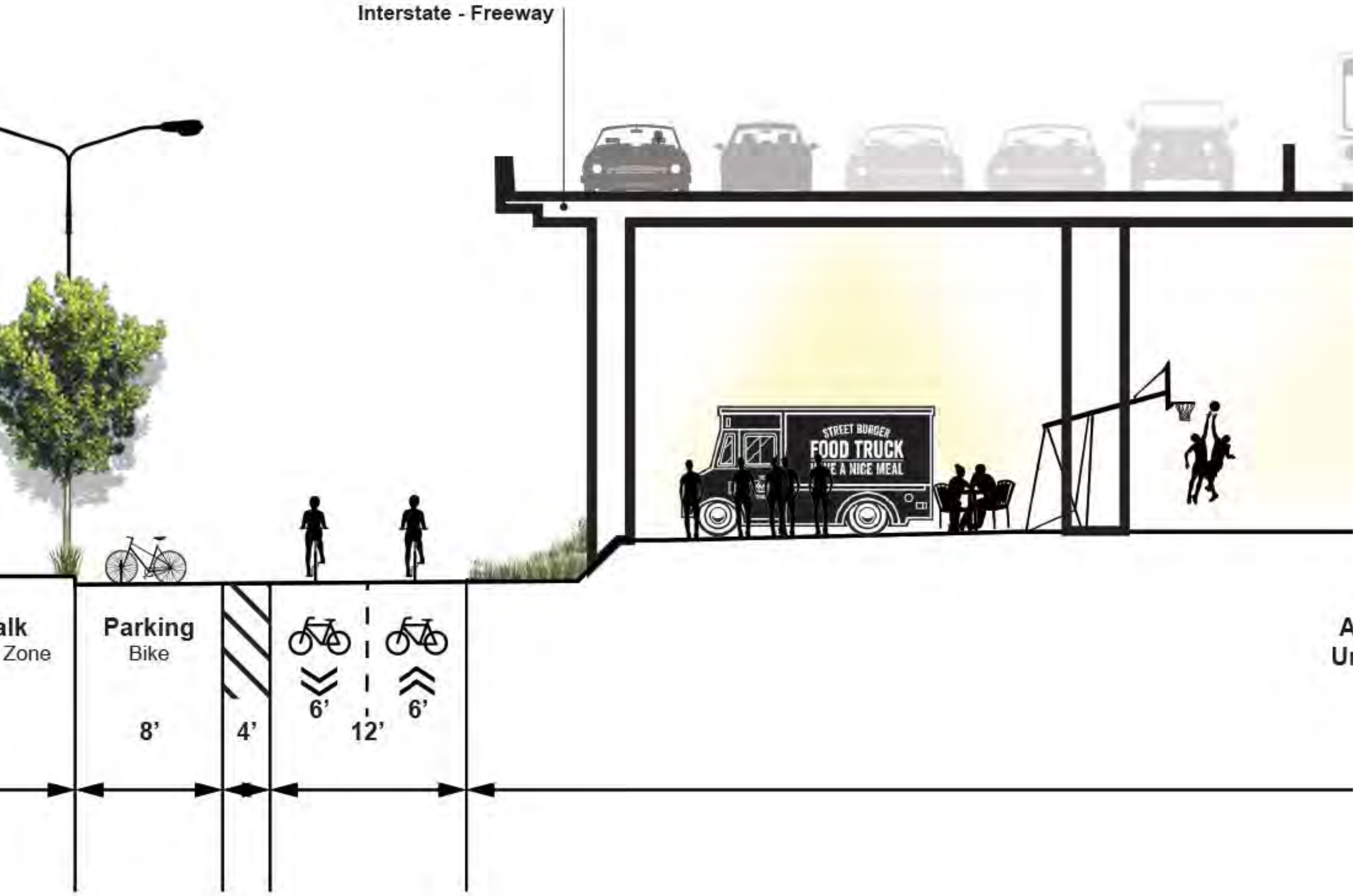

Interstate - Freeway
STREET BURGER
FOOD TRUCK
alk
Zone
Parking
Bike
8'
4'
6'
12'
6'
A
Ur

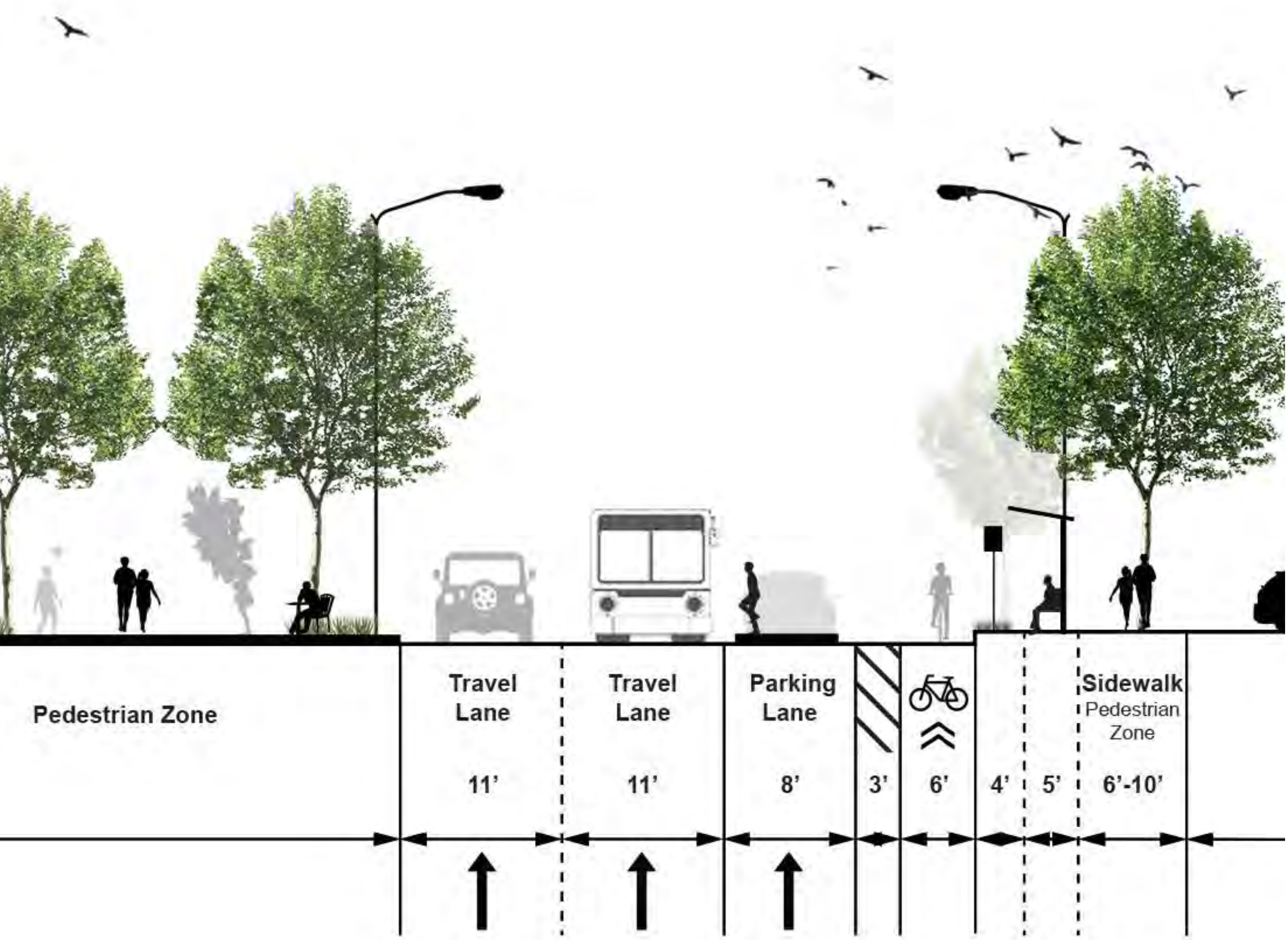
Continued

Activated Underpass
Varies
6'
4'
Residential Shared Street
One Way
15 MPH
4'

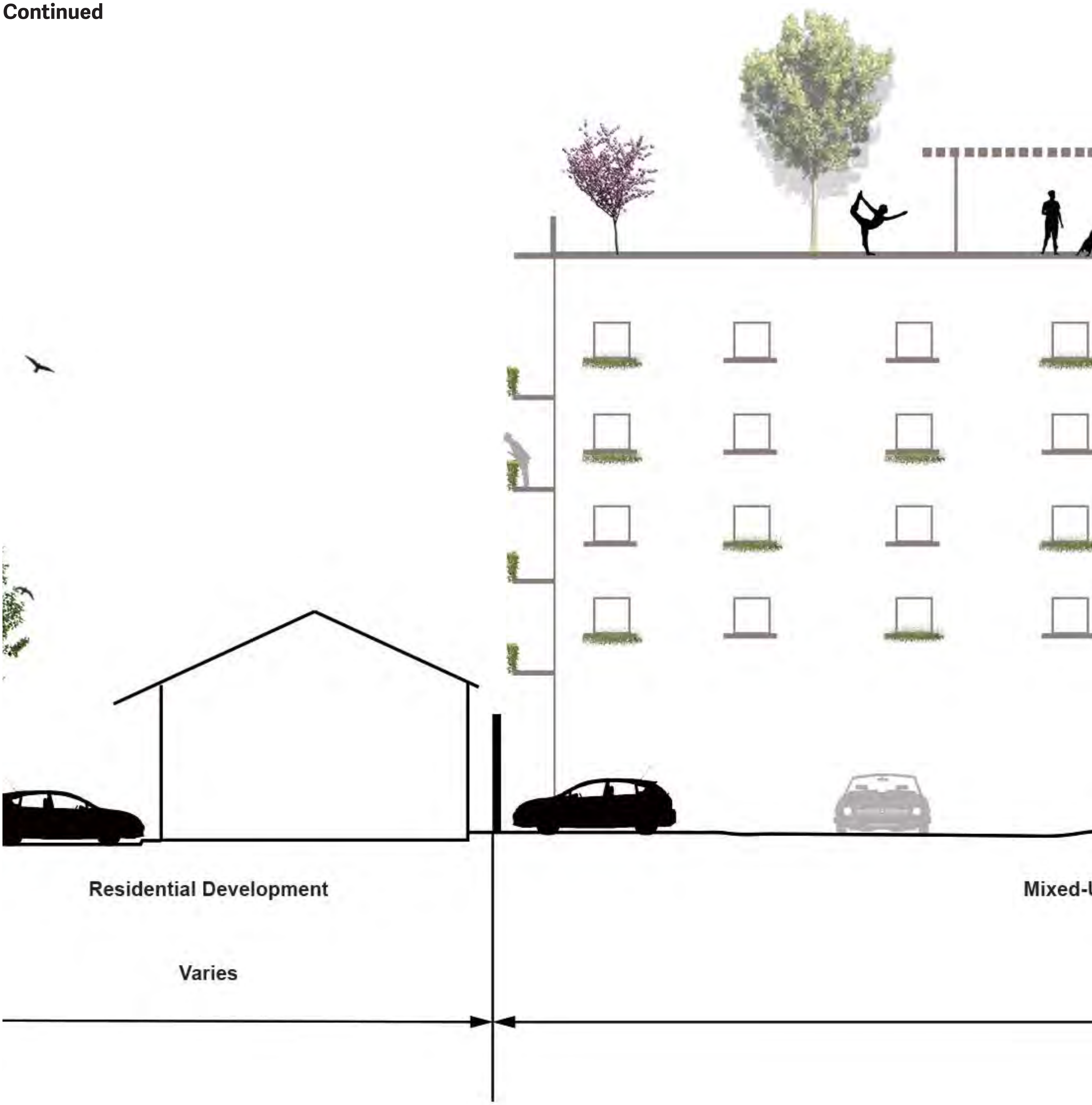

Sidewalk
Pedestrian Zone
Residential Development
Varies

Continued


Sidewalk
Pedestrian Zone
6'-10'
5'
4'
6'
3'
Parking Lane
8'
Travel Lane
11'
Travel Lane
11'
2'-4'

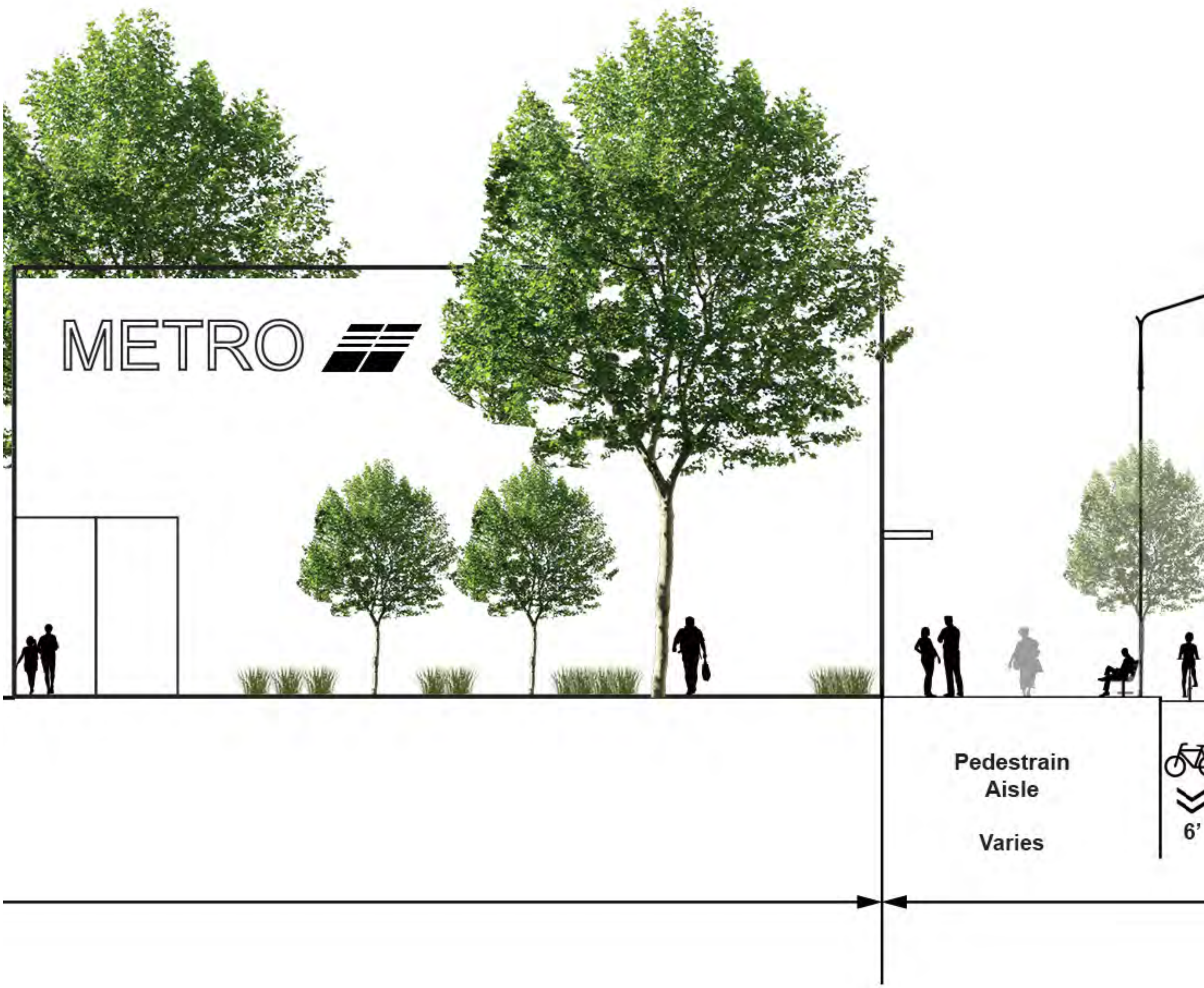

Pedestrian Zone
Travel Lane
11'
Travel Lane
11'
Parking Lane
8'
3'
6'
4'
5'
Sidewalk
Pedestrian Zone
6'-10'

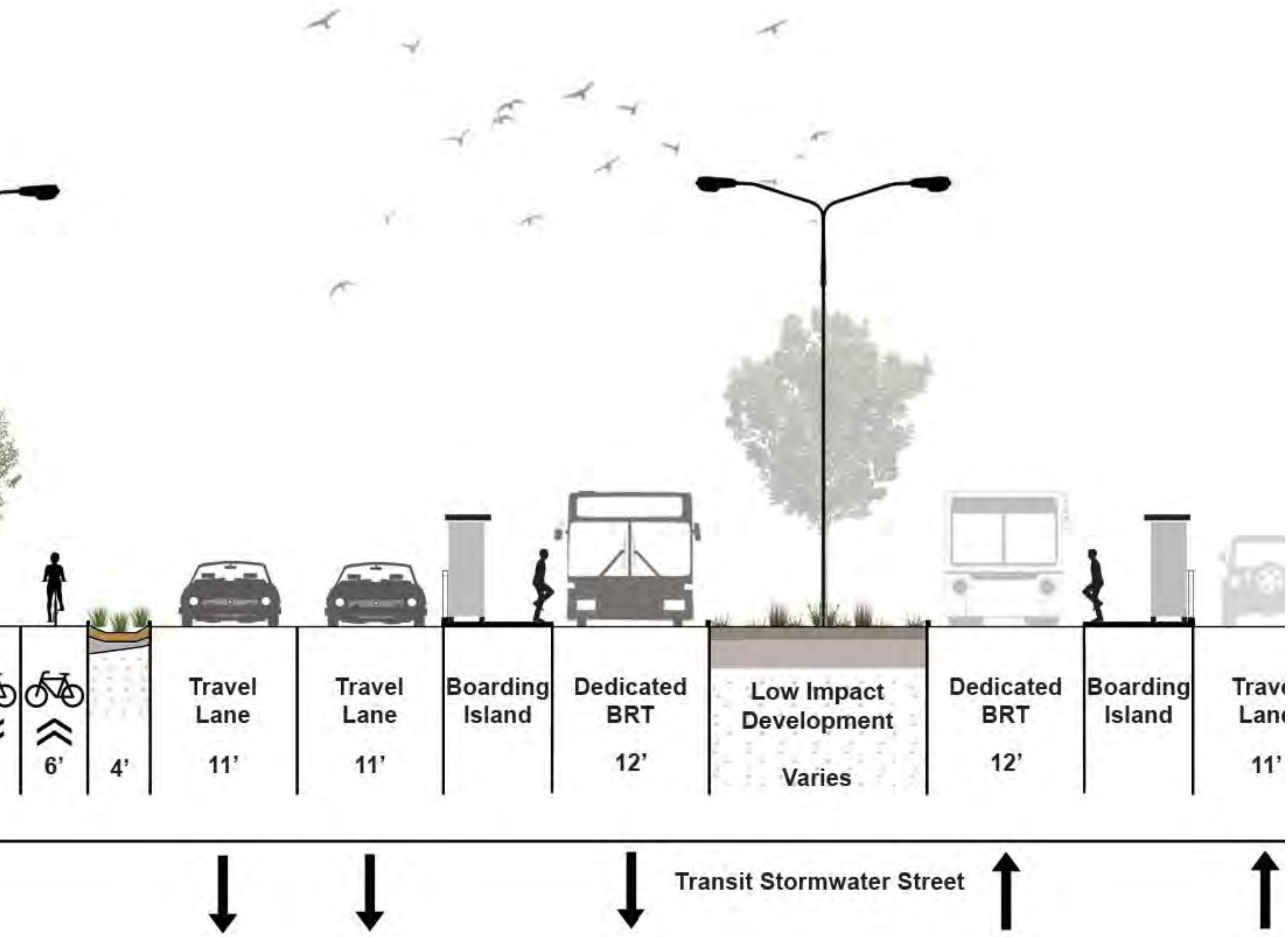
Continued




EAT
HERE
Use Development
Varies
Travel
Lane
11’

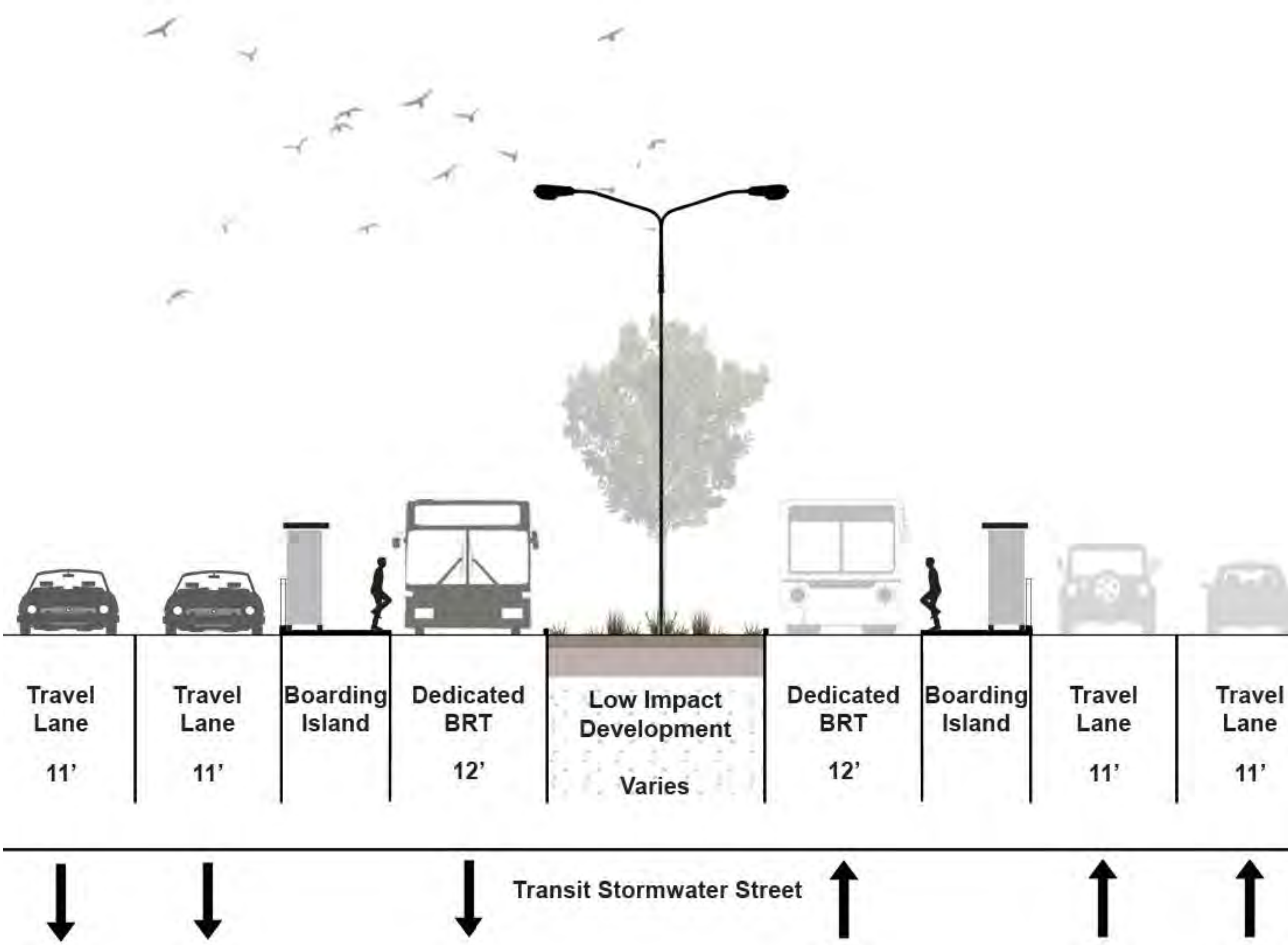
Continued

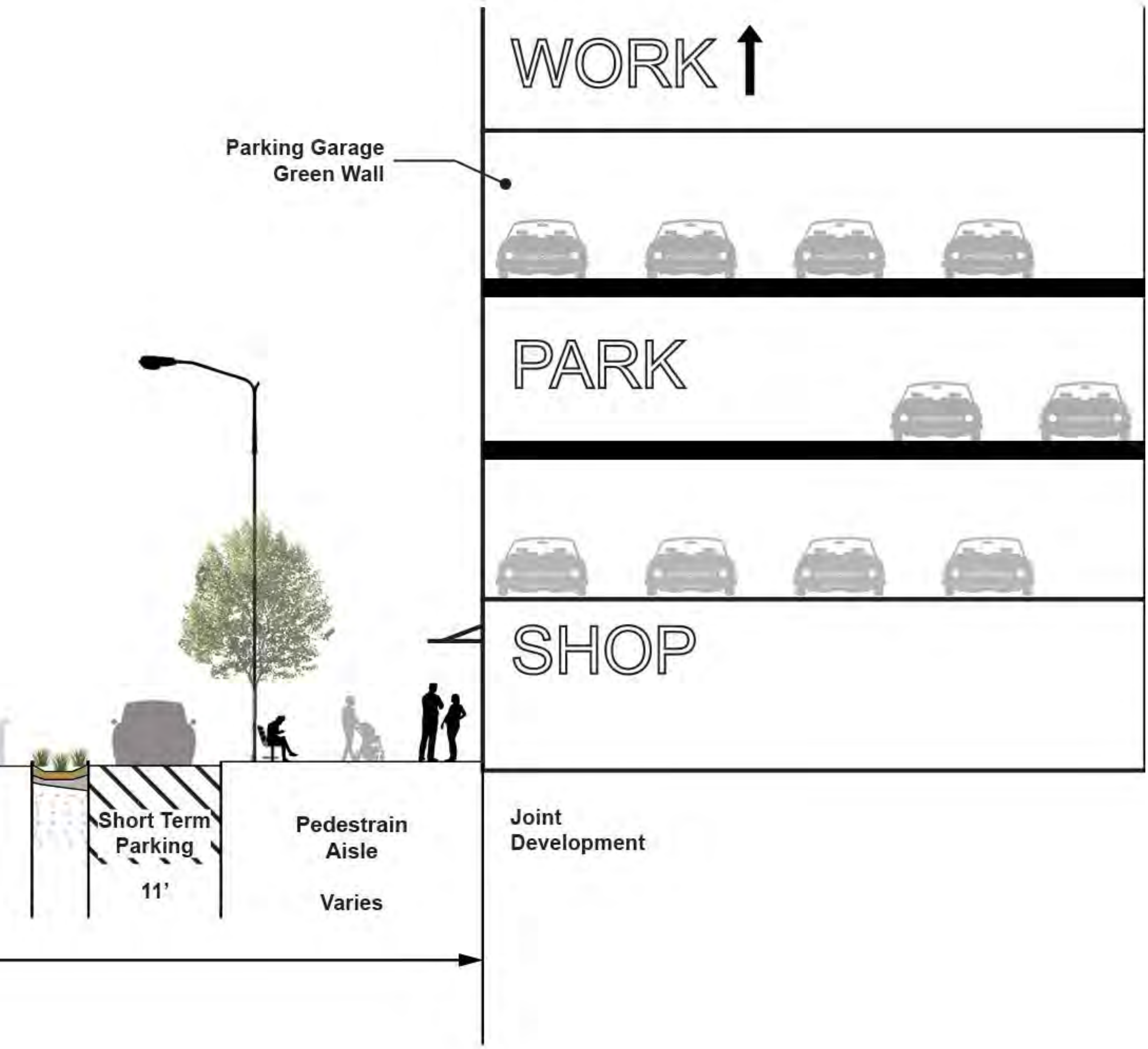




6'
4'
Travel Lane
11'
Travel Lane
11'
Boarding Island
Dedicated BRT
12'
Low Impact Development
Varies
Dedicated BRT
12'
Boarding Island
Trave Lane
11'
Transit Stormwater Street

Continued


Travel Lane
11'
Travel Lane
11'
Boarding Island
Dedicated BRT
12'
Low Impact Development
Varies
Dedicated BRT
12'
Boarding Island
Travel Lane
11'
Travel Lane
11'
Transit Stormwater Street


WORK
Parking Garage
Green Wall
PARK
SHOP
Short Term
Parking
11'
Pedestrain
Aisle
Varies
Joint
Development

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A

APPENDIX

Service Standards

Metropolitan Transit Authority
of Harris County, Texas

Service Design and Development's
Service Planning Department
April 28, 2011

METRO SERVICE STANDARDS

Contents

OVERVIEW

The Metropolitan Transit Authority of Harris County (METRO) strives to provide high quality transit service in an effective and efficient manner. The application of service standards provides assistance in achieving a balance between quality and the cost-effective use of limited public resources.

METRO continually receives requests for changes to existing service and for new service in growing areas within the Authority's jurisdiction and beyond. Additionally, METRO could potentially be operating some services that are not attracting enough riders to justify their present level of service. In order to be consistent in the evaluation of service proposals and to ensure that the service being provided represents the most cost-effective use of labor, equipment and other resources, METRO has developed a set of service standards to apply to new and existing bus service.

The specific standards and the service evaluation process are presented in this document. Since service standards are intended to optimize usage of METRO's resources, they will be reviewed and updated every five years, or more frequently, in order to reflect substantive changes in Board policy, costs of service, and/or other changes.

Application of Service Standards

There are two primary applications for the ongoing use of the service standards:

- The evaluation and management of existing services
- The evaluation and implementation of new services

The application of standards to existing routes is a multi-faceted process. The standards are used to identify routes which are most in need of service changes, such as restructuring the route to eliminate less productive segments or branches of the route, adjusting the service frequency to reflect the demand for service, or providing additional promotion of lower volume routes where appropriate. Routes that do not meet standards are not automatically designated for elimination. Alternative service delivery options and/or other adjustments can be explored in lieu of complete elimination. However, elimination of a route may be the best option, if it has been determined that no cost-effective actions are likely to improve the route's productivity or if the route does not serve valuable system connectivity or purpose.

The standards for existing routes are not intended to preclude changes to routes that meet these minimum standards. In many cases, it may be possible to improve the productivity of routes that meet the minimum standards by making minor changes to headways or trip times.

The evaluation of new service proposals will take place as proposals are received or needs are identified. New routes will be expected to meet all applicable route design standards, and will be expected to show a reasonable probability of meeting their productivity standards by the end of the first two years. If the route does not display a reasonable probability of meeting its productivity standards within its first two years, it will be advised to allow for discontinuation of the route.

METRO SERVICE AREA CHARACTERISTICS

The need and demand for transit service vary throughout METRO's service area. For example, the demand for transit service in a low-density, auto-oriented, developing suburban area will vary considerably from the demand for transit service in a highly concentrated urban area, such as inside the IH 610 Loop. Each environment offers different challenges in providing effective, cost-efficient transit services. By identifying certain demographic characteristics of METRO's service area, standards can be established for the design and implementation of types and levels of transit services best suited to the different areas.

The Transit Market

Past studies conducted in the U.S. and elsewhere have concluded that there are two primary indicators that are used to identify the transit market: population and employment density.

Briefly reflecting on the nature of mass transit, we can understand why these two factors are so critical. Transit is in the business of bringing together people to share rides. The more compact the geographic market of intended shared rides, the more effectively and efficiently transit is able to deliver its service. The more dispersed the pattern and location, the more penalties that are imposed on both the rider and the operators. For the rider, trips can become more circuitous, route spacing more diffused, and frequencies less attractive. For the operator, costs increase as it becomes necessary to travel greater distances to pick up riders. With varying markets in the region, it becomes necessary to develop strategies (i.e., park & rides, dial-a-rides, differing levels of service, etc.) which are tailored to these multiple markets.

In addition to population density and employment density, two other factors are acknowledged as determinants of transit usage; the number of trips people take and their dependency on transit. These four factors can be thought of as pieces of a puzzle which, when assembled, will distinguish different transit markets.

Population Density

Figure 1 identifies the population density in persons per square mile by census block group based on a 2009 population estimate from the company Nielsen Claritas. The next update will be based on the 2010 Census. Four groupings have been made:

- Low density: 0-2,000 persons per square mile
- Medium density: 2,001-6,000 persons per square mile
- High density: 6,001-10,000 persons per square mile
- Very high density: 10,001+ persons per square mile

Employment Density

Figure 2 identifies the employment density in jobs per square mile by traffic analysis zone (TAZ) based on 2005 estimates from the Houston-Galveston Area Council (H-GAC). As can be seen from the figure, the highest employment concentrations occur in the major activity centers of Downtown, Galleria/Uptown, Texas Medical Center, Greenway Plaza, Greenspoint, the Westchase District, and the Energy Corridor. These data will be updated when new data become available.

Number of Trips People Take

The number of trips people take varies greatly throughout the METRO Service Area, and the process of estimating it takes several factors into consideration. Long-range plans usually base the number of trips people take on a computer-based model. METRO and H-GAC share a computer-based model, called a travel model, that uses mathematical representations of how travel occurs in the region today and how it will change in the future. Although this tool is used for many general planning purposes, METRO is keenly aware of the limitations of the methodology. Actual ridership projections for a specific project undergo closer scrutiny that not only combine data from H-GAC and METRO, but also take into account public input, demographics from the U.S. Census and other sources, as well as actual field visits in order to assess a project's feasibility and potential ridership impact in the short to mid-term horizons. METRO's Ridership Analysis and Service Evaluation (RASE) and Service Planning Departments closely evaluate past and present ridership information for existing services in order to develop accurate future ridership projections for potential services.

Dependency on Transit

Figure 3 identifies the census block groups where the number of families living below poverty is above the average for the METRO Service Area based on a 2009 population estimate from the company Nielsen Claritas. Although low-income does not necessarily translate into transit dependency, more often than not, low income populations tend to have a higher dependency on transit when compared to mid to high income populations. Data on car availability per household from the Census also help determine potential transit dependent populations. However, no recent car availability data is currently available to METRO. The upcoming release of the 2010 Census data will make available current data for both poverty and car availability.

Figure 1

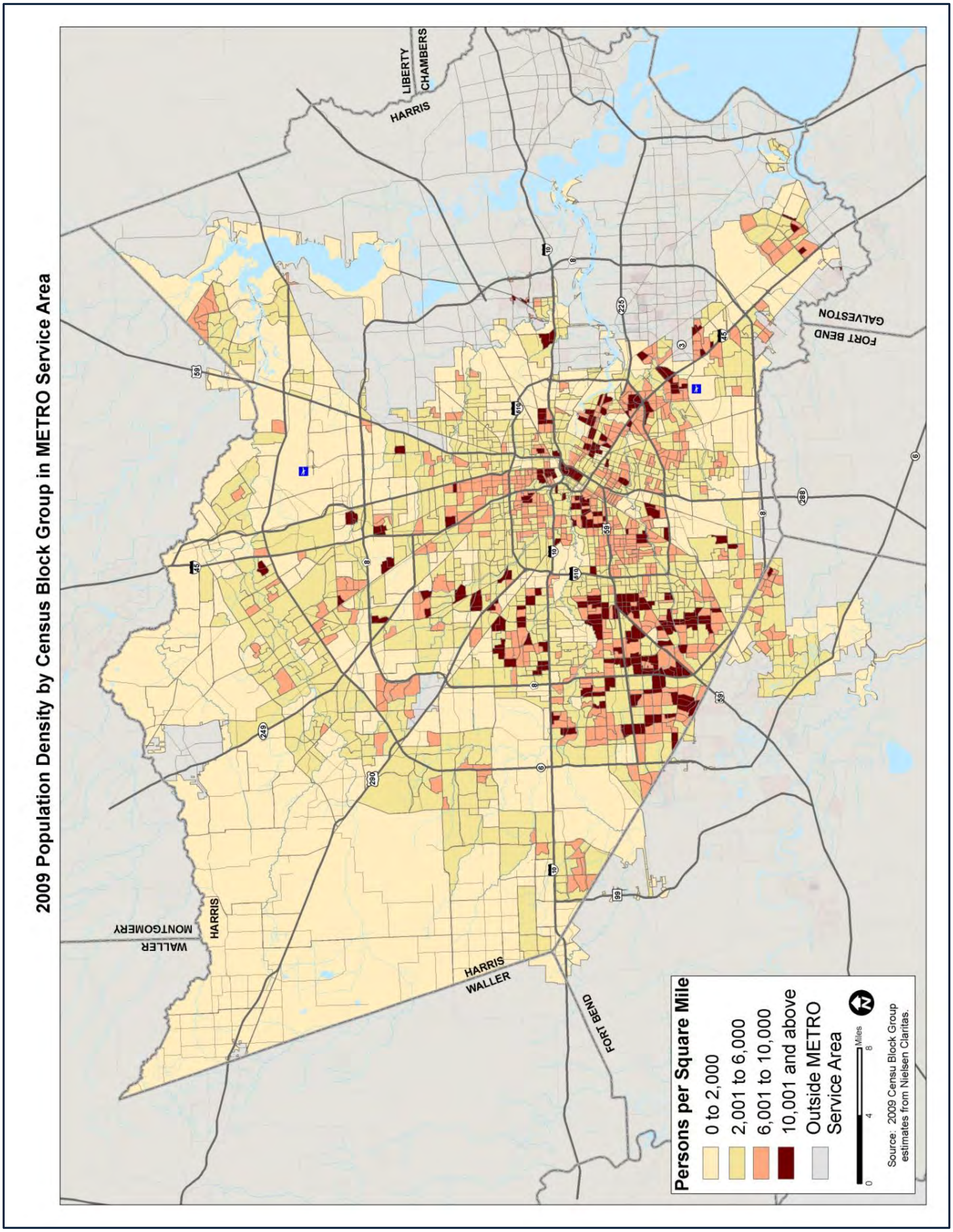

2009 Population Density by Census Block Group in METRO Service Area
Persons per Square Mile
0 to 2,000
2,001 to 6,000
6,001 to 10,000
10,001 and above
Outside METRO Service Area
Miles
0
4
8
Source: 2009 Censu Block Group estimates from Nielsen Claritas.
HARRIS
LIBERTY
CHAMBERS
GALVESTON
FORT BEND
WALLER
MONTGOMERY

Figure 2

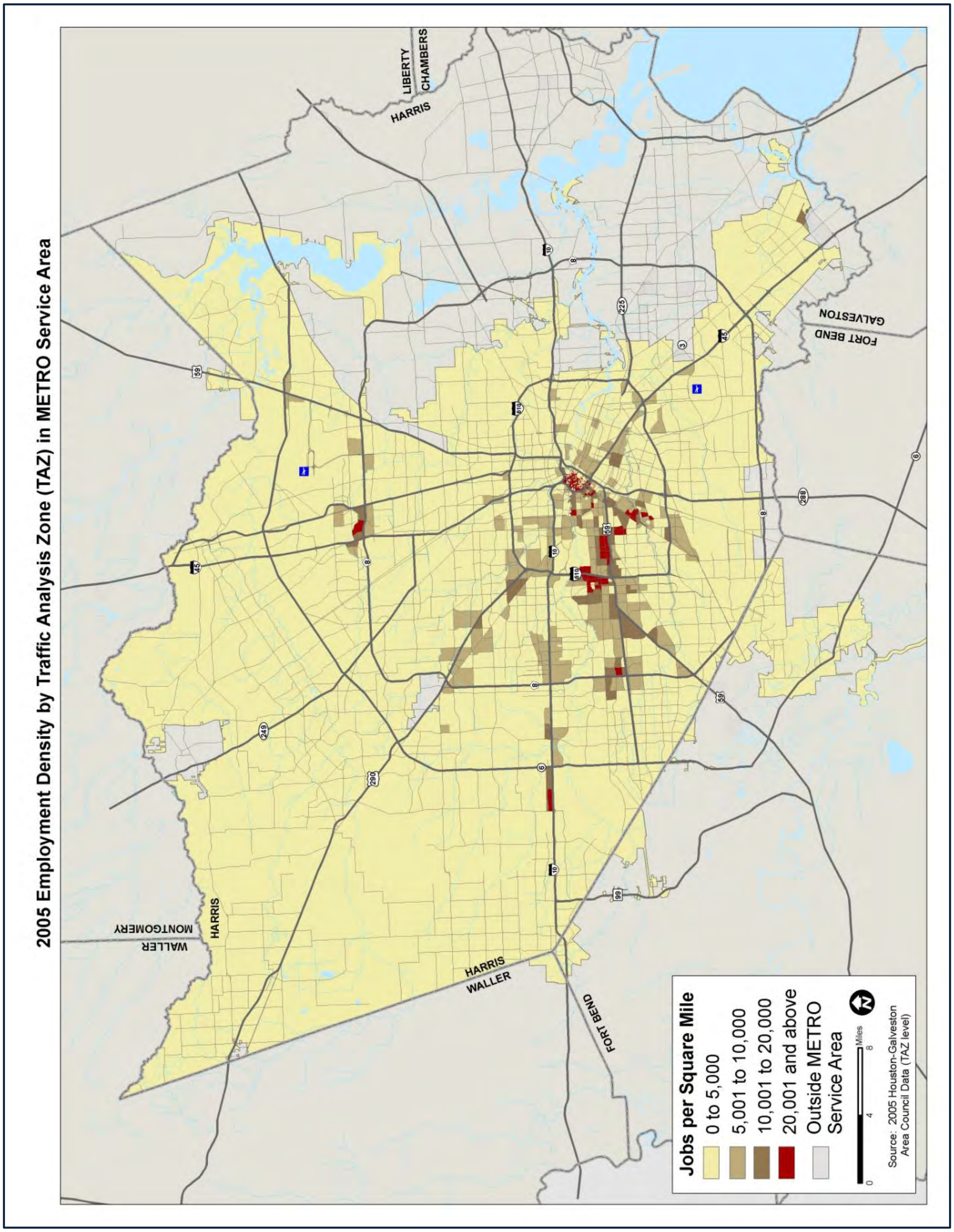
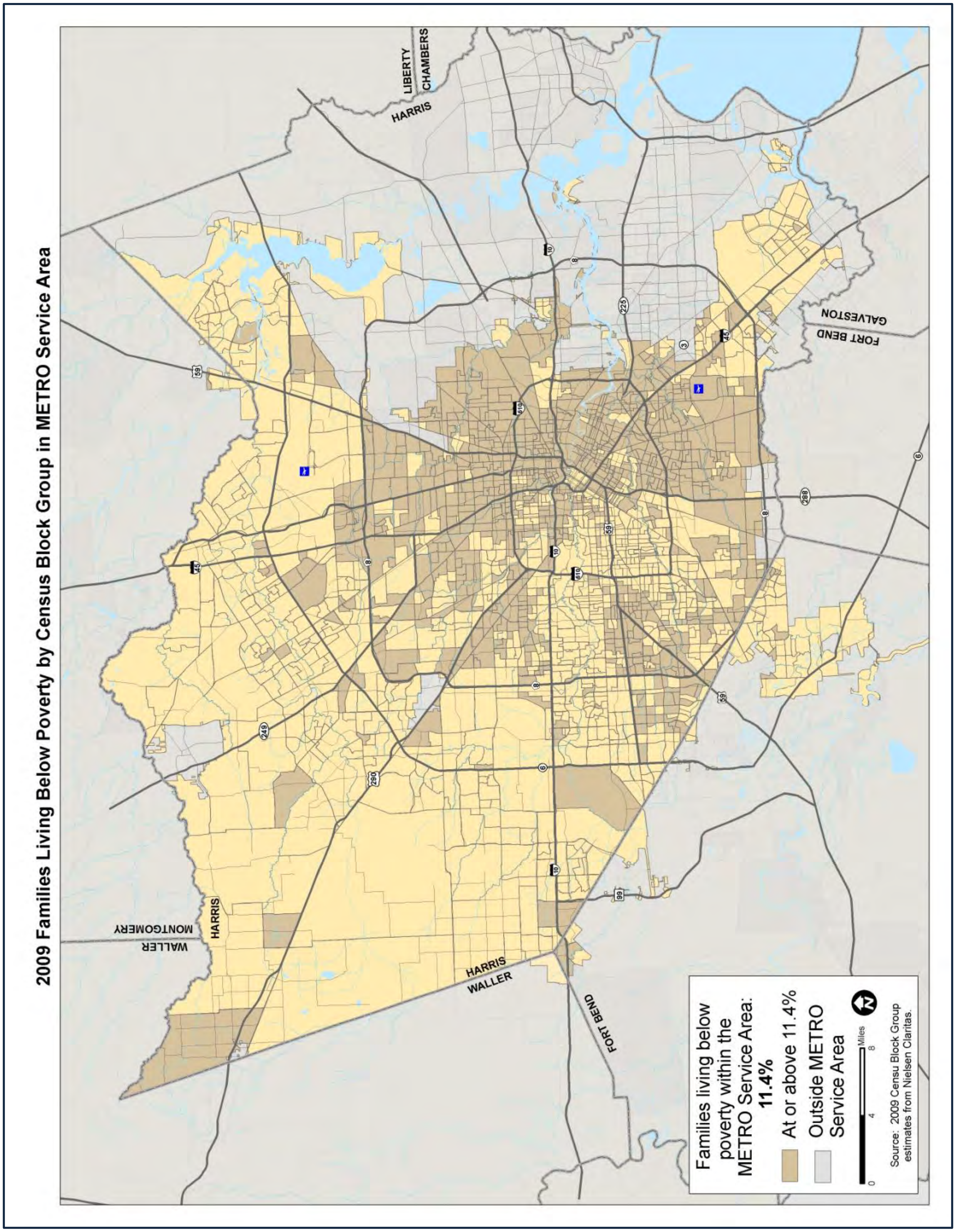

2005 Employment Density by Traffic Analysis Zone (TAZ) in METRO Service Area
Jobs per Square Mile
0 to 5,000
5,001 to 10,000
10,001 to 20,000
20,001 and above
Outside METRO Service Area
Miles
0
4
8
Source: 2005 Houston-Galveston Area Council Data (TAZ level)
HARRIS
LIBERTY
CHAMBERS
GALVESTON
FORT BEND
WALLER
MONTGOMERY

Figure 3



2009 Families Living Below Poverty by Census Block Group in METRO Service Area
Families living below poverty within the METRO Service Area: 11.4%
At or above 11.4%
Outside METRO Service Area
Miles
0
4
8
Source: 2009 Censu Block Group estimates from Nielsen Claritas.
HARRIS
LIBERTY
CHAMBERS
GALVESTON
FORT BEND
WALLER
MONTGOMERY

TYPES OF TRANSIT SERVICE

This section describes the transit services and programs presently offered by METRO. There are two basic classifications of bus service, Fixed-Route Bus Service and Other Transportation Services. In addition, the light rail service known as METRORail is also described. The standards contained in this document focus on fixed-route service; however, some aspects of light rail service are also covered. Although infrequent, METRO may provide emergency/evacuation and charter services under certain circumstances; these are also covered in this section.

Fixed-Route Bus Service

Fixed-route services operate on a predetermined, fixed-time schedule over a prescribed route using specified streets. The consistency of fixed-(or regular) route service allows the printing and distribution of timetables and route maps. Fixed-route service is operated by buses generally with 38 or more seats and constitutes the majority of METRO's bus service. Fixed-route service is further classified into two major types: Local Service and Commuter Service.

Local Service

Local bus service is transit service that picks up and discharges passengers all along the route and, consequently, operates at a relatively low average speed. Local service provides the greatest concentrated geographic coverage of the METRO Service Area.

Signature Service

This is local bus service that serves select limited stops that have high connectivity and ridership on existing local service routes. The service operates with reduced headways and higher speeds than the existing local service route. METRO currently operates two Signature Service routes branded as the 402 Quickline and the 426 Swiftline.

Commuter Service

Commuter Service is transit service that travels directly to or from a major employment activity center with single or limited passenger pickup locations. Commuter service is offered by METRO's Park & Ride Routes.

Other Transportation Services

METROLift – METROLift is a complementary paratransit service, in accordance with the 1990 Americans with Disabilities Act (ADA). METROLift provides transportation for persons with disabilities who cannot board, ride or disembark from a regular METRO fixed-route bus, even if that bus is equipped with a wheelchair lift or ramp.

METROLift is a currently contracted service using METRO-owned vans with wheelchair lifts and contractor-owned, ramp-equipped minivans. Trips are scheduled one day in advance and provide curb-to-curb transportation for persons with disabilities, who have applied for and are eligible for ADA paratransit service.

In addition, METRO contracts with cab companies to provide same-day service, best provided by taxicabs using the METROLift Subsidy Program (MSP). MSP is taxi transportation for certified METROLift patrons who have same-day trip requirements that can't be provided by METROLift.

Guaranteed RideHome – A service that uses the MSP contract for taxi transportation providing users of METRO's commuter service with a free ride home in the middle of the workday, should they have an emergency and there is no midday bus service on their route. A taxi ride is arranged to pick up the passenger at their place of work within 20 minutes after contacting a METRO representative. Riders must be registered with METRO to utilize this service and must meet the emergency criteria of the program.

METRO STAR – A regional vanpool service offering hundreds of scheduled vanpool routes serving the 8-county Houston-Galveston Transportation Management Area, including the counties of Harris, Brazoria, Chambers, Fort Bend, Galveston, Liberty, Montgomery, and Waller. METRO sponsors the vanpool service for commuters who do not have access to convenient transit services. METRO STAR promotes vanpooling to the public, assists with the formation of vanpools, arranges vanpool vehicles, supports vanpool groups, and administers the service. Characteristics of the METRO STAR vanpool service include:

- Five to fifteen commuters share the ride and cost of commuting to-and-from work in a METRO STAR vanpool vehicle.
- Volunteer drivers operate the METRO STAR vanpools and are also counted as passengers. Drivers often pay a smaller share of the costs in exchange for coordinating the vanpool and assuming primary driving responsibility.
- Many area employers offer a transportation benefit to participating employees to defer some or all of the cost to participants.
- METRO STAR customers are eligible for an emergency ride home service, in the event of a qualifying mid-day emergency or unscheduled overtime.

METRO STAR also offers RideShare, a free service that assists commuters in matching with others who have a similar commute pattern through the web, over the telephone, and through outreach.

- METRO allows vanpoolers and carpoolers to park in many METRO Park and Ride lots to begin their trips.
- Vanpoolers and carpoolers are allowed to use METRO's High Occupancy Vehicle (HOV) lanes and managed lanes to reduce travel time.

Light Rail (METRORail)

METRORail is a light rail line that is 7.5 miles in length with 16 accessible stations connecting the Central Business District, the Museum District, Texas Medical Center and Reliant Park. METRORail provides connections with many local and commuter service bus routes.

Charter Services

Federal Regulations 49 CFR Part 604, Charter Service; 73 FR 2326 Final Rule 4/30/08 prohibits all public transit agencies from providing Charter Services unless certain exceptions are met. The Federal Transit Administration (FTA) requires METRO to provide a quarterly report for all transit service exceptions.

Emergency/Evacuation Services

Local Area Assistance

METRO has transportation services and other available resources that may be requested by the cities, counties, school districts, and organizations within METRO's service area or the Houston/Galveston region before, during, and after an emergency.

As a standard practice, METRO's resources should be used first to provide public transportation service for METRO passengers as "Top Priority." To the extent that resources become available, METRO will consider requests for assisting in programs that save lives, protect property or the environment, help stabilize an emergency, or restore services to any affected community.

METRO Emergency Management Plan provides general guidance to METRO management and employees who are responsible for the mitigation, preparation, response, and recovery from any disaster. The Plans developed for Local Area Assistance have been designed to support the intent of the Authority's Emergency Management Plan.

Four Local Area Assistance plans have been developed to support the community if the need for transit service is requested. Each plan is established with the Authority's normal level of daily service as the baseline operation. These Plans are:

A. Early / Emergency Evacuation Transit Service
B. City of Houston's 311 / METRO Emergency Evacuation Plan
C. City of Houston / Harris County Evacuation Hub Plan
D. City of Galveston / METRO Emergency Evacuation Plan

Early / Emergency Evacuation Transit Service

The Early / Emergency Evacuation Transit Service Plan is designed to support an Early Transit Service, an Early/Emergency Transit Service, or a Total Evacuation Service.

Early Transit Service – Early Transit Service is normally required when employers of companies located in major activity centers are releasing their employees from work prior to their normal work hours for the holiday (e.g. day before a holiday, etc.) These days can be scheduled as additional hours to the regular operation on selected runs. This operation is classified as a normal operation with street and weather conditions clear. The execution of Early Transit Service is subject to budget approval every year.

Day of Operation Day before Thanksgiving, Christmas, New Years
Normal Operation
Span of Service: 12:00 noon – 3:30 p.m.
Headways: 30 minutes
Standard Materials Required and Updated Annually: Facility sign-up sheet and pull-out information; Buffalo Bayou pull-out sheet; schedules, operator paddles and operator maps; supervisor guides; equipment required to provide service.

Early / Emergency Transit Service – Early Transit Service is desirable when employers of companies located in major activity centers are releasing their employees from work early when the National Weather Service has issued a flash flood warning, ice storm watch, ice storm warning, snow storm warning, hurricane watch or hurricane warning for a given day.

During these events, TranStar and Service Supervision shall continuously monitor the local and National Weather Service reports to provide the agency the required time to schedule Early / Emergency Transit Service. The monitoring of these reports will allow the decision-making process the required time for these days to be scheduled as an addition to the day to day operations. This operation is classified as a severe operation when street and weather conditions and traffic congestion will impair our ability to operate normal service.

Day of Operation: As Requested
Normal Operation
Span of Service: 12:00 noon – 3:30 p.m.
Headways: 15 minutes
Standard Materials Required and Updated Annually: Facility sign-up sheet and pull-out information; Buffalo Bayou pull-out sheet; schedules, operator paddles and operator maps; staging area corner guides; supervisor guides; equipment required to provide service.

Total Evacuation Service – Total Evacuation Service for a major activity center is required when the agency is informed that the Houston area is subject to a major disaster. Employers of companies located in a major activity center are releasing their employees from work early due to a natural or man-made disaster or the knowledge of the occurrence of a disaster.

The agency must respond in a timely manner by dispatching buses to various predetermined staging locations to implement the required service. It is important that the decision-making process allows the required time to capture the maximum number of personnel and equipment to support the evacuation process. This operation is classified as a severe operation because street and weather conditions and traffic congestion are unknown and may impair our ability to operate normal service.

Day of Operation: As Requested
Severe Operation
Span of Service: 9:00 a.m. – 3:30 p.m.
Headways: 5 minutes
Standard Materials Required and Updated Annually: Facility sign-up sheet and pull-out information; Buffalo Bayou pull-out sheet; schedules, operator paddles and operator maps; staging area corner guides; supervisor guides.

City of Houston's 311 / METRO Emergency Evacuation Plan

The City of Houston and METRO have established an Emergency Evacuation Operational Center to provide transportation for individuals in the community requiring assistance to evacuate the area. The Emergency Evacuation Operational Center is an extension of the City of Houston's 311 Service Helpline. The Operational Center is located on the 5th Floor of 611 Walker Street in the 311 Service Helpline training room and the Dispatch Section of the Operational Center is located on the 1st Floor of the same location. Individuals requiring transportation assistance during an evacuation will now have the option to call the City of Houston's 311 Service Helpline. The requests for transportation will be forwarded to METRO and equipment will be dispatched to evacuate those individuals. Equipment and staff assigned to this operation include:

METRO buses
METROLift vehicles
Yellow Cab
Super Shuttle

Day of Operation: As Requested
Severe Operation
Span of Service: 72 hours to 8 hours prior to landfall
Headways: Dispatched upon request
Standard Materials Required and Updated Annually: George R. Brown Convention Center Operator Maps

City of Houston / Harris County Evacuation Hub Plan

The George R. Brown (GRB) Convention Center is a large facility centrally located out of the storm surge risk area. This facility has been designated to serve as the hurricane evacuation hub for residents from both the City of Houston and Harris County.

This plan will be activated at approximately H-48 (48 hours prior to storm's predicted landfall) and is expected to continue to approximately H-12 to coordinate the evacuation of special needs individuals who reside within Harris County. At H-12 operations will shift focus, based on remaining resources, to move individuals from the evacuation hub to a refuge of last resort. The evacuation hub will be closed by H-6. The City of Houston's 311 Call Center will be established to receive calls from residents requiring assistance with transportation to evacuate. METRO will coordinate the transportation and deliver individuals to the GRB. METRO will also coordinate the delivery of State buses from Tully Stadium to Minute Maid Park Lot A.

Day of Operation: As Requested
Severe Operation
Span of Service: 72 hours to 6 hours prior to landfall
Headways (Tully Stadium): Dispatched upon request
Standard Materials Required and Updated Annually: Tully Stadium to George R. Brown Convention Center Operator Maps

City of Galveston / METRO Emergency Evacuation Plan

METRO has signed an Inter-Local Agreement or Memorandum of Understanding with the City of Galveston to provide and/or obtain additional transportation services or other resources during an emergency. Under an existing agreement with the City of Galveston, METRO may provide up to 30 emergency evacuation buses to the City of Galveston's Island Community Center and transport evacuees to designated evacuation shelters in the City of Austin.

Day of Operation: As Requested
Severe Operation
Span of Service: 72 hours to 24 hours prior to landfall
Headways: Dispatched upon request
Standard Materials Required and Updated Annually:
Island Community Center to the City of Austin Operator Maps

ROUTE DESIGN GUIDELINES

Bus Route Design Guidelines are established to ensure that METRO bus routes provide service to major activity centers or other passenger destinations with the highest level of accessibility and service coverage possible, while making the most efficient and productive use of METRO's available financial, physical and labor resources. Because of the variation in demand for transit services in the region, due to the existence of different transit markets, one set of standards is not adequate to design an effective and efficient system. Therefore, standards have been developed that take into account the differing needs of transit riders based on certain underlying service area characteristics, especially population density (persons per square mile).

It must be noted that providing any level of service to an area depends on the productivity of that service. If existing or proposed services cannot meet the appropriate productivity standards, then METRO may elect not to provide the minimum level of service identified in this section.

Area Coverage (Route Spacing)

The distance between parallel routes is referred to as route spacing. To enhance the attractiveness of transit usage, service should provide all segments of the region with good access from residential areas to concentrations of employment, essential services and other passenger destinations. The distance people must walk to reach bus passenger loading areas is a good indicator of the area coverage provided by METRO. It must be noted that parallel routes that are operating too close together (generally within 1/2 mile of each other) have the potential to split the demand for service. In areas of low demand, this can result in multiple routes competing for the same passengers with no route generating sufficient demand to support a higher level of service. Thus, providing the appropriate route spacing to attain good area coverage requires a tradeoff between walking distance and frequency of service provided in the region.

For METRO's service area, the recommended route spacing standards are as follows. Please note that these are to be used only as general guidelines. Other factors such as passengers per trip and/or passengers per stop, street layout, natural or man-made barriers, and other factors should also be considered when determining route spacing.

- Very High and High Density Census Block Groups – In census block groups with 6,001 or more people per square mile, bus routes are recommended to be spaced at a maximum distance of 1/2 mile apart.
- Medium Density Block Groups – In census block groups with 2,001 to 6,000 people per square mile, bus routes are recommended to be spaced at a maximum distance of 1 mile apart.
- Low Density Census Block Groups – In census block groups with up to 2,000 people per square mile, Park & Ride facilities are recommended to be located so that the majority of the area's residents live within a 10-mile or a 20-minute drive of the facility.

Route Variations

It is sometimes more efficient to provide service to a certain area with one route having several branches than to operate several different routes. In addition, some bus trips on a route may not go to the end of the line due to very low ridership in that area at a particular time of day. This is called a "turnback" trip. However, these actions can result in a system that is much more difficult for current, as well as potential, transit passengers to understand and utilize. Therefore, to provide a user-friendly service and to encourage maximum use of the system by all current and potential riders, the following standards for branches and turnbacks are strongly recommended:

- No new route should have more than two (2) distinct branches.
- No new route should have more than one (1) turnback location.
- Reducing the number of branches and/or turnbacks will be given consideration in the preparation of the Transit Service Plan.

Note: 1) Two routes serving different parts of the service area with both terminating in the Central Business District (CBD) may be joined together as one route in order to operate more cost-effectively. By reducing bus requirements and duplicative service, congestion in the CBD is lessened. The two routes involved are listed as a single route, and such routes are called "hooked" routes. Each end of a "hooked" route will be considered a separate route for the application of this standard. 2) It must be noted that some existing routes currently have more branches and/or turnbacks than what is recommended. Consideration will be given in future service plans in order to bring these routes within recommended parameters.

Directness of Travel

METRO bus routes will be designed to operate as directly as possible to or from a major destination in order to minimize passenger travel time. Routes shall operate on major arterial streets as much as possible. However, there may be situations in which a route may deviate from the shortest, most direct routing. Such situations include a mid-route deviation to serve a particular trip generator or other high potential passenger area that does not have service, at the end of the line terminal loop, or for a route serving a small geographical area.

When a deviation exists or is being considered, the gain in convenience to those passengers who are boarding or alighting during the deviation must be balanced against the additional travel time for the passengers traveling through. How the potential deviation would affect the route’s safety, reliability, and operational integrity must also be considered.

Bus Stop Spacing and Positioning

Bus stops are spaced according to two (2) main criteria: accessibility and travel speed. Close spacing of stops increases patron accessibility but increases transit trip time and may reduce carrying capacity. Therefore, a balance must be made between these two criteria.

Travel speed is considered the primary criterion for route segments that usually have heavy volumes of automobile and transit passenger traffic. Closely spaced stops tend to reduce transit speed and interrupt the traffic flow. Therefore, stops are usually placed only at major intersections, transfer points, and major passenger generators. Notwithstanding this, an attempt is made to maintain a maximum of 1,000 feet between stops.

Accessibility is considered the more important criterion for route segments in which closely-spaced stops would not adversely affect transit speed and/or traffic flow. Stops are spaced to reduce the passenger's walking distance to the stop. These stops are placed at most intersections, crosswalks, passenger generators and transfer points. The average spacing of stops on this type of route is about every two blocks. Two other important criteria that are examined are consistency in stop spacing and the impact on adjacent land use and development.

As a general rule, bus stops are located on the nearside of intersections. Many factors, notably safety, indicate the nearside stop as the most desirable in the majority of circumstances.

Quickline Signature stops will follow the same general guidelines as other bus stops, except that they will only be located at select high connectivity and/or high ridership locations along existing routes.

Detailed guidelines and further elaboration on bus stop spacing and positioning can be found in METRO's Criteria for Bus Stop Placement manual, which is currently used in the spacing and positioning of METRO's bus stops. The manual was last revised in February 2008 and is available from the Service Delivery Department.

Bus Stop Amenities

Bus stop amenities, such as passenger shelters, benches and seats, curb cuts and wheelchair ramps, signs and posts, info panels and info posts along with maps, can increase the use of transit services by making the system safer and easier to use. Amenities can improve passengers' physical comfort by reducing the inconvenience of waiting at a stop, can put riders at ease about the availability of service by providing a schedule and other information and can add to a feeling of safety by being installed in well-lit locations. In addition, the presence of permanent, physical amenities conveys a sense of the stability of the system to both current and future riders.

METRO's Passenger Shelter Task Force is responsible for identifying new shelter sites throughout the service area. The Task Force is comprised of staff representatives from Planning, Engineering, Service Delivery, and Maintenance, and reviews ridership, site, cost estimates, and prioritizes new shelter installations. As a general guideline, bus stops within the METRO service area that have a minimum daily activity of 35 boardings are considered for a passenger shelter. This number was derived many years ago to provide an adequate list of candidate sites which have a higher than average number of passenger boardings.

Besides the 35 daily boardings, other criteria used for evaluation are transfer points, proximity to major activity centers, presence of elderly/physically challenged patrons, safety issues, and site feasibility. Shelter sites are also identified through public requests. METRO has at least four types of anodized shelters (IB, IIB, IVB, and VB) plus Midtown, Uptown, Greenspoint, Downtown, and Hobby Airport shelters to match the varying circumstances encountered in the service area. Shelter type descriptions can be found in METRO's Facilities Manual, and is available from the Service Design & Development Department.

The following guidelines are used to prioritize the desirable installation of amenities at current and proposed bus stop locations, although some variation does exist due to site specific constraints:

Daily Passenger Boardings

Feature	≤35	36-100	101-200	201-300	>300
Sign and Post	S	S	S	S	S
Seating (No Shelter)	O	n/a	n/a	n/a	n/a
Passenger Shelter	O	S	S	S	S
Trash Receptacle	O	S	S	S	S

Key: S = Standard Feature, O = Optional Feature, *n/a* = not applicable

Although it may not always be practical or possible, it is METRO's goal for all bus stops that have a shelter to have an info panel. In order to maintain accurate information, info panels shall be updated every time there is a schedule and/or route change that modifies the route information displayed.

Signs at Bus Stops – All bus stop signs shall have the route number, route name and METRO's information phone number, 713-635-4000, on the sign. All bus stop signs are also numbered for reference in case of an emergency.

Signature Service stops will have distinctive features compared to other bus stops. The 402 Quickline currently has a distinctive shelter design, distinctive landscaping and signage, and the presence of an electronic sign that displays the real time arrival information for the upcoming bus. These stops are referred to as "stations" because of the amenities present. The 426 Swiftline currently has distinctive signage.

Service Detours and Interruptions

METRO's objective is to operate a safe, reliable and efficient multi-modal transportation network. This network includes, but is not limited to, the following components - METROBus, METRORail and METROLift. The integration of these transportation services will assist in accomplishing the region's clean air standards, alleviating traffic congestion and improving the overall quality of life in the METRO service area. Sometimes, however, circumstances arise that require detours and/or cause service interruptions.

For fixed-route service, all efforts shall be made to move routes to the closest adjacent street. If the affected area is in the CBD or another area with many one-way streets, then the detour shall be a maximum of two (2) blocks from the current routing, if possible.

Signs informing passengers of long-term detours shall be placed at all regular bus stops several days prior to scheduled events. These signs will be posted as soon as possible if the condition(s) requiring a long-term detour occurs with short notice. Temporary bus stop signage shall be installed at the new stop locations the day prior to the change. In the case of unplanned events; temporary signage shall be provided at the new stops as soon as possible if the detour is going to last more than 24-hours. All efforts shall be made to return service to the streets that are identified on the public timetables within 24-48 hours by the next day after the disruption is over or removed.

The following defines the three types of detours experienced by our fixed-route bus service. Also described is the general strategy for service interruption for bus and rail.

Emergency/Temporary Bus Detours

Emergency/temporary bus detours result from unforeseen circumstances that prevent a bus from operating on its regular route. Examples of unforeseen circumstances which may cause an emergency or temporary bus detour are unplanned or unscheduled street repairs, fires, traffic accidents, blocked railroad crossings, temporary street closures for parades, or unplanned or unscheduled closure of high occupancy vehicle (HOV) lanes. These detours generally are in effect from one (1) or more hours up to one (1) week.

Short-Term Bus Detours

Short-term bus detours result from planned changes to street conditions that prevent a bus from operating on its regular route. Planned changes to street conditions may be the result of utility work, street renovation or repairs, or other construction projects that cause the closure of a street section or an entire street. A department within a city, county, or state agency, or a utility company generally initiates the planned changes. These detours generally are in effect from more than one (1) week up to three (3) weeks.

Long-Term Bus Detours

Long-term bus detours also result from planned changes to street conditions that prevent a bus from operating on its regular route. The causes for long-term bus detours are generally the same as those for short-term bus detours. Planned changes for long-term detours are initiated in generally the same manner as planned changes for short-term detours. These detours generally are in effect from more than three (3) weeks up to six (6) months. A detour that is in effect longer than six (6) months will be considered a permanent change to the route.

Service Interruptions

To maintain a seamless service, the Authority must establish a service recovery plan to assist with any scheduled or unscheduled service interruptions to the network. The operational strategy for service interruptions is to restore service as fast as possible and to maintain a seamless transition between bus and/or rail service. This operating strategy consists of the following:

- Develop and maintain bus and rail recovery procedures.
- Identify key personnel.
- Establish response times for all key personnel.
- Establish and implement a notification process.
- Establish an emergency contact list.
- Develop the required print materials to support a service interruption (maps, signage, etc). Post, update, and distribute print materials to inform customers and staff of the service interruption.
- Maintain a training program to address service interruptions.
- Establish and implement emergency announcements for our customers.
- Conduct announcements to inform our customers of their transportation options.
- Dispatch buses to all disabled vehicles to assist with the provision of service to our passengers.
- Establish a service interruption evaluation process.

Rail Service Interruptions

The Authority must maintain an operational strategy for providing service for scheduled or unscheduled rail service interruptions. This strategy must consist of the use of a “single track rail operation,” bus bridge operation or existing fixed-route service. It is imperative that the standard operating procedures for rail service interruptions include the following areas:

- Incident Reporting Process
- Notification Process
- Staffing and Equipment Assessment
- Troubleshooting Evaluation
- Rail Service Interruption Status Review
- Required transit service in lieu of normal rail service
- Recovery Process

SCHEDULE DESIGN STANDARDS

Schedule design standards are established to ensure that the level of service offered by METRO will be adequate to attract new riders to the system and to maintain present riders. Service reliability, measured as schedule adherence, is critical in keeping customers who must rely on METRO's service or who may not have alternate means of transportation. A standard for adherence to the printed schedules is necessary to ensure that this crucial aspect of our service is regularly reviewed and addressed.

It is also essential to establish criteria for the scheduled interval between buses, as well as the hours during which a route will operate. In addition, standards for the number of passengers on a bus and the type of bus on a route are vital in ensuring that these patrons have a comfortable trip that will encourage them to continue to utilize the service.

All METRO's buses are accessible to handicapped riders, and most buses are equipped with racks that hold up to two bicycles. Our standards for accessible service reflect our commitment to the citizens of Harris County who have mobility impairments, while our standards for bicycle racks reflect our support for various forms of mobility.

Schedule Adherence

An important element of the success of the service METRO provides to its customers is the quality of that service. Service quality is directly related to customer satisfaction. On-time-performance (OTP) is a critical service quality issue. OTP will be reviewed annually as part of the development of the METRO Business Plan. At this time, a target percentage for OTP service for the upcoming fiscal year will be established so that an acceptable level of OTP reliability can be maintained and ensure that patronage is not discouraged by an unacceptable level of on time reliability. For FY 2011, the OTP goals are 67% for local service, 75% for Park & Ride service, and 69% for the weighted average.

METRO Bus

The current Integrated Vehicle Operations Management System (IVOMS) technology enables METRO to identify and quantify issues that compromise OTP, and to provide a method to implement corrective action. Weekly reports prepared by the Operations Management Analyst are compiled and used to identify low performing routes, blocks, patterns, and time-points. Reports from the IVOMS MOBILEstatistics system facilitate this process with granular detail by block, trip, and time point. Analysis of schedules and route performance utilizing reports from the IVOMS MOBILEstatistics system can help identify chronic variance from schedules, and facilitate investigating causative factors. Factors that can be addressed and identified when conducting investigations include, but are not limited to:

- Passenger loading factors
- Traffic or street conditions
- Travel time
- Scheduled cycle time relative to headway and coordination requirements
- Allocation of cycle time among route segments and recovery time
- Consistency of scheduled time among routes sharing common segments
- Location of time points relative to route length and transfer connection needs

- Variance of scheduled time versus actual time departures/arrivals
- Consistency of bus operation with traffic flow along route segments

Bus Operators encounter many situations that prevent precise schedule adherence at each and every time point. It is necessary to establish measurement standards that acknowledge this reality. The measurement standard is established for reporting on-time performance. The current measurement standards for on-time performance are as follows:

- Local Service – It is based on weekday and weekend scheduled trips. A departure parameter of no early departures/less than 6 minutes late is used, which is in compliance with the Texas Transportation Code. All time-points and every day of the month will be included in the calculation.
- AM Peak (5:00am to 8:59am) Commuter Service – This is calculated based on inbound trips, using only departures from Park & Ride stops. Any early departures within 5 minutes of the schedule are considered as load and go buses and, therefore, are considered on-time. (Load and go is defined as buses that are at capacity prior to scheduled departure, buses that depart early due to bus crunching, or under the direction of a supervisor). The calculation will be based on a sufficiently large sample size, generally one month of data.
- PM Peak (3:00pm to 6:59pm) Commuter Service – This is calculated based on outbound trips using downtown time-points prior to the bus entering the HOV lane or highway under the parameter of no early departures/less than 6 minutes late. This calculation will also be based on one month of data.
- Identified data anomalies will be excluded. These anomalies include those that have proven to be caused by short-term detours, construction delays, train delays, inclement weather, and other delays that exceed normal boundaries not accounted for in the schedules (i.e. flooding).

METRORail

On-time performance for METRORail is measured according to the following standards:

- The time-points used to measure on-time performance are the two terminal stations, Fannin South and University of Houston.
- A rail OTP application retrieves arrival and departure times from the VICOS (Vehicle and Infrastructure Control and Operating System) computer system. The application also calculates the OTP.
- A late arrival occurs when the trip arrives +5 minutes past the scheduled time.
- A late departure occurs when the trip departs +5 minutes past the scheduled time.
- An early arrival is considered On-Time.
- An early departure occurs when the trip departs -1 or more minutes prior to the scheduled time.

Span of Service

METRO Bus

The time between the start and the end trip operated on a route is the span of service on that route. Public transit must operate at times that riders will want or need to use the services being offered. In order to maximize the opportunities for passengers to avail themselves of the connectivity of METRO's bus service, and to give them the confidence that direct and connecting service will be provided, a consistent span of service is needed. In order to develop span of service guidelines, the lengths of various service periods will be defined as follows:

A.M. Peak Period	6:00 a.m. – 8:30 a.m.
Midday Service	8:31 a.m. – 3:00 p.m.
P.M. Peak Period	3:01 p.m. – 6:30 p.m.
Late Night Service	6:31 p.m. – 6:00 a.m.
Saturday Service	6:00 a.m. – 6:00 p.m.
Sunday Service	6:30 a.m. – 5:30 p.m.

The recommended minimum span of service for each type of METRO fixed-route service is:

Weekday	
Local Service	6:00 a.m. – 6:30 p.m.
Commuter Service	6:00 a.m. – 6:30 p.m.
Saturday	
Local Service	6:00 a.m. – 6:00 p.m.
Commuter Service	Not applicable
Sunday	
Local Service	6:30 a.m. – 5:30 p.m.
Commuter Service	Not applicable

It is important to note that not all commuter service routes have midday service since they have to be adjusted by peak shift time and their travel distance to their major employment activity center.

If the average ridership on the first and/or last trip(s) on the schedule exceeds 65% of the seated capacity of the assigned bus, then extending the span of service on the route will be evaluated as part of the preparation of the Transit Service Plan. If this occurs, it is advisable to add the early/late trips as soon as possible since a peak bus would not be required.

METRORail

The standard for span of service for METRORail service is as follows:

Monday – Thursday	4:30 a.m. – 11:40 p.m.
Friday	4:30 a.m. – 2:20 a.m.
Saturday	5:30 a.m. – 2:20 a.m.
Sunday	5:30 a.m. – 11:40 p.m.

Service Frequency

METRO Bus

The frequency of service on a particular route (or the related measure of bus headways, which is the time interval between vehicles) is normally determined by demonstrated or projected passenger demand. Some routes, however, operate during periods characterized by low passenger demand. In such cases, adherence to frequency standards based solely on vehicle loads would result in a very low frequency of service, with excessively wide headways between trips. Therefore, minimum standards for service frequency are needed to ensure that a reasonable and attractive level of transit activity is available on all routes.

Typically, 30 minutes between bus arrivals during the peak service period is the minimum frequency at which transit provides an adequate level of basic mobility in a dense urban area. Service headways beyond 30 minutes are generally not attractive enough to develop a solid, consistent base of ridership.

The minimum standards for METRO service frequency, as expressed in minutes between buses or headways, shall be as follows:

Local and Commuter Service

Time Period	Local	Commuter
Weekdays – Peak	30 minutes	20 minutes
Weekdays – Midday	45 minutes	60 minutes
Weekdays – Evening	60 minutes	30 minutes
Saturday	45 minutes	Not applicable
Sunday	60 minutes	Not applicable

Note: These are minimum service standards that will be adjusted to ensure an efficient and/or functional schedule. Many local routes do not operate service on Saturdays and/or Sundays. These standards apply only to existing or proposed service and do not require METRO to operate service on all routes on Saturdays and/or Sundays.

METRORail

METRORail's travel time from end-to-end is 30 minutes. The standards for METRORail service frequency, as expressed in minutes between trains or headways, are as follows:

Time Period	Minutes Between Trains
Monday – Thursday	
4:30 a.m. – 7:30 p.m.	6 minutes
7:30 p.m. – 9:00 p.m.	12 minutes
9:00 p.m. – 11:40 p.m.	20 minutes
Friday	
4:30 a.m. – 7:30 p.m.	6 minutes
7:30 p.m. – 9:00 p.m.	12 minutes
9:00 p.m. – 2:20 a.m.	20 minutes
Saturday	
5:30 a.m. – 10:00 a.m.	15 minutes
10:00 a.m. – 9:00 p.m.	12 minutes
9:00 p.m. – 2:20 a.m.	20 minutes
Sunday	
5:30 a.m. – 10:00 a.m.	15 minutes

10:00 a.m. – 9:00 p.m.	12 minutes
9:00 p.m. – 11:40 p.m.	20 minutes

Passenger Load Factors

The intent of passenger load standards is to balance passenger comfort and safety with operating costs. These standards define maximum passenger loads at different times of day, to ensure acceptable levels of rider comfort and safety, while providing METRO good operating efficiencies.

The values shown represent the total number of riders as a percent of the number of seats on the bus. The following passenger load standards shall be in force for METRO's transit service:

Service	Load
Local Service	135%
Local Service (on Freeway)	100%
Commuter Service	100%

Actions shall be taken to reduce the standing load on bus trips with load factors that are consistently greater than the values indicated above. Change in service will be targeted for the following service change. Earlier action will be taken if equipment and operators are available, and/or if the overcrowding is particularly severe.
It is important to note that loads consistently greater than the values indicated above will not require a change if: 1) Headways during the period of the trip in question are 10 minutes or less, and 2) the previous or following trip, in combination with the trip in question, both consistently have enough capacity to accommodate loads below the values indicated above. In these cases, it will be determined that the passenger(s) elect(s) to stand.

Equipment Assignments

METRO owns two types of buses: 40-foot (standard length) buses and 45-foot over-the-road buses.

Local service will be typically assigned 40-foot (standard length) buses. Commuter service will be typically assigned 45-foot over-the-road buses. All buses should be equipped with operating destination signs that display both route number and route name.

METRO owns eighteen (18) light rail car vehicles that are used exclusively for the 7.5 mile long METRORail line. These cars are deployed either as a single-car train or as a double-car train. During peak times and other periods of high demand, it is recommended that single and double-car trains alternate every other trip in order to maximize capacity.

METRO is in the process of increasing its light rail car vehicle fleet, as well as increasing its light rail service coverage. The Service Standards will be updated when these changes occur.

CAPITAL FACILITY STANDARDS

METRO has invested a substantial amount of resources into the construction, operation and maintenance of facilities that provide multiple benefits to our riders. As of May 2010, there are twenty-nine (29) Park & Ride lots and twenty (20) transit centers in operation. The Park & Ride lots provide a place for patrons to park their cars and to board a bus, carpool or METRO STAR vanpool in a convenient, weather-protected environment. METRO Park & Ride buses, some local buses, METRO STAR vanpools, and carpools can travel nonstop on High Occupancy Vehicle (HOV) lanes in six freeway corridors to work destinations in the CBD and other major employment centers.

In addition, METRO serves the riders of the local bus system by operating transit centers, which are sheltered waiting areas, strategically located where two or more weekday bus routes converge. These facilities serve as efficient hubs to allow bus riders from various locations to assemble at central points where express trips or other route-to-route transfers can easily occur. Transit centers are designed to provide a comfortable, weather-protected facility where bus patrons have a wider selection of destinations through greater transfer opportunities.

Park & Ride Lots	Park & Ride Lots
Addicks	West Bellfort
Bay Area	West Loop
Baytown	Westchase
Cypress	Westwood
Eastex	**Transit Centers**
Fannin South (Rail)	Acres Homes
Fuqua	Bellaire
Gessner	Denver Harbor / Fifth Ward
Grand Parkway	Downtown (Rail)
Kingsland	Eastwood
Kingwood	Greenspoint
Kuykendahl	Gulfgate
Maxey Road	Heights
Mission Bend	Hillcroft
Missouri City	Hiram Clarke
Monroe	Hobby
North Shepherd	Kashmere
Northwest Station	Magnolia
Pasadena	Mesa
Pinemont	Northline
Seton Lakes	Northwest
South Point	Southeast
Spring	Texas Medical Center (TMC) (Rail)
Townsen	Tidwell
West Little York	Wheeler (Rail)

Standards for the location, sizing and expansion of these facilities are used to address ongoing changes in METRO's ridership levels or passenger trip patterns. Detailed information on capital facilities can be found in METRO Facilities Reference Book, which is available from the Service Design & Development Department.

Park & Ride Lots

At the present time, METRO operates bus service from 29 Park & Ride lots owned by, or accessible to, the Authority. One Park & Pool lot at I-45 is also served by Gulf Freeway routes. Fannin South, Mission Bend, and North Shepherd are also considered Park & Ride lots; however, they do not serve any Park & Ride routes.

Average daily boardings on the primary route at each lot range from 40 on the Pasadena portion of the 244 Monroe route to nearly 2,800 on the West Bellfort routes. Vehicle parking capacity ranges from 100 spaces at the Pasadena lot to 2,361 spaces at the Northwest Station lot.

Methodology and Criteria for Park & Ride Lots

METRO utilizes standard transit practices and procedures and a tiered process for the selection of potential Park & Ride locations. The tiered process consists of a first level screening and the rating of each potential site against a criterion to develop a total point value for each site. The sites are then ranked according to the point's value; the sites with the highest point's value are considered the most desirable and are ranked accordingly. Measures were developed to assign ratings of *3= Good, 2= Fair, 1= Poor* for each criterion. No priority or weighting has been established per individual criterion. Sites are selected and reviewed based on a set of criteria that include, but is not limited to, capacity, land use compatibly, visibility, and customer convenience.
Once the sites are ranked and "short listed," the highest ranking sites are considered the highest performing sites and undergo further analysis utilizing a set of characteristics that complement and contribute to the criterion. The contributing characteristics assist in narrowing down the highest performing sites to a set of candidate sites. The candidate sites are put forth for detailed analysis, such as environmental, design, community input, etc.

Criteria

- **Bus operations** – Assessment of the travel demand and ridership to best determine the number of bus trips to serve the Park & Ride. This criterion is rated based on road access and signalized intersections.
- **Capacity** – Aerial photography and fieldwork are used to identify specific sites that meet the size requirements for Park & Ride lots (typically at least 14 acres to accommodate detention requirements). Vacant and undeveloped properties are normally chosen with enough space for platforms, bus bays, transit lanes, parking, environmental mitigations, etc. This criterion is rated based on acreage.
- **Customer Convenience** – Sites should be close enough to residential areas to provide a cone of opportunity for ridership and travel time purposes, but maintain the appropriate distance for environmental purposes; i.e. noise, air quality, etc. This criterion is based on the service (access to the Park & Ride) provided.

- **HOV Access/Managed Lanes** – Availability of HOV/Managed lanes between the freeway interchange nearest to the site and major employment destinations.
- **Land Use Compatibility** – Assessment of surrounding land use such as residential, industrial, commercial, mixed-use, etc. and its compatibility with transit.
- **Lot Location Prior to a Critical Congestion Point** - Potential sites in relation to freeway congestion; i.e., whether the site is located prior to, in the midst of, or beyond the point of freeway congestion.
- **Travel times** – Assessment of bus travel times to ensure a better bus to auto travel time ratio. Sometimes the travel time for bus and auto may be the same due to no HOV or Diamond Lanes; however it is useful in determining patronage.
- **Visibility** - Assessment of how visible the lot would be from the nearest freeway or major street (arterial), and assessment of the attractiveness of the location from a ridership standpoint. This criterion is rated based on distance from the corridor.

Contributing Characteristics

Based on the first level screening and ranking, the "short listed" sites are evaluated against contributing characteristics. As previously stated, the contributing characteristics are designed to complement the criteria, but they may also offset a missing element of the established criteria. The contributing characteristics assist in the selection of candidate sites which will undergo detailed analysis. The contributing characteristics are as follows:

- **Customer Input/Opposition –** Assessment of strong community input or opposition.
- **No Competing METRO Service** - Potential sites should also assess the proximity and utilization of any other METRO services; i.e. the nearest Park & Ride(s), Transit Center(s), local service, rail, etc.
- **Direct Ramp to a HOV** – Assessment of the availability of HOV ramps at or near the proposed site.
- **Joint Development Opportunities** - Assessment of joint development opportunities that are considered to be cost-effective and a significant benefit to the proposed Park & Ride.
- **Size –** Based on the assessment, the needs of the market to be served, and the employment destination. To determine if the site has sufficient developable acreage to meet current and projected demand for the target market.

Operating Standards

When parking conditions at a Park & Ride facility consistently approach or exceed 80% of its vehicle capacity, remedial action will be evaluated to alleviate such overloads. Remedial action may include:

- Site expansion
- Acquisition of interim Park & Ride facilities
- Establishment of parking restrictions
- Development of a new Park & Ride facility

Transit Centers

At the present time, METRO operates bus service from 20 Transit Centers owned by the Authority. METRO has established the following standards to locate transit centers that are intended to control operating costs, minimize travel time impacts to existing riders, serve a high number of riders, expand opportunities to reach a broader market and provide METRO a greater presence in a community:

- Existing routes shall have a minimum level of deviation to access the facility.
- Provide transfer opportunities between at least two (2) routes.
- The routes at the facility must serve more than one activity center.
- Transit centers should be located in areas where future services can be easily integrated with existing services.

EVALUATION OF ROUTE PERFORMANCE

METRO performs two different analyses on all existing routes and on proposed new routes. The first analysis is a route performance evaluation comparing all services, while the second evaluates routes that are classified as poorly performing routes. These analyses provide key information on the relative performance of existing and proposed new routes.

Comparative Evaluation (Route Ranking) Model

A comparative evaluation is conducted by Ridership Analysis and Service Evaluation (RASE) to identify which routes are top performers and which routes are performing below standards. The Route Ranking Model can also be used to determine whether a proposed route will likely be a high or low performer.

The general steps in the process are described below with examples of the specific methodology outlined.

- Develop average daily ridership (boardings), fare revenue, and service levels for each route. If a route is operated on weekday, Saturday, and Sunday, each service day is evaluated individually.
- Develop estimated annual ridership, fare revenue, service levels, and costs for each route. Three separate costs are derived: 1) variable cost; 2) operating cost; and 3) total cost. Total cost is used to calculate the total subsidy per boarding indicator, while operating cost is used to calculate the operating ratio. Variable cost provides a measure of the out-of-pocket cost of the service.
- Evaluate all existing routes across key productivity measures and rank the services from most productive to least productive. The comparative evaluation process utilizes four key performance factors to provide a balanced analysis between effectiveness and efficiency measures. The routes are sorted by this composite score, from the best to the worst.
- Identify “Maturing” routes (routes that have been in operation less than 2 years) for possible exclusion from the classification of Poorly Performing Routes. “Maturing” routes can be granted an exception for up to the first two years of operation to allow for adequate marketing and public information efforts to promote the route to potential riders.
- Identify Poorly Performing Routes. Poorly Performing Routes are routes with total subsidies per boarding in excess of 100% above the average total subsidy per boarding for the respective service category. These routes are subject to productivity review up to and including proposed discontinuation during the upcoming year.

Performance Indicators

The comparative evaluation for the existing and proposed new routes is composed of four performance indicators:

- Passenger Boardings / Revenue Mile;
- Passenger Boardings / Revenue Hour;
- Total Subsidy / Passenger Boarding; and
- Operating Ratio

These four factors provide a balanced weighting between effectiveness measures (the first two factors), and efficiency measures (the last two factors). Equal weight is therefore given to usage-related indicators and cost-related indicators. The four factors also provide a balance among the different types of services since a factor that favors one type of service (e.g. operating ratio favors Park & Ride routes due to the higher fares paid on Park & Ride routes relative to Local routes), is off-set by another factor that favors a different type (e.g. passenger trips / revenue mile favors local routes due to the turnover associated with multiple stops on local routes relative to Park & Ride routes).

The development of these four factors requires the calculation of several pieces of data on a route level basis. The specific definitions for each indicator are:

- **Passenger Boardings / Revenue Mile.** The number of average daily boardings per route divided by the daily number of revenue miles of service supplied on the route (total miles less "deadhead" miles, or the miles to and from the garage).

- **Passenger Boardings / Revenue Hour.** The same information as the previous indicator except using revenue service hours instead of miles.

- **Total Subsidy / Passenger Boarding.** The net cost (total cost less revenue) of operating a route divided by the number of passengers. At METRO, total cost is determined by allocating all service-related expenses over three cost factors:
    1) *Total miles* – Revenue miles plus deadhead miles.
    2) *Total hours* – Revenue hours plus deadhead hours.
    3) *Peak vehicles* – The number of peak weekday vehicles required on the route. The number of buses required to operate weekday service far exceeds weekend services resulting in bus procurements to meet weekday demand. Since buses are already available for use on weekends, no peak vehicle costs are allocated to weekend services.

- **Operating Ratio.** The operating ratio calculates the percentage of operating costs covered by that route's revenue.

Special Route Classifications

In the course of applying the service standards and the comparative evaluation model, METRO has developed definitions for certain routes that are either exempt from or are targeted for the application of the analyses. “Maturing” routes can be exempt from the analyses while routes that have significantly higher subsidies per boarding are classified as “Poorly Performing” routes and are subject to increased scrutiny.

Maturing Routes. Maturing routes are recently implemented routes that have not been in place long enough to have reached the full level of ridership projected for the route. Maturing routes can be granted an exemption for up to two years of operation to allow for adequate marketing and public information to promote the route to potential riders. For FY2011, the following routes would be classified as “maturing:”

Route	Date Started
32 Renwick	June 2009
402 Bellaire Quickline	June 2009
426 TMC Swiftline	August 2009
75 Energy Corridor Connector	January 2010
352 Swingle Shuttle	June 2010

Poorly Performing Routes. Poorly performing routes are routes with total subsidies per boarding in excess of 75% above the average total subsidy per boarding for a service category. These routes are subject to intense productivity review including modification of service mode and/or reduction in service levels up to and including discontinuation. For FY2011, the following routes would be classified as “poorly performing:”

Route	Route	Route
3 Langley – Weekday	59 Aldine Mail – Weekday	286 West Little York – NWTC / Uptown – Greenway – Weekday
32 Renwick – Weekday *Maturing*	60 Hardy – Weekday	313 Allen Parkway – Weekday
35 Fairview – Weekday	64 Lincoln City – Weekday	402 Bellaire Quickline – Weekday *Maturing*
38 Manchester Docks – Weekday	70 Memorial – Weekday	426 TMC Swiftline – Weekday *Maturing*
39 Parker Road – Weekday	75 Energy Corridor – Weekday *Maturing*	500 Airport Direct – Weekday
48 Navigation – Weekday	77 Liberty – Weekday	500 Airport Direct – Saturday
48 Navigation – Sunday	131 Memorial – Weekday	500 Airport Direct – Sunday
49 Chimney Rock – Weekday		

Route Ranking Process

The application of the comparative evaluation process described in the previous section provides a ranking of all routes in the system. The model sorts the routes from the most productive to the least productive based upon the four indicators identified above. The routes will be divided into quartiles such that the 1st quartile represents the top 25% of all routes while the 4th quartile represents the bottom 25% of all routes.

However, an absolute value to measure route productivity is needed to establish an acceptable level of performance. METRO uses the total subsidy per passenger boarding as discussed previously. The greater the individual route performance variance from the average performance within the local or Park & Ride service type, the more significant the corrective action required. METRO's guidelines for the total subsidy per passenger boarding analysis are:

- If a route's total subsidy per boarding is 51 – 75% higher than the average subsidy for the service type, METRO will monitor the route and consider minor modifications to improve route performance.
- If a route's total subsidy per boarding is 76% or higher than the average subsidy for the service type, METRO will consider major restructuring or elimination of the service.

GLOSSARY OF TERMS

Activity Center – An area with a high concentration of activities that generate a large number of trips such as shopping centers, business or industrial parks, recreational facilities, etc. The major activity centers in the METRO Service Area include Downtown, Galleria/Uptown, Texas Medical Center, Greenway Plaza, Greenspoint, the Westchase District, and the Energy Corridor.

Block – A series of trips conducted by one bus (it may be either in the morning or evening time periods).

Commuter Service – Bus service that travels directly to a central activity center with single or limited passenger pickup locations. Commuter service is offered by METRO's Park & Ride routes.

Deadhead – The miles or hours when a bus is being driven to its first scheduled time point or returning to the garage from its last scheduled time point.

45-Foot Bus – A bus used in Park & Ride service with 49-57 seats.

Frequency – How many buses pass by a point in a given time period.

Headways – The time between buses in the schedule: 5 minutes would be a very short headway; 60 minutes would be a long headway.

Hooked Routes – Two routes that generally serve different areas of the city, but are connected in the CBD to operate as one route in order to save equipment, reduce duplicative service and thereby reduce congestion in the CBD.

HOV Lane – A barrier-separated road for buses and for cars with more than one occupant that provides faster trips than freeway mainlanes and that has limited access points (not always barrier-separated in other cities).

Layover – Time built into a schedule to allow a break for the operator and to allow "catch-up" if traffic conditions cause service delays.

Local Route – Bus service that picks up and discharges passengers all along the route.

METRORail – Accessible light rail service line that is 7.5 miles in length with 16 accessible stations connecting the Central Business District, the Museum District, Texas Medical Center and Reliant Park.

Park & Ride Route – Commuter service that operates from a single or minimal number of pickup points and travels directly to the activity center with no interim stops.

Park & Ride Lot – A facility comprising of a parking area and a passenger boarding area with a covered shelter and other amenities where commuters can park their cars and catch the bus to work.

Passenger Boardings – The number of times all passengers get on any bus or train in the system.

Passenger Trips – The number of "journeys" made by all passengers in a given time period. A passenger transferring to a second bus to complete his trip would count as two boardings but only one trip.

Quickline Bus Service – A local bus service that serves select stops that have high connectivity and ridership on existing local service routes. Service is characterized by reduced headways, higher speeds, and distinctive buses and stops, when compared to regular local service. Also known as Signature Bus Service.

Revenue Service – The miles or hours operated by a bus when it is scheduled to be picking up or discharging passengers.

Run Cut – The process of setting up the operator work assignments for all the service that will be provided at the next service change.

Run – A bus operator's daily assignment. It may be eight hours straight or it may comprise two or more pieces of work on different routes.

Running Time – The time allowed on the schedule between two points.

Signature Bus Service – A local bus service that serves select stops that have high connectivity and ridership on existing local service routes. Service is characterized by reduced headways, higher speeds, and distinctive buses and stops, when compared to regular local service. Also known as Quickline and Swiftline bus service.

Time Point – A location on a route associated with the time that a bus is scheduled to depart as it operates on the route. A selection of these points (not all) is listed on the published public timetables.

Transit Center – A facility usually comprised of a passenger boarding area with little or no long-term parking, where passengers can transfer from one bus to another in a sheltered environment without having to go to downtown.

Tripper – A work assignment that includes only one revenue trip before it returns to the garage. METRO provides service at a level to meet demand. Since demand on most routes is highest in the a.m. and p.m. peak periods, it is necessary to operate additional equipment in these periods to handle the increased ridership. Most buses go out of service during the midday period when ridership falls to much lower numbers.

B APPENDIX

METRO

BOOST

NETWORK

A BETTER WALK

A BETTER STOP

A BETTER RIDE

Basis of Design

BOOST Basis of Design

Implementing Bus Operations Optimized System Treatments

Contents

Introduction

The Bus Operations Optimized System Treatments (BOOST) program aims to holistically improve the transit experience for METRO's customers with a focus on a network of the busiest bus routes across the system. The BOOST program delivers benefits to tens of thousands of existing riders and positions the corridors to attract new ridership in the years to come. Through a coordinated set of capital, operating and service improvements, the BOOST program provides existing and prospective bus riders with an enhanced experience to all parts of their trip: a better walk, a better stop, and a better ride. The BOOST program creates transit corridors that are safer, more accessible, and more comfortable for METRO riders and all people traveling along the corridor. These improvements also deliver faster, more reliable, and more frequent service.

This Basis of Design document serves as a roadmap for agency project managers, staff and partner organizations involved in the planning, design and implementation of a BOOST corridor. It outlines the process, general timeline, and roles and responsibilities of different METRO departments, and describes the principles that underpin context-sensitive, corridor-specific recommendations and designs.

BOOST Benefits & Toolbox

A transit trip involves more than just the time a customer spends on a bus or train. It starts when the customer leaves their starting point, such as their home or workplace, and includes travel to their stop or station. Trips include the time and experience waiting at the stop for the next bus to arrive, time on the transit vehicle, and travel from the stop to the destination. BOOST aims to improve each of the elements by focusing on three key components of a trip.

- **A Better Walk** – improving access and the trip to the bus stop through improved sidewalks, ADA ramps, safe street crossings, bikeways, and other first- and last-mile connections to key destinations
- **A Better Stop** – improving bus stops with more waiting space, enhanced shelters, lighting, programmable spaces tailored to the customer's needs at the stop, and customer information
- **A Better Ride** – corridor enhancements to provide faster, more reliable trips including stop placement, transit signal priority (TSP), and reinvesting savings generated from faster service into more service

The key components of each of these three elements are detailed below.

A Better Walk

Nearly every transit trip involves walking at one or both ends of the ride; this can be challenging for customers as many streets in the METRO service area have missing or uneven sidewalks or lack accessible curb ramps. Crossing high-speed streets to safely reach the bus stop or a trip destination can be difficult and unsafe. The BOOST program addresses these issues by making improvements to the sidewalk and bikeway networks along and connecting to project corridors so more people can safely access transit service. These improvements benefit all people who are traveling along these corridors, not just transit riders.

Focus areas for BOOST access improvements include:

1. Better sidewalks – New, wider sidewalks and accessible curb ramps connecting the bus stop to nearby intersections and destinations. These make reaching a bus stop easier for all types of transit users, including people using wheelchairs and people traveling with strollers, carts, or

suitcases. As some stops will be relocated to optimize service, sidewalks improvements will ensure accessibility to the nearest stop along the corridor. METRO will also work with partners such as the City of Houston, other member cities, and Harris County to facilitate the completion or repair of sidewalks along and connecting to BOOST corridors.

2. Safer street crossings – Where high-ridership bus stops on BOOST corridors are located far from existing safe street crossing locations like traffic signals and four-way stops, appropriate crossing treatments will be identified and implemented. These help customers safely cross streets on their way to and from bus stops or other destinations. The Basis of Design includes a toolbox of best practice crossing treatments to apply based on context.
3. First- and last-mile connections to major destinations – BOOST corridor projects can include high-value sidewalks to key destinations such as schools, public facilities, and parks. The BOOST program can also help implement elements of the Houston Bike Plan that provide meaningful connectivity to existing or programmed bikeways or destinations. Where feasible, this can include network segments of high-comfort bikeways to expand access to transit service to more people. Bikeways will use thoughtful design treatments—such as protected bike lanes, safe intersection crossings, and floating bus stops—to reduce conflicts between bikes and buses. Bicycle parking can also be integrated at high-use stops where space allows.

A Better Stop

While the BOOST program aims to provide more frequent and reliable service for METRO customers to simply "show up and go," some portion of the trip will still be spent waiting at the bus stop. Well-placed and well-designed bus stops can make the wait more pleasant and can even make it seem shorter, a critical component to improving the overall transit experience.

Focus areas for BOOST improvements at bus stops include:

1. New shelters and crossings – BOOST corridors will be planned to have improved shelters at every bus stop, providing shade and protection from the elements. Quality seating and lean rails will be included to make the experience more comfortable. Shelters will have integrated lighting to improve safety, security and visibility for waiting passengers. Where possible, additional space will be acquired behind the curb to provide more room for waiting customers and increased separation from traffic on the street.
2. Improved passenger information – Passenger information is important toward maximizing rider understanding of the transit system and communicating service conditions. Enhanced stops on BOOST corridors will provide real-time bus arrival and status updates. Improved signage and wayfinding maps will provide schedule data, key information, and wayfinding to destinations from the transit stop.
3. Easier boarding platforms and safe all-door access – To improve access to the bus and help improve bus speeds, stops will be designed to include near-level accessible platforms. This allows customers, particularly those with mobility challenges, to board buses faster and more seamlessly. Stops will be designed to allow riders to safely use all doors to board and alight the bus, reducing conflicts that occur at busy stops when only the front door is accessible.
4. Programmable spaces – Well-designed bus stops can be centers of activity and help improve the visual appeal and the sense of community along a BOOST project corridor. Each bus stop will be designed to fit into the local context. Where space allows, they can include programmable spaces that can be tailored to include trees for shade, space for local art, or room for bicycle parking. These

spaces will help transit integrate into the overall design of the street as an asset for the neighborhood.

A Better Ride

Transit riders seek quality service that safely and comfortably brings them to their destination as quickly and reliably as possible. The BOOST program improvements support faster service with buses that arrive frequently on each corridor. This means more time for customers to devote to other important activities in their life and less time spent waiting and riding the bus.

Focus areas for BOOST improvements to improve speed and reliability include:

1. Faster service – BOOST corridor improvements aim to improve transit travel times by at least 10 to 15 percent, helping people reach their destinations faster. Optimized stop placement and better designs mean buses make fewer, faster stops, allowing buses to pick up and maintain speed in between. Riders spend less time waiting at red lights because the bus communicates its location and expected arrival time to traffic signals as it approaches an intersection. Transit-friendly signal timing and far-side stop locations let the bus pass through the intersection upon arrival, reducing time caught in congestion.
2. Reliable service – The same treatments that improve bus speed help with reliability, so METRO's customers can depend on arriving at their destination on time. Where possible, dedicated bus lanes and queue jump lanes will provide dedicated space for buses to bypass congestion. At times when buses arrive every 12 to 30 minutes, riders can expect fewer late buses and can trust the service will take them to their destinations on schedule. When service is very frequent (every 10 minutes or less), headways are actively managed so buses maintain consistent spacing, allowing customers to know they will never wait long for the next bus to arrive.
3. More frequent service to key destinations – Faster, more reliable bus service is great for customers and has the additional benefit of lowering the cost to operate each bus route. With these cost savings, METRO can reinvest in more service, extending span to serve early-morning and late-night riders, or adding trips at the times people ride most by increasing the frequency of bus arrivals. The savings can also be reinvested into additional corridor improvements including more sidewalks, bikeways and safe street crossings.
4. More trips when people ride most – Travel time savings and simplified service patterns allow METRO to more effectively tailor bus schedules to match customer demand. This means more frequent service at the busiest times of day and less crowded buses with room for everyone to sit.

BOOST Corridors

The BOOST program is a key component of the METRONext Moving Forward Plan, focusing transit improvements on seventeen frequent, high-ridership routes that form the backbone of METRO's expanding Frequent Network. Carrying nearly 100,000 customer trips each weekday, these routes account for over half of local bus ridership and over a third of boardings systemwide—comparable to the combined total of the three METRORail lines and the full Park & Ride system (October 2019).

The seventeen initial BOOST routes were selected to include many of the highest-ridership routes, high productivity routes, and routes with strong weekend performance with a goal of providing geographic coverage across the local bus system. This allows the benefits of the BOOST program to reach a wide cross-section of METRO's customers throughout the service area. As resources allow, the BOOST program could be expanded to more routes in the future and BOOST principles can be included in any capital projects on bus corridors.

Figure 1 provides a map of the 17 BOOST corridors. Table 1 shows route performance data from October 2019 for the BOOST program routes.

Figure 1. METRONext Moving Forward Plan BOOST Corridors

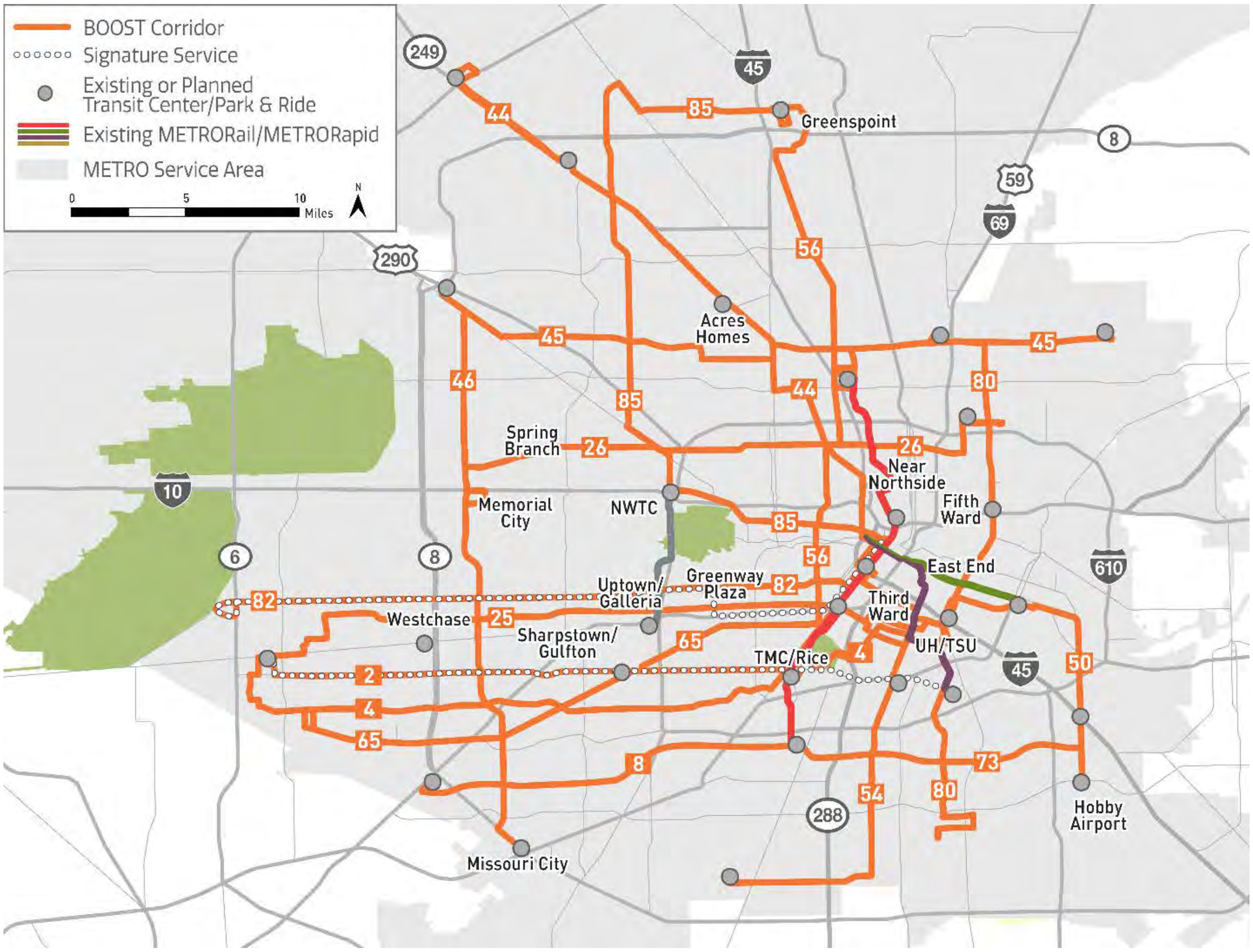


Table 1. METRONext Moving Forward Plan BOOST Corridors

#	ROUTE	WEEKDAY Ons[1]	WEEKDAY BRH[2]	WEEKDAY BRM[3]	SATURDAY Ons[1]	SATURDAY BRH[2]	SATURDAY BRM[3]	SUNDAY Ons[1]	SUNDAY BRH[2]	SUNDAY BRM[3]
82	Westheimer	13,427	28.31	2.77	9,343	24.28	2.25	7,908	23.41	1.90
4	Beechnut	8,738	26.72	2.27	5,245	22.86	1.63	4,255	18.55	1.32
2	Bellaire	7,463	29.51	2.92	5,835	29.77	2.63	4,842	24.70	2.19
25	Richmond	7,156	24.55	2.21	4,793	20.91	1.84	3,906	17.21	1.50
54	Scott	6,940	36.17	3.23	4,603	28.94	2.47	3,691	23.20	1.98
46	Gessner	6,881	32.87	2.85	4,962	25.10	2.11	3,814	19.28	1.62
85	Antoine / Washington	6,777	24.38	1.94	4,318	19.01	1.46	3,676	16.22	1.24
65	Bissonnet	6,597	29.21	2.69	4,051	22.82	1.87	3,098	17.50	1.43
56	Airline / Montrose	6,239	23.35	1.82	5,043	21.43	1.70	4,921	20.98	1.65
80	MLK / Lockwood	5,581	24.89	1.92	3,471	17.48	1.20	2,640	13.30	0.92
73	Bellfort	5,217	38.29	3.19	3,190	28.86	2.49	2,607	24.33	2.03
45	Tidwell	4,609	31.20	2.41	3,091	28.41	2.22	2,428	22.35	1.75
26	Long Point / Cavalcade	3,895	23.15	1.82	3,065	19.42	1.50	2,497	15.94	1.23
8	West Bellfort	3,264	38.75	3.24	1,965	26.63	2.35	1,651	22.38	1.97
50	Broadway	2,918	19.84	1.65	1,957	17.37	1.39	1,837	15.84	1.31
44	Acres Homes	2,832	15.97	1.19	1,915	12.76	0.95	1,618	11.09	0.83
402[4]	Bellaire Quickline	1,457	18.01	1.52	NA	NA	NA	NA	NA	NA

[1] Average daily boardings

[2] Average boardings per revenue hour

[3] Average boardings per revenue mile

[4] The 402 Bellaire Quickline will be upgraded in coordination with BOOST improvements on the 2 Bellaire corridor.

Planning, Design & Implementation

Project Team

A BOOST program manager oversees the network of BOOST corridors broadly, providing guidance to project managers for individual BOOST corridors and leading policy development, interagency coordination, and other tasks spanning multiple corridors.

On each corridor, a Planning project manager and an Engineering project manager will oversee the development of recommendations, plan sets, public outreach, and other key deliverables. The overall program manager will work closely with project managers on each corridor to coordinate the planning, design, and implementation process from start to finish. The core project team will be supported by representatives from a range of METRO departments including:

- Capital Planning
- Environmental Planning
- Real Estate
- Service Planning
- Scheduling
- Bus Operations
- Engineering
- Traffic
- Information Technology
- Facilities Maintenance
- Safety
- METRO Police
- Finance
- Procurement

- Marketing
- Community Outreach/Public Engagement
- Urban Design
- Government Affairs
- Press Office

To fully capture the opportunities and maximize benefits to the most people, implementation of the BOOST program on a bus corridor requires an integrated approach within METRO and coordination with key METRO partners such as the City of Houston, Harris County, management districts, and Tax Increment Reinvestment Zones (TIRZs). These partnerships will be critical to the outcomes of any corridor, as METRO does not control many of the elements that make a bus line successful such as signal operations, sidewalk maintenance, or street design. Sustained, ongoing coordination with partner agencies will also enable the program manager to identify opportunities to incorporate BOOST designs and treatments into capital projects led by others throughout the service area.

Moving from existing conditions to implementation of a BOOST corridor involves three primary phases: planning, design, and implementation.

Phase 1: Planning

The planning phase includes development of the specific recommendations for a BOOST corridor based on a detailed analysis of the corridor. This includes analysis of existing bus and traffic operations, assessment of street conditions and safety data, and review of the corridor in context of regional plans such as METRONext, the Houston Bike Plan, the Major Thoroughfare and Freeway Plan, flood management, and neighborhood plans such as Livable Centers studies. The deliverables of this phase include recommendations on:

- Optimized bus stop locations and potential stop design elements
- Sidewalk, bikeway and street crossing improvements
- Easement opportunities to pursue as part of design
- Transit operations including transit-friendly signal timing, queue jumps and dedicated transit lanes
- Bus service changes including route alignment, schedule adjustments, headways, and span
- Safety enhancements
- Partnership opportunities
- Initial cost estimates
- Implementation plans and schedule

Planning Phase Schedule & Timeline

The planning phase for a BOOST corridor is scheduled to be completed over a five-month time period as shown in Table 2. This allows enough time to obtain a detailed understanding of the corridor and make well-supported recommendations while progressing timely from project initiation to detailed design.

Table 2. Planning Phase Schedule

Phase I - Planning																				
	Month 1				Month 2				Month 3				Month 4				Month 5			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Data Request & Collection	■	■	■	■																
Baseline Conditions			■	■	■	■	■	■												
Corridor Overview & Conditions			■	■	■	■														
Partnership Opportunities			■	■	■	■														
Stop Activity & Conditions					■	■	■	■												
Implementation Plan							■	■	■	■	■	■	■	■						
Stop & Crossing Optimization							■	■	■	■										
Service Optimization									■	■	■	■								
Cost & Benefit Analysis											■	■	■	■						
Final Deliverables															■	■	■	■	■	■
Implementation Schedule																	■	■	■	■

The end of the planning phase will have a critical handoff from the corridor planning team to the design team that will develop the detailed implementation designs and the community engagement staff who will work with the residents and businesses along the corridor. To support a successful transition, the corridor planning team will be responsible for developing the 15% civil design deliverables discussed below and remain heavily involved in METRO's internal review of 30% civil designs. The planning team will remain involved in review of subsequent designs, but its role is expected to decrease after key design criteria are confirmed.

Phase 2: Design

The design phase for a BOOST corridor will translate the planning recommendation into a detailed design package including engineering drawings, integrated urban design elements, and recommendations on traffic operations. This design package will be developed to support the implementation timeline. Typically, the entire corridor would be developed into one plans, specifications and estimates (PS&E) bid package that would be used to procure construction services. In situations where METRO desires fast-tracking some design elements of the corridor or where real estate or other challenges could slow implementation of the whole corridor, other design approaches for those segments may be developed. Figure 2 describes the typical design deliverables for the six major types of BOOST civil design improvements throughout the planning and design phases, along with the METRO departments and partner agencies involved in internal and external review. BOOST corridor design phases are assumed as follows:

- 15% Civil Design – The first step of the design phase is the development of the 15% civil design package for the corridor. The deliverable for this step is a detailed engineering scope including all recommended bus stops, sidewalks, street crossings, street reconfigurations including bikeways, pavement repair, and traffic studies. The deliverable includes an initial construction cost estimate for planning purposes. After review within METRO, the final 15% design forms the basis for the 30% civil design.
- 30% Civil Design – The 30% design develops the layout of major design elements and refines the project's scope, schedule, and budget. The 30% design develops the initial design schematic, determines any fatal flaws, confirms design criteria, and refines the cost and schedule. Any real estate needs are confirmed and specified through this phase. A plan to complete the design including any segmentation or phasing is developed based on the 30% design.

- On sites where additional right-of-way or driveway modifications are desired, the design process will effectively pause after 30% design while METRO's Real Estate group approaches relevant property owners to assess the likelihood of negotiating right-of-way acquisition or driveway modifications. After initial outreach to property owners, the program manager and corridor project managers will assess the path forward for these sites, and many will proceed to 60% design.
- 60% Civil Design – This step develops the recommended design for the corridor that meets the goals for the project and ensures the recommended design is constructable without significant design changes. Major design decisions are defined and updates of implementation and cost estimates are included.
- 90% Civil Design – This step completes the project design, including plans, specifications and updated costs for review by the permitting agencies and funding partners. It includes METRO’s QA/QC process involving review by Planning, Engineering, and Urban Design.
- 100% Civil Design – This step produces the full PS&E set to support procurement of the construction process incorporating any final comments from the 90% review phase.

Frequent internal and external review by multiple METRO departments and partner agencies throughout the design process is critical to achieving a high-quality, cost-effective project that achieves BOOST goals and delivers improvements to customers within a short timeframe. The program manager will lead METRO’s internal review at every step of the planning and design phases. Early coordination and frequent external review by the City of Houston, Harris County, and other relevant agencies including TxDOT and TIRZs can help ensure the project proceeds on schedule.

During the design phase, the internal review process will focus on ensuring that key design criteria aligned with BOOST goals are met to the extent feasible. Table 3 outlines the required, recommended, and ideal design criteria for BOOST civil design components. Additional site-specific design criteria will also be included in 15% design deliverables. Confirming design criteria is particularly critical at the 30% design review, because the survey and field assessments conducted as part of 30% design will reveal obstacles and site constraints that make constructing ideal designs infeasible. In all situations where required and recommended design criteria cannot be achieved on the sites described in the 15% design deliverables, the program manager, Planning project manager, and Engineering project manager will collaboratively explore alternative locations, design modifications, real estate acquisitions, and other strategies to achieve the best outcome possible within a reasonable budget and timeline.

A PS&E design package will be developed for the corridor for use in soliciting bids for construction services. This could include one bid package for the whole corridor or could be divided into segments based on the implementation strategy.

Figure 2a. Planning & Design Process

PLANNING

DELIVERABLES • *Lead: Capital Planning*

- Report and supplemental deliverables including maps and tables
- Planning-level quantity and cost estimates for budgeting and scope review
- ***Bus stops:*** Location of stops to improve, relocate, add, and remove
- ***Sidewalks:*** Street segments for field assessments of sidewalk width and condition
- ***Street crossings:*** Intersections for pedestrian crossing improvements
- ***Street reconfigurations:*** Segments for bikeways, bus priority lanes, and other geometric changes
- ***Pavement repair:*** Corridor pavement quality based on City of Houston data
- ***Traffic studies:*** Locations for signal warrant analyses and other traffic studies

INTERNAL REVIEW • *Lead: Program Mgr.*
Capital Planning • Service Planning • Urban Design • Public Outreach

EXTERNAL REVIEW • *City of Houston* • Harris County • TIRZs

- Identify and coordinate timelines of overlapping projects
- Introduce street reconfiguration, crossing improvement, and traffic study concepts

15% DESIGN

DELIVERABLES • *Lead: Capital Planning*

- Maps, tables, descriptions, and design criteria of all improvements by segment
- Refined planning-level quantity and cost estimates for budgeting and scope review
- Description of survey, field assessments, and traffic counts to occur in 30% design
- ***Bus stops:*** Platform length, depth, height, and shelter placement at each stop; anticipated need for additional right-of-way based on aerial measurements
- ***Sidewalks:*** Field assessment of sidewalk width and condition; extents of new construction, reconstruction, and spot repairs; sidewalk width
- ***Street crossings:*** Location and treatment of pedestrian crossing improvements
- ***Street reconfigurations:*** Extents and typical cross sections
- ***Pavement repair:*** Estimate of pavement repair locations by segment
- ***Traffic studies:*** Definition of scope

INTERNAL REVIEW • *Lead: Program Mgr.*
Capital Planning • Engineering • Urban Design • Public Outreach

PUBLIC OUTREACH

- Initial public outreach effort in communities surrounding BOOST corridor
- Present options for programmable spaces and collect information about community preferences

30% DESIGN

DELIVERABLES • *Lead: Engineering*

- Plan set for improvements meeting required and recommended design criteria noted in Basis of Design and 15% design (see internal review)
- Survey, field assessments, and traffic counts described in 15% design
- Refined quantity and cost estimates for budgeting and scope review
- ***Bus stops:*** Layout of platform, clear sidewalk, shelter foundation, and programmable spaces avoiding obstacles; survey of sites where additional right-of-way is desired; site assessments to identify obstacles
- ***Sidewalks:*** Layout of sidewalk, ramp, and driveway modifications; field assessments to determine improvements needed to achieve continuous accessible path
- ***Street crossings:*** Layout of ramps, median islands, pavement markings
- ***Street reconfigurations:*** Layout of pavement markings; traffic signal elevations
- ***Pavement repair:*** Specific locations of concrete and asphalt repair
- ***Traffic studies:*** Technical memo documenting analyses and recommendations

INTERNAL REVIEW • *Lead: Program Mgr.*
Engineering • Capital Planning • Real Estate • Urban Design • Public Outreach

- Evaluate alternatives and decide path forward for sites where required and recommended design criteria are infeasible
- Review scope based on cost estimates
- Integrate programmable spaces findings

EXTERNAL REVIEW • *City of Houston*

- Submit traffic studies for concurrence

Figure 2b. Planning & Design Process, Continued

30% DESIGN

DELIVERABLES • *Lead: Engineering*

- Plan set for improvements meeting required and recommended design criteria noted in Basis of Design and 15% design (see internal review)
- Survey, field assessments, and traffic counts described in 15% design
- Refined quantity and cost estimates for budgeting and scope review
- *Bus stops:* Layout of platform, clear sidewalk, shelter foundation, and programmable spaces avoiding obstacles; survey of sites where additional right-of-way is desired; site assessments to identify obstacles
- *Sidewalks:* Layout of sidewalk, ramp, and driveway modifications; field assessments to determine improvements needed to achieve continuous accessible path
- *Street crossings:* Layout of ramps, median islands, pavement markings
- *Street reconfigurations:* Layout of pavement markings; traffic signal elevations
- *Pavement repair:* Specific locations of concrete and asphalt repair
- *Traffic studies:* Technical memo documenting analyses and recommendations

INTERNAL REVIEW • *Lead: Program Mgr.*

Engineering • Capital Planning • Real Estate • Urban Design • Public Outreach

- Evaluate alternatives and decide path forward for sites where required and recommended design criteria are infeasible
- Review scope based on cost estimates
- Integrate programmable spaces findings

EXTERNAL REVIEW • *City of Houston*

- Submit traffic studies for concurrence

REAL ESTATE

- Approach property owners at sites where right-of-way, driveway closure/narrowing, or construction easements are desired.
- After initial outreach, assess whether to pursue constrained designs or pursue acquisition further.

60%

DELIVERABLES • *Lead: Engineering*

- Plan set with designs updated based on 30% review and comment coordination
- Refined quantity and cost estimates for budgeting
- *Bus stops:* Layout including material/paving of programmable spaces
- *Sidewalks & Street Crossings:* Layout including curb ramp slope information
- *Street reconfigurations:* Layout including signage; traffic signal designs
- *Traffic studies:* Plan sets for improvements based on 30% external review

INTERNAL REVIEW • *Lead: Program Mgr.*

Engineering • Planning • Urban Design

EXTERNAL REVIEW • *City of Houston*

- Submit for initial review

90%

DELIVERABLES • *Lead: Engineering*

- Complete plan set including details, specifications, and construction documents
- Designs updated based on 60% external review
- Demolition plans
- Detailed quantity and cost estimates for construction procurement

INTERNAL REVIEW • *Lead: Program Mgr.*

Engineering • Planning • Urban Design • Construction • Procurement

EXTERNAL REVIEW • *City of Houston*

- Submit for final review

100%

DELIVERABLES • *Lead: Engineering*

- Complete plan set and construction documents
- Designs updated based on 90% external review
- Detailed quantity and cost estimates for construction procurement

INTERNAL REVIEW • *Lead: Program Mgr.*

Engineering • Construction • Procurement • Public Outreach

EXTERNAL REVIEW • *City of Houston*

- Submit for permitting

Table 3. Corridor Capital Improvements Design Criteria

	REQUIRED (See Note 1)	RECOMMENDED (See Note 1)	OPTIONAL
BUS STOPS	• 5'x8' clear boarding area • 5' clear sidewalk • Foundation for 2'x12' cantilevered shelter	• Platform serving all doors of design vehicle • 9" curb • 2' detectable warning • 6' clear sidewalk • Foundation for 4'x12' shelter and trash can	• Foundation for two 5'x12' shelters and trash can • Programmable spaces
SIDEWALKS	• ADA-compliant accessible route from all rebuilt segments to nearest bus stop	• ADA-compliant street crossings and ramps to any intersecting sidewalk routes • 6'-wide sidewalks and ramps • 6'-wide sidewalk crossing of driveways • Landscape strip of at least 2' between sidewalk and curb • 7'-wide sidewalk preferred adjacent to curb • Rebuild segments narrower than 6' on full block faces of BOOST corridors and major thoroughfares scoped for reconstruction • Rebuild segments narrower than 5' on full block faces of intersecting streets scoped for reconstruction	• Wider segments based on context • Tree cut-outs based on context
STREET CROSSINGS	• ADA-compliant crossing treatments	• Context-sensitive crossing treatments. • Reference Harris County Engineering Department Pedestrian Crossing Guidance.	• See Note 2
STREET RECONFIGURATION	• See Note 2	• NACTO All Ages & Abilities Bikeways Criteria • 11' bus travel lanes	• See Note 2
PAVEMENT REPAIR	• See Note 2	• Repair pavement failures in lane(s) used by buses where they affect safe and comfortable bus operation	• See Note 2
TRAFFIC STUDIES	• See Note 2	• Analysis of option(s) for improved transit operations and any general traffic capacity trade-offs	• See Note 2

Notes:
1. As site constraints are identified, the program manager, Planning project manager, and Engineering project manager will explore alternative locations, design modifications, and other strategies to achieve required and recommended criteria for all improvements.
2. Additional required, recommended, and optional criteria for specific improvements will be described in the 15% design deliverable.

As part of the design phase, other complementary tasks will also be completed. These include:

- Marketing and Outreach – This task educates and engages the community about the benefits of the project, identifies how changes will affect customers and stakeholders along the corridor, and shares information on the project timeline. This task will also collect community input on elements of the project such as recommendations for how programmable spaces at bus stops can best meet the needs in each specific context.
- Traffic Signal Operations – To fully achieve the travel time benefits of the BOOST program, transit-friendly signal timing will be implemented. This includes options for transit signal priority (TSP). The design phase will make recommendations for TSP on the corridor in coordination with the agencies responsible for signal timing and maintenance including the City of Houston and Harris County.
- Service Changes – To fully capture the travel time benefits of BOOST, bus schedules will need to be developed with the travel time savings embedded. During the design phase, schedule and service analysis will be completed and draft schedules will be developed for the route. A target service change date to implement the new schedules will be defined to support implementation planning.

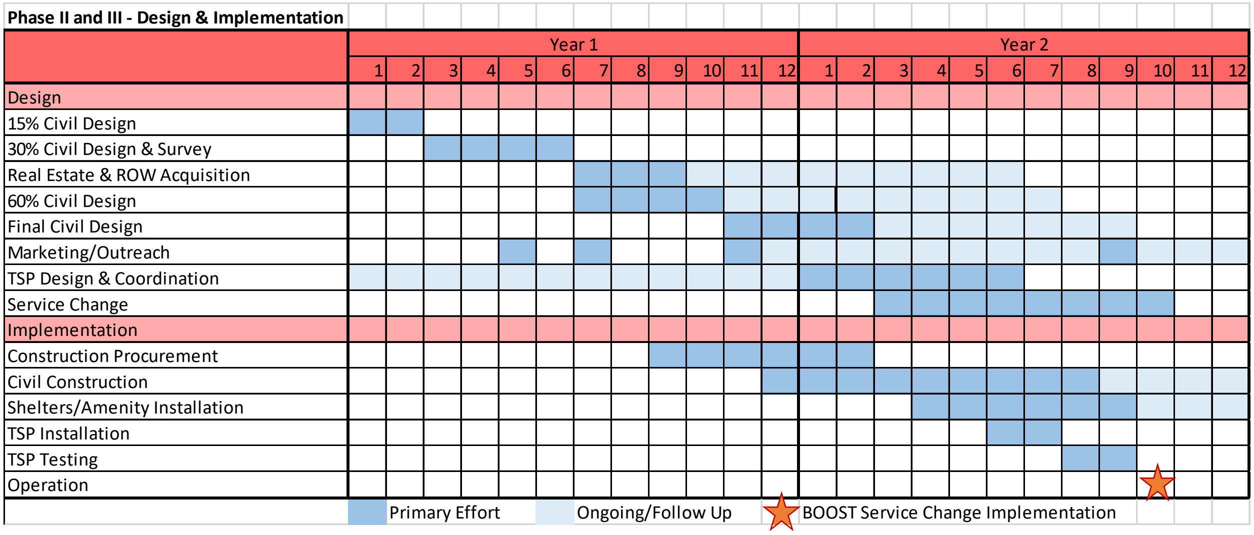
Phase 3: Implementation

The PS&E package from the design phase will serve as the basis for initiating the implementation phase. This phase includes procurement of a construction firm to implement the BOOST design elements and construction management to ensure the design is built correctly. It includes implementation and testing of any traffic signal changes to capture the benefit of TSP in coordination with City of Houston and Harris County. METRO will install bus shelters and stop amenities as new bus pads are completed and finalize bus schedules for the target service change. Implementation will require continued community engagement to explain any changes and answer questions from customers and the community. When solidified, METRO will communicate the date of the full implementation of the BOOST program on the route.

Design and Implementation Phases Schedule & Timeline

The design and implementation phases can be thought of as a continuum from when the planning phase recommendation are finalized to when the first bus travels with a new schedule on an implemented BOOST corridor. Typically, the full implementation of a BOOST corridor would align with a service change so that a new bus schedule can incorporate faster travel speeds. The timeline of the implementation plan should be developed with a target service change in mind. This target can also be embedded in the procurement approach to ensure the construction contract is aligned with the implementation timeline. Table 4 shows a typical schedule for design and implementation.

Table 4. Design and Implementation Schedule



Roles & Responsibilities

Holistically improving the transit experience along high-ridership bus corridors spanning the METRO service area will require extensive collaboration and coordination across many METRO departments and with partner agencies, particularly the City of Houston and Harris County who manage the roads where the BOOST improvements will be implemented.

The program manager will coordinate the BOOST planning, design, engagement, and construction process. The Planning project manager will oversee deliverables and recommendations in the planning phase, while the Engineering project manager will oversee the design and implementation phases. While these groups may lead, nearly every department in METRO will need to be available to support successful implementation of the BOOST program. Table 5 provides an overview of the various tasks and deliverables for the successful implementation of a BOOST corridor. It identifies the roles and responsibilities for each METRO department and where they will need to lead and provide support. The program and project managers can use this table as a checklist ensure that the full capabilities of METRO are aligned to the project success.

Partner Agencies

The success of the BOOST program will also rely heavily on close coordination between METRO and partners. The City of Houston maintains the roads and signals for the majority of the 17 BOOST corridors. Harris County also maintains some roadway segments and signals and can be a partner on implementation of others. Regular coordination meetings with these agencies should occur to support successful implementation.

Each corridor will also have additional potential partners such as local management districts and TIRZs. These potential partners can assist in implementation and may also have capital investment projects along or intersecting the BOOST corridors. As applicable on each corridor, early coordination with these groups will allow METRO to identify relevant plans, projects, and partnership opportunities.

Table 5. BOOST Roles & Responsibilities

	Capital Planning	Env. Planning	Real Estate	Service Planning	Scheduling	Bus Operations	Engineering	Traffic	Information Technology	Facilities Maintenance	Safety	METRO PD	Finance	Procurement	Marketing	Community Outreach	Urban Design	Government Affairs	Press Office	Partner Agencies (e.g. City of Houston, Harris County, TxDOT)
Planning Phase																				
Existing Conditions	X	X		X	X			X			X	X								X
Service Evaluation	X			X	X	X		X			X									
Stop Optimization	X	X	X	X	X	X	X	X	X	X	X					X				X
Stop Design	X	X	X	X	X	X	X			X				X			X			X
Street Crossing Improvements	X	X					X	X	X											X
Initial Public Outreach	X														X	X	X	X		
Partnership Opportunities	X			X			X	X									X	X		X
Traffic Operations	X			X			X	X												X
Procurement (Design & Stop Amenities)	X					X	X	X		X			X	X						
Implementation Schedule	X			X	X	X				X	X	X	X		X	X				
MTFP Amendment Process	X							X										X		X
Initial ROW/Easement Pursuit		X	X					X					X							
Design Phase																				
Service Change	X			X	X	X					X	X	X		X	X				
Detailed Stop Design	X		X	X		X	X	X	X	X							X			X
Street Crossing Design						X	X	X			X									X
Stop Optimization	X						X													
Corridor & Sidewalk Design (0-15%)	X						X													X
Marketing	X														X	X	X		X	X
Surveying							X			X						X				
ROW Acquisition			X				X						X							
Initiate TSP Coordination	X						X	X	X	X	X	X	X							
Community Engagement	X										X	X			X	X	X	X		X
Implementation Phase																				
Procurement (Construction)	X						X						X	X						
Stop Improvements			X	X		X	X	X	X	X				X		X				
Street Crossing Improvements			X			X	X			X	X									
Corridor & Sidewalk Improvements			X			X	X			X	X									X
TSP installation					X		X	X	X				X	X						X
Testing					X	X		X	X		X									X
Community Engagement	X										X	X			X	X	X	X		X
Operation				X	X	X		X							X	X				
Post Operations Activities																				
Maintenance						X		X		X										
Project Monitoring/Evaluation	X	X		X		X	X	X		X					X		X		X	X

Highlighted cells indicate lead group for activity

Corridor Capital Improvements

This section describes design guidelines and principles for METRO's capital investments in BOOST corridors. First, it describes how and where METRO will improve sidewalks, curb ramps, street crossings, and bikeways to improve customers' trip to and from bus stops—the BOOST objective of a better walk. Next, it describes new BOOST standards for bus stops with spacious, accessible platforms, consistent amenities, and flexible programmable spaces—standards intended to provide customers with a better stop. Finally, it describes principles for stop optimization and an approach to pavement repair on BOOST corridors, both of which contribute to a better ride.

METRO will coordinate the design and construction of capital improvements described in this section with projects by partner agencies—as well as other METRONext efforts—with anticipated completion dates within five years of the BOOST planning phase. For example, if the City of Houston or a TIRZ has a funded capital improvement project along a segment of a BOOST corridor within five years, METRO will coordinate design with this agency and may postpone capital improvements along this segment in order to leverage investments by partner agencies. Likewise, METRO will phase BOOST improvements to align with other METRONext projects planned for construction within five years. However, METRO will proceed with bus stop, sidewalk, and crossing improvements along segments where other investments are proposed but not funded or anticipated within the next five years.

Sidewalks & Curb Ramps

In the interest of providing riders with a better walk to and from stops, METRO will upgrade sidewalks and ramps to create a continuous, accessible route for people walking and using wheelchairs along BOOST corridors and connecting to nearby destinations. As a part of 15% design, METRO's System & Capital Planning division will conduct sidewalk and intersection assessments to determine the general improvements needed to achieve this. These assessments use a letter rating to capture the presence, approximate width, and condition of sidewalks on a parcel-by-parcel basis, as described in Table 6. A full description of the sidewalk and intersection assessment methodology is included as an appendix. As a part of 30% design, METRO's Engineering department will specify the improvements necessary to provide a continuous, accessible route on BOOST corridors and first- and last-mile connections based on sidewalk assessments and additional field observation if necessary.

Table 6. Sidewalk Assessment Matrix

		CONDITION[1]	
		Traversable	Not Traversable
WIDTH	5+ feet	A	C
	Under 5 feet	B	D

E: Missing

G: Under Construction[2]

[1] Traversable sidewalks are flat and smooth, without significant vertical deviations or cross-slopes.

[2] Sidewalks under construction are assumed to be built to City of Houston standard, typically condition "A."

Corridor Improvements

As a part of 15% design, METRO's Capital Planning department will identify the types of improvements needed to provide a fully traversable route on both sides of the streets traveled by the BOOST corridor bus route. Based on sidewalk and intersection assessments, METRO's Capital Planning department will identify segments for three general types of improvements:

- **New construction** of sidewalks and ramps. This treatment is appropriate on streets segments lacking pedestrian infrastructure entirely (sidewalk assessment "E" in Table 6), provided that new, 6-foot sidewalks can be constructed in the existing right-of-way without major street reconstruction. On streets where open-ditch drainage or other constraints make new sidewalk construction impractical, METRO will request that the jurisdiction responsible for the street prioritize its reconstruction or otherwise address the underlying issue to enable sidewalks in the future.
- **Reconstruction** of existing sidewalks and ramps. This treatment is appropriate on street segments where vertical displacements, steep cross-slopes, and broken panels frequently make sidewalks and ramps inaccessible to people walking or using in wheelchairs—segments where many parcels receive sidewalk assessment "C" or "D" in Table 6. METRO will not reconstruct pedestrian infrastructure on street segments with narrow but otherwise traversable sidewalks (sidewalk

assessment “B” in Table 6), except in places where most of the surrounding blocks will require sidewalk reconstruction to provide a traversable route.

- **Spot improvements** to existing sidewalks and ramps. This treatment is appropriate where pedestrian infrastructure is generally smooth, flat, and traversable by people walking or using wheelchairs, but where vertical displacements, gaps, or other issues make ramps and sidewalks inaccessible at a few locations. The 30% design phase will survey parcels identified for spot improvements to determine the specific changes—such as ramp construction, panel replacement, or driveway reconstruction—needed to provide a continuous, accessible route.

METRO’s System & Capital Planning team will use planning and engineering judgement when choosing whether to pursue spot improvements or reconstruction on different segments, taking into account factors such as ridership, nearby destinations, adjacent land uses, and width of existing sidewalks into account.

All new and reconstructed sidewalks will meet applicable City of Houston standards. Typically, new and reconstructed sidewalks will be 6 feet in width; short segments less than 6 feet in width are acceptable to avoid immovable obstacles or to match existing width. New and reconstructed sidewalks located directly adjacent to the curb will typically be 7 feet in width in order to provide extra separation between people walking and vehicle travel lanes. Even wider sidewalks will be designed within the available right-of-way on BOOST corridors with heavy pedestrian traffic and/or near high-comfort walking and biking facilities such as bayou greenway trails; these wider sidewalks will help pedestrians and cyclists who opt to ride on the sidewalk safely and comfortably share space. Driveways will be reconstructed when necessary to provide the desired level sidewalk width. METRO will remove abandoned curb cuts and seek the resizing of driveways exceeding city standards.

First- & Last-Mile Connections

In order to improve riders’ journey to and from their destinations, METRO will pursue first- and last-mile connections to schools, universities, community centers and services, parks, hospitals and health care facilities, shopping centers, and libraries. As a part of the planning phase for each BOOST corridor, METRO’s Capital Planning team will identify all such destinations within a half mile of the corridor. Then, as part of 15% design, planners and engineers will assess sidewalks and curb ramps on streets connecting to these destinations and identify the type of improvements needed to provide a continuous, accessible route for people walking and using mobility devices. METRO will then design the improvements needed to provide an accessible route to all of the identified destinations within a quarter-mile of the BOOST corridor and will consider additional first- and last-mile connections to major destinations within a half-mile. METRO will also assess and design accessible connections to the nearest bus stops served by intersecting routes.

Along each BOOST corridor, METRO will prioritize connections to major destinations that riders are most likely to reach via that particular BOOST corridor. Accordingly, METRO will not pursue improved sidewalk connections to small neighborhood parks with only passive recreation space or to destinations better served by another BOOST route.

As with corridor sidewalk improvements, METRO will only construct or reconstruct sidewalks where it is feasible to do so in the existing right-of-way without rebuilding the street. Open-ditch drainage may pose challenges to implementing the desired first- and last-mile connections as neighborhood destinations in some parts of the service area are located along minor streets without curbs and gutters. In such cases, METRO will request that the jurisdiction responsible for the street prioritize its reconstruction or otherwise address the underlying issue to enable sidewalks in the future.

Street Crossings

In order to provide riders with a safer, better walk to and from stops, METRO will pursue improved street crossings connecting to bus stops at both signalized and unsignalized intersections.

Signalized Street Crossings

METRO will implement high-visibility crosswalks and repaint stop bars at all signalized intersections adjacent to bus stops on BOOST corridors. In addition to improving ramps as described in the Sidewalks & Ramps section, METRO will modify medians as needed to ensure accessible, unobstructed crosswalks on all legs of signalized intersections.

In addition, METRO will coordinate with the City of Houston (or any other agency responsible for signal timing) to implement an automatic pedestrian phase at all signalized intersections adjacent to stops and to consider leading pedestrian intervals on an intersection-by-intersection basis. Automatic pedestrian phases give pedestrians the green light to safely cross during every signal cycle, regardless of whether someone has pressed the pedestrian push button. This eliminates the need for pedestrian push buttons, which is helpful because push buttons are often missing or inaccessible. Leading pedestrian intervals give pedestrians the walk signal to cross before vehicles receive a green light, providing people the opportunity to safely cross the street with fewer potential conflicts with turning vehicles.

METRO will also notify the City of Houston or other responsible agency about any missing pedestrian signal heads at signalized intersections.

Unsignalized Street Crossings

Along many segments of BOOST corridors, fast and heavy vehicle traffic makes it challenging for people to safely cross the corridor at unsignalized intersections. This severely detracts from customers' transit experience and jeopardizes their safety because most riders must cross the transit corridor on at least one leg of their journey. Riders typically will need to cross the street either to reach their destination on the outbound trip or to catch the bus in the other direction on the return trip.

To facilitate access to transit service, METRO will build safe, accessible crossings of BOOST corridors at select stop pairs located more than one-sixteenth mile from controlled crossings at signals or all-way stops. Stops located more than one-sixteenth mile (330 feet, or approximately one block) from a traffic signal or all-way stop require that customers travel an additional eighth-mile to reach the stop via a safe, controlled crossing—a deviation that many are unwilling to make.

Of the stop pairs located more than one-sixteenth mile from a controlled crossing, those that meet one or more of the following criteria are strong candidates for unsignalized crossing improvements:

- Expected to see a combined total of at least 20 daily boardings after stop optimization. Estimates of expected boardings should take into account existing ridership data as well as the new stop locations. Stop optimization typically reduces the total number of stops along a corridor, meaning many of the optimized stops will see more activity after BOOST implementation.
- Directly adjacent to first- and last-mile connections identified for improvements
- Directly adjacent to key destinations such as schools, parks, services, or shopping

The Design Standards section contains a toolbox of unsignalized crossing treatments—including pedestrian safety islands, raised crosswalks, and median closures—suitable for different contexts. Traffic and speed counts collected during the 30% design phase will inform the choice of crossing treatment(s). At unsignalized intersections where the BOOST corridor has several lanes of travel in each direction, high volumes, and/or high speeds, traffic control devices such as pedestrian hybrid beacons (HAWKs) or full signals may be the only appropriate way to provide a safe crossing for pedestrians. METRO will coordinate these types of improvements with the City of Houston or other jurisdictions.

Bikeways

In order to provide riders with better multimodal access to transit service, METRO will pursue high-comfort bikeways along segments of BOOST corridors and intersecting streets identified in the Houston Bike Plan that meet the feasibility and connectivity criteria outlined below.

Bikeway designs will strive to meet standards for high comfort as set forth in NACTO's "Designing for All Ages and Abilities" guide as well as METRO's Transit Design Standards. Traffic and speed data collected during the 30% design phase will inform the treatments needed to meet these standards. Armadillo delineators are the preferred separation treatment where separated bike lanes are provided in the City of Houston.

Corridor Improvements

METRO will design bikeways along segments of BOOST corridors identified in the Houston Bike Plan, provided that high-comfort facilities are feasible within the existing pavement and right-of-way. Pavement modifications that do not impact a street's drainage infrastructure—such as narrowing the median along a four-lane boulevard—are feasible and encouraged on BOOST corridors.

In places where high-comfort facilities proposed in the Houston Bike Plan are *not* feasible within the existing pavement and right-of-way without street reconstruction or acquisition, METRO will seek to design BOOST improvements that do not preclude the construction of high-comfort bike facilities by other agencies in the future.

Bikeways designed along BOOST corridors will include floating bus stops wherever feasible to safely manage and prevent conflicts between buses and bikes. Floating bus stops also contribute to fast, reliable service, because they prevent buses from incurring travel time delays by merging in and out of the bike lane to service traditional curb-side stops. The Design Standards section later in this document includes a METRO engineering detail for a floating bus stop, but designs will vary based on specific applications and contexts.

Bikeway designs will consider other treatments that contribute to the BOOST objective of faster, more reliable service. For example, bikeway designs that reduce the street section to one travel lane in each direction may include left turn lanes at intersections with heavy turning volumes to prevent buses from queuing behind vehicles waiting for gaps in traffic to turn.

First- & Last-Mile Connections

METRO will also design bikeways along streets identified in the Houston Bike Plan or more feasible alternate alignments that intersect BOOST corridors and deliver meaningful network connectivity. Specifically, METRO will consider high-comfort bikeways along intersecting streets that connect to existing (or programmed and funded) high-comfort bike facilities within a mile of the BOOST corridor and are feasible within the existing pavement and right-of-way.

Bus Stop Design

In order to improve the customer experience and reduce the perceived wait time at bus stops, METRO will implement spacious, accessible stops that accommodate wide sidewalks along with a range of amenities. The new standard for bus stops on BOOST corridors, described below and included in the Design Standards section, is also designed with an eye toward the objectives of faster, more reliable service and universal accessibility by employing treatments that reduce dwell time and help passengers with limited mobility safely navigate the stop and board and alight the bus.

BOOST corridors run through a variety of street conditions and development patterns, many of which make it challenging to build the safe, accessible, comfortable, and spacious bus stops that customers desire. Planners and engineers will work thoughtfully and creatively to overcome these constraints and to meet the following standards for platform height, width, and length at all BOOST stops. In some cases, meeting these standards will require additional space behind the curb or driveway modifications; the Real Estate section of this document outlines an approach for pursuing additional right-of-way and modifying driveways on adjacent properties.

Platform Height

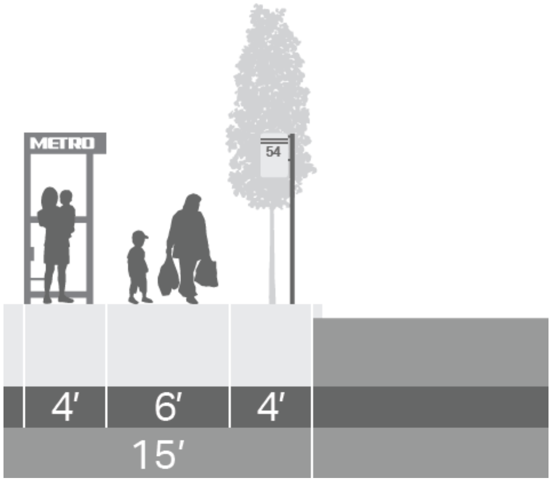
To enable near-level boarding, BOOST platforms will be nine inches above street level, three inches above the standard six-inch curb height. Low-floor vehicles still have to kneel, or lower the front door, to accommodate six-inch curbs. Reducing the kneeling distance by raising the platform saves time and increases operating efficiency. The extra height will require sufficient length parallel to the street to provide transition areas that meet ADA slope requirements and drainage needs. METRO will coordinate with the Houston Commission on Disabilities on BOOST stop designs and amenities to ensure they meet accessibility standards. A two-foot detectable warning surface along the length of the platform is proposed at all stops with nine-inch curbs. A memo with a more detailed rationale for nine-inch platforms is included in an appendix to this document.

Platform Depth

Spacious bus stops with at least 15 feet behind the curb are the standard for BOOST corridors. Stops with 15 feet behind the curb accommodate a cross-section consistent with the streetscape standards developed by the City of Houston's Walkable Places Committee, which includes:

- a 4-foot deep shelter, the standard for BOOST corridors;
- a 6-foot wide clear sidewalk, the City of Houston standard for Major Thoroughfares;
- a 4-foot safety buffer between the sidewalk and the street, providing extra separation from traffic and space for trees, bike parking, other programming as well as the 2-foot detectable warning strip at the platform edge; and
- a 1-foot buffer between the shelter and the property line, accommodating retaining walls and the shelter roof overhang.

Figure 3. Standard BOOST Stop Section



Modified designs for constrained locations and opportunities to provide more spacious bus stops through easements and ROW acquisitions are discussed in the Design Standards and Real Estate sections, respectively.

Platform Length

BOOST platforms will be designed to provide clear spaces for boarding and alighting at all doors of all vehicles likely to service the stops in the future. While all-door boarding is not a near-term recommendation on BOOST corridors, providing safe and accessible places for riders to alight at all doors will reduce dwell times and contribute to the BOOST goals of speed and reliability. At a minimum, BOOST corridors will feature platforms with clear boarding/alighting zones at both doors of standard 40-foot buses; this requires a total platform length of 32 feet. Many BOOST corridors may benefit—either in the short term or the long term—from the extra capacity provided by 60-foot articulated buses and will therefore feature longer, 52-foot platforms. Platforms will be designed to accommodate 60-foot buses on corridors that meet one or more of the following criteria:

- 60-foot articulated buses currently operate on the corridor
- existing route achieves weekday productivity of over 30 boardings per revenue hour
- existing service runs every 10 minutes or better at peak times

The Design Standards section of this document describes the preferred dimensions and configuration of bus stops in different contexts, including for constrained sites where additional behind-the-curb space cannot be acquired.

Figure 4. Standard BOOST Stop Plan – 60-Foot Bus

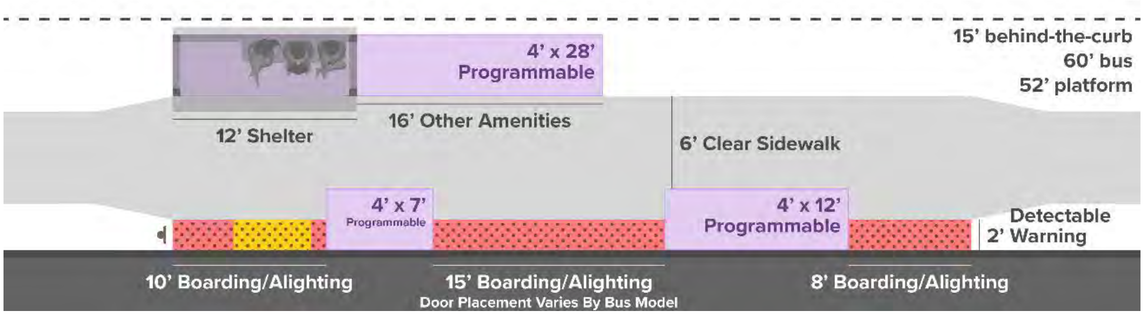
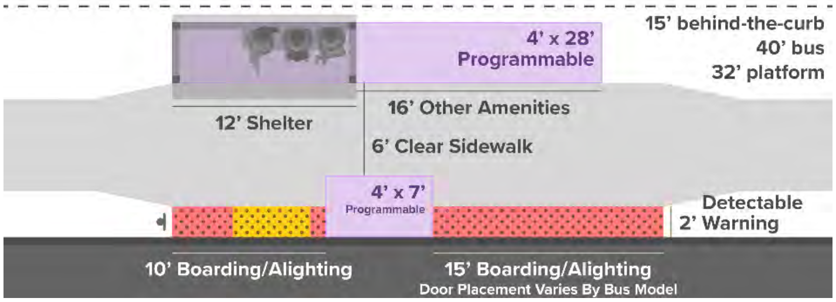


Figure 5. Standard BOOST Stop Plan – 40-Foot Bus



Bus Stop Amenities & Programming

Bus stops along BOOST corridors will include a range of amenities and flexible programming spaces that enhance the customer experience. While some amenities will be selected based on community preferences, others—such as shelters with integrated seating, lighting, and real-time passenger information—will be the standard at all BOOST stops.

Shelters & Amenities

METRO is in the process of designing new shelters specifically for BOOST corridors. The BOOST shelter design will integrate lighting, seating, and real-time information signage, and will provide panels for additional passenger information and wayfinding. The design package will include three sizes of shelters:

- a standard, 4-foot deep by 12-foot wide shelter for stops with 13 to 15 feet behind the curb
- a larger, 5-foot deep and 12-foot wide shelter for stops with over 15 feet behind the curb
- a cantilevered shelter with a 2-foot deep and 12-foot wide footprint for constrained stops with less than 13 feet behind the curb

Other amenities being designed as part of the BOOST shelter scope include seating, lean bars, and bus stop markers. The designs developed through this effort and the rationale behind them will be included in future versions of this document.

Programmable Spaces

BOOST bus stops feature several areas that do not interfere with the shelter, the clear sidewalk, and the multiple boarding and alighting zones. These areas are flexible, programmable spaces that can accommodate a range of amenities, including street furniture, bike parking, landscaping, and public art. The specific programming at each stop will be informed by site conditions and community preferences expressed during the first round of BOOST engagement on each corridor, described in more detail in the Community Outreach section.

Bike parking and micromobility docking stations or zones can improve multimodal access to transit stops. Street furniture and public art can help transform the bus stop into a civic space with additional space for riders to sit, as well as a canvas for cultural expression that reflects neighborhood identity.

Landscaping can enhance the customer experience by providing shade and an aesthetically pleasant environment. Landscaped spaces break up the impermeable surface of the extended bus pad and allow stormwater to infiltrate the ground, aligning with the regional imperative to bolster resiliency by "working with water."

Programmable spaces can also be strategically positioned to accommodate existing utilities and trees, enabling METRO to build stops at sites that meet spacing and placement goals described in the Stop Optimization section that would otherwise be infeasible.

METRO's Urban Design team is in the process of documenting programming options for these spaces that will be used to facilitate the first round of public outreach along the two pilot BOOST corridors. Programming options—including bike parking and landscaping—for the first 14 stops identified for improvements as a part of the Studewood Street BOOST Demonstration are included as an appendix to this document; many of the recommended plantings and amenities are suitable at BOOST stops throughout the METRO service area. Additional materials developed through this ongoing effort will be included in subsequent versions of the Basis of Design.

Figure 6. BOOST Bus Stop Programmable Spaces Plan

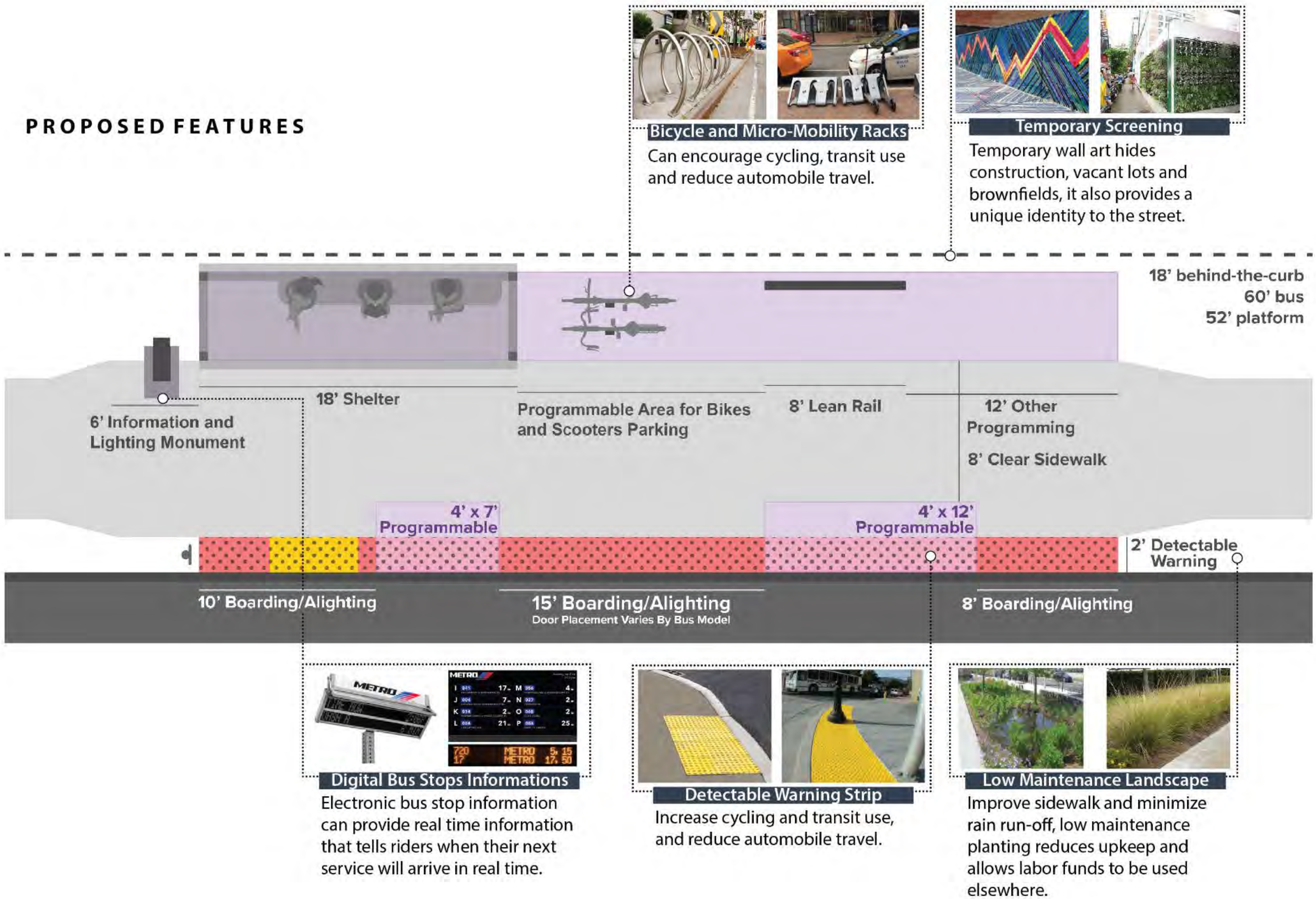
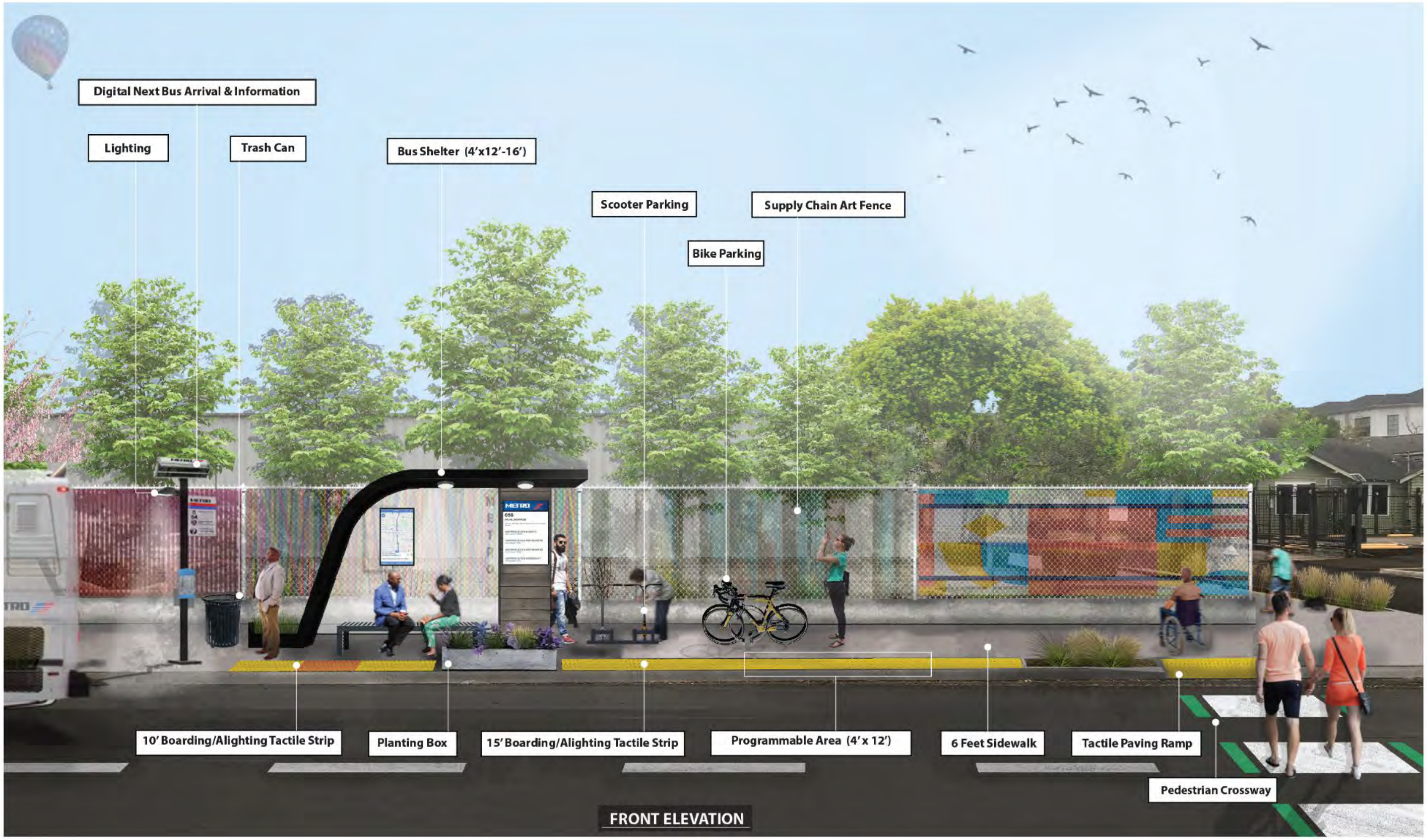


Figure 7. BOOST Bus Stop Programmable Spaces Profile



Transit Centers

METRO will coordinate BOOST improvements with transit center upgrades planned by the agency. Transit centers along BOOST routes will be prioritized for new passenger information (including real-time signage), universal accessibility improvements, and operator facilities including restrooms as needed.

Stop Optimization

In addition to investing in spacious platforms, shelters, and amenities at bus stops, the BOOST program will optimize the spacing and placement of bus stops. These improvements aim to generate speed and reliability benefits that create a better ride for customers.

Stop Spacing

Stop spacing refers to the distance between bus stops along the route. BOOST corridors will feature approximately one quarter-mile stop spacing while preserving stops at connection points and controlled crossing locations. Four key principles underpin BOOST stop spacing:

- METRO's service standards call for one-quarter mile spacing for stops between transfer locations and signalized intersections. This strikes an appropriate balance between walking access to destinations and transit speed. Because many existing corridor segments have approximately one eighth-mile stop spacing, achieving one quarter-mile spacing entails consolidating nearby stops. Sidewalk improvements will ensure that an accessible route is provided to the nearest proposed stop.
- Easy locations to transfer to and from intersecting bus routes and rail lines connect customers to the broader transit network and help them reach their destinations faster. Stop optimization along BOOST corridors will keep, relocate, and/or add stops at streets with intersecting transit routes and will include shared stops where feasible to ease transfers.
- Signalized intersections, often the site of transfer locations, also provide controlled crossings that help customers safely reach their stop. Stop optimization on BOOST corridors will include stop pairs at all signalized intersections, except on segments with exceptionally close signal spacing.
- Origins, destinations, and transfer points are generally sites that generate high ridership and are considered as part of the decision making process for stop optimization.

The optimized spacing will allow buses to pick up speed between stops and will reduce the variability in travel times, creating faster and more reliable service without compromising riders' ability to safely access destinations and transfer to other transit services. All origins and destinations located directly on BOOST corridors will remain within an approximately one eighth mile-walk of a bus stop after optimization.

Stop Placement

Stop placement refers to the position of transit stops relative to intersections and other elements of the block. To the extent possible, BOOST corridors will:

- Include far-side stops at signalized intersections, which generate travel time benefits and allow buses to take full advantage of transit signal priority.
- Place stops in locations with ample behind-the-curb depth (preferred minimum of 15 feet, absolute minimum of 10 feet) and sufficient length of continuous curb (32 feet to 52 feet) to accommodate

the proposed platform designs discussed in the stop platforms and design standards sections of this document.

- Avoid stops with obstructions such as utilities, inlets, and driveways.

Far-side stops should be placed to allow 20 feet of clear space between the rear of the bus and the crosswalk. This placement keeps the stop as close to the intersection as possible (minimizing passengers' walking distance to the crossing and any connecting stops) while safely accommodating another vehicle behind the bus without blocking the crosswalk. Stops designed for 40-foot buses should be placed a preferred minimum of 65 feet past the crosswalk, while stops designed for 60-foot articulated buses should be located 85 feet past the crosswalk. These dimensions refer to the placement of the flagpole. The standard BOOST platform design places the flagpole approximately 5 feet past the front of the bus, so that passengers with bikes can step in front of the bus from the platform in order to load their bike.

Far-side stops serviced by multiple routes (or by local and signature service patterns) should be placed further from the crosswalk at signalized intersections. These stops should be placed so that a second bus can safely clear the intersection and fit behind the first bus without blocking the crosswalk – ideally 15 feet plus the combined length of the expected buses past the crosswalk. A far-side stop serviced by two routes using 40-foot buses should be placed 95 feet past the crosswalk, while one serviced by two routes using (or expected to use) 60-foot articulated buses should be 135 feet past the crosswalk.

At some signalized intersections, driveways, ROW availability, utilities, and other constraints may pose challenges to far-side stop placement. At signalized intersections where far-side stops prove infeasible even after discussions with the property owner, near-side stop placement should be considered on a case-by-case basis. At signals without significant traffic congestion and at unsignalized intersections, near-side stops should be placed 10 feet in advance of the crosswalk, the METRO standard. Placing stops immediately on the near side of an intersection discourages vehicles from merging into the right lane and turning in front of a stopped bus, a dangerous maneuver.

However, at congested signalized intersections, it is preferable to place stops well on the near side of the intersection, at least 50 feet before the crosswalk. Near-side stops extremely close to busy intersections delay buses and hurt reliability by causing some buses to "triple stop." When a bus approaches an intersection with cars queued behind a red light, it stops at the end of the queue, often well in advance of the bus stop. When the light turns green and the queue clears, the bus advances to the near-side stop, where it stops for a second time to let passengers on and off. Once passengers board and the bus closes its doors, the light may once again be red, forcing the bus to wait through a second cycle and effectively stop for a third time.

Placing near-side stops further in advance of signalized intersections can also help with TSP, which relies on the accurate prediction of a bus's arrival at an intersection. While a far-side stop is more conducive to TSP than any near-side stop, a stop located immediately near-side of a signal makes predicting a bus's arrival at the intersection all but impossible. A bus's dwell time at any stop is highly variable. Sometimes it may wait for several passengers to board and alight, and other times it may not stop at all. Therefore, it is most effective for buses to send priority requests to signals *after* they service a near-side stop. However, immediately near-side stops leave buses with no time to communicate with the signal. Once the bus services the stop, it is already at the intersection.

At unsignalized intersections with improved pedestrian crossings, far-side stops are preferred to improve visibility of people walking across the street. At unsignalized intersections without improved crossings, METRO will select stop sites that consider stop spacing, safety, available right-of-way, adjacent land uses, and existing stop locations. All else being equal, improving stops at existing locations rather than new locations extremely nearby is often less disruptive to adjacent property owners.

Connecting Stops

In order to facilitate a better experience for riders who transfer between BOOST corridors and other routes, METRO will improve connecting stops along intersecting streets. Where two BOOST corridors intersect, METRO will design and improve connecting stops to BOOST standards and will select sites based on the spacing and placement principles described above, placing stops on the far side of signalized intersections where feasible. In places where BOOST corridors intersect other local routes not identified for BOOST improvements, METRO will improve connecting stops that do not meet the current standard for local routes.

Traffic Studies & Geometric Changes

To achieve the BOOST goals of faster, more reliable service and safer access to transit stops, METRO will conduct traffic studies that consider the feasibility, benefits, and tradeoffs of implementing geometric changes or new traffic control devices. These can include signal warrant analyses at locations where bus stops are far from other signals and controlled crossings (and where geometric treatments alone would be insufficient to provide a safe crossing), and at locations where buses make unprotected left turns that contribute to bus delay. These studies may also consider treatments such as Business Access & Transit (BAT) lanes—which permit buses and right-turning vehicles—and dedicated bus lanes at key junctures or on longer segments of BOOST corridors. BAT lanes may be a suitable treatment along street segments with at least three travel lanes in each direction, particularly approaching far-side stops at signalized intersections serviced by at least 10 buses per hour.

The planning phase will identify locations that will benefit from additional traffic studies. The 15% design phase will specify the study to be conducted during the 30% design phase, and coordination with City of Houston regarding implementation will occur thereafter.

In specific contexts where excess lane width (greater than 11 feet) exists but behind-the-curb space for bus stops is below the minimum of ten feet, the feasibility of moving the curb may be examined where drainage conditions allow.

Pavement Repair

METRO will pursue full-depth concrete repair or asphalt mill and overlay at locations where defects in the curb lane prevent safe and comfortable bus operation. Preliminary assessment of the number of defect locations will be included in 15% design; specific locations and extents of repairs will be determined in 30% design.

Transit-Friendly Signal Timing

Along with stop optimization, transit-friendly signal timing—in the form of transit signal priority or preemption—is critical to achieving fast, reliable service for riders on BOOST corridors systemwide.

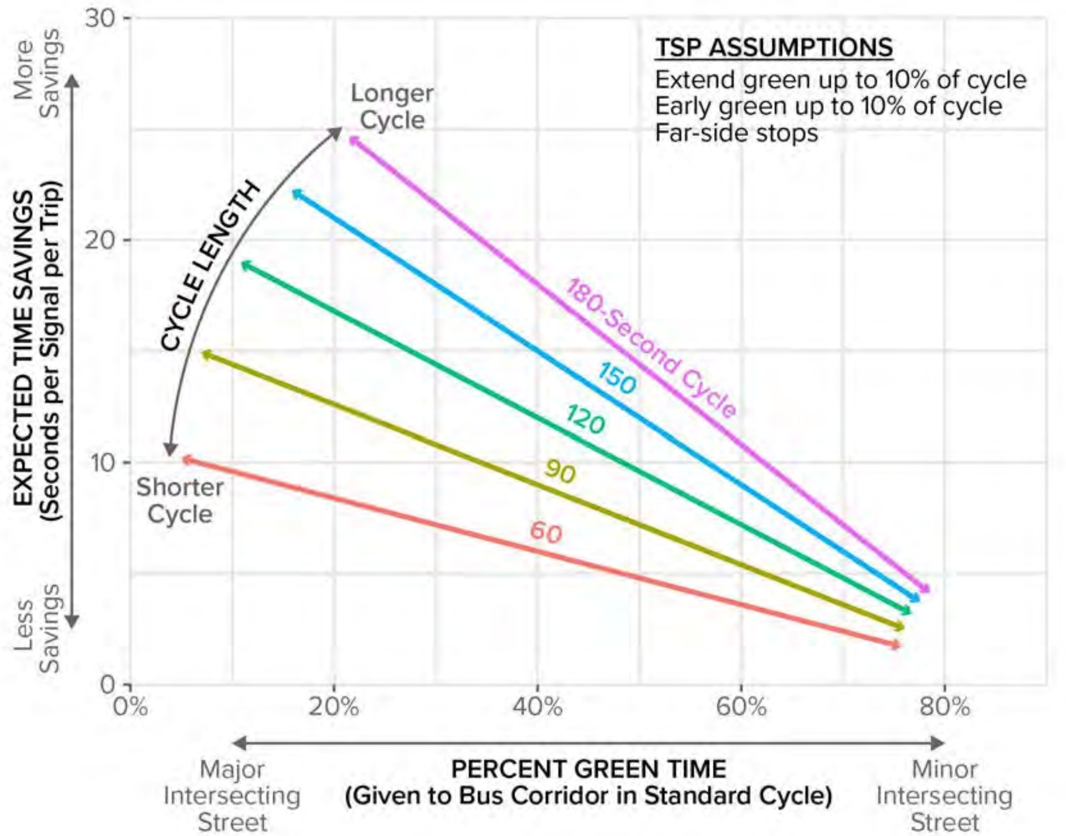
Transit signal priority typically extends a green signal phase or calls the opposing green phase early to minimize bus delay. As a bus approaches a signalized intersection, it communicates its location to the traffic signal and the signal timing is adjusted based on specified parameters to benefit the bus. Transit preemption overrides the normal operation of a traffic signal cycle to provide trains or buses with a green signal to proceed directly through the intersection. Preemption is commonly used for emergency vehicles. All emergency vehicles will continue to have priority over transit.

Because transit priority and preemption rely on the accurate prediction of a bus's arrival at the signal, the treatments work most effectively at intersections where bus stops are located on the far side of, or after, the signal. As discussed in the Stop Optimization section, BOOST capital improvements will include far-side stops where feasible to support transit-friendly signal timing.

METRO will purchase GPS- and cell-based TSP equipment to be installed both on vehicles and at signal cabinets. Compared to infrared technology, GPS and cellular communication between buses and signals is less sensitive to environmental conditions and is more accurate, helping the signal timing to recover more quickly after the bus clears intersection.

METRO's Operations team will coordinate transit priority and preemption for buses at all BOOST corridor signals with the City of Houston Traffic Department on an intersection-by-intersection basis. As a baseline, METRO will pursue transit preemption at signals where the bus corridor intersects a minor street, and transit priority at signalized intersections with major streets. At major intersections, METRO will request extending the bus corridor's green phase and calling the opposing red early up to 10% of the cycle length. Implementing transit-friendly signal timing is especially beneficial to METRO at major intersections, because signal priority yields greater travel time savings at signals with longer cycles and where the bus corridor receives a green for a smaller share of the cycle. Figure 8 shows how the expected time savings from this strategy varies based on cycle length and green time distribution.

Figure 8. Expected Travel Time Savings from Transit Signal Priority



METRO will coordinate with other jurisdictions and partner agencies to implement transit signal priority and preemption at signals outside of the City of Houston. Harris County has invested in cell-based signal preemption technology for emergency vehicles, so future investments at Harris County signals along BOOST corridors can be leveraged between the two agencies.

METRO's Service Planning team will adjust route schedules along BOOST corridors to ensure that travel time savings from TSP and stop optimization translate into faster, more reliable service for riders. The optimized schedules drafted during the planning phase will consider anticipated time savings, the distribution of existing running times, and other factors discussed in the Service Improvements section.

Before and after implementing BOOST improvements, METRO will utilize detailed location data from IVOMS to assess and monitor travel time savings achieved through BOOST, and will work with City of Houston and other partner agencies to adjust transit signal priority and preemption parameters to ensure travel time reductions reach or exceed 15% corridor-wide.

Service Improvements

The BOOST process provides an excellent opportunity to explore and implement service changes that improve speed and reliability and better connect customers to key destinations along frequent and high-ridership local bus corridors. BOOST plans should consider two types of service optimization: route design and schedule optimization.

Route Design

Route designs should consider opportunities to improve customers' transit experience by extending routes to key destinations and transfer locations, removing lengthy deviations that delay more riders than they help, and streamlining service patterns. Specific strategies and principles for achieving these goals include:

Strong Endpoints

Optimization plans should consider route extensions that extend frequent and high-ridership local bus corridors to strong endpoints—i.e., major origins and destinations and connection points that provide opportunities to transfer to other METRO services. Wherever possible, service optimization plans should terminate routes at safe, functional layover locations with ample room for multiple buses and restroom access for operators, or provide recommendations for coordination and/or capital improvements to accommodate layovers at locations that do not meet these criteria.

Straight & Direct Routes

Optimization plans should consider options for creating faster, more direct routes by removing deviations from the primary corridor that add travel time but do not serve major origins and destinations, provide connections to other routes, or generate strong ridership. To preserve coverage, plans should assess opportunities to maintain service on the removed segments with other routes or by improvements to first/last mile access to existing stops.

Streamlined Service

Several frequent and high-ridership local bus routes identified for BOOST improvements currently run multiple service patterns—typically a frequent (red) short line and a less frequent (blue) long line. BOOST plans for these routes should evaluate options for eliminating the distinction between the short and long lines and establishing a single service pattern. Running a single service pattern on frequent and high-ridership local bus routes creates simpler and more legible service, improves reliability, enables headway management, and allows METRO to efficiently operate a schedule tailored to passenger demand.

One option for establishing a single service pattern on corridors with a frequent short line and less frequent long line is to offer frequent service on the entirety of the route. The operating cost savings generated through travel time improvements can contribute to—and potentially fully offset—the cost of extending frequent service to the route's long line. This is a suitable option when the portion of the corridor serviced only by the long line exhibits strong ridership and merits more frequent service.

Another option for establishing a single service pattern is to truncate the route at the terminus of the frequent short line and maintain the same level of service on the long line by extending another route. This is a suitable option when the portion of the corridor serviced only by the long line exhibits lower ridership that does not justify more frequent service, and when extending a nearby route to maintain service levels is feasible and cost-effective. Considerations for passenger connections, stop amenities and layovers should be factored into this decision.

A combination of approaches can also work on corridors where some portions of the long line merit more frequent service but others do not.

Certain types of service changes—route extensions, realignments, and some frequency increases—result in changes to the METRO system map and therefore require METRO Board approval. Significant service changes will also benefit from public engagement.

Route and Network Connectivity

Optimization plans should also consider opportunities to improve connectivity between individual routes and within the overall transit network. These could include route extensions, realignments, frequency changes, and/or span adjustments to bus routes intersecting the BOOST corridor.

Schedule Optimization

The operating cost savings generated through transit-friendly signal timing and stop optimization can fund additional trips on the corridor. During the planning phase, Capital Planning and Service Planning will coordinate to develop conceptual optimized schedules that specify how operating cost savings can be reinvested in the corridor to best serve existing and prospective riders.

Span

On many corridors, customers will benefit from a longer span of service—i.e., trips that begin earlier in the morning or start later at night. BOOST corridor plans will assess demand for early morning and late-night service by examining existing ridership by trip. High ridership on the first and final trips of each day suggests demand for trips earlier in the morning and later at night, respectively. Schedules of important connecting service like rail lines should also be considered. Wherever possible, consistent span should be provided seven days a week. Maintaining the same early morning and late evening trip times across the week, especially after midnight, can make them easier for riders to remember and reduce confusion about which schedule applies.

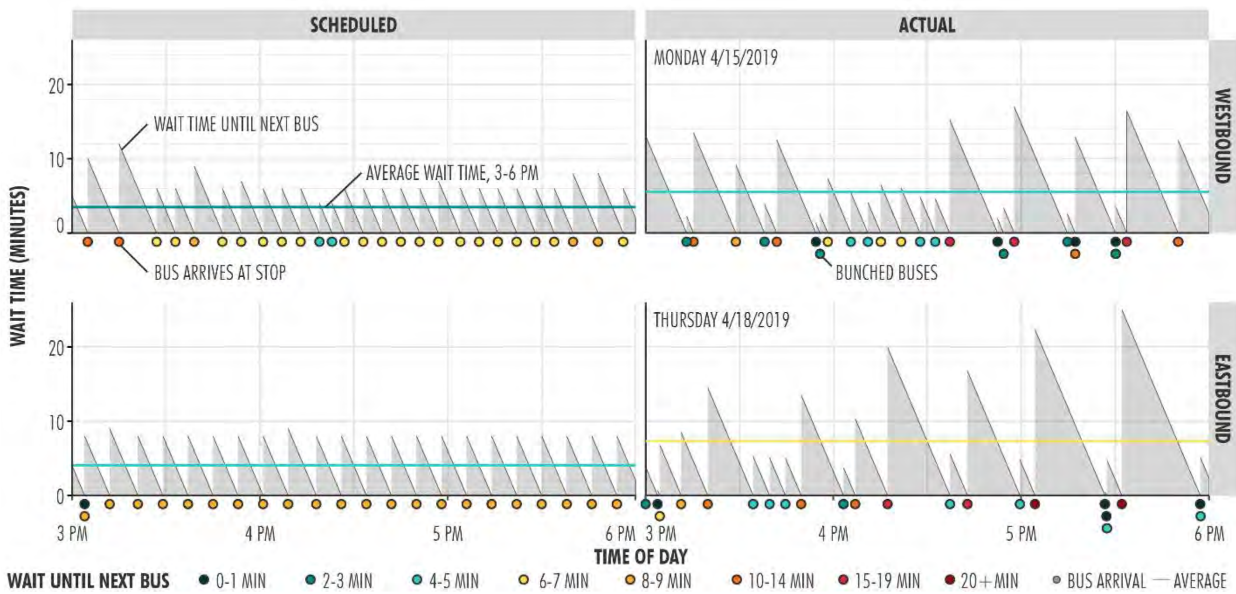
Frequency

Customers will also benefit from additional trips that create more frequent service at the times when people ride most. BOOST corridor plans will examine ridership and seating capacity by trip and tailor the schedule to match observed customer demand. Optimized schedules will gradually transition between early morning, peak hour, midday, and evening frequencies, ramping up and scaling back in step with demand throughout the day. To the extent possible, optimized schedules will improve frequency at times when the median seating utilization exceeds 75 percent in the existing system to provide capacity for ridership growth and to accommodate minor service disruptions. Frequency decreases will be considered at times when median seating utilization falls below 25 percent while maintaining the span of frequent service defined by METRO's service standards. Clockface schedules, i.e., headways that divide evenly into 60 minutes, are strongly preferred whenever headways are 10 minutes or greater.

Headway Management

One of the chief benefits of frequent service is the idea that passengers can “show up and go" and do not need to plan their trips around transit timetables. When buses arrive sufficiently frequently, customers know they will never wait more than a few minutes for the next bus, no matter what time they arrive at the bus stop. However, reliably achieving consistent headways on frequent service is operationally challenging, as even a small delay on one trip can spur bus bunching and long service gaps that frustrate customers. Figure 9 demonstrates this concept by comparing scheduled and actual bus arrival times and customer wait times on the 82 Westheimer, specifically at the eastbound and westbound stops at Hillcroft Avenue. Although buses are scheduled to arrive at regular intervals every 4 to 8 minutes, in reality they often bunch, causing long gaps—some over twenty minutes—between buses and increasing average wait times for customers.

Figure 9. Scheduled & Actual Wait Times at Westheimer Road & Hillcroft Avenue



Source: April 2019 IVOMS, GTFS

Headway management helps address these challenges to deliver more reliable frequent service. Under headway management, operators focus on maintaining consistent spacing between buses, rather than adhering to a specific schedule. This can be made easier by improving operating characteristics of the corridor through elements of the BOOST process such as stop optimization and TSP. As a part of schedule optimization and BOOST, headway management should be implemented at times when headways are 10 minutes or less.

Transitioning from a schedule-based operating practice to headway management requires additional displays on board buses to indicate to drivers their headway-based performance. The cost of these fleet upgrades should be incorporated into the capital cost estimate developed for BOOST corridors.

Real Estate

Right-of-Way Acquisition

Along many segments of BOOST corridors, building comfortable, spacious bus stops will require additional right-of-way or easements from adjacent property owners. METRO's Real Estate group will engage property owners and pursue such acquisitions using the approach outlined below.

As discussed in the Stop Design section, spacious bus stops with at least 15 feet behind the curb are the standard for BOOST corridors, as they fit a 4-foot deep shelter, a 6-foot wide clear sidewalk, a 4-foot safety buffer between the sidewalk and the roadway, and a 1-foot buffer between the shelter and the property line.

At sites with 13 feet behind the curb, it is possible to reduce the width of the safety buffer from 4 feet to 2 feet (the required width of the detectable warning strip) and keep the same core elements as the 15-

foot stop. Sites with less than 13 feet require using a cantilevered shelter with a narrower footprint (which provides customers with less protection from the elements), or reducing the width of the clear sidewalk to less than 6 feet (the City of Houston standard for Major Thoroughfares).

Accordingly, METRO will approach adjacent property owners about acquiring additional right-of-way at all sites with less than 13 feet behind the curb, except at those where buildings, retaining walls, or other immovable elements would prevent METRO from building a 15-foot deep bus stop.

At certain locations—especially at stop sites adjacent to property owned by public entities or nonprofit groups with an interest in enhanced bus stops—METRO will approach property owners about acquiring right-of-way or obtaining easements up to 25 feet behind the curb. With 25 feet behind the curb, wider sidewalks, more expansive programmable areas, and additional bike parking can improve the experience of people riding transit and visiting the adjacent school, park, or other service/amenity.

The 15% design phase will identify stop sites where additional right-of-way is desired based on planning-level estimates of the available behind-the-curb depth, and specify the desired stop depth for the purposes of 30% design (typically 15 feet or the available behind-the-curb depth, whichever is greater). Survey conducted as a part of 30% design will identify the true behind-the-curb depth and right-of-way requirements and may adjust the proposed stop depth based on available right-of-way, presence of obstacles, other constraints. While 30% design is underway, METRO's Capital Planning team will prepare site-specific justifications for each stop where additional right-of-way is desired, based on the stop optimization principles in this document.

After survey and 30% design is complete, METRO's Real Estate department will approach adjacent property owners with the 30% stop designs, any pertinent 30% sidewalk improvement designs, the specific rationale for placing a stop at each site, and marketing materials including renderings of BOOST bus stops, shelters, and other amenities.

After initial outreach to property owners—approximately the first month after the completion of 30% design—METRO's Real Estate team will continue to engage with property owners who express interest in further negotiation and continue to pursue right-of-way at these locations. In addition, Real Estate and Capital Planning groups will meet to weigh the costs and benefits of pursuing right-of-way at locations where property owners appear uninterested in further negotiations. Decisions about whether and how to pursue right-of-way at locations with uncooperative and uninterested property owners will be made on a site-by-site basis. While 30% design is underway, METRO's Capital Planning team will prepare information about the tradeoffs and relative importance of pursuing right-of-way at each site in order to help prioritize Real Estate's efforts and guide this decision-making process.

At most sites with 10 or more feet behind-the-curb, METRO will not pursue additional right-of-way and will instead design constrained stop platforms if property owners appear uninterested in further negotiations after initial discussion.

At sites with less than ten feet behind-the-curb, it is challenging to design a stop with the full set of amenities and accessibility treatments described in the Corridor Capital Improvements section. Stop sites with less than ten feet behind-the-curb, with especially high ridership, or near transfer locations may be prioritized for right-of-way acquisition if nearby sites with the desired behind-the-curb-depth are not available. Particularly challenging locations may also be revisited to examine the feasibility of moving the curb to create more space.

Driveway Modifications

Narrowing, relocating, or removing driveways along BOOST corridors can enable METRO to achieve stop spacing and placement goals that contribute to faster, more reliable service. This is especially true at signalized intersections, where far-side stop placement is necessary for buses to realize the full travel time benefits of transit signal priority and preemption, and where commercial land uses with wide driveways tend to cluster.

The stop optimization plan and 15% design phase will identify the specific locations where METRO will pursue removing disused or redundant driveways and narrowing excessively wide driveways to meet applicable City of Houston standards. Driveway removals that facilitate stop placement and spacing goals will also be considered where multiple driveways provide access to vacant lots; property owners would need to apply for new driveway permits prior to redeveloping these sites. The 30% design phase will produce engineering plan sets and schematics that Real Estate can use to approach adjacent property owners about the desired driveway modifications. As with right-of-way acquisition, METRO's Capital Planning and Real Estate teams will decide on a case-by-case basis how aggressively to pursue driveway modifications on sites where property owners are uninterested in doing so.

Community Engagement & Marketing

Community outreach to the both the general public and key stakeholders will occur throughout the BOOST design and implementation process.

First, METRO's Community Outreach and Urban Design teams will host a series of workshops in communities along BOOST corridors while 30% design is underway. These initial workshops will serve to introduce the surrounding neighborhoods to the overarching BOOST goals of a better walk, a better stop, and a better ride as well as the specific types of METRO investments they can expect to see in their community. These workshops will also collect community feedback and preferences for different types of amenities in the flexible programming spaces at BOOST bus stops.

After these first workshops, the Community Outreach and Urban Design teams will synthesize community preferences for programmable spaces and provide site-specific recommendations—most importantly, decisions about landscaping vs. hardscaping—for appropriate programming to the Engineering team immediately after 30% design. Follow up public meetings will occur approximately two months after the initial workshops related to programmable spaces to inform the surrounding communities of how their input has been integrated into designs along the corridor and to update the public regarding the anticipated improvements and schedule.

METRO's Community Outreach group will also engage key stakeholders and potential partners including management districts and TIRZs while 30% design is underway. Management districts and TIRZs often have strong connections with local property owners on commercial corridors and can provide guidance and introductions to property owners at sites where additional right-of-way will enable METRO to construct spacious bus stops to BOOST standards.

The next major round of public outreach will occur just prior to the start of construction, several months after the last public events. The Community Outreach team will continue to engage as needed throughout the construction process.

Engagement and marketing of upcoming BOOST changes will also occur immediately before and after the BOOST service change implementing faster travel times to inform customers of upcoming stop location and schedule changes. Public engagement and marketing can help customers understand which stops to use throughout the construction process as new stops become available. Stop-specific marketing will occur on a rolling basis depending on the precise phasing of construction and facilities installation. As soon as all amenities have been installed at new stop sites, existing unimproved stops at the same intersection will be discontinued, and buses will instead service the new and improved stops. Existing unimproved stops *not* included in the stop optimization plan will be discontinued only when all nearby sidewalk improvement are complete and faster schedules are implemented at the BOOST service change, so existing patrons of these stops will have a continuous accessible route to the nearest improved stop and will benefit from faster travel times.

Design Standards

BOOST Bus Stop – Standard Right-of-Way

Table A-1 - Bus Stop Design Variables

Design Variable	Value	Design Criteria
Back-of-Curb to ROW Dimension (E)	E ≥ 12'	See Table A-2
	8' ≤ E < 12'	See Constrained ROW Detail
	E < 8'	Noncompliant; Not Recommended
Design Bus Length	40'	Dimensions Marked * = 0'
	60'	Include Dimensiones Marked *
Platform Curb Height	9" (Preferred)	Include Design Elements Marked ^
	6"	Omit Design Elements Marked ^

Table A-2 - Dimensions

Dimension	Minimum	Standard	Signature	Preferred
DWS/safety buffer/programming (A)	2'	4'	4'	6'
Clear sidewalk (B)	5'	6'	8'	10'
Shelter/amenity zone (C)	4'	4'	5'	8'
ROW buffer (D)	1'	1'	1'	1'
Total Back-of-Curb to ROW (E)	12'	15'	18'	25'

Table A-3 - Slopes and Concrete Thickness

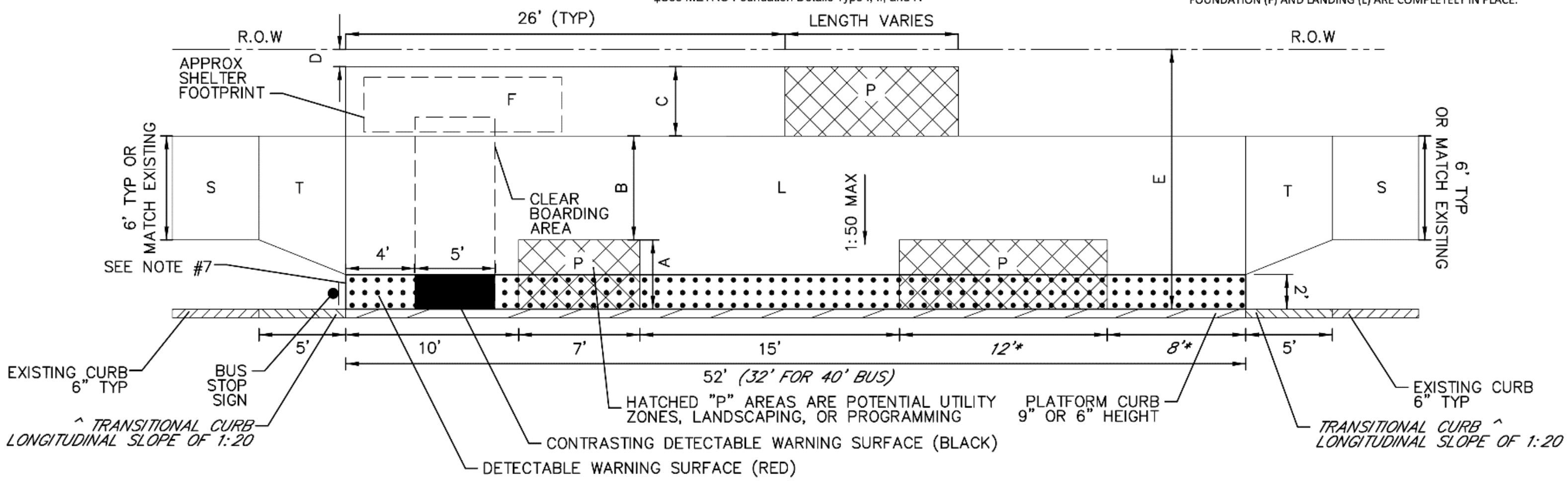
Area	Paving Thickness	Running Slope	Cross Slope
Landing (L)	4.5"	Match Street	2% max
Bus Shelter Area (F)'	9"	2% max	2% max
Transition Area (T)	4.5"	5% max	2% max
Sidewalk (S)	4.5"	5% max	2% max'
Programming Areas (P)	4.5" (Optional)	2% max	2% max

†Except to match existing

‡See METRO Foundation Details Type I, II, and IV

Notes

1) LOCATION OF BUS STOP LONGITUDINALLY ALONG THE ROADWAY SHOULD ACCOUNT FOR THE CRITICAL SHELTER OBSTRUCTION TO LINE OF SIGHT AND OTHER GUIDELINES SET FORTH IN METRO TRANSIT DESIGN STANDARDS.
2) THE TRANSITION (T) SHOULD BE MINIMUM 5' LONG OR MAY BE LENGTHENED TO MITIGATE EXCESSIVE SLOPE.
3) REFER TO "METRO BUS STOP CONCRETE DETAILS" FOR REBAR REQUIREMENTS FOR 9 INCH AND TRANSITIONAL CURB AND EXPANSION AND CONTROL JOINTS.
4) REFER TO CITY OF HOUSTON "CONCRETE SIDEWALK DETAILS FOR STREETS WITH CURBS" DWG NO. 02775-01 FOR SIDEWALK DETAILS. THE DRIVEWAY/SIDEWALK HEADER DETAIL PER CITY OF HOUSTON DWG NO. 02775-01 WILL BE USED TO CONNECT THE LANDING (L) (4 1/2" THICK) TO THE PAD (F) (9" THICK).
5) PROGRAMMING AREAS (P) MAY INCLUDE LANDSCAPING, BIKE PARKING, UTILITIES, STREET FURNITURE, ETC. TO BE DETERMINED BY METRO.
6) THE LANDING AREA (L) SHALL CONTAIN REINFORCING TRANSVERSE STEEL #4 BAR CONTINUOUS 12" C-C (TYP) AND LONGITUDINAL STEEL #4 BAR CONTINUOUS 12" C-C (TYP).
7) TACTILE WARNING MATERIAL SHALL EXTEND ALONG TRANSITIONAL CURB WHERE SIDEWALK PAVING MEETS TRANSITIONAL CURB.
8) SHOW EXISTING PRIVATE AND PUBLIC UTILITIES. ADJUST VALVES AND PULLBOXES IF NEEDED. AVOID VERTICAL UTILITY CONFLICTS IN AREAS MARKED "L." VERTICAL UTILITES MAY EXIST IN AREAS MARKED "P." IDENTIFY AND PROTECT EXISTING GAS PIPELINES OR VALVES WITHIN THE WORK AREA.
9) CONTRACTOR TO AVOID DAMAGE TO ANY PRIVATE PROPERTY AND/OR TREES.
10) CONTRACTOR TO CONTACT METRO AT (713) 615-6195 ONCE FOUNDATION (F) AND LANDING (L) ARE COMPLETELY IN PLACE.



NO. DATE | REVISIONS | BY CK APP

METRO

DESIGNED JLL DATE 4/16/2020
DRAWN JLL DATE 4/16/2020
CHECKED JLL DATE 4/16/2020
APPROVED DATE
SCALE: N.T.S.

METRO BOOST Bus Stop Detail
Standard Right-of-Way

CONTRACT NO | DRAWING NO | PAGE

BOOST Bus Stop – Sidewalk Behind Shelter

Table B-1 - Bus Stop Design Variables

Design Variable	Value	Design Criteria
Back-of-Curb to ROW Dimension (E)	20' ≤ E ≤ 25'	See Table B-2
	E < 20'	Use Standard ROW Detail
	E > 25'	Noncompliant; Not Recommended
Design Bus Length	40'	Dimensions Marked * = 0'
	60'	Include Dimenesiones Marked *
Platform Curb Height	9" (Preferred)	Include Design Elements Marked ^
	6"	Omit Design Elements Marked ^

Table B-2 - Dimensions

Total Back-of-Curb (E)	20'	23'	25'
Curbside Programming Zone (A)	3'	6'	6'
Clear Shelter Frontage (B)	6'	6'	7'
Shelter/Amenity Zone (C)	4'	4'	4'
ROW Buffer (D)	1'	1'	1'
Clear Sidewalk (G)	6'	6'	7'

Table B-3 - Slopes and Concrete Thickness

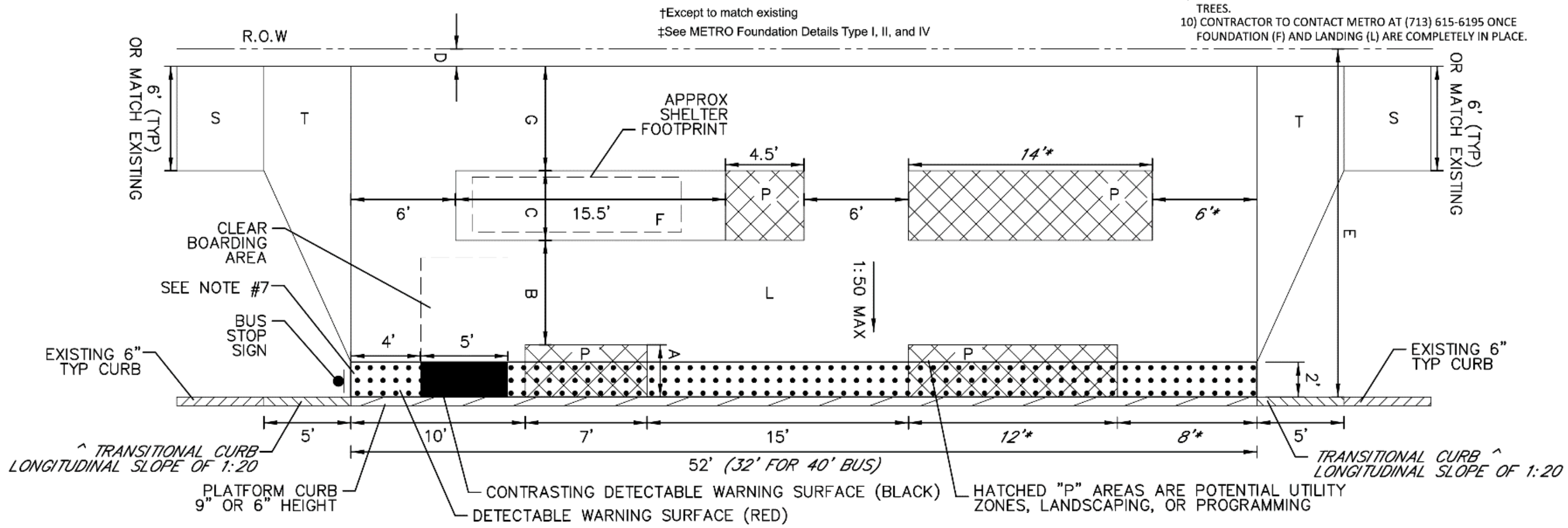
Area	Paving Thickness	Running Slope	Cross Slope
Landing (L)	4.5"	Match Street	2% max
Bus Shelter Area (F)‡	9"	2% max	2% max
Transition Area (T)	4.5"	5% max	2% max
Sidewalk (S)	4.5"	5% max	2% max†
Programming Areas (P)	4.5" (Optional)	2% max	2% max

†Except to match existing

‡See METRO Foundation Details Type I, II, and IV

Notes

1) LOCATION OF BUS STOP LONGITUDINALLY ALONG THE ROADWAY SHOULD ACCOUNT FOR THE CRITICAL SHELTER OBSTRUCTION TO LINE OF SIGHT AND OTHER GUIDELINES SET FORTH IN METRO TRANSIT DESIGN STANDARDS.
2) THE TRANSITION (T) SHOULD BE MINIMUM 5' LONG OR MAY BE LENGTHENED TO MITIGATE EXCESSIVE SLOPE.
3) REFER TO "METRO BUS STOP CONCRETE DETAILS" FOR REBAR REQUIREMENTS FOR 9 INCH AND TRANSITIONAL CURB AND EXPANSION AND CONTROL JOINTS.
4) REFER TO CITY OF HOUSTON "CONCRETE SIDEWALK DETAILS FOR STREETS WITH CURBS" DWG NO. 02775-01 FOR SIDEWALK DETAILS. THE DRIVEWAY/SIDEWALK HEADER DETAIL PER CITY OF HOUSTON DWG NO. 02775-01 WILL BE USED TO CONNECT THE LANDING (L) (4 1/2" THICK) TO THE PAD (F) (9" THICK).
5) PROGRAMMING AREAS (P) MAY INCLUDE LANDSCAPING, BIKE PARKING, UTILITIES, STREET FURNITURE, ETC. TO BE DETERMINED BY METRO.
6) THE LANDING AREA (L) SHALL CONTAIN REINFORCING TRANSVERSE STEEL #4 BAR CONTINUOUS 12" C-C (TYP) AND LONGITUDINAL STEEL #4 BAR CONTINUOUS 12" C-C (TYP).
7) TACTILE WARNING MATERIAL SHALL EXTEND ALONG TRANSITIONAL CURB WHERE SIDEWALK PAVING MEETS TRANSITIONAL CURB.
8) SHOW EXISTING PRIVATE AND PUBLIC UTILITIES. ADJUST VALVES AND PULLBOXES IF NEEDED. AVOID VERTICAL UTILITY CONFLICTS IN AREAS MARKED "L." VERTICAL UTILITES MAY EXIST IN AREAS MARKED "P." IDENTIFY AND PROTECT EXISTING GAS PIPELINES OR VALVES WITHIN THE WORK AREA.
9) CONTRACTOR TO AVOID DAMAGE TO ANY PRIVATE PROPERTY AND/OR TREES.
10) CONTRACTOR TO CONTACT METRO AT (713) 615-6195 ONCE FOUNDATION (F) AND LANDING (L) ARE COMPLETELY IN PLACE.



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DESIGNED JLL DATE 4/16/2020
DRAWN JLL DATE 4/16/2020
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APPROVED DATE
SCALE: N.T.S.

METRO BOOST Bus Stop Detail
Sidewalk Behind Shelter

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BOOST Bus Stop – Constrained Right-of-Way

Table C-1 - Bus Stop Design Variables

Design Variable	Value	Design Criteria
Back-of-Curb to ROW Dimension (E)	E ≥ 12'	See Standard ROW Detail
	8' ≤ E < 12'	See Table C-2
	E < 8'	Noncompliant; Not Recommended
Design Bus Length	40'	Dimensions Marked * = 0'
	60'	Include Dimensions Marked *
Platform Curb Height	9" (Preferred)	Include Design Elements Marked ^
	6"	Omit Design Elements Marked ^

Table C-2 - Dimensions

Total Back-of-Curb to ROW (E)	11'	10'	8'
Warning/safety buffer/programming (A)	4'	4'	2'
Clear sidewalk (B)	6'	5'	5'
ROW buffer (D)	1'	1'	1'

Table C-3 - Slopes and Concrete Thickness

Area	Paving Thickness	Running Slope	Cross Slope
Landing (L)	4.5"	Match Street	2% max
Bus Shelter Area (F)‡	9"	2% max	2% max
Transition Area (T)	4.5"	5% max	2% max
Sidewalk (S)	4.5"	5% max	2% max†
Programming Areas (P)	4.5" (Optional)	2% max	2% max

†Except to match existing

‡See METRO Foundation Details Type I, II, and IV

Notes

1) LOCATION OF BUS STOP LONGITUDINALLY ALONG THE ROADWAY SHOULD ACCOUNT FOR THE CRITICAL SHELTER OBSTRUCTION TO LINE OF SIGHT AND OTHER GUIDELINES SET FORTH IN METRO TRANSIT DESIGN STANDARDS.
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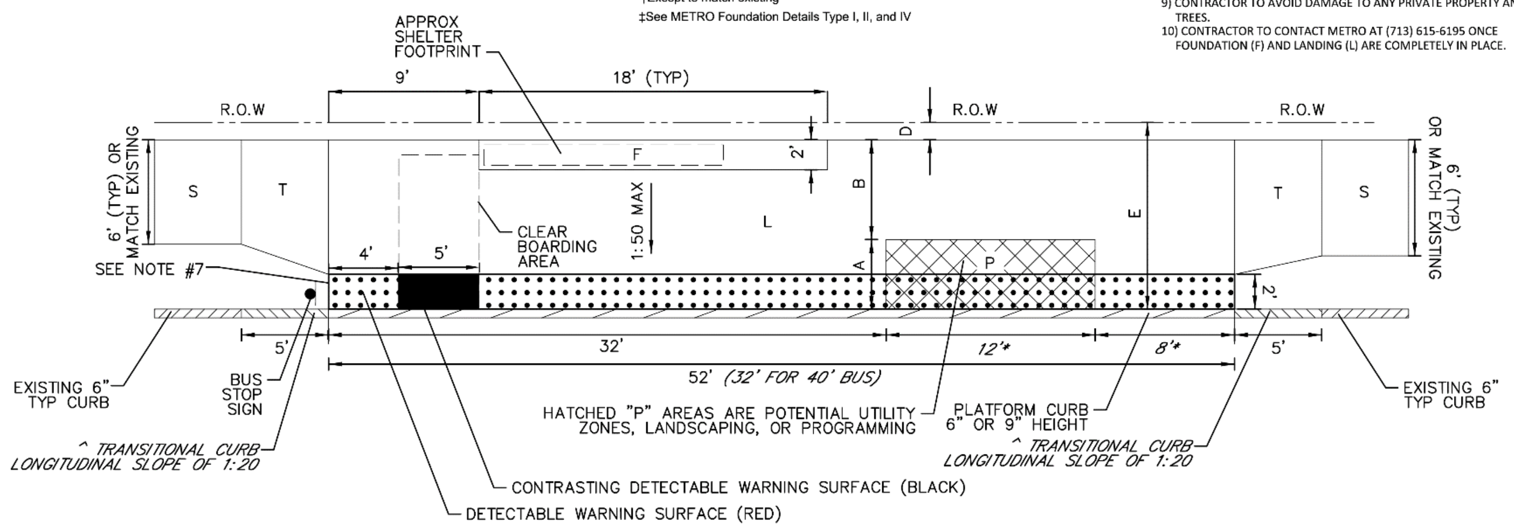

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JLL DRAWN 4/16/2020 DATE
JLL CHECKED 4/16/2020 DATE
APPROVED DATE
SCALE: N.T.S.

METRO BOOST Bus Stop Detail
Constrained Right-of-Way

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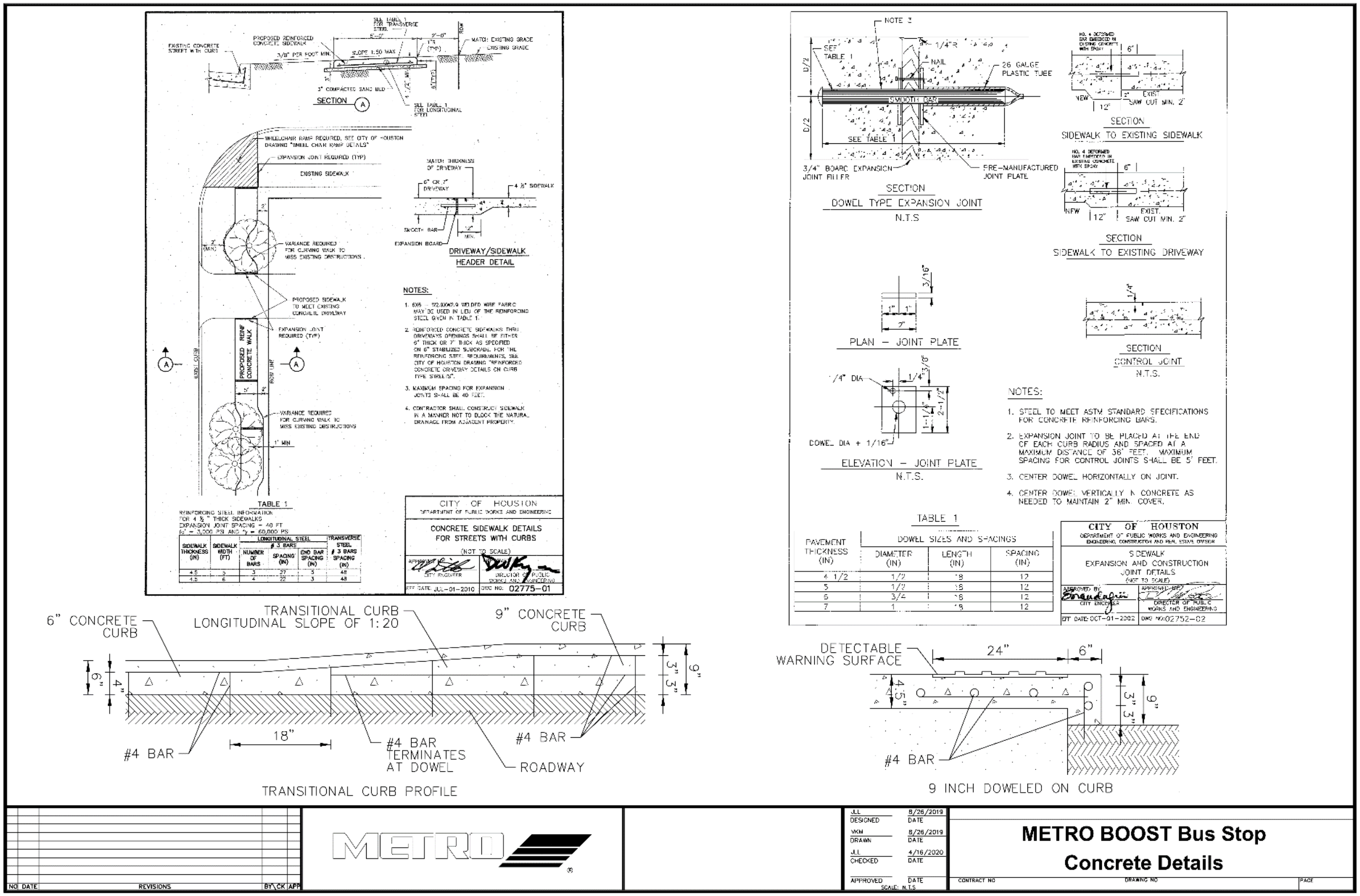
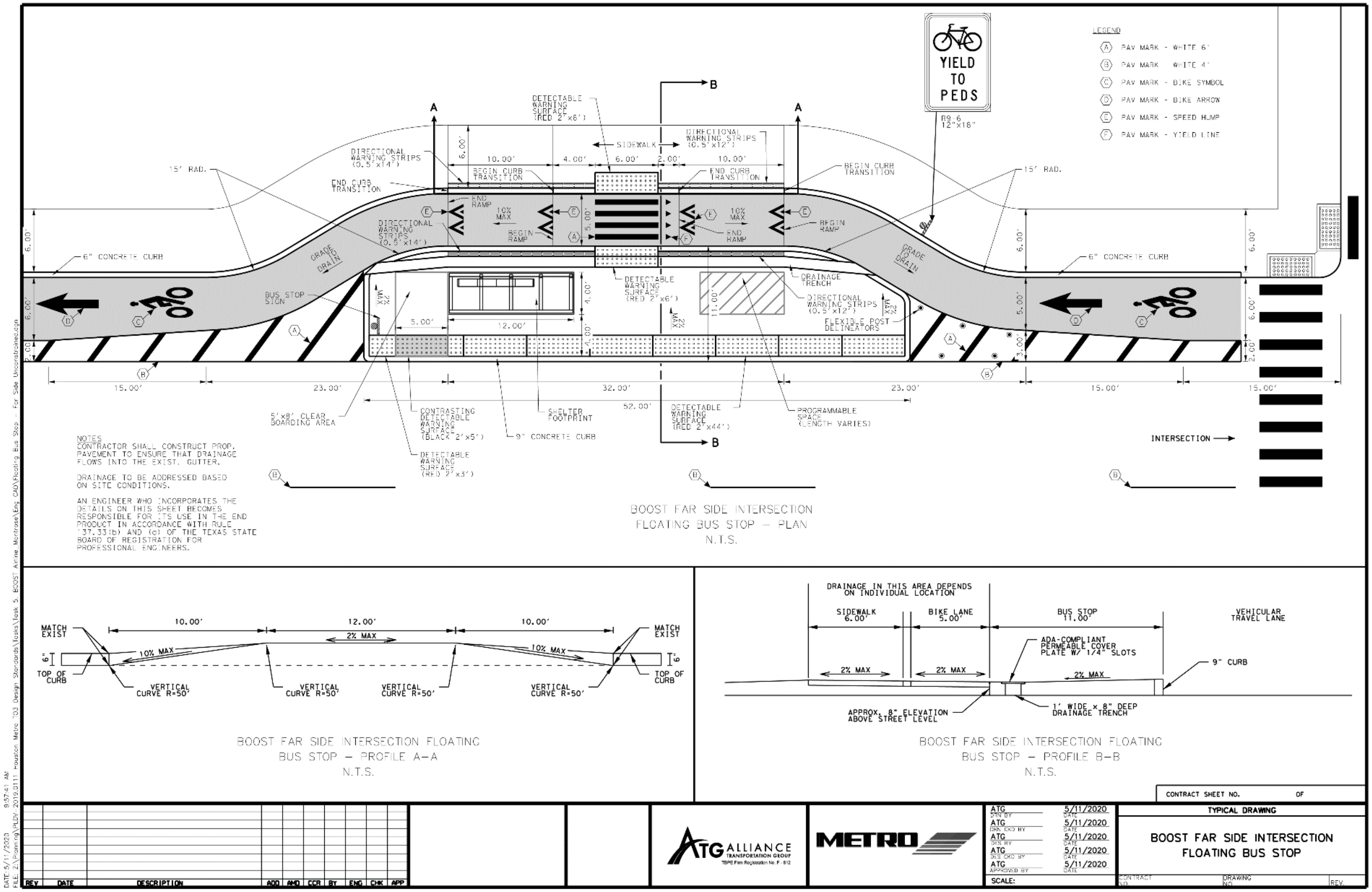
BOOST Bus Stop – Concrete Detail

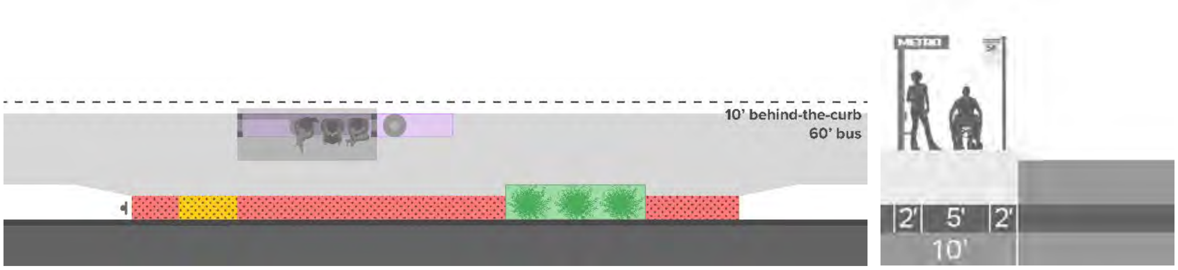


BOOST Bus Stop – Floating Bus Stop

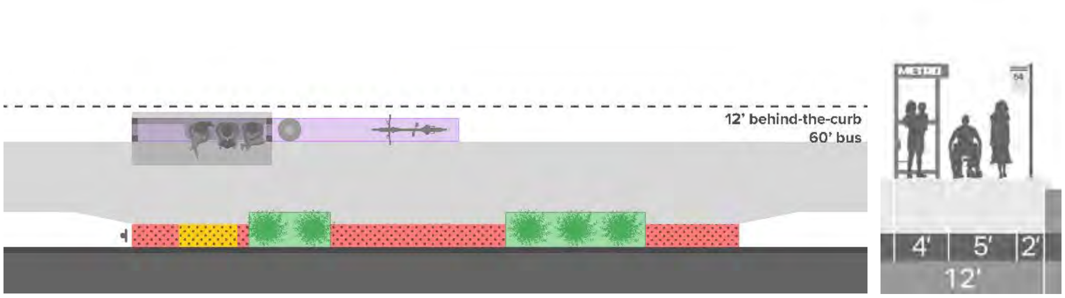


Alternate Stop Configurations

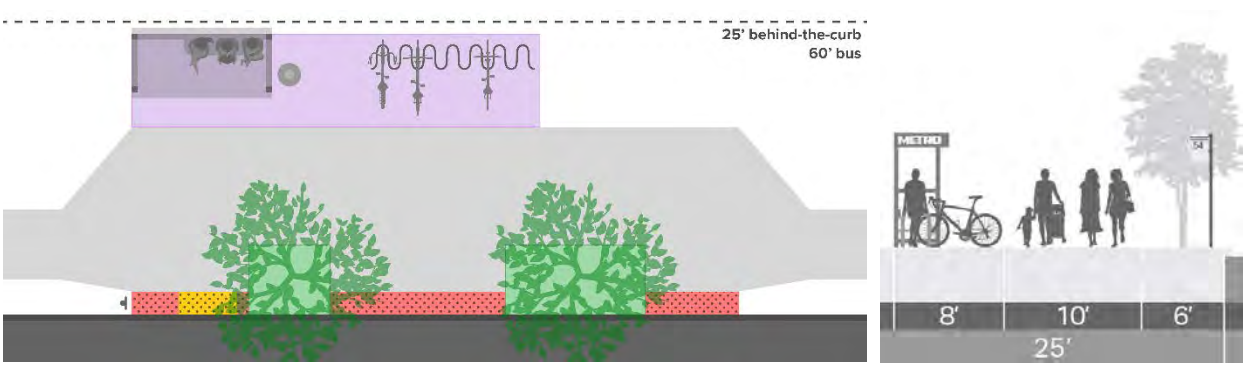
10 feet behind-the-curb



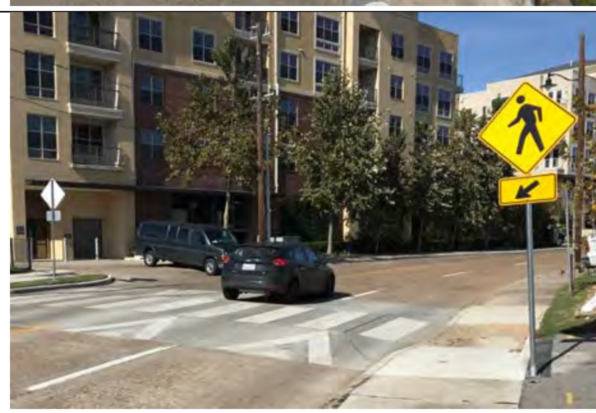
12 feet behind-the-curb

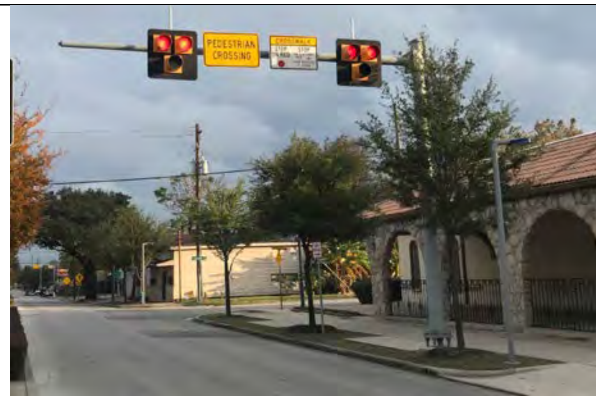


25 feet behind-the-curb



Crossing Toolbox

Pedestrian refuge/Median cut-through – Gaps or ramps in raised center medians or designated waiting areas that enable ADA access and bicyclists to cross or obtain refuge in the median when crossing wide or busy intersections.	
Curb extensions/Bulb-outs – Extending the curb line into the adjacent lane to reduce the crossing distance	
Raised crosswalks – Slight elevation of a crosswalk to increase visibility and slow traffic	
Rapid Flashing Beacons – Pedestrian activated beacon that does not stop traffic but warns drivers that pedestrians are crossing.	

Pedestrian Hybrid Beacon/HAWK – Activated pedestrian signal that stops crossing traffic. These typically require traffic analysis and authorization from the City of Houston	
Signage and pavement markings – Enhanced signage and markings to designate pedestrian activity between signalized intersections that do not warrant a beacon.	

APPENDIX A

To: Adam Elghoul
Transit Planner, METRO

From: James Llamas, TEI

CC: Yuhayna McCoy, METRO
Geoff Carleton, TEI
Kelsey Walker, TEI

Date: July 12, 2019

Re: **BOOST Raised Curb Design Guidance & Applications**

This memo synthesizes design guidance regarding the application and best practices for raised curbs at bus stop platforms in anticipation of the Bus Operations Optimized System Treatments (BOOST) implementation.

Benefits and Design Guidance

The floor height of a typical local bus is approximately 14 inches, requiring an eight-inch step up for a person boarding from a stop with a standard, 6-inch curb. The local bus models in METRO's fleet can pneumatically "kneel," dropping the front step height to about 11 inches (and some as low as 9 inches), reducing the step height. Raising the curb at the bus stop can further reduce the step, a benefit to accessibility for all passengers but especially those with mobility challenges, strollers, or luggage. Improved access can, in turn, reduce stop dwell time by allowing passengers to board more quickly and by reducing instances of ramp deployments for customers with walkers or carts. Reducing stop dwell time will help achieve the objectives of BOOST to provide faster, more reliable local bus service.

Bus platform heights of 8 to 11 inches are referred to as "near-level boarding." This is a distinction from "level boarding" platforms of 12 to 14 inches that most closely match the floor of the vehicle and can offer roll-on access for customers with wheelchairs. For reference, the Uptown BRT Line currently under construction will have level boarding.

For BOOST, near-level boarding with 9-inch curb height is proposed for the following reasons:

- **Compatibility with the existing local bus fleet.** No modification is required to the existing fleet to serve a stop with a 9-inch curb. Higher platforms would require specially designed curbs, rub boards, or wheel hub modifications to avoid potential damage to the bus or platform resulting from contact. Field measurements of METRO equipment indicate that wheel hubs will clear a 9-inch curb but could make contact at 10 inches or higher. A 9-inch curb is also compatible with the standard, fold-out wheelchair ramps on current buses which will still be used to board passengers with wheelchairs.
- **Compatibility with existing driver training and practices.** Drivers can continue to pull into and out of stops as they do currently without additional training or special caution.
- **Ability to retrofit on existing roadways.** Tolerances for higher platform heights are tighter, presenting challenges for implementation along existing roadways with varying cross-slopes and

states of repair. Higher platforms could also present challenges where tying into existing sidewalks and may be more likely to introduce drainage impacts behind the right-of-way line.
- **Use of front-of-bus bike racks.** Customers with bikes need to be able to step down from the curb to secure their bikes on the rack. Curb heights approaching level boarding make this more difficult.

Design Considerations

Situations exist where raised curbs should be avoided or given special consideration, such as where the bus may overhang the curb on arrival or departure. This can occur at bus pull-outs without adequate distance for the bus to straighten up or other stops that are angled from the main direction of travel. Other factors to overcome might include constrained right-of-way, nearby obstructions such as driveways or utilities, or topography such as excessive slope or the presence of a drainage ditch.

Design Details

Due to the raised surface, a 24-inch deep tactile warning strip is recommended along the platform edge. Some agencies mark or color the warning strip differently at door locations to help drivers stop at the same location consistently and for passengers to know where to wait.

The transition from the raised portion of the platform back to an existing curb-height sidewalk will typically require 3 to 5 feet of distance depending on whether a ramp slope of 1:12 or a running slope of 1:20 is used. Generally, a running slope is recommended unless constraints exist.

Design of raised stops should take care not to introduce drainage issues where existing drainage may occur across the sidewalk.

Additional Guidance

The *Transit Street Design Guide*, a publication of the National Association of City Transportation Officials (NACTO), provides further guidance regarding near-level platforms and tactile warning strips, including:

- "Near-level platforms are suitable for side and center boarding islands, boarding bulbs, or sidewalk stops with sufficient width to provide a raised area. Provide ADA-compliant ramps to achieve desired height leading to the boarding pad. Ramps should not impede pedestrian paths or crossings."
- "Where the boarding platform is higher than a typical curb height, including near-level or level boarding platforms, 24-inch deep detectable warning strips must be applied the entire length of the platform edge (PROWAG §R208)."

Applications and Examples

Most examples use some form of physical solution in situations where curb height is taller than nine inches. These interventions typically modify curbs or instal rub boards to provide alignment guidance while also preventing tire sidewall and wheel nut damage from repetitive curb abrasion. Those with nine-inch curbs chose that height to avoid the need for such design elements and to maintain compatibility with existing bus fleets.

A Line – METRO Transit, Minneapolis/St. Paul, Minnesota

- Retrofit of enhanced bus platforms on existing streets, serving local and signature bus lines
- Nine-inch curb used where feasible
- Nine inches selected for universal fleet compatibility

Super-Stops – IndyGo, Indianapolis, Indiana

- Enhancement of downtown stops with high volumes of local buses
- Nine-inch curb height selected for local fleet compatibility
- Project currently in design: https://www.indygo.net/transitplan/super-stops/

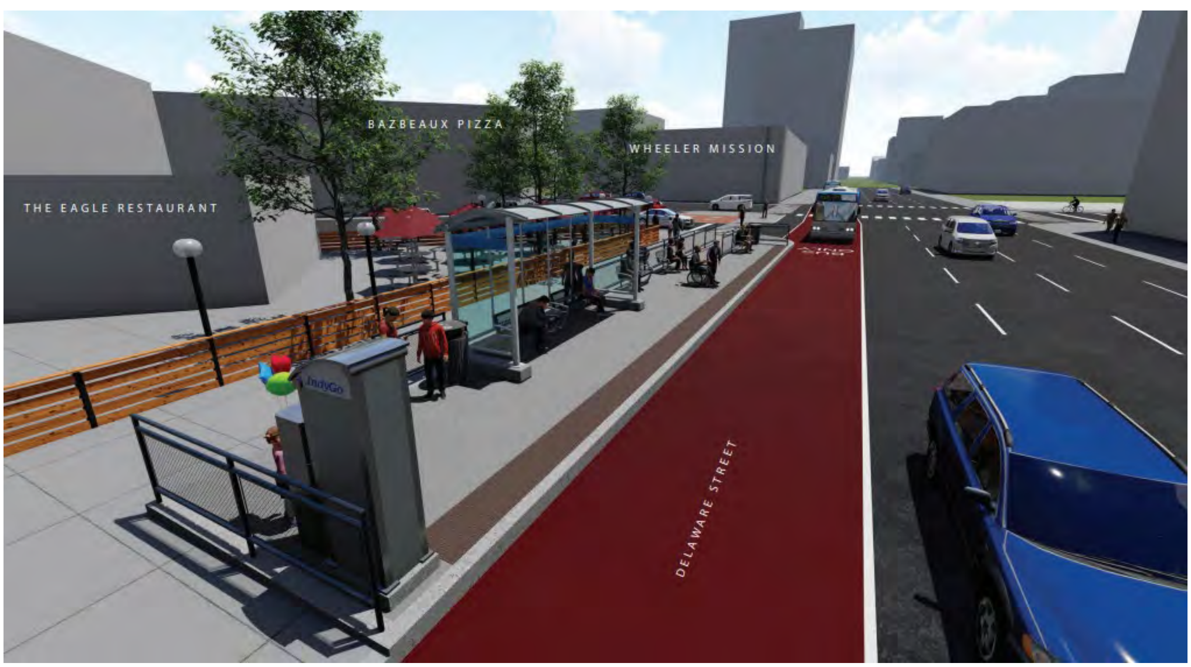


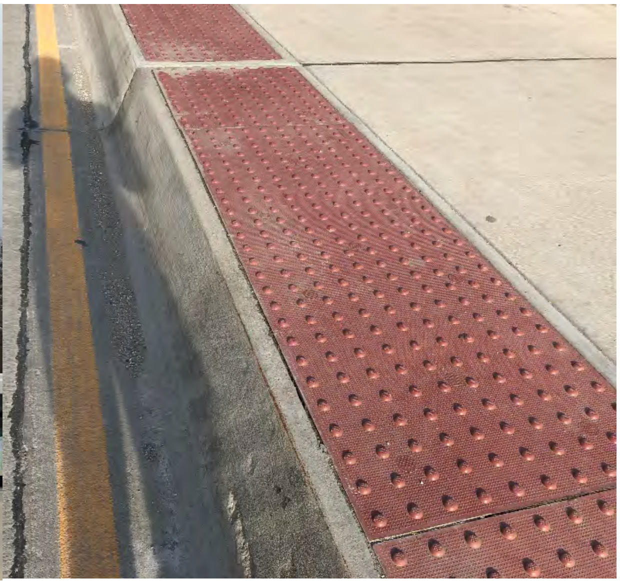
Image: IndyGo

Loop Link – Chicago Transit Authority, Chicago, Illinois

- Dedicated transit lane and stations serving multiple local lines within the Downtown Loop
- Eleven-inch platforms employ rub boards for alignment and to prevent any concrete scraping

MCORE – MTD, Champaign-Urbana, Illinois

- Series of bus platforms served by multiple local routes adjacent to university
- Eleven-inch curbs used, which is the upper limit for near-level boarding
- Concave (or Kassel) curbs were constructed to protect the wheel well and to guide operators



Resources

- Transit Street Design Guide, National Association of City Transportation Officials (NACTO) https://nacto.org/publication/transit-street-design-guide/
- Correspondence with Katie Roth, Project Manager, Bus Rapid Transit, Metro Transit
- Correspondence with Jennifer Henry, Senior Manager, Bus Strategic Planning & Policy, Chicago Transit Authority
- Correspondence with Evan Alvarez, Transit Planner & Outreach Coordinator, Champaign Urbana Mass Transit District
- Correspondence with Austin Gibble, Project Development Planner, IndyGo

Appendix B: BOOST Corridor Sidewalk Assessment Field Work Reference Sheet

Sidewalk Conditions

A: 5'+, traversable

B: <5', traversable

C: 5'+, not traversable

D: <5', not traversable

E: missing

G: under construction / cannot assess

Traversable: no significant cross-slope or vertical deviation; driveways have level sections.

Not Traversable: one or more of the following: 1"+ vertical deviation, significant cross-slope (including at driveways), severe cracking.

For most parcels worst condition controls; mark the **worst** condition existing on the parcel.

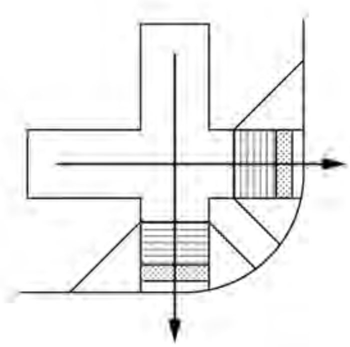
For very large parcels mark the **typical** condition and note specific problem areas (e.g. – "All B except for two D segments circled").

Other things to note: significant but passable cracking, drainage problems, mud/vegetation, obstructions, other miscellaneous problems.

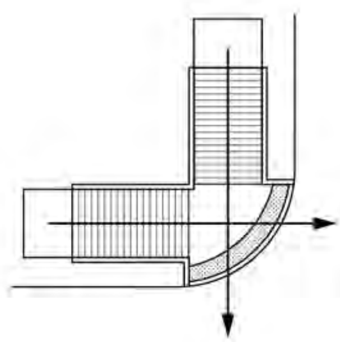
Curb Ramp Form

Directional: slope aligned to direction of travel

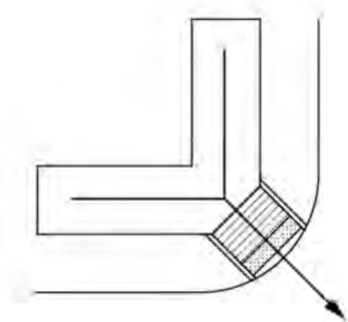
Diagonal: slope aligned to intersection center



Directional (standard)



Directional (sunken corner)



Diagonal

Ramp Not Traversable: one or more of following: noticeable cross-slope, 1"+ vertical deviation at any point (including landing area), obstruction rendering impassable, overly steep running-slope.

Gutter Makes Ramp Inaccessible: meant to capture problems that will require street repair rather than ramp repair. If ramp is traversable except where it meets the roadway due to pavement/gutter issues, mark ramp condition as "traversable" and check this box.

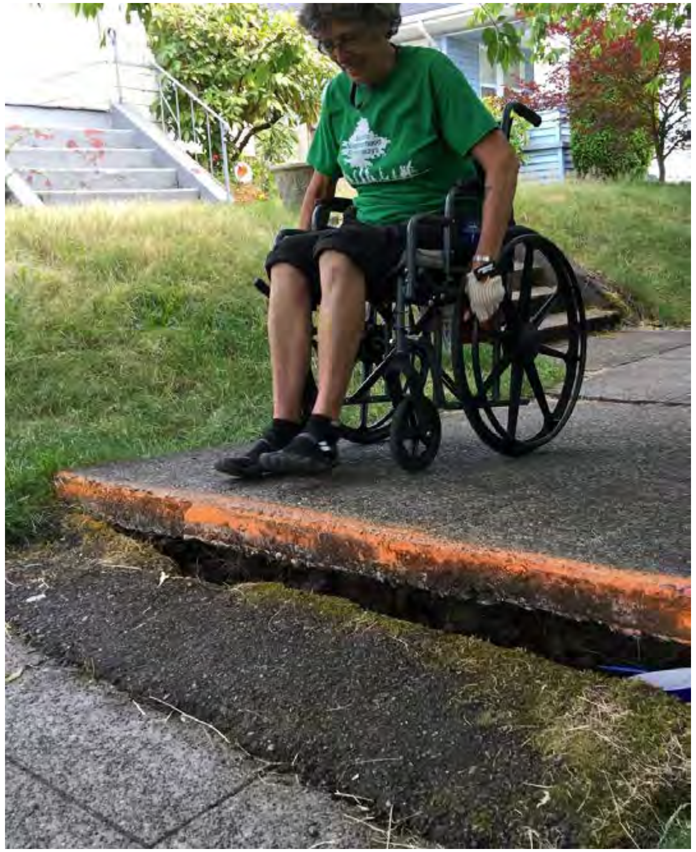
Other things to note: drainage problems, mud/vegetation, obstructions, other miscellaneous problems.

BOOST Corridor Sidewalk Assessment

Orientation for Field Work

BOOST means **a better walk**, a better stop, and a better ride.

A better walk means **an accessible, traversable route** along the entire corridor, and connections to key destinations.



Sidewalk Evaluation Process

Mark sidewalk condition by parcel

Paper maps will be provided

- **Condition A**: Wide & Traversable
- **Condition B**: Narrow & Traversable
- **Condition C**: Wide & Not Traversable
- **Condition D**: Narrow & Not Traversable
- **Condition E**: No Sidewalk
- **Condition G:** Under Construction (Cannot currently be assessed)

		Width	
		Wide: 5'+	Narrow: <5'
Traversable?	Traversable	**A**	**B**
	Not Traversable	**C***	**D***

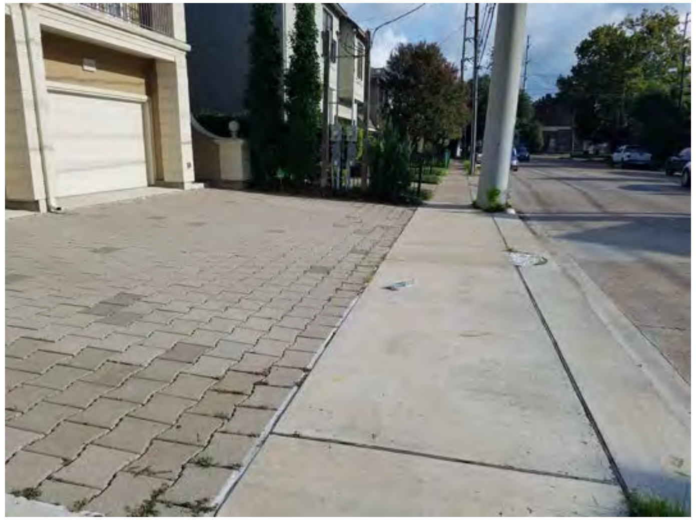
No Sidewalk	**E***
Under Construction	**G**

*pursue improvements through BOOST

Sidewalk Condition A
Wide & Traversable

- Wide: 5’+
  - Can be narrower for short distances in order to avoid obstacles (See photos at right)
- Traversable:
  - No significant cross-slope*
  - Driveways should have a level section where the sidewalk crosses
  - No significant vertical deviations (over 1”)

*: slope in direction other than the intended direction of travel




Sidewalk Condition B
Narrow & Traversable

- Narrow: <5’
- Traversable:
  - No significant cross-slope
  - Driveways should have level sections to minimize cross-slope
  - No significant vertical deviations (over 1”)

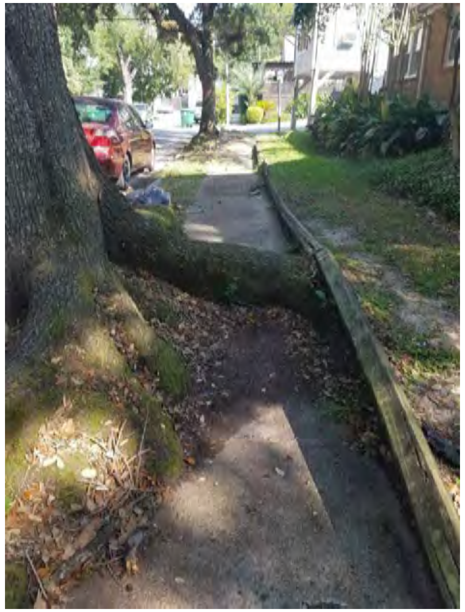
Sidewalk Condition C
Wide & Not Traversable

- Wide: 5'+
  - Would become an A if repaired
- Not traversable; one or more of the following problems
  - Vertical deflection over 1"
  - Significant cross-slope (including at driveways)
  - Significant cracking that impedes traversal

Sidewalk Condition D

Narrow & Not Traversable

- Narrow: <5’
  - Would become a B if repaired
- Not traversable; one or more of the following problems:
  - Vertical deflection over 1”
  - Significant cross-slope (including at driveways)
  - Significant cracking that impedes traversal



Sidewalk Condition E

No sidewalk

Worst condition controls

If a parcel is not traversable at one point, then the parcel is not traversable.

- For most parcels, mark the **worst** condition, e.g. "E" for the parcel at right.
- For very large parcels, mark the **typical** condition and note specific problem areas, e.g. "All B except for the two segments circled."

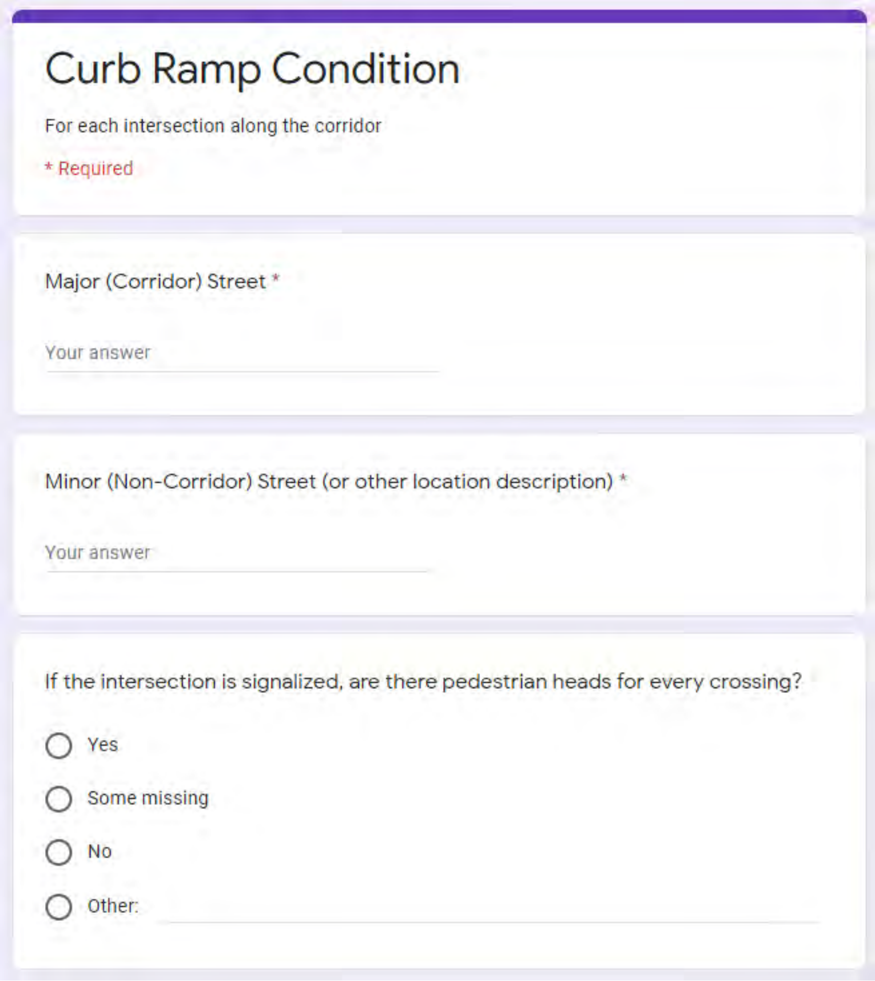
Other Things to Note

- Significant but passable cracking
- Drainage problems
- Mud/vegetation
- Obstructions such as poles

Curb Ramp Evaluation Form

https://forms.gle/J2XdUCcEdLezMDSd6

1. Enter location information



Curb Ramp Condition

For each intersection along the corridor

* Required

Major (Corridor) Street *

Your answer

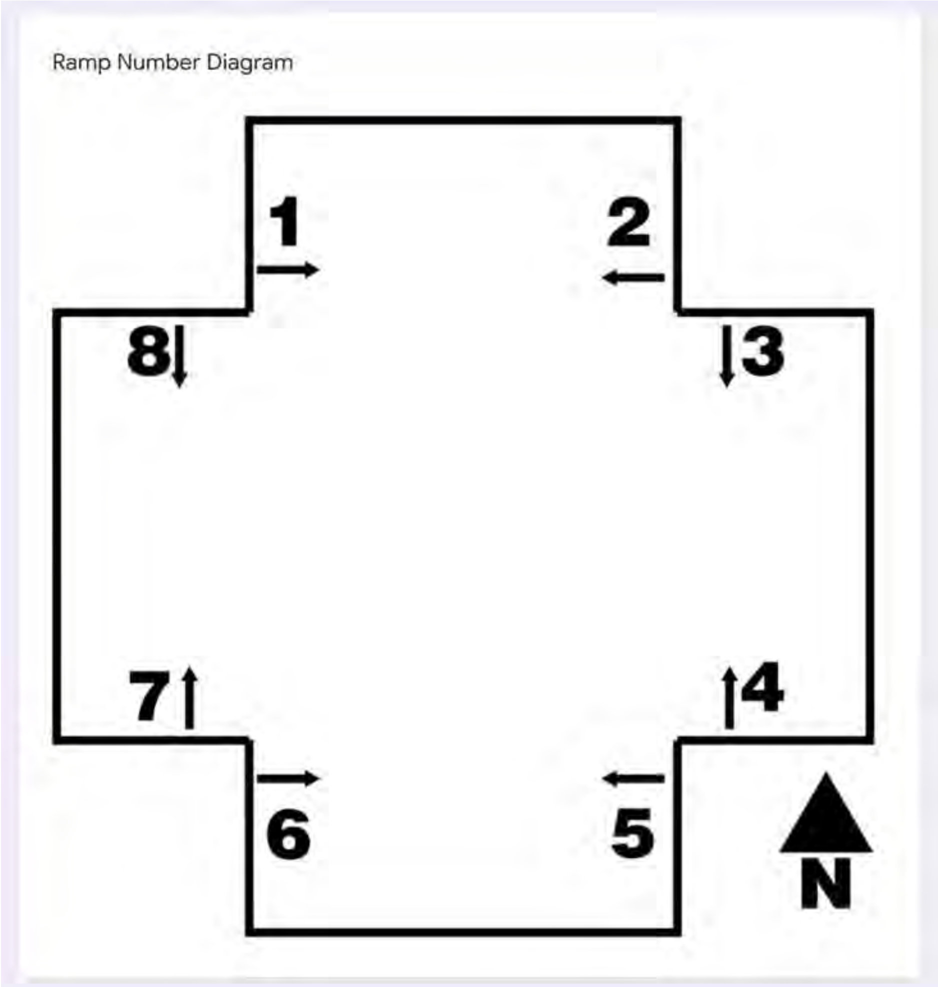
Minor (Non-Corridor) Street (or other location description) *

Your answer

If the intersection is signalized, are there pedestrian heads for every crossing?

- Yes
- Some missing
- No
- Other:

2. Orient yourself



3. Enter ramp conditions

Curb Ramp 1 (NW Corner EB)

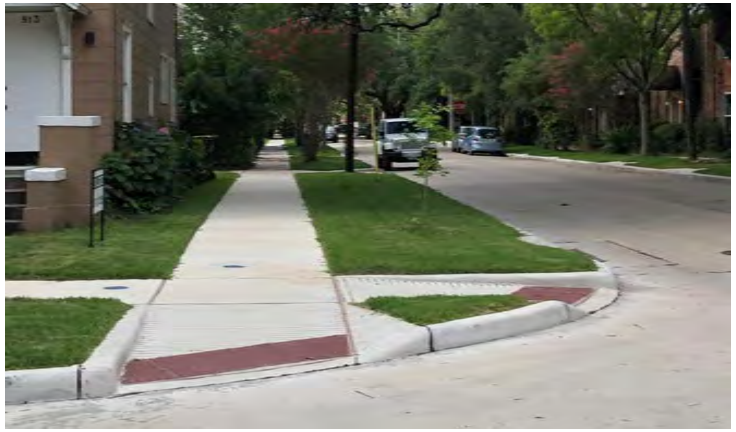
- ◯ Directional - Traversable
- ◯ Directional - Not Traversable
- ◯ Diagonal - Traversable
- ◯ Diagonal - Not Traversable
- ◯ Missing

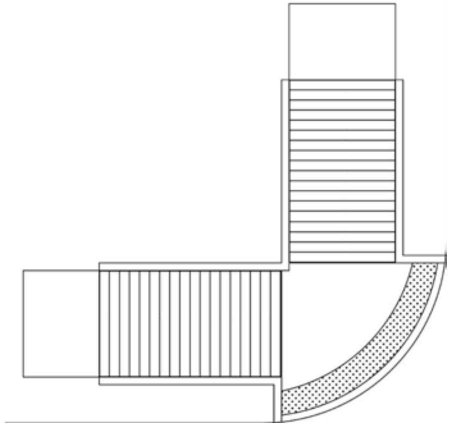
Curb Ramp 1 (NW Corner EB)

- ☐ Gutter makes ramp inaccessible to wheelchair

Directional Ramps

- Slope is aligned to direction of travel – parallel to roadway
- Includes "sunken corner" ramp format (see figure at right)





Sunken corner ramp format

Diagonal Ramps

- Slope is directed towards center of intersection rather than direction of travel

Ramp Condition

Not traversable: ramp has one or more of the following issues:

- Noticeable cross-slope
- 1”+ vertical deflection at any point (including landing area)
- Obstruction rendering impassable
- Overly steep running-slope*

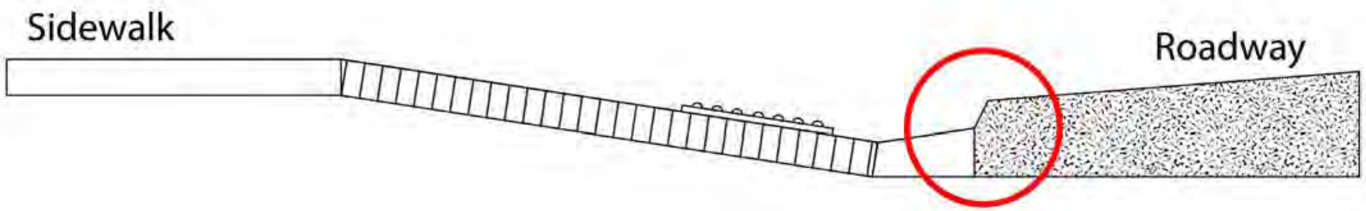
Traversable: ramp has none of the noted issues.

Missing: no ramp.

*: Slope in direction of travel

Checkbox: “Gutter makes ramp inaccessible”

- Meant to capture issues that will require street pavement or gutter work rather than ramp repair
- If ramp is traversable except where it meets the roadway due to pavement/gutter issues, mark ramp condition as “traversable” and check this box.



Other things to note

- Drainage problems
- Mud/vegetation
- Obstructions such as poles
- Other miscellaneous problems

2500 Summer Street, Suite 3228
Houston, TX 77007
Planning | Urban Design | Landscape Architecture
P: (713) 337-5830
www.asakurarobinson.com

ASAKURA ROBINSON

APPENDIX C

5 March 2020

RE: METRO BOOST (Bus Operations Optimization Service Treatments), Airline Montrose Corridor

Programmable Areas Preliminary Recommendations

This memo accompanies engineering drawings for fourteen METRO BOOST pilot platforms along Studewood Street. Each of the fourteen platforms have indicated two locations for Programmable Areas, which may be individually customized according to specific character or context of platforms or may be unified along a corridor to enhance the visibility and branding of the METRO platforms.

The Programmable Areas for the Airline Montrose Corridor pilot project are provided in two configurations:

- Front of Platform at back of curb (7' x 3')
- Back of Platform adjacent to shelter pad (4.5' x 4')

The recommendations in this memo are intended to be among a larger portfolio of potential interventions and activations for BOOST Programmable Areas. For the purposes of the pilot project, this memo is not intended to be comprehensive but should provide sufficient information for the final engineering and construction of pilot program BOOST platforms. The memo concludes with an overview of METRO's ongoing progress in providing a matrix for determining priorities for future BOOST Programmable Area spaces. Pilot project recommendations include:

PLANTING

Planting areas are identified as the most practical use of Programmable Areas for the BOOST pilot. These have the benefit of providing immediate visual delight to METRO riders and allow for ease of future retrofit into other Programmable Area elements in the future, if desired. METRO would establish planting but no permanent irrigation is included. Planting is selected for low water use, low maintenance, scale and visibility, and seasonal interest.

Programmable Areas adjacent to back-of-curb should provide seasonal interest but be small enough to not interfere with sight lines or transit users' ability to board and deboard buses. Planting recommendations for these Areas include utilizing groundcover species or installing raised bed planters.

See *Appendix 1: Planting Images* for images of recommended plantings.

2500 Summer Street, Suite 3228
Houston, TX 77007
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Groundcover (Small Planting Area in High Traffic Zones with No Irrigation)

Common Name	Scientific Name	Description	Size	Sun/Shade
Zexmenia	Wedelia hispida zexmenia	Perennial	12-15" h	Sun
Mexican Feather Grass	Nassella tenuissima	Semi-Evergreen	1-2' h; 1-3' w	Sun
Butterfly Iris	Dietes sp.	Perennial	24-30" h	Shade
Horseherb	Calyptocarpus vialis	Perennial	6-12" h	Sun/Shade
Society Garlic	Tulbaghia violacea	Perennial	1-2' h; 6-12" w	Sun/Shade

Groundcover should be installed with 18" triangular spacing throughout beds, leaving 18" between plant material and edge of paving on all sides.

Raised bed planters reduce maintenance requirements and ensure that groundcover planting is not damaged by foot traffic. Simple raised beds may be constructed of ¼" steel with welded edges and interior bracing. Beds are filled with drainage and planting media and drain naturally through the bottom. Pre-fabricated steel beds may are an alternative if anchors are provided to affix the planter to the ground; in this case, powder-coated steel provides the opportunity to add contextual color or branding with METRO colors.

Programmable Areas at the rear of BOOST platforms offer the ability to provide enhanced screening and visual interest for transit users. Recommended species would have a maximum 3' height in order to maintain clear visibility around platform. In some cases, where a platform benefits from additional screening, recommended spaces would have a 4-6' range in height. Species are selected to provide visual interest during all seasons.

Low Height Planting, 1'-3' Height

Common Name	Scientific Name	Description	Size	Sun/Shade
Dwarf Yaupon	Ilex vomitoria 'Nana'	Broadleaf Evergreen	2-3' h; 2-4' w	Sun
Lantana	Lantana sp.	Broadleaf Evergreen	1-3' h; 4' w	Sun
Sage, various	Salvia 'Henry Duelberg', 'Indigo Spires', 'Black Knight'	Perennial	2-3' h; 2-3' w	Sun/Shade
Gulf Muhly	Muhlenbergia capillaris	Ornamental Grass	2-3' h; 2'3; w	Sun

Lilyturf	Liriope muscari	Perennial	1-2' h; 1-2' w	Sun
Variegated Flax Lily	Dianella tasmanica 'Variegata'	Perennial	1-2' h; 2-3' w	Sun/Shade
Texas Spiderlily	Hymenocallis liriosme	Bulb	1-2' h; 1-2' w	Shade
Joe Pye Weed	Eutrochium fistulsum	Perennial	4-7' h; 2-4' w	Sun/Shade
Eulalia	Miscanthus sinensis 'Adagio'	Ornamental Grass	3-4' h; 3-4'	Sun/Shade
Flame Acanthus	Anisacanthus quadrifidus var. wrightii	Perennial	3-5' h	Sun
Butterfly Weed	Asclepias tuberosa	Perennial	1-3' h; 1-2' w	Sun
Gregg's Mistflower	Conoclinium greggii	Perennial	1-3' h; 1-2' w	Sun/Shade

Low Height Planting should be installed with 24" linear spacing between plants, centered in beds.

Medium Height Planting, 3'-6' Height

Common Name	Scientific Name	Description	Size	Sun/Shade
Don's Dwarf Wax Myrtle	Myrica cerifera 'Don's'	Evergreen	3-6' h; 3-6' w	Sun
Texas Sage (Cenizo)	Leucophyllum frutescens	Evergreen	4-5' h; 4-5' w	Sun
Turk's Cap	Marvaceae arboreus var. drummondii	Deciduous	2-6' h; 3-5' w	Shade
Bamboo Muhly	Muhlenbergia dumosa	Deciduous	4-5' h; 4-5' w	Sun
Canna Lily	Canna indica	Bulb	2'-6' h; 2-6'w	Sun

Medium Height Planting should be installed with 36" linear spacing between plants, centered in beds.

Planting Locations

Shade-tolerant planting should be used where tree or shrub cover is predominant, particularly on the western side of the corridor in places it may receive less direct sunlight. Plantings listed as "sun" should be placed in full sun. Plantings listed as "shade" should receive full shade.

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Planting Maintenance

The seasonal cutting of planting is not required. METRO should establish a monthly maintenance schedule during the months of May-October in order to trim planting to shape. The species listed above have been provided because they are generally resilient to damage, require little water, and are unlikely to be attractive habitat for pests such as rats.

The listed plantings should not require regular watering, outside of extreme conditions. Planting does require an establishment period of watering. This is generally performed by the contractor who installed the plantings. For plantings established in the Fall through early Spring, a minimum 90-day establishing watering period is recommended; for plantings established between late Spring and Summer, a watering period of up to 180 days may be required. For this reason, METRO should consider seasonal timing of plantings to best assure success in establishment. Any dead plants during watering period should be replaced as warranty items by the contractor.

Low-Impact Development

As the city endeavors to build its resilience in the face of climate change, low-impact development (LID) strategies are an increasingly viable option for small-scale stormwater management in the right-of-way. At present, the BOOST program has not identified specific LID strategies for Programmable Spaces; however, there is interest within the agency to work with the City of Houston and other partners in supporting city-wide green infrastructure strategies.

AMENITIES

METRO's commitment to improving transit experience for bicyclists supports consideration of enhanced bicycle amenities in Programmable Areas. While space is limited, Programmable Areas may contain a variety of bicycle-related elements:

Bicycle Amenities

Amenity	Size (Minimum Footprint)	Basis of Design
Bicycle Repair Station	90" x 45"	Dero Fixit, or equal
Bicycle Rack	36" x 18"	Dero Hoop Rack Heavy Duty, or equal
Custom Bicycle Rack	Varies	Dero Custom Bike Rack, or equal

To the extent possible, bicycle amenities should be surface mounted on center of applicable Programmable Areas, allowing clearances as required for Texas Accessibility Guidelines and City of Houston bike parking space requirements.

PUBLIC ART

Public Art is highly recommended for BOOST platforms. However, METRO's construction schedule for the BOOST pilot projects may not be conducive to the public outreach and/or artist solicitation process required to provide public art interventions. METRO may consider identifying a small number of signature Programmable Area locations throughout the BOOST pilot and begin a process for identifying artists to provide public art interventions within the dimensions outlined on page 1 of this memo.

As an interim measure, METRO may utilize permeable pavers or non-grouted pavers inside of Programmable Areas identified for public art interventions. The use of 6" x 6" or 6" x 12" (nominal) pavers is recommended to ensure proper coursing and not require cutting of pavers.

Pavers

Amenity	Size (Nominal)	Basis of Design
Paver	6" x 6"	Belgard Commercial Moduline, or equal
Paver	6" x 12"	Belgard Commercial Moduline, or equal

DECISION-MAKING MATRIX

METRO is undertaking a concurrent effort to identify and illustrate a process by which Programmable Area interventions may be identified through a combination of contextual influence and public engagement. Briefly, the decision-making process involves three steps:

- Map local contextual influencers (schools, parks, community centers, churches, grocery stores, and others) and provide ¼ walkshed distance; identify all BOOST platform locations within the range of influencers and assign each platform one or more of the following themes based on the nature of the influencers: Storytelling, Health & Happiness, Happenings, Education, and Ecology
- Using a public engagement process, identify from a list of possible Programmable Area elements (including Public Art, Activities, Planting, Signage/Wayfinding, Defining Materials, Kiosks, Programs, and Amenities) the community preferences for each BOOST platform.
- Pair the identified themes with preferred elements to produce a conceptual design for the implementation of BOOST Programmable Area interventions.

The interventions recommended in this memo are included in the list of elements; however, many of the preliminary proposed elements are not sufficiently developed for consideration for the pilot project.

END OF MEMO

Appendix A: Plant Images




Zexmenia	Mexican Feather Grass	Butterfly Iris	Horseherb
Wedelia hispida zexmenia	Nassella tenuissima	Dietes sp.	Calyptocarpus vialis




Society Garlic	Dwarf Yaupon	Lantana	Henry Duelberg Sage
Tulbaghia violacea	Ilex vomitoria 'Nana'	Lantana sp.	Salvia 'Henry Duelberg'




Dark Knight Sage	Indigo Spires Sage	Gulf Muhly	Lilyturf
Salvia 'Dark Knight'	Salvia 'Indigo Spires'	Muhlenbergia capillaris	Liriope muscari

Variegated Flax Lily	Texas Spiderlily	Joe Pye Weed	Eulalia
Dianella tasmanica 'Variegata'	Hymenocallis liriosme	Eutrochium fistulsum	Miscanthus sinensis 'Adagio'

Flame Acanthus	Butterfly Weed	Gregg's Mistflower	Don's Dwarf Wax Myrtle
Anisacanthus quadrifidus var. wrightii	Asclepias tuberosa	Conocllinium greggii	Myrica cerifera 'Don's'

Texas Sage (Cenizo)	Turk's Cap	Bamboo Muhly	Canna Lily
Leucophyllum frutescens	Marvaceae arboreus var. drummondii	Muhlenbergia dumosa	Canna indica

Maculata Aloe	Crosby's Prolific Aloe		
Aloe maculata	Aloe 'Crosby's Prolific'		

C
APPENDIX

METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, TEXAS

DESIGN CRITERIA FOR METRO PARK & RIDE AND TRANSIT CENTER FACILITIES

CCN: PAR-DC-001
Baseline Document

September 14, 2012

Revision 2

Addendum 2

METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, TEXAS

DESIGN CRITERIA FOR METRO PARK & RIDE AND TRANSIT CENTER FACILITIES

ORIGINATED BY: _______________ DATE: 9/14/12
Program Manager

REVIEWED AND APPROVED BY: _______________ DATE: 9/14/12
Program Management Support/Configuration Management

REVIEWED AND APPROVED BY: _______________ DATE: 9/14/2
Sr. Director/Chief Engineer

REVIEWED AND APPROVED BY: _______________ DATE: 9/14/12
AVP of Engineering & Major Capital Projects

REVIEWED AND APPROVED BY: _______________ DATE: 9/14/12
Sr. Director State of Good Repair

REVIEWED AND APPROVED BY: _______________ DATE: 9/14/12
VP of Facility Maintenance

REVIEWED AND APPROVED BY: _______________ DATE: 9-14-12
VP of Safety

REVIEWED AND APPROVED BY: _______________ DATE: 9/20/12
Sr. VP of Service Delivery

REVIEWED AND APPROVED BY: _______________ DATE: 3/1/13
Sr. VP Capital Programs

September 2012
Revision 2

This document, once printed is an uncontrolled copy and may be outdated. To ensure you are using the correct version of this document, please refer to the Oracle Primavera Contract Management "Metro Solutions Phase 2" being hosted at http://ridemetro.ihshosting.com:7008/exponline/logon.jsp after login: click on "Projects, 2009/2010 Metro Solution Phase 2, Library and Reference Documents" or contact Document Control via email at documentcontrol@ridemetro.org.

October 2012
Revision 2, Addendum 1

REVIEWED AND APPROVED BY: [signature] **DATE:** 1/2/13
Chief of Police

Document History

Title	Revisions	Revision #	Revision Date
Design Criteria for METRO Park & Ride & Transit Centers	Initial Release	0	Nov 1998
Design Criteria for METRO Park & Ride & Transit Centers	Revisions to All Sections	1	Nov 2000
Design Criteria for METRO Park & Ride & Transit Centers CCN: PAR-DC-001	Revisions to All Sections	2	Sept 14, 2012
Design Criteria for METRO Park & Ride & Transit Centers CCN: PAR-DC-001	Added Chief of Police Signature and Section 10	2 Addendum 1	Nov 9, 2012
Design Criteria for METRO Park & Ride & Transit Centers CCN: PAR-DC-001	Removed conflicts between Section 10 and other Sections; removed telephone requirements and added PA/PIS system	2 Addendum 2	March 1, 2013

Configuration Control:

This is a baseline document for METRO's Capital Programs – Park & Ride and Transit Centers. The baseline document configuration control number (CCN) is **PAR-DC-001**.

Record Retention:

State Record Number: 1000-38
State Retention Period: Until superseded + 5 years

Sensitive Security Information (SSI):

"WARNING: This record contains Sensitive Security Information that is controlled under 49 CFR parts 15 and 1520. No part of this record may be disclosed to persons without a "need to know", as defined in 49 CFR parts 15 and 1520, except with the written permission of the Administrator of the Transportation Security Administration or the Secretary of Transportation. Unauthorized release may result in civil penalty or other action. For U.S. government agencies, public disclosure is governed by 5 U.S.C. 552 and 49 CFR parts 15 and 1520."

TABLE OF CONTENTS

1.0 GENERAL

1.1. DESCRIPTION

A. The design criteria specify the minimum requirements for the performance of professional design and engineering services.

B. Project design and engineering services shall include but not be limited to; refinement of the conceptual geometric design, grading, drainage, utilities, pavement, structures, architectural landscaping, irrigation, fencing, security, communications & control (SC&C), and soil borings for stabilization & foundation design.

C. This design criteria is provided as a technical resource to guide the design of Park & Ride and Transit Centers by engineers and architectural consultants under contract by METRO. The professionals contracted by METRO shall verify and validate the information presented contained in this design criteria during the various phases of the project/contract and in particular during final design. Any deficiencies encountered here, shall be reported to METRO immediately.

D. METRO accepts no liability for the use of this design criteria manual. Any person making use of the information presented here shall be solely responsible for its use. The information here is not intended as substitute for professional judgment of a design professional.

E. Design Package: The design package shall include all drawings, specifications, calculations, submittals, reports, construction estimates and schedules, approvals needed for the successful implementation of the project through the various phases.

F. Engineer of Record (EOR): A Texas Professional Engineer who is in responsible charge for the preparation of the design package and has the over all quality assurance and control of the project. The EOR shall certify that all the design elements have been properly interfaced and there are no conflicts among the different disciplines and the design package is ready for bids and construction and that all legal and contractual obligations have been met.

1.2. CONFIGURATION MANAGEMENT AND CONTROL

A. METRO has established a formal configuration management process that requires the evaluation, coordination, and approval of changes in the configuration of a project component after establishment of a technical baseline. This baseline is required to be in compliance with the appropriate regulatory compliance, code requirements, design criteria and standards and any approved deviations. The baseline consists of all approved technical project documentation.

B. If changes are needed to this design criteria for METRO, the EOR shall secure first approval of METRO by means of a variance or a change request and shall follow the procedures established by METRO. The Configuration Control Board (CCB) or equivalent organization shall evaluate the request for approval or other corrective actions.

1.3. DOCUMENT CONTROL REQUIREMENTS

A. All official documentation shall be uploaded by the Consultant as required in Section 01312 – Document Control Requirements. These shall include correspondence, specifications, calculations, reports, design plans and all other submittals required or prepared by the Consultant.

1.3.1. METRO Deliverables to Consultant

A. METRO deliverables to the Consultant vary for each facility. METRO generally provides the Consultant with the following items:

- Conceptual layout of the proposed facility (hard copy and CADD file)
- Construction budget and schedule for the site, serving as a basis for design
- METRO Guide Technical Specifications
- Design Criteria Manual for Park & Ride and Transit Center Facilities
- METRO's Standard Drawings
- METRO's Directive Drawings
- METRO's CADD Manual
- METRO’s Document Control Requirements
- Acquisition boundary survey of the site
- Environmental report(s) on the site
- CADD files of METRO’s “Title Sheet” and 22”x34” standard sheet border
- METRO Urban Design Guidelines
- METRO’s Review Comments form

METRO will deliver the above items using METRO’s Project Management Information System (PMIS) based in Oracle Primavera Contract Management.

1.4. QUALITY CONTROL/ASSURANCE

A. Project design shall comply with the latest edition of the documents listed in this Design Criteria, Appendix A - Reference Standards, all applicable laws, rules, codes, regulations and ordinances of Federal, State and Local governmental agencies.

B. Project design shall comply with all conditions contained in Categorical Exclusion, Environmental Assessment/Finding of No Significant Impact or Final Environmental Impact Statement/Record of Decision issued for the subject project by the Federal Transit Administration or Federal Highway Administration. Along with any METRO agreements with other Local , State, or Federal agencies, or other entities except as provided for and written by METRO. The design shall also incorporate ADA requirements and considerations for sustainability features.

C. The Consultant shall be responsible for the technical and professional quality, accuracy, adequacy, and comprehensiveness of construction documents for the Project, including all documents produced by his/her subcontractors, and shall provide all necessary supporting calculations and backup as requested by METRO.

D. The Consultant shall take appropriate corrective action upon receipt of all evaluations and when appropriate, respond to the evaluations. The Consultant's written response shall be submitted to METRO's Project Manager with a copy to the Contracting Officer.

E. The Consultant shall establish or have in place a quality control system for reviewing and checking all elements of the work, including that of its lower-tier subcontractors, to ensure conformance to terms and conditions of the Contract. Consultant shall submit a copy of their QA/QC Manual to METRO for review.

F. The Consultant shall document his/her established quality control system in a QA/QC Plan. This Plan shall include, as a minimum, the Consultant's proposed quality control organization, and shall indicate the responsibility and authority for each individual to be used in a quality control function.

G. The Consultant's QA/QC Plan shall include, but not be limited to:

1. Assurances that all plat drawings, construction drawings, standard drawings and specifications are consistent within themselves and with other drawings.
2. Identification of specific points in the Project where QA/QC activities occur.
3. Identification of specific individuals engaged in QA/QC activities.
4. Specific procedures for ensuring continuity of work between the different organizations of the Project team, including all subcontractors and partners.
5. Method of reviewing, checking, approving construction documents and design changes.

H. Forms used to document the results of reviews and checking shall be included in the QA/QC Plan. The type of forms used shall adequately cover the type of review being performed. If, during performance of the Contract, METRO deems QA/QC Plan revisions necessary, the Consultant shall revise the QA/QC Plan accordingly and resubmit it within five (5) calendar days after notification.

I. Prior to submitting the drawings to METRO for formal program design reviews, an inter-disciplinary coordination checklist and overlay checking process should be conducted by the Consultant.

J. This coordination checking process should not replace the single discipline, technical reviews that are essential for quality assurance.

K. Adherence to the following production guidelines will avoid the most common coordination errors, and will expedite the reviewing-approval process.

1. Comply with the Design Criteria Manual furnished by METRO.
2. Comply with the CADD Manual furnished by METRO.
3. Match lines for all discipline design drawings should be consistent.
4. Terminology used on drawings should be consistent with the one used in the Technical Specifications and Standard Drawings.
5. The term "by others" shall be avoided. When applicable, use N.I.C. (Not Included in Contract).
6. Duplication of information and details should be avoided.

7. All details and sections should be cross-referenced to a specific detail and drawing number. The use of notes as “See Architectural” or “See Structural” should be avoided.
8. The word “new” shall be avoided. All in formation provided in the plan set reflects proposed work. Only call out existing item s as “existing …” with all proposed items being implied.
9. Architectural floor plans shall be the base plan which other discipline floor plans must match.
10. The column location system and any other grid lines used in t he project should be consistent for all disciplines.

1.5. VALUE ENGINEERING (VE)

A. METRO shall conduct a VE study, generally at the 30% design level, on all projects with construction cost over $1 million. The following is th e minimum work the Consultant must perform unless otherwise directed in writing by METRO:

1. Provide electronic files and three (3) full-size sets of drawings, one (1) half- size set of drawings, construction cost estimate, soils report and any other pertinent design information requested by METRO.
2. Key personnel shall attend the VE kick-off meeting and the findings presentation held on the last day of the VE study.
3. Assist METRO’s Project Manager in reviewing the validity of the VE proposals and prepare responses for each VE proposal.
4. METRO accepted VE changes should be implemented at no additional cost to METRO.

1.6. CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (CPTED)

A. METRO requires that A/E firms under contract with METRO s hall be trained in, and apply CPTED design strategies. Consultant shall identify CPTED trained personnel.

B. The basic premise that characterizes CPTED is that the proper design and effective use of the built environment is conductive to enhance safety and security, while reducing risk to people, operations, and assets at public transit facilities. The term environment includes the people and their physical environment and social surroundings. The environment is that which has recognizable territorial and/or system limits. The term Design includes physical, social management and law enforcement directives that seek to positively affect human behavior as people interact with their environment.

C. CPTED design strategies seek to prevent certain specified c rimes (and the fear attendant on them) within a specifically defined environment by applying variables that are closely related to the environment itself. CPTED does not purport to develop crime prevention solutions in a broader universe of human behavior, but rather solutions limited to variables that can be manipulated and evaluated in the specified man/ environment relationship.

D. CPTED strategies utilize natural surveillance, natural access control, and territorial behavior.

E. The primary thrust of access control strategies is to deny access to a crime target and to create the perception of risk to the perpetrators of a crime. Surveillance is a design concept directed primarily at keeping intruders under observation either through police patrol (organized), lighting (mechanical), or through the use of windows or structural design and landscaping (natural). The concept of territoriality suggests that physical design can contribute to a sense of territoriality. Physical design can create or extend a sense of influence so that, users develop a sense of "proprietorship"--sense of territorial influence and the potential for offenders to perceive that influence.

F. There are numerous of examples of CPTED techniques in practice today. In each, there is a mixture of the CPTED strategies that are appropriate to the setting and to the security or crime problem. The most basic common thread is the primary emphasis on naturalness--simply doing things that you already do, a little better. Some examples of CPTED techniques are:

1. Provide clear border definition of controlled space and clearly marked transitional zones, which indicate movement from public to semi-public to private space.
2. Relocate gathering areas to locations with natural surveillance and access control.
3. Place safe activities in unsafe locations to bring along the natural surveillance of these activities (to increase the perception of safety for normal users and risk for offenders.)
4. Place safe activities in unsafe spots to overcome the vulnerability of these activities with the natural surveillance and access control of the safe area.
5. Designate the use of space to provide natural barriers to conflicting activities.
6. Improve scheduling of space to allow for effective use and appropriate "critical intensity".
7. Redesign or revamp space to increase the perception of reality of natural surveillance.
8. Overcome distance and isolation through improved communications.

1.7. AMERICANS WITH DISABILITIES (ADA) CODE REQUIREMENTS

A. Design must fully comply with all ADA code requirements and Texas Accessibility Standards of the Architectural Barriers Act, Article 9102, Texas Civil Statutes, whichever is more stringent.

B. Consultant shall submit plans and specifications to the Architectural Barriers Department in Austin, Texas. Filing fee shall be incidental to the overall design fee.

C. Upon receipt of comments from the Architectural Barriers Department, bring design into compliance and resubmit until final approval is received. Provide copies of all correspondence to METRO's Project Manager.

1.8. SUSTAINABILITY CONSIDERATIONS

A. Sustainability considerations consistent with Leadership in Energy and Environmental Design (LEED) principles shall be applied to the design of METRO facilities.

B. Consultant shall evaluate applicable design features which would preserve energy consumptions, reduce water use, and conserve environmental qualities, while within the constraints of project budget and schedule.

C. Consultant shall present sustainability options and is to advise METRO of the ramifications of each in short-term and long-term impacts to the project, and to the operations and maintenance of the facility.

1.9. SCHEDULE AND PROGRESS REPORTING

1.9.1. Schedule

A. Milestones for submittals have been established and are outlined in Section 1.9.2. Consultant shall provide a breakdown of time between review submittals, outlining; A/E design time; QA/QC; revisions; printing and submittal to METRO. Consultant shall also show other agencies review time along with permitting process. Consultant shall provide METRO's Project Manager with an updated schedule on a monthly basis.

1.9.2. Bi-Weekly Progress Review Meetings

A. Bi-Weekly Progress Review meetings shall be conducted with the participation of the respective Project Managers and other members of the designer's team, as necessary. The time, day, and place for the meeting shall be mutually agreed to. Meetings shall start within five (5) minutes of the designated time. The agenda of the meeting will pertain to relative subjects. Consultant shall maintain minutes of all project related meetings. A copy of all meeting minutes shall be sent to METRO's Project Manager within five (5) working days after the meeting takes place. Meeting minutes shall be uploaded in METRO's PMIS System.

1.10. SUBMITTALS

A. Documents to be reviewed shall be submitted by the Consultant to the Project Manager. The submittal shall be accompanied by a transmittal letter from the Consultant tabulating the contents of the design review package. It shall specify the purpose of the submittal, the design review point, and shall outline any items within the submittal that are known to the Consultant to represent variances from the previous baseline or review point. The transmittal shall also be signed by the QA/QC manager and state that the plans comply with the contract according to the QA/QC process. The Consultant is required to upload and deliver submittal utilizing METRO's Oracle Primavera Contract Management.

B. Construction Drawings shall be submitted to all agencies having jurisdiction over the site for approval in order to obtain necessary permits. Consultant shall coordinate with the agencies as to when the plans should be submitted for review. Copies of correspondence shall be provided to METRO's Project Manager via METRO's PMIS System.

1.10.1. Design Services

A. The Consultant shall, within fourteen (14) calendar days after the Notice-To-Proceed (NTP), furnish to the Contracting Officer for approval, five (5) copies of a Program Outline of Design Services that the Consultant will provide including a detailed schedule of activities. Sufficient detail shall be provided outlining manpower to perform each of the tasks. Also, provide a Schedule of Values (SOV). The Consultant shall also provide a list of deliverables along with the submittal schedule. Unless otherwise directed, the breakdown shall be in sufficient detail to permit an analysis of the direct manpower and cost requirements, as required to conduct:

1. The Preliminary Design Report (15% level of completion)
2. Preliminary Design (30% level of completion)
3. VE Workshop
4. In-Progress Design (60% level of completion)
5. Pre-Final Design (95% level of completion)
6. Final Design (100% level of completion), and
7. Final Submittal.

B. Consultant shall provide an overview of all software used in the design process. CADD software must be consistent between all sub-contractors. All CADD file s shall be uploaded to METRO's PMIS.

1.10.2. Submittals Level of Completion

Unless otherwise directed in writing by METRO, the Consultant shall adhere to the following level of completion for reports, design drawings, and technical specifications to be reviewed by METRO:

SHEET	15% Preliminary Report	30% Preliminary Submittal	60% In-Progress Submittal	95% Pre-Final Submittal	100% Final Submittal
Cover					
Index of Drawings					
Plat					
Topographic Survey					
Elevation and Contour					
Boring Location Plan					
Boring Logs					
Storm Water Poll. Plan					
Project Layout					
Site Demolition					
Construction Sequence					
Horizontal Control					
Drainage Analysis					
Site Drainage					
Water Line					
Sanitary Line					
Site Grading					
Pavement Joint Layout					
Fence and Gate					
Traffic Plan, Signing &					
Traffic Analysis					
Stripping Layout					
Traffic Signal and Details					
Platform and Canopy					
Utility Building					
Mechanical					
Electrical					
CPTED,Security and SC&C					
Irrigation					
Landscape					
METRO Standards					
Technical and Special Provision Specifications					

1.10.3. Preliminary Design Report

A. The Consultant, within 30 calendar days after NTP, shall submit for METRO's review and comments, fifteen (15) sets of the Preliminary Design Report. This submittal shall include information at approximately the 15% level of completion. The documentation included in this submittal shall consist of:

1. Three (3) conceptual alternatives for the bus shelter canopy (all must stay within METRO's budget constraints).
2. Provide evaluation report for each conceptual alternative.
3. A review of the Project budget and information furnished by METRO to ascertain the requirements of the Project.
4. Preliminary Traffic Analysis Report.
5. Copy of survey field notes with computer ASCII data file containing the survey information. The ASCII data file will include the Point Number, Northing Coordinate, Easting Coordinate, Elevation and Descriptive Comments for all points tied in the field survey. The point numbers will correspond with the CADD file and field notes.
6. Preliminary plans of the Project.
7. Provide two (2) Topographic Survey and two (2) Planimetric Survey layout check prints, signed and sealed by a Texas Registered Professional Land Surveyor.
8. Preliminary re-plat document for the Project (if required).
9. Availability of utilities: potable/irrigation water, telephone, electrical and sanitary services (if required).
10. Preliminary construction cost estimate for the Project.
11. Storm Water Management Report including site drainage calculations and recommendations.
12. CPTED and Security recommendations.
13. Preliminary list of Technical Specifications.
14. Preliminary list of Standard Drawings to be used.
15. CADD files for all drawings at the 15% level of completion (Include Surveyors ASCII file) Design layouts shall be prepared based on a coordinate system.
16. In addition to the native files of the above documents, searchable pdf files shall be provided to METRO.

Quantities and types for the above requirements shall be outlined in other Contract documents.

All of the above submittals shall be uploaded on METRO's PMIS.

1.10.4. Preliminary Submittal

A. The Consultant, within 60 calendar days after receipt of METRO comments on the Preliminary Design Report, shall submit for METRO's review and comments the Preliminary Design. This submittal shall include information at approximately the 30% level of completion. The documentation included in this submittal shall consist of:

1. Design Package including standards at the 30% level. Full size sets of

bounded design drawings and standards. Drawing package shall be uploaded on METRO's PMIS.

2. Final Traffic Analysis Report
3. CADD files for all design drawings including ancillary files such as Geopak and Descartes files.
4. Two (2) marked up outlines of the Technical and Special Provisions Specifications to be used, along with preliminary specifications for new materials or items.
5. Two (2) sets of each Manufacturers' Specifications and Cut-Sheets for proposed lighting fixtures and other items, along with a list of materials to be used and samples when available.
6. Computer printouts and drawings indicating maintained illumination levels in foot-candles, including maximum, minimum, average to minimum ratio, and maximum to minimum ratio.
7. Two (2) copies of all pertinent design calculations, including but not limited to: storm drainage, Storm water Pollution Prevention Plan, canopy structure, utility building, platform slab, parking lot & bus way pavement, sanitary sewer, potable water, COH landscape ordinance (if applicable) and irrigation water requirements and others as required.
8. Update of necessary utilities.
9. Two (2) copies of the updated construction cost estimate and preliminary construction schedule.
10. List of all permits required and time needed to obtain them.
11. Provide two (2) Topographic Survey and two (2) Planimetric Survey layout s, signed and sealed by a Texas Registered Professional Land Surveyor.
12. Final sealed and signed Plat or Re-Plat (if required).
13. Preliminary report on crime analysis and security issues including; problems addressed alternatives considered and final selection with rationale. Also provide cost, feasibility and other recommendations as needed.
14. Provide responses to METRO Preliminary Design Report review comments.
15. In addition to native files of the above documents, searchable pdf files should be provided to METRO.

All of the above submittals shall be uploaded on METRO's PMIS.

1.10.5. In-Progress Design Submittal (Start of Detail Design)

A. The Consultant, within 45 calendar days after receipt of METRO's review comments for the Preliminary Design submittal, shall submit for METRO's review and comments, the In-Progress Design. This submittal shall include information at approximately the 60% level of completion. The documentation included in this submittal shall consist of:

1. Design Package including standards at the 60% level. Full size sets of bounded design drawings and standards. Drawing package shall be uploaded on METRO's PMIS.
2. One marked up copy of the Technical and Special Provisions Specifications to be used indicating additions or deletions.
3. One (1) set of electronic CADD files for all design drawings (on flash drive or portable hard disk).

4. Updated design calculations.
5. One (1) copy of the updated construction cost estimate.
6. Finalize all utility requirements, both public and private.
7. Provide responses to METRO Preliminary Design review comments.
8. Final CPTED and Security report.
9. In addition to native files of the a bove documents, searchable pdf files should be provided to METRO.

All of the above submittals shall be uploaded on METRO's PMIS.

1.10.6. Pre-Final Design Submittal

A. The Consultant, within 45 calendar days after receipt of METRO's review comments for the In-Progress Design submittal, shall submit for METRO's review and comments, the Pre-Final Design. This submittal shall include information at approximately the 95% level of completion. The documentation included in this submittal shall consist of:

1. Design package including standards at the 95% level. Full size sets of bounded design drawings and standards. Drawing package shall be uploaded on METRO's PMIS
2. Design calculations including but not limited to civil, structural, architectural/ landscaping, mechanical, electrical, and system. Design calculations shall be sealed by a licensed professional in the State of Texas. Design calculations s hall have been properly reviewed including by and independent quality assurance professional and by the Engineer of Record for the project.
3. Technical and Special Provisions Specifications proof read and marked up. The consultant shall submit a report outlining the changes needed for the project.
4. Electronic CADD files of all design drawings, standard drawings, and ancillary files such as Geopak and Auto-turn files (on flash drive or portable hard disk including associated path structures).
5. One (1) copy of updated Construction cost estimate and schedule.
6. Provide responses to METRO In-Progress Design review comments.
7. In addition to Native files of the above documents, searchable pdf files should be provided to METRO.

All of the above submittals shall be uploaded on METRO's PMIS.

B. The Consultant shall submit drawings to Texas Department of Licensing and Regulations, Architectural Barriers Department, along with all other agencies and utilities having jurisdiction over this project.

1.10.7. Final Design Submittal

A. The Consultant, within 30 calendar days after receipt of METRO's review comments for the Pre-Final Design submittal, shall submit, for METRO's review and comments, the Final Design. This submittal shall include information at approximately the 100% level of completion. The documentation included in this submittal shall consist of:

1. Design Package including standards at the 100% level. Full size sets of bounded design drawings and standards. Drawing package shall be uploaded on METRO's PMIS.
2. Design calculations including but not limited to civil, structural, architectural/ landscaping, mechanical, electrical, and system. Design calculations shall be sealed by a licensed professional in the State of Texas. Design calculations s hall have been properly reviewed including by and independent quality assurance professional and by the Engineer of Record for the project.
3. Electronic CADD files for all design drawings, including ancillary files such as Geopak and Descartes files.
4. One (1) master set of Technical and Special Provisions Specifications ready for printing and One (1) electronic copy of the master Technical and Special Provisions Specifications on a flash drive.
5. Two (2) sets of each Manufacturers' Specifications and Cut-Sheets.
6. Two (2) copies of all pertinent design calculations, (checked and sealed by a Professional Engineer or Architect licensed to practice in the State of Texas, indexed and bound).
7. Provide comments from all agencies and utilities having jurisdiction over this project and incorporate comments into plans, and
8. Provide responses to METRO Pre-Final Design review comments.

All of the above submittals shall be uploaded on METRO's PMIS.

1.10.8. Final Submittal

A. The Consultant, within 14 calendar days after receipt of METRO review comments for the Final Design submittal, shall submit:

1. Original signed and sealed by a Texas Professional Engineer and "Issue for Construction (IFC)" full size Construction and Standard Drawing mylars.
2. Design calculations including but not limited to civil, structural, architectural/ landscaping, mechanical, electrical, and system. Design calculations shall be sealed by a licensed professional in the State of Texas. Design calculations s hall have been properly reviewed including by and independent quality assurance professional and by the Engineer of Record for the project.
3. Signed and sealed by a Texas Professional Engineer Master set of Technical and Special Provisions Specifications. The consultant shall submit one electronic Microsoft Word file(s), one pdf and one hard copy set.
4. One (1) half size set of vellums of Construction and Standard Drawings.
5. Design Package including standards at the 100% level. Full size sets of bounded design drawings and standards. Drawing pack age shall be uploaded on METRO's PMIS.
6. Electronic CADD files for all design drawings, including ancillary files such as Geopak and Descartes files.
7. Five (5) copies of the construction cost estimate and schedule.

8. Plans should reflect all comments from METRO, other agencies and utilities.
9. In addition to Native files of the above documents, searchable pdf files should be provided to METRO.

All of the above submittals shall be uploaded on METRO's PMIS.

1.11. METRO REVIEW PROCEDURE

A. METRO's Project Manager will first check the submittal for completeness, according to the requirements in this manual for each submittal.

B. After METRO's Project Manager has determined that the submittal is complete, the submittal will be distributed to various engineering disciplines within METRO for technical review.

C. METRO will return the formal submittal with comments, additions or corrections required no later than 21 days after receipt of the complete submittal from the Consultant.

D. All action taken/responses to METRO's comments shall be incorporated prior to the next submittal being accepted.

1.11.1. Status Reviews

A. Status reviews shall be on an as-needed basis as determined by METRO's Project Manager. These reviews are mainly informal and for information regarding the timeliness of the progress in accordance with the Consultant's proposed schedule. These reviews will generally not require formal transmittals or responses.

1.11.2. Formal Design Reviews

A. Formal Design Reviews shall take place at METRO's offices at the designated milestones of the design progress. Formal transmittals of the design materials submitted for review shall be required.

1.12. APPROVALS AND PERMITTING

A. The Consultant shall have the construction drawings reviewed and approved for construction by all governmental, municipal and private utilities having jurisdiction over the project. The Consultant shall also obtain the following (as applicable) along with others listed within the Scope of Services:

1. Provide a Notice of Intent (NOI) for Storm Water Discharges associated with construction activity under the National Pollutant Discharge Elimination System (NPDES) General Permit to be submitted to the EPA.
2. Obtain sanitary and potable/irrigation water rights.
3. Obtain storm water discharge permit from HCFCD.
4. Assist METRO in securing all Inter-Agency agreements required to complete the Project (i.e.; TXDOT Multi-Use Agreement, Transportation Improvement Agreement (TIA), Subdivision Plat, etc).

5. Perform all work necessary to obtain a building permit from the governmental agency having jurisdiction over the area. The Construction contractor will be responsible for paying the building permit fee.

B. The Consultant shall pay all filing, permit and impact fee's (less the building permit fee) and shall be incidental to the overall design cost.

END OF SECTION 1.0

2.0 SURVEYING

2.1 GEODETIC COORDINATE SYSTEM

Park & Ride and Transit Center projects shall be referenced to the Texas State Plane Coordinate System (South Central Zone) NAD 83 Adjustment. Horizontal and vertical datums shall be as provided by METRO per the scope of the project. System of computation for coordinates shall be Surface Coordinates and will be so identified on all drawings produced. The conversion factor and conversion formula from surface to grid coordinates will also be provided. All standards and specifications of accuracy referenced hereon are based on the accuracy prescribed and required by METRO.

2.2 HORIZONTAL CONTROL

Horizontal Control is the controlling monumented network for the positioning of any data gathered for the project.

A. The horizontal control survey shall be tied to the Coast and Geodetic Survey / N.G.S. control system or other METRO approved monumentation recovered by previous recovery survey specified by METRO and based on the Texas St ate Plane Coordinate System, South Central Zone (NAD-83). Horizontal control traverse shall be tied to two (2) GPS observations. The Texas Department of Transportation (TxDOT) control system may also be utilized as directed on various projects of overlapping areas by utilizing TxDOT data.

B. Error of closure for the Horizontal Control shall meet the requirements for a Category 7 Condition II, per Manual of Practice for Land Surveying in the State of Texas.

C. The traverse of the horizontal control survey should be laid out to provide accessible reference observations to points along the perimeter of the Park and Ride and Transit Center Facility and connecting drives, access ramps and structures. All angle points set in the main traverse line of the horizontal control survey shall be set by the surveyor as follows. All permanent survey control monuments shall be marked by an aluminum, brass cap or other material as directed on the ground and shall be set in place in concrete prior to commencing actual turning angles of traverse. A 5/8-inch iron rod with a minimum length of 12 inches s hall be set under the aluminum or brass cap to enable the cap to be recoverable by use of a metal locator.

2.3 VERTICAL CONTROL

A. Vertical Control primary benchmarks monuments to be based on the latest USC&GS or National Geological Survey Benchmark most recent adjustment by N.G.S. or other approved monumentation as directed by METRO. Temporary benchmarks (TBM's) shall be set for any secondary level work not to exceed third (3rd) order accuracy from the base vertical control network.

B. Error of closure for the Vertical Control shall meet the requirements for a Category 8 Condition II, per Manual of Practice for Land Surveying in the State of Texas.

C. Points used for vertical control shall have elevation values determined from a closed level loop and shall have been used as a turning point in the loop. Foresights and backsights shall be balanced as near as practical.

D. Vertical control shall be determined by direct differential leveling. Trigonometric leveling will not be accepted. All equipment used shall be calibrated and adjusted prior to the commencement of the project and thereafter shall be checked regularly to maintain correct adjustment.

E. The surveyor shall set a secondary control traverse from the METRO monumentation system and shall maintain at least a 3rd order accuracy. A minimum of two (2) semi-permanent control points and T BM's shall be set on the project site for future use for construction. Set iron rods, "X" inscribed in concrete or any semi-permanent mark in a safe location where it will not be disturbed during construction. Provide sketches in field notes with three (3) swing ties for recovery for control points.

F. All primary and secondary control traverse points shall have surface coordinates based on METRO monumentation system and shall include the conversion factor to convert to grid coordinates.

G. All data shall be acquired in 2D or 3D as required per the scope of work.

2.4 TOPOGRAPHIC SURVEY

A. Provide a Topographic Survey of the proposed Site along with a minimum of 20-feet outside of METRO's property line in accordance with the requirements for a Category 6, Condition II, Topographic Survey per the Manual of Practice for Land Surveying in the State of Texas. The Topographic Survey shall be signed and sealed by a Texas Registered Professional Land Surveyor. The Topographic Survey shall include the following as a minimum:

1. Recovery and verification of all boundary corners for the proposed Park and Ride/ Transit Center Facility. Reset all boundary corners found disturbed or missing with minimum 5/8-inch diameter by 3-foot long iron rods, set flush with natural ground. Call out bearings and distances of all boundary lines, including points o f curvature and points of tangency. Call out surface coordinates of all boundary corners based on the coordinate system specified in Section 2.1.
2. Show all existing surface features and utilities. Include nearest sanitary sewer manhole, fire hydrant and potable water service. Provide rim and flow-line elevations of manholes and inlets. The Designer is responsible for obtaining all utility drawings and shall provide copies to METRO.
3. Set and identify a minimum of two (2) benchmarks on site with surface coordinates and elevations and provide ties to the horizontal and vertical control system described in Sections 2.2 and 2.3. Benchmarks shall be brass caps set in a minimum of 8 inches of concrete or drilled and epoxied into existing concrete. Call out bearings and distances of all boundary lines, including points of curvature and points of tangency. Call out surface coordinates of all boundary corners based on the coordinate system specified in Section 2.1.
4. The Topographic Survey should determine the position and configuration of natural and/or man-made objects such as buildings, roadways, railroads, fences, utility

housing (manholes), power poles, natural and/ or man made waterways, etc. All observed points will have an X and Y value and a Z value, if requested in the project scope.

5. Use a grid system to survey topography on 50- foot centers where possible, delineating grade breaks of entire proposed facility site. Cross sections shall be taken at 50-foot intervals along adjacent roadways and streets, if determined necessary by METRO. Decimal point of spot elevation shall represent location of shot taken. If shots are too close together, provide an “x” to denote location of shot. Show contour lines at 0.50-foot intervals. All elevations and information on drawing shall be legible and shall not overlap. Obtain elevations along the property line, 10 feet and 20 feet outside of the property line, to determine the natural storm water drainage courses.
6. Vertical ties shall be made to METRO, City of Houston, TxDOT, Harris County Flood Control District (HCFCD), and any other agency having jurisdiction over the project area. Provide a comparison char t on the drawing, showing the project elevation as related to each agency’s published elevation.
7. Provide grid marks on 5-inch grid. Scale of drawing will determine actual distance of grid marks. At the outer edge of the drawing show northing and easting coordinates. Coordinates shall conform to requirements of Section 2.1.
8. Utility surveys are to be performed for any public and private utility services that exist on the site, within 20 feet from the perimeter of the site, or along and connecting drives, roadways, ramps, or structures included as part of the project. Subsurface Utility Engineering (SUE) will be performed as requested by METRO per the American Society of Civil Engineers (ASC E) criteria. The topographic map shall show the configuration and location of the existing above ground and underground utilities. All above ground and marked below ground utilities should be located as necessary. Utility features such as manholes for sanitary sewers, storm sewers, water meters, gas valves shall be opened, documented, and measured to the extent possible. No power utility manholes or vaults shall be opened without the consent and supervision of the utility agency representative. All utility lines shall be connected to their respective consecutive facility, inlets, valves identifying type of structure, direction of flow by noting invert elevations at all manholes or vaults.

2.5 LAND TITLE SURVEYS, PLATS, RIGHT-OF-WAY MAPS AND DRAWINGS

Property surveys shall be represented by a plat, map or drawing to depict the results of the survey, be it a planimetric, topographic, or land title plat. Drawing shall show dimensions, bearings, distances, curve data information, coordinates, elevations and any improvements or other data necessary for the use of such property map. Drawings may be developed at a scale suitable for the use of such map. For Park & Ride and Transit Facilities accessing TxDOT roadways, right-of-way maps shall be prepared which conform to TxDOT requirements (i.e., the TxDOT Survey Manual, Chapter 5, for Boundary Surveys, Mapping Requirements and ROW Components). Right-of-way maps for Park & Ride and Transit Facilities connecting with non-TxDOT roadways shall meet the requirements of the appropriate jurisdictional government agency. Development of the land title plat for property to be retained under METRO ownership shall be coordinated with the METRO Real Estate Department. Verification of right of entry is the responsibility of the surveyor. Upon completion of the title plat, the surveyor is responsible for completing the Land Surveyor’s Certification, for each parcel per METRO Real Estate Department requirements.

2.6 CADD STANDARDS AND DELIVERABLES FOR SURVEY MAPS AND DRAWINGS

Survey data shall be compiled into MicroStation DGN file format as specified in the project scope of work. All survey data shall be input into the CADD file in State Plane Coordinates and drawings will be plotted in Surface coordinates and noting the conversion factor based on the METRO Primary Control provided. Consultant shall use the special level structure provided for this project as provided with the scope of services.

The Survey Consultants shall submit all drawing files in MicroStation (.dgn) v.8 or later. All 3d and 2d files developed must be submitted, etc. METRO's CADD Manual.

METRO requires each Consultant who is performing survey-related work to deliver their complete suite of files which have been created during a Geopak session. This suite of files includes, but is not limited to, the following:

job###.gpk
This is created when the user starts a Coordinate Geometry (COGO) session for the first time, or uses Store Graphics for the first time. All coordinate geometry data is stored in this data base file. The ### is the only variable in this name. It represents a job number unique to a project and is defined by the user upon creation. Example: job123.gpk

name###.ioc
This is an input file used for loading data into the GPK file during a COGO session. The ### represents the job number (gpk file to receive the data for storage) and the "oc" represents the "operator code", usually the user's initials. The only variable is the "name" that the user assigns. Example: HA1123.isp

j###ooc.inp
This is a special COGO input file that is created the first time that either Store Graphics or Create Existing Ground Profile is used. This file is appended automatically as each of these tools are used during the design process. Example:123osp.inp

name###.ooc
This is an output file created by GEOPAK during a COGO session. The file can be created by using the COGO pulldowns File > Output or simply typing Out [name], in the COGO command window. The only variable is the "name" that the user assigns. Example: HA1123.osp would result from typing OUT HA1

name.inp
This is the simple naming convention for any input file used in conjunction with the Geopak Process Cross Sections tool. These would include input files for creating "auto shapes", proposed cross sections, earthwork, etc... The only variable is the "name". It is user defined and can support 1-8 characters. Example: PRXS_09.inp

name.dat
This is an input file for generating topographical surfaces, (DTM input file). The only variable is the "name". It is user defined and can support 1-8 characters. Example: site_1.dat

name.tin
Binary DTM file created from processing the .dat file used for all surface computations and creating things such as contours. The only variable is the "name". It is user defined and can support 1-8 characters. Example: site_1.tin

name.dgn
This is the file extension of all MicroStation design files created by Geopak, both 2d and 3d. All MicroStation drawings are to be delivered in the V7 file format. The consultant shall follow the file name convention adopted by METRO.

For clarification for the above requested submittals contact:

Jose Castellanos, P.E.
Director, Program Management Support
Capital Programs
Phone: (713)739-3727
E-mail: jose.castellanos@ridemetro.org

Electronic DGN files and ASCII files shall be submitted to METRO on Flash Drives or as directed by METRO. Horizontal and vertical control point key map shall be delivered in separate files. All CADD files shall contain a note that all coordinates are (Grid/Surface) Texas State Plane Coordinates South Central Zone NAD 83 and Surface to Grid Coordinates Conversion Factor.

2.7 SURVEY DELIVERABLES

The deliverables from the surveyor should consist of a coordinate listing of all points, computer generated sketch, or annotated plat as required by METRO CAD Standards. The deliverables must fully comply with the requirements set fort h in the drafting standards and per the contract scope.

The deliverables should also meet the standards of the Texas Society of Professional Surveyors (TSPS), the America n Land Title Association (ALTA) or any other applicable authority or agency. Additionally, the Texas Boar d of Professional Land Surveyors (TBPLS) has minimum standards that should be adhered to for survey projects. It shall also be the responsibility of the surveyor to maintain and submit as required by the project scope of services, legible field notes, sketches, and any other material useful to the recovery and/or identification of field information by others. Surveyor shall also provide a “Point No. Key Map” of plotted data from field notes for reference. All this information shall be provided to M ETRO at the conclusion of the project.

2.8 PROJECT DESIGN

Consultant shall be responsible for any additional survey work required in completing the Project.

2.9 MOCK-UP LAYOUT

During the Preliminary Design Review, the Consultant is required to lay out the geometric design of the busways, at METRO's Field Services Center. All critical points shall be flagged or coned to simulate curb lines. This work shall be coordinated through METRO's Project Manager.

END OF SECTION 2.0

3.0 CIVIL

3.1 GEOMETRIC DESIGN

3.1.1 Facility Components

A. The geometric design shall establish the location and configuration of eac h component with respect to the physical features of the Site.

B. The geometric design of the Project shall provide for the following as a minimum:

1. Existing Site features (e.g., geometric shape, easements, adjacent traffic arteries, open drainage courses)
2. Storm water drainage system with or without a detention pond
3. Bus loading/unloading platform and passenger shelter
4. Busways, bus bays, and layover locations
5. Sidewalks for internal and external pedestrian traffic
6. Passenger drop-off/pickup area
7. Parking and accessibility for the handicapped
8. Conformance to ADA requirements
9. Passenger vehicles access routes and parking

C. Utility Building location and access route

D. Surveillance, Communications and Control (SC&C)

E. Perimeter fencing and access gates.

3.1.2 Site Features

A. Existing site improvements that cannot be relocated or removed (e.g., underground well, pumping station) shall be isolated by security fencing to mitigate potential safety problems with paved access for maintenance and service. These physical features at the Site shall be identified in the Preliminary Design Report.

B. Existing open storm water drainage course s shall be enclosed by means of pipe or a box culvert wherever the flow requirements of the drainage course can be met by such construction. If the flow requirements of the drainage course cannot be met in this manner, coordinate with METRO and jurisdictional agency the next course of action. All storm pipes 18 inches and larger shall have safety end treatments.

C. The perimeter of the bus loading/unloading platform and passenger shelter shall be horizontally isolated from the clearance envelope of all hazardous transmission lines (e.g., high voltage lines, natural gas lines) by a minimum of 100 feet of separation in Park and Ride facilities and whatever is possible in Transit Center facilities.

D. Passenger vehicle parking, raised pedestrian walkways, vehicle access lanes and other improvements will be acceptable within the bounds of an easement inside the Site when written permission is obtained for METRO by the Consultant, from the easement holder.

E. Sufficient access roads for passenger vehicles shall be provided to and from adjacent primary and secondary traffic arteries consistent with the vehicle parking capacity.

3.1.3 General Site Design Consideration

A. All points of access from public right-of-way shall have unobstructed cross-visibility for both vehicle and pedestrian movement. The visual envelope that shall remain unobstructed is between height s of 2 feet 6 inches and 7 feet 0 inches above the centerline of the street and 15 feet back from the curb with a 45-degree lateral visibility envelope or AASHTO sigh t distance standards, whichever is more stringent.

B. Entrances and exits shall be located so that patron traffic is evenly distributed along the public street serving the Site as determined by the traffic analysis.

C. The circulation systems shall permit easy recirculation of vehicles back onto the local streets with minimal or no mixing with other traffic.

D. Crosswalks shall have a minimum width of 8 feet.

E. Sidewalks shall be provided along the adjacent public streets. The width of the sidewalk shall conform to the applicable governmental or relevant community standards but shall not be less than 5 feet wide.

F. In order to maximize safety, care shall be exercised in the determination of grades and profiles and in the specification of clearances. Single steps shall be eliminated in all public areas with the exception of 6-inch-high curbs.

G. In order to develop continuity, a system of coordinated elements and interrelated areas and spaces shall be provided, which by size, shape, texture, color, and symbolism best express and accommodate their intended function.

H. Clarity of directional movement shall be designed into the site plan through the use of contrasting color, textures and forms, and through in corporation of definitive lighting and signing.

I. The perimeter of the Site shall be fenced. Vehicle access points shall be controlled with cantilever sliding gates. Pedestrian access points shall be controlled with swing gates. Fence shall consist of 6-foot-high chain link fence with black polyvinyl coating. Fence shall be centered on 1-foot-wide concrete mow strip.

3.1.4 Bus Loading/Unloading Platform

A. The bus loading/unloading platform is the focal point of activity, and as such shall be centrally located to minimize walking distances.

B. The top of the bus loading/unloading platform concrete slab shall be 6 inches above the adjacent busway pavements and the adjacent parking pavements.

3.1.5 Busways

A. Except as otherwise specified in the Contract Documents; the geometric design of the bus ways shall be in accordance with the geometric design criteria of AASHTO and METRO governing vehicle criteria. (See Tables 3.1.1 through 3.1.3 and Figures 3.1.1 through Figure 3.1.12)

B. A roadway with separate entry and exit access shall be provided for the exclusive use of bus traffic between a primary traffic artery and the busway. This busway shall be arranged so that there is no intermingling of bus traffic with passenger vehicle traffic within the Site. Horizontal separation between bus roadway and passenger access roadway shall be a minimum of 8 foot, back of curb to back of curb.

C. The overall Site layout shall be arranged such that pedestrian traffic crossing the busway from the passenger vehicle areas will only occur at controlled locations.

D. The busway shall be designed so that one bus can pass another bus in the event of out-of-sequence arrivals or if there are multiple loading bays employed.

E. A minimum tangent length of 120 feet shall be provided along the busway for bus lay over parking.

F. The busway concrete pavement surface at the bus loading/unloading plat form shall be given a transverse metal-tine finish. The metal-tine device shall be operated to obtain randomly s paced grooves approximately 3/16-inc h deep, with minimum depth of 1/8-inch and approximately 1/16-inch wide. Successive passes of the tines shall not overlap a previous pass.

G. The busway concrete pavement around the loading/unloading platform shall be sealed with waterproofing agent to disperse oils and other fluids that may leak from idle buses.

H. During the Preliminary Design Review process, the Consultant shall coordinate with METRO and layout the bus ways, at METRO's Field Service Center. With the mock setup, METRO shall drive buses through the busways to verify geometric design of the layout.

I. Light poles shall not be located in the median of busways.

3.1.6 Pedestrian Traffic

A. Dedicated raised pedestrian walkways shall be provided at ever y third par king aisle. Walkways shall be a minimum of 11 feet wide (face of curb to face of curb).

B. Pedestrian movements from parking areas to the bus loading/unloading platform shall be arranged to minimize the crossing of vehicle lanes. This shall be accomplished with the use of low (3-foot-high maximum) fences and landscaping. Pedestrian walkways shall be given priority over vehicular routes.

C. Pedestrian walkway layout should be as direct as possible to avoid “shortcut” routes.

D. The majority of pedestrians shall be provided a comfortable on-site walking distance, preferably within a distance of 600 feet from the bus loading/unloading platform.

E. Walkways shall have a minimum unobstructed width of 5 feet.

F. Walkways shall comply with most current and stringent ADA and State of Texas accessibility requirements.

3.1.7 Passenger Vehicle Access Routes and Roadways

A. A minimum of two (2), two-way traffic access routes separated by a minimum of 300 feet shall be provided into the passenger vehicle parking area. A third access route shall be provided when the capacity of the Site exceeds 750 total parking spaces.

B. In high volume lots, as determined by the traffic analysis and as otherwise indicated, a traffic signal with a left turn lane for exiting traffic shall be reviewed and considered. ME TRO and governing agency shall have final decision on placement of traffic signal.

C. An access route may serve the drop-off/pickup area, handicapped parking area, and the passenger vehicle area if the access route is arranged to avoid traffic conflicts. If possible, access to the drop-off/pickup area and handicapped parking area should be separated from the access to the parking areas.

D. Access routes with a major road shall have a minimum of 120 feet of auto queuing lane to avoid possible blocking of intersections. The actual queuing length shall be determined by the traffic analysis. A minimum of 75 feet, from other street access points, shall be provided to the first parking area.

E. Major feeder access into the passenger vehicle parking area shall be arranged to divide the area into several smaller parking areas or, if several feeder access routes are available, shall be routed around the perimeter of the subdivided parking areas.

F. Vehicle access routes from a traffic artery and servicing subdivided parking areas shall be 24 feet wide.

G. The minimum horizontal clearance (the minimum distance between any structure and the face of a curb or roadway shoulder) shall be 2 feet 6 inches.

H. Traffic islands defined by curbing shall be provided to control traffic movements, protect pedestrians and to highlight parking aisles. Island surface shall be a different color than the surrounding pavement by means of colored concrete or concrete stain.

3.1.8 Passenger Drop-Off/Pickup Area

A. Passenger vehicles shall not interfere with, or be routed through, the bus areas.

B. A curb side drop-off lane having a minimum width of 12 feet shall be provided in front of the bus loading/unloading platform.

C. Only one way, counter-clockwise circulation through the drop-off area shall be provided.

D. Access roadways to the drop-off area shall be a minimum of 18 feet wide.

E. The drop-off area shall be arranged to serve as a transfer location for pickup and drop-off of bus passengers by drivers of private vehicles and taxis. The drop-off area shall be located in proximity to the bus loading/unloading platform.

F. The drop-off area shall be arranged for easy access and short-term, high turnover parking. Parking spaces shall consist primarily of side-by-side, pull-in/pull-out, angle type parking spaces in single depth parking bays.

G. The number of parking spaces in the drop-off area should be approximately 1 percent of the total regular parking spaces available but not to exceed 15 total spaces.

3.1.9 Parking and Accessibility for the Handicapped

A. Specially designed and identified parking spaces for handicapped persons shall be provided in proximity to the bus loading/unloading platform in order to minimize the crossing of traffic lanes by the users of these spaces.

B. The design of parking for the handicapped shall comply with all relevant codes. The number of typical handicapped parking spaces and “van accessible” spaces shall be provided in accordance with the ADA requirements.

3.1.10 Passenger Vehicle Parking

A. Parking spaces for passenger vehicles shall be arranged in parallel rows for double bay, front-to-front parking. The length of a parking aisle from the centerlines of the adjacent traffic aisles shall be 360 feet to 540 feet.

B. Parking aisles should be oriented perpendicular to the loading/unloading platform and parking spaces should be oriented perpendicular to the parking aisles for maximum space efficiency.

C. Parking spaces shall be 19 feet long by 9 feet wide, except for parking spaces along the outer perimeter and dedicated raised walkways, which shall be 16 feet long by 9 feet wide. Traffic routes between parking aisles shall be 24 feet wide. Therefore, centerline of parking aisle to centerline of parking aisle shall be 62 feet.

D. No compact vehicle parking spaces shall be allowed.

E. Motorcycle parking shall be in normal parking spaces.

3.2 SITE GRADING

A. The finished grade of all pavements in METRO's Facility shall be above the floodplain created by a 100-year, 24-hr rainfall event frequency storm unless otherwise directed by METRO in writing.

B. The finished floor elevation of the bus platform and utility building shall be a minimum of 1 foot above the 100-year, 24-hr rainfall event frequency storm unless approved by METRO in writing.

C. The site shall be brought up to the required grade by the use of approved fill material where necessary after removal of all the topsoil and waste material on the site. Removal from the site of all spoil shall comply with all applicable Local, State and Federal requirements.

D. Fill material placed in the 100 year flood plain shall be offset by detention pond area that is equal to the volume of fill within said 100 year flood plain. Coordinate this effort with HCFCD and any other governmental agency having jurisdiction over the Site.

E. The Geotechnical Consultant shall provide compaction and stabilization and design recommendations data for earthwork, pavement base courses, lime or cement stabilized areas and detention pond bottoms when concrete lined detention ponds are provided.

F. The majority of the concrete pavements cross slopes should be around 1.0 percent. The maximum cross slope s hall be 2.0 per cent and the minimum shall be 0.5 percent. The surface flow of storm water shall be directed away from pedestrian traffic routes and as directed in Section 3.3 of this manual. Dedicated raised pedestrian walkways shall always be located at highpoints. For landscaping grades see Section 6.6.

G. Changes in grade along the busway and along access routes that exceed 1 percent shall be accomplished by means of vertical curves. The vertical curve shall be based on a design velocity of 30 miles-per-hour and a safe sight distance for this velocity in accordance with AASHTO's "A Policy on Geometric Design of Highways and Street s" and METRO's critical vehicle criteria. (See Figure 3.1.6.)

H. Site grading shall consider the visual clearances and views to the site from adjacent roadways and from the platform to the parking areas.

I. METRO property shall be internally drained and where possible, sheet flow from property line to parking area. Due to extreme cases area in let’s may be used but must be approved by METRO in writing. Grading design shall not obstruct natural storm water drainage courses.

J. Grading shall be designed to direct water away from building structures.

K. Apply sustainability principles, per LEED, in site design.

3.3 SITE DRAINAGE

A. The Consultant shall prepare a drainage analysis report. Such report shall be approved by the agency having jurisdiction.

B. The Consultant shall develop Storm Water Pollution Plans (SWPPP) in accordance with NPDES.

C. Storm water drainage system shall be designed for the site and its environs, in accordance with the criteria of the agency into whose jurisdiction the site and its environs drain into.

D. The volume of storm water discharge from the Project Site to Off-Site drainage shall be calculated based on the required design storm. The calculations shall be submitted to the agency having jurisdiction for approval. A storm water flow study and an analysis of flooding potential l for the surrounding and downstream areas shall be made whenever required by the agency having jurisdiction. The study and analysis shall be performed as required by the agency and shall be subject to the approval of the agency, following review by METRO.

E. The hydraulic grade line of the closest major storm water collector, flowing full, shall be calculated, and compared to the elevation of METRO's facility. If it is higher, measures shall be taken to prevent backflow into METRO's facility. The hydraulic grade line shall be shown on all storm water and sanitary sewer profiles.

F. The flow calculations for storm water in closed conduits shall be based on the Manning Formula and a value of "n" equal to 0.013 for reinforced concrete pipe, 0.009 for internally smooth-walled PVC, SDR or HD PE plastic pipe and 0.025 for corrugated metal pipe. The minimum and maximum flow velocities shall be 3 and 10 feet per second, respectively, inside METRO facilities.

G. Subsurface storm water pipe shall be PVC, SDR or HDPE for pipe diameters of eight (8) inches to 15 inches and reinforced concrete pipe for pipe diameters equal to or greater than 18 inches unless agreed upon in writing by METRO’s Project Manager.

H. A drainage structure consisting of an inlet or manhole shall be provided at each change of grade, alignment, or both and at each intersection of two (2) or more storm sewers. The drainage structures provided should be the standard drainage structures of the agency having jurisdiction over the site.

I. A storm water inlet shall be provided for each 0.5 to 0.8 acres of paved area within the site. Where possible, sheet flow unpaved area from the property line to the parking area. Inlets shall be provided for drainage at low points in unpaved areas that will not otherwise drain by surface flow but must be approved by METRO in writing.

J. Only curb inlets shall be used in the busways. Inlets shall be located opposite the bus loading/unloading platform and away from the utility building crossing.

K. Inlets located in the passenger drop-off/pick up area shall be located opposite the bus loading/unloading platform, away from where the cars will be parked.

L. Direction and location of sheet flows shall be indicate d on the drawings in accordance with HCFCD requirements or the agency having jurisdiction.

M. The roof drainage system of the shelter shall be designed for a storm having an intensity of 9.36 inches per hour. Manifold piping for the roof drainage system shall be sized accordingly and shall drain into the storm system designed for the Site.

N. All open-ended storm pipe (18 inches and larger) shall have safety end treatments.

3.4 DETENTION POND

A. When required, a storm water detention pond and other flood control measures shall be provided and designed in accordance with the HCFCD and governing agency hav ing jurisdiction over the Site.

B. The Consultant shall recommend the type of detention pond(s) to be provided, appropriate to the site and in accordance with such agreements as may exist between METRO and the jurisdictional agencies.

C. All detention ponds having a design depth greater than three (3) feet shall be completely enclosed with a s ix- (6) foot high, one (1) inch mesh chain link fence. An eight- (8) foot wide gate shall be provided for getting maintenance equipment into the pond area. The fence shall have a one- (1) foot wide mow strip like the perimeter fence.

D. Wherever possible, detention ponds shall drain naturally to the local storm sewer system. Where the local storm water system flow line is above the bottom of the detention pond, ponded water below the local system shall be pumped out of the pond. Pumps shall only operate when the pond surface is below the flow line of the detention pond outflow pipe. The pumps shall draw storm water from a concrete lined sump sized to provide an extended period between cleanings of silt from the sump area. Pumps shall be located with their intakes a minimum of two (2) feet above the sump floor. A minimum of two (2) pumps shall be provided having a duplex control panel with a hand/ off/automatic switch for each pump and level sensors to control on/off and lag/lead pump operation. Pumps shall be securely mounted with a quick disconnect design for easy removal. A frame or jib crane shall be provided along with a suitably sized electrically operated hoist to remove the pumps from the sump and set the m on level ground for maintenance and repair. The hoist shall be removable with removable weatherproof electrical connector along with a NEMA 4X enclosed electrical disconnect switch.

E. Detention ponds shall be designed to provide a minimum of 18 inches of freeboard from the top of the detention pond side slope to the surface of the designated contained storm water. In addition, 12 inches of freeboard from the top of the emergency overflow channel to the surface of the designated contained storm water.

F. Overflow channel shall be concrete lined for at least five (5) feet on both sides of the top of the detention pond side slope. The emergency overflow channel flow line shall be at least six (6) inches below the top of the detention pond side s lope. The width of the overflow channel shall be at least one-eighth (1/8) the detention pond's circumference at the top of the side slope.

G. If detention ponds are bounded by planting areas; metal edging shall be used to prevent mulch from washing into the detention ponds.

H. Culverts entering and exiting the detention pond shall have safety end treatments.

3.4.1 Natural Detention Ponds

A. Natural detention ponds shall be solid sod grass lined with side slopes not greater than one (1) vertical to three (3) horizontal.

B. Natural detention ponds shall have a centerline pilot channel running from the main storm pipe feed to the outfall pipe. The centerline pilot channel shall be "V" shaped, 10 foot wide, 6-inch reinforced concrete, with side slopes of 1 vertical to 12 horizontal. All secondary storm pipes shall have "V" shaped, 6-inch reinforced concrete pilot channels that connect to the centerline pilot channel. These secondary pilot channels shall be two (2) feet wider than the storm pipe feed with the same side slopes as the centerline pilot channel.

C. The pond bottom shall have a minimum two (2) percent slope towards the pond' s outflow pipe. Transverse slopes of the bottom from the toe of t he side slopes to the centerline pilot channel shall be a minimum of three (3) percent.

D. The sub-grade preparation and the paving of pilot channels shall be the same as the parking area pavement.

3.4.2 Concrete-Lined Detention Ponds

A. Detention ponds which require side slopes steeper than 3:1 shall be concrete lined.

B. Sub-grade preparation, concrete and concrete reinforcing shall be the same a s the parking area. Geotextile fabrics s hall be used as a filter medium and as a bond breaker between the concrete paving and the sub-grade.

C. Side slopes shall be paved with four (4) inches of reinforced concrete and have adequate top and bottom beams to hold the slope paving in place. The bas e slab shall be six (6) inches of reinforced concrete.

D. Weep holes shall be provided in the side slopes and bottom slab as recommended by the Geotechnical Consultant to relieve any hydrostatic pressure, but not greater than 40-foot centers each way nor through any expansion joints. Weep hole s shall contain filter mate rials to prevent sub-grade materials from passing through the weep holes.

E. If the detention pond(s) have either side slopes greater than 2: 1 or are vertical, stairs or ladders shall be provided at s pacing not greater than 100 feet along the wall. Vertical walls shall have a minimum thickness of eight (8) inches.

F. All concrete lined detention ponds shall be provided with concrete roadways down to the bottom of the detention pond. The roadway shall be 10 feet wide and six (6) inches thick, with sub-grade treatment and reinforcing the same as the parking area. The roadway slope into the detention pond s hall not be gr eater than 6:1.

3.5 PAVEMENT

A. All paving for vehicular traffic shall be jointed reinforced Portland cement concrete. Geotechnical Consultant shall recommend stabilization of sub-grade and determine if geotextile fabric is required under the pavement. Pavement thickness recommendations shall be bas ed on the soil's investigation, but in no case shall the thickness be less than nine (9) inches in area exposed to bus traffic nor six (6) inches in all other traffic lanes nor five (5) inches in all parking areas.

B. The minimum amount of reinforcing shall be number 4 bars at 18 inches each way for 6-inch or 5-inch pavement and number 4 bars at 12 inches each way for 9-inch pavement. The reinforcing bars shall be Grade 60.

C. Pavement concrete shall be Class 3,000.

D. Hot-mix asphalt concrete may be used only in unique cases (e.g., the repair of a cut in an existing asphalt pavement or over underground gas or petroleum pipeline easements where the pipelines are not in casings and as temporary pavement where final paving by others is not already in place). Cold mix asphalt concrete shall not be used.

E. Pavement joints shall be in accordance with METRO standard drawings CES-1003-1A and CES-1003-1B.

3.6 TRAFFIC ENGINEERING

3.6.1 Traffic Analysis

A. The Consultant shall prepare a traffic analysis report. Such report shall be approved by the agency having jurisdiction.

B. The intersection of public streets and access driveways for the facility as well as other specified intersections within the study area shall be analyzed to obtain level-of-service operation and signal warrants. All traffic analysis shall conform to the guidelines established by the governing entities within the proposed site e.g., City of Houston Department of Public Works & Engineering – Design Manual Traffic and Signal Design Requirements. METRO will define the study area. The Consultant shall perform the following tasks for the analysis:

   1. Collect available traffic data of the study area from METRO, City of Houston, TxDOT, HGAC and other available sources as needed for the analysis. Identify 24-hour approach volumes and AM & PM peak- hour turning

movements at the intersections. In the event traffic counts do not exist for locations to be analyzed, the Consultant shall perform traffic counts needed for evaluation purposes. Develop AM & PM peak-hour site ingress and egress traffic volumes to add to the existing traffic in the study area.

2. Using appropriate traffic analysis procedures based on the 2010 Highway Capacity Manual or latest revision. Existing, No-Build, and Build Conditions, intersection delays and levels-of-service for the AM & PM peak hours.
3. Eliminate deficiencies by recommending improvements, such as intersection improvements, signalization/signal optimization, roadway widening, signing, and pavement marking within the study area.

C. Traffic circulation inside the facility shall be designed to minimize conflict points and confusion among the drivers. Driveways shall be designed with proper turning radii and travel lanes (widths and number) to correspond to the traffic demand and vehicle type usage.

D. The maximum speed inside any METRO facility shall be 15 miles per hour.

3.6.2 Traffic Signing

A. As the individual facility design is developed; a signing layout shall be prepared by the Consultant in cooperation with METRO. Supports for all signs and provision of electrical power, where required, shall be the responsibility of the Consultant.

B. Basic Signage Goals

1. To guide patrons and bus operators through the facility in the most efficient and least complicated manner.
2. To provide safety by keeping the visual envelope open as defined in Section 3.1.3-A.

C. Signage Requirements

1. All informational signs shall be in accordance with the latest editions of METRO standards and all regulatory signs shall be in accordance with TMUTCD guidelines.
2. Proper signing shall be provided for directional information, including regulatory and warning requirements at all entrances and exits of the facility, and at appropriate locations within the facility.
3. Signs shall be kept to the minimum necessary for patron and bus operator guidance. Signs shall reinforce architectural elements and landscaping in identifying entrances, exits, and circulation routes.
4. Signing shall identify situations such as pedestrian crosswalks, parking for the handicapped, bicycle access routes and storage racks, bus circulation, passenger pick-up/drop-off area circulation, no-parking areas and any potential hazards.
5. The message on each sign shall be concise, clear and simple for easy understanding.

6. Signs shall be located at key points of separation and at intervals frequent enough to allow unsure patrons to find their way confidently.
7. Sign design and placement shall be uniform system wide to aid in immediate recognition by the patron.
8. Due to the importance of their messages, certain signs shall have priority over others to achieve the prime goal of efficient movement of patrons. These include signs directing the patron and bus operator to ex its, and direction-oriented signs. This priority may be achieved by differences in size of copy, color, or location of signs, with the result being signs of optimum visibility and dominance over lesser signs, which may occur, in the same field of view.
9. All signage shall have reflective backing, size and shape shall follow METRO's Standards.

3.6.3 Pavement Markings

A. All pavement markings shall comply with TMUTCD requirements.

B. Individual parking spaces shall be defined by standard painted lines. Traffic lanes shall be clearly delineated by appropriate reflectorized marking.

C. Crosswalks for pedestrians shall be defined by pavement markings or contrasting pavement treatment at all points where pedestrians will cross vehicular traffic routes.

D. Pavement markings shall be used to clearly delineate handicapped parking areas.

3.7 UTILITIES

3.7.1 Proposed Utilities

A. The Consultant shall be responsible for determining the manner in which the METRO facility will be supplied with the utility services that it requires.

1. Coordinate with the agency having jurisdiction over the site for water & sanitary services, see Section 7.0 MECHANICAL.
2. For electrical and telephone services, see Section 8.2 ELECTRICAL SERVICE and Section 8.7 TELEPHONE SYSTEM.

3.7.2 Existing Utilities

A. The Consultant shall be responsible for determining the number, location and kinds of Utilities that will be impacted by the construction of the METRO facility.

B. At each review submittal, the Consultant in coordination with METRO shall forward applicable drawings to the utility companies for their review. Comments shall be returned to the Consultant and the Consultant shall forward a copy to METRO. If a conflict arises, the Consultant shall meet with METRO and the utility company to discuss the most cost-effective manner of resolving the conflict.

C. If a utility adjustment is required, METRO will coordinate this effort with the utility company. Relocation of any utility, owned by others, is subject to reimbursement and such reimbursement shall be included in the construction cost estimate.

D. Utility service to adjoining properties shall not be interrupted without permission of the Utility owner and, if temporarily rearranged, shall be restored to original condition upon completion of METRO construction.

E. If there is a potential underground Utility conflict; the Consultant shall eliminate the potential conflict by specifying sufficient elevations and horizontal dimensions to ensure that the design is effectively prosecuted in the construction. Provide elevations along with horizontal clearances for the following: footings; sanitary sewers; storm sewers; water, gas, and oil lines; conduits for communications; electric service and distribution lines; under drains; retaining wall stems and counterforts; manholes, inlets and pull boxes; and structure walls.

F. Utilities may exist in public right-of-way and on private property that will become part of the right-of-way for the METRO facility. When such Utilities are encountered, they will be allowed to remain in place if the following conditions are met:

1. The Utility can withstand the construction loading and the permanent facility loading.
2. The depth of cover over the Utility will not be less than the minimum cover allowed by the Utility owner or greater than the maximum depth utilized by the Utility owner in its own construction.
3. The Utility is not located beneath bus stalls or longitudinally beneath the major access roads to the METRO facility.
4. The Utility does not compromise METRO reliability, maintainability, or safety.
5. Cables are installed in conduit.
6. The utility shall be no closer than 100 feet from the bus loading/unloading area in Park & Ride facilities. In Trans it Centers, no utilities shall be in the bus loading area.

3.8 AUTO-TURN

The Consultant shall verify all turning paths for all METRO operating bus fleet, and operating speeds included on these design criteria using Au to-Turn software by Transoft Solutions, Inc and meeting the criteria established on ASSHTO – Geometric Design of Highways and Streets. The Consultant shall submit “Turning Paths ” schematics at the submission of the conceptual phase and 30% milestone. The Consultant shall submit CADD drawings along with this submission. The information shall be shown on Auto-Turn layers within the CADD drawings. Turning path envelop shall show as minimum the following:

- Path of the Front Overhead
- Path of Front wheel (outer)
- Center Line Geometrics including radii and dimensions (Centerline Turning)
- Path of Back wheel (inner)
- Path of right rear overhead
- Clearance – Min. Clearance

The Consultant shall design for a minimum clearance of 2 feet from any object. In the case of two way traffic, the consultant shall show and design for this movement with a minimum of 5 feet clearance. All geometric design prepared by the consultant shall be validated using Auto-Turn software Release 8.0 or as directed by METRO.

On parking lots, the Consultant may be required to show car parking movements (paths) to demonstrate safe operation. The Consultant s hall also design for safety with drawal of WB-20 vehicles that accidentally can get in to the Park & Ride and Transit Center lots.

TABLE 3.1.1

METRO BUSES IN OPERATION

	60 FOOT ARTICULATED BUS	45 FOOT REGULAR BUS	40 FOOT REGULAR BUS	29 FOOT REGULAR BUS
Length	727”	540”	480” – 504”	348”
Width	102”	102”	102”	102”
Height	132”	150” *	110” – 135”	120”
Wheel Base	504”	295” – 366”	245” - 293”	108”
Curb Weight	42,860–44,800 lbs	35,100 - 36,377 lbs	26,400 - 30,840 lbs	23,340 lbs
Gross Weight	66,600 lbs	46,000 - 51,800 lbs	39,930 - 42-540 lbs	39,920 lbs
Seating	63 - 65	55 – 57	37 – 41	25
Standee	32 – 33	28 – 29	19 – 21	13

*** Governing** Design Clearance (Measurement up to the top of air conditioning)

TABLE 3.1.2a
METRO OPERATIONAL PAVEMENT WIDTH AT TURNING CURVES (SINGLE LANE)

RADIUS INSIDE CURB FT.	RADIUS OUTSIDE CURB FT.	MINIMUM LANE WIDTH FT.	RECOMMENDED LANE WIDTH FT.	MAX SPEED MPH	FOR TURNS OVER 90° ONLY FOR TURNS 90° OR LESS USE FIG. 3.1.9
30	55-57	25	27	5	
35	59-61	24	26	7	
40	63-65	23	25	9	
45	67-69	22	24	10	
50	71-74	21	24	12	
55	76-78	21	23	14	
60	80-82	20	22	15	
65	85-87	20	22	16	FOR BUS TURNS AT ANY ANGLE
70	89-91	19	21	17	
75	94-96	19	21	17	
80	99-101	19	21	18	
85	103-106	18	21	19	
90	108-110	18	20	20	
95	113-115	18	20	20	
100	118-119	18	19	21	
110	127-129	17	19	22	
120	137-138	17	18	23	
140	156-157	16	17	24	
150	166-167	16	17	25	
230	265	15	15	30	
310	324	14	14	35	
400	412	12	12	MAX	

TABLE 3.1.2b
METRO OPERATIONAL PAVEMENT WIDTH AT TURNING CURVES (TWO LANES)

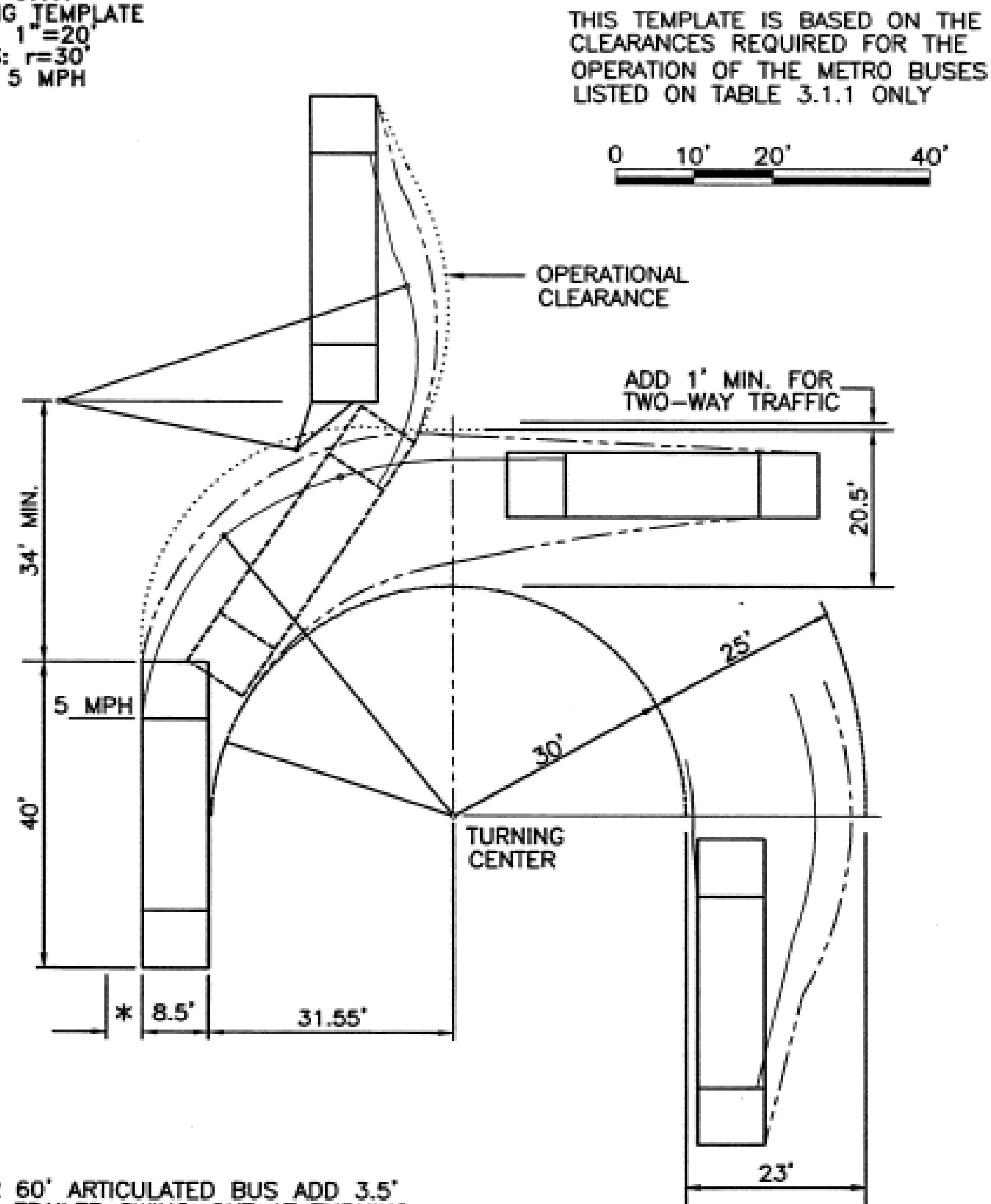
MAX. SPEED	R INSIDE	PAVING WIDTH	ISLAND/ STRIPE	R OUTSIDE	PAVING WIDTH	REMARKS
5 MPH	30'	25'	1'	56'	21'	Table 3.1.2 (Single Lane)
7 MPH	35'	24'	1'	60'	20'	Table 3.1.2 (Single Lane)
10 MPH	45'	22'	1'	68'	19'	Table 3.1.2 (Single Lane)
15 MPH	60'	20'	1' 81'		19'	Table 3.1.2(Single Lane)
	53.5'	23'	3'	71.5'	22'	Fig. 3.1.10 Over 90
	53.5'	21'	3'	64.5'	20.4'	Fig. 3.1.11 Less 90 (15' Normal Lane)
	54'	19.5'	3'	52'	19.1'	Fig. 3.1.12 Less 90 (12' Normal Lane)
20 MPH	90'	18'	1'	109'	18'	Table 3.1.2 (Single Lane)
25 MPH	150'	16'	1'	167'	16'	Table 3.1.2 (Single Lane)
30 MPH	230'	15'	1'	246'	15'	Table 3.1.2 (Single Lane)

TABLE 3.1.3
RECOMMENDED DESIGN CRITERIA FOR USE OF THE BUS TURNING CURVES INSIDE ALL METRO PARK & RIDE AND TRANSIT CENTER FACILITIES

MIN. SPEED	MOVEMENT CONDITION	LOCATION	CURVE NO.
5 MPH	Turning after stop or turning to stop	At bus stop or bus bay	Fig. 3.1.1 or equivalent Auto-turn template
7 MPH	Turning after slowing down from 10 MPH. Turning during acceleration	At bus loop at Park & Ride or Transit Center	Fig. 3.1.2 or equivalent Auto-turn template
10 MPH	Turning after slowing down from 15 MPH. Turning after acceleration	At bus loop at Park & Ride and Transit Center	Fig. 3.1.3 or equivalent Auto-turn template
15 MPH	Turning after slowing down from 30 MPH. Turning after acceleration	Entering or exiting HOV Ramp	Fig. 3.1.4 or equivalent Auto-turn template

MINIMUM DESIGN SPEED 5 MPH
MAXIMUM ALLOWABLE SPEED INSIDE P&R AND T.C. IS 15 MPH

FIGURE 3.1.1
TURNING TEMPLATE
SCALE: 1"=20'
RADIUS: r=30'
SPEED 5 MPH



* FOR 60' ARTICULATED BUS ADD 3.5' FOR TRAILER SWING-OUT AT TURNING

FOR 45' BUS ADD 1.8' SWING-OUT AT TURNING
ADD 2.3' SWING-OUT AT BUS STOP

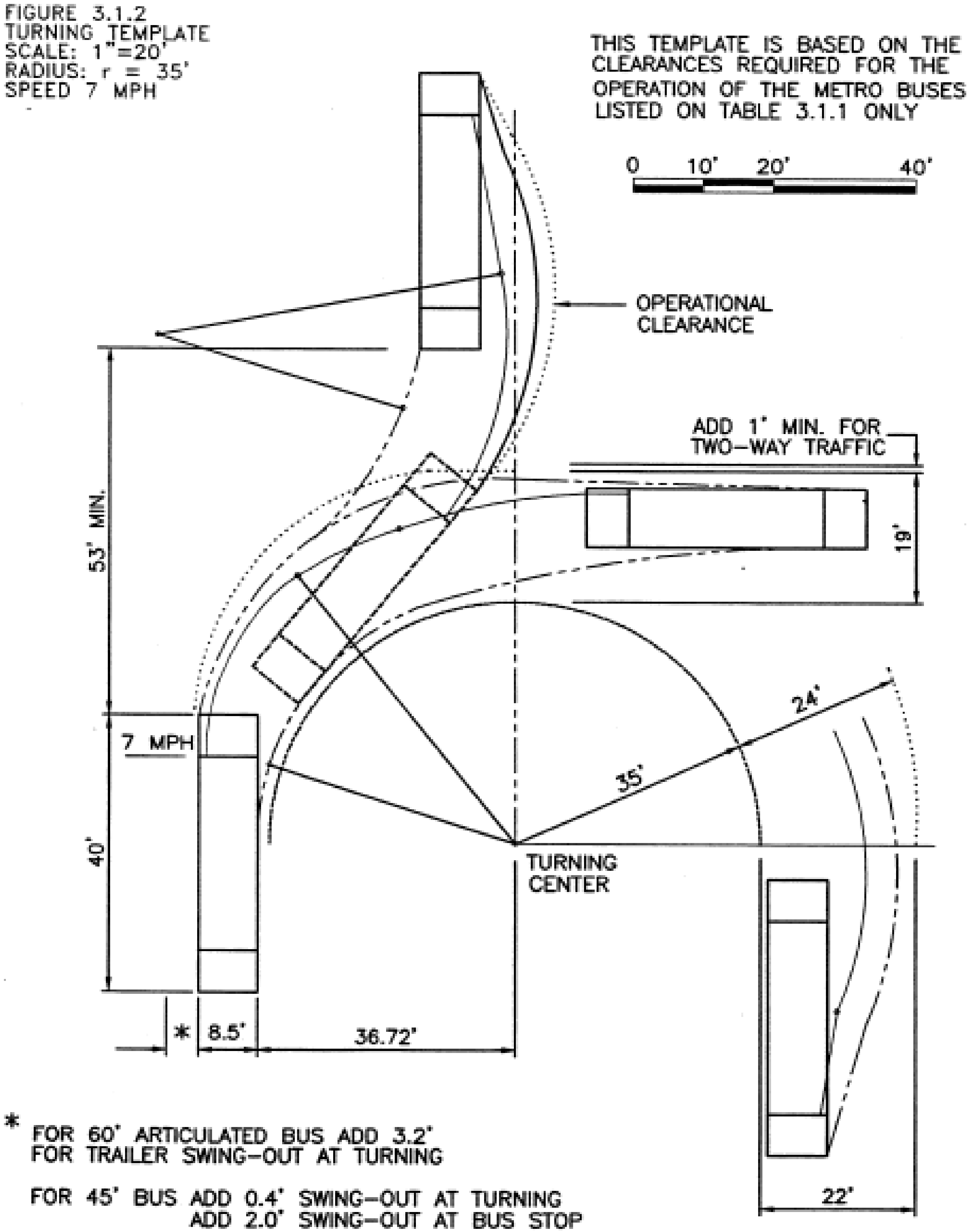


FIGURE 3.1.2
TURNING TEMPLATE
SCALE: 1"=20'
RADIUS: r = 35'
SPEED 7 MPH
THIS TEMPLATE IS BASED ON THE CLEARANCES REQUIRED FOR THE OPERATION OF THE METRO BUSES LISTED ON TABLE 3.1.1 ONLY
0 10' 20' 40'
OPERATIONAL CLEARANCE
ADD 1' MIN. FOR TWO-WAY TRAFFIC
19'
53' MIN.
7 MPH
24'
35'
TURNING CENTER
40'
* 8.5'
36.72'
22'
* FOR 60' ARTICULATED BUS ADD 3.2' FOR TRAILER SWING-OUT AT TURNING
FOR 45' BUS ADD 0.4' SWING-OUT AT TURNING
ADD 2.0' SWING-OUT AT BUS STOP

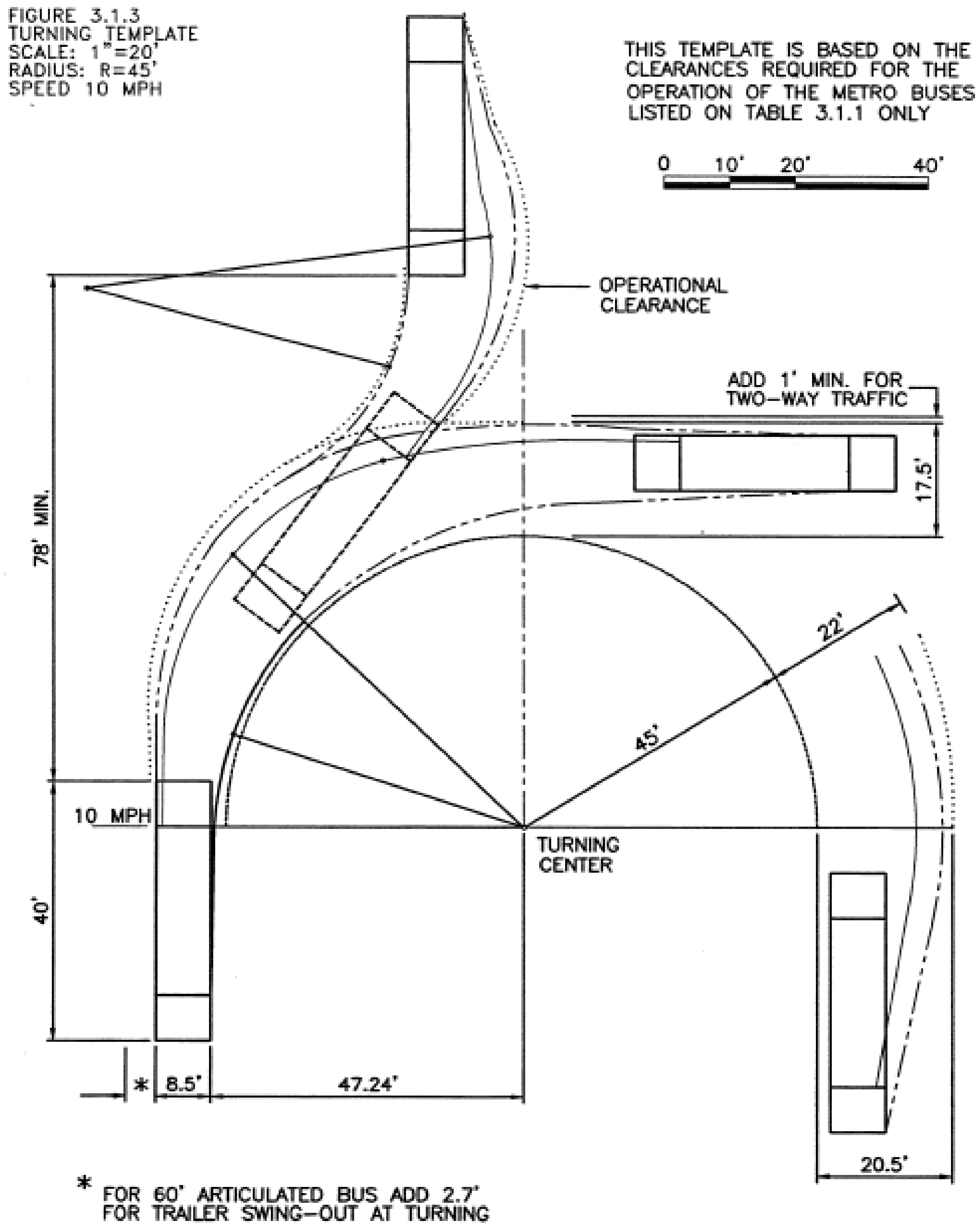


FIGURE 3.1.3
TURNING TEMPLATE
SCALE: 1"=20'
RADIUS: R=45'
SPEED 10 MPH
THIS TEMPLATE IS BASED ON THE CLEARANCES REQUIRED FOR THE OPERATION OF THE METRO BUSES LISTED ON TABLE 3.1.1 ONLY
0 10' 20' 40'
OPERATIONAL CLEARANCE
ADD 1' MIN. FOR TWO-WAY TRAFFIC
17.5'
78' MIN.
22'
45'
10 MPH
TURNING CENTER
40'
* 8.5'
47.24'
20.5'
* FOR 60' ARTICULATED BUS ADD 2.7' FOR TRAILER SWING-OUT AT TURNING

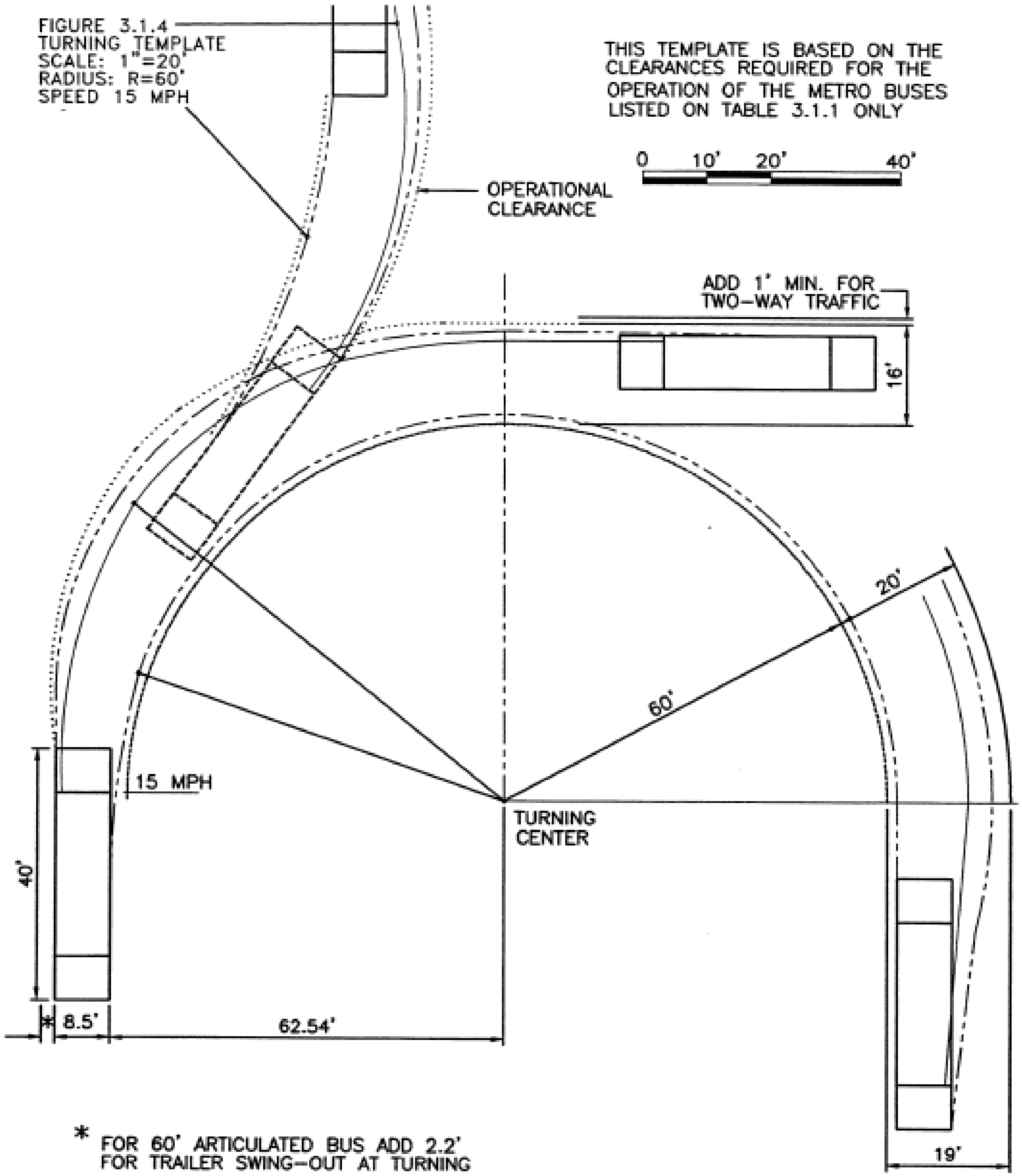


FIGURE 3.1.4
TURNING TEMPLATE
SCALE: 1"=20'
RADIUS: R=60'
SPEED 15 MPH
THIS TEMPLATE IS BASED ON THE CLEARANCES REQUIRED FOR THE OPERATION OF THE METRO BUSES LISTED ON TABLE 3.1.1 ONLY
0
10'
20'
40'
OPERATIONAL CLEARANCE
ADD 1' MIN. FOR TWO-WAY TRAFFIC
16'
20'
60'
15 MPH
TURNING CENTER
40'
8.5'
62.54'
19'
* FOR 60' ARTICULATED BUS ADD 2.2' FOR TRAILER SWING-OUT AT TURNING

Figure 3.1.5
Vertical Control - 1

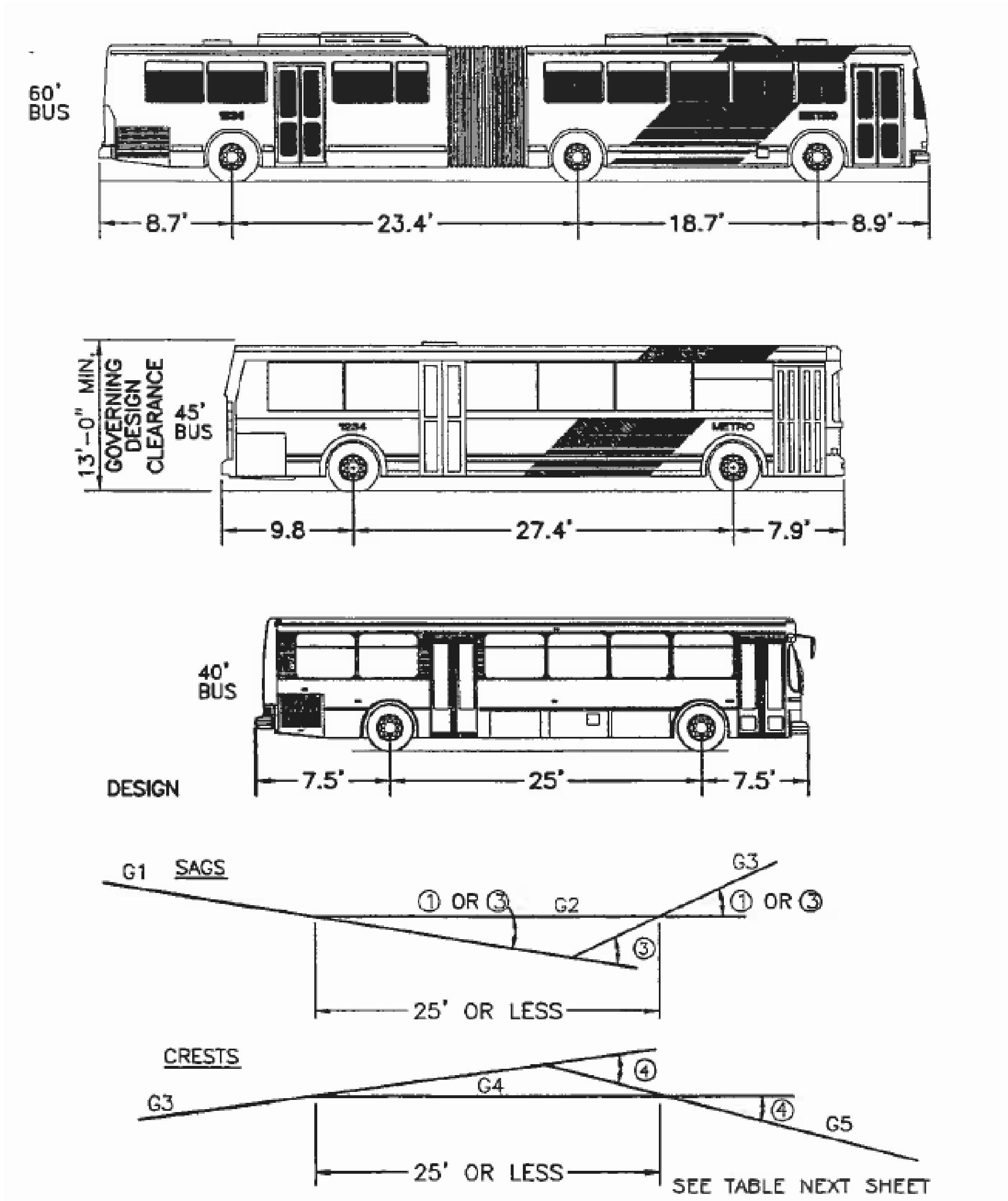
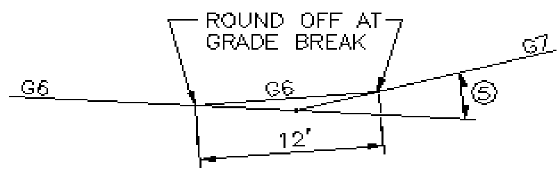


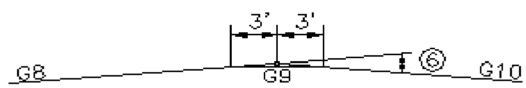
Figure 3.1.6
Vertical Control - 2

	ACTUAL						DESIGN	
	ANGLE °			SLOPE %			ANGLE °	SLOPE %
BUS	60'	45'	40'	60'	45'	40'	ALL	ALL
① APPROACH ANGLE	8°	10°	9.8°	14%	18%	17%	5.7°	10%
② UNDER BODY CLEARANCE	8"	11.5"	9"					
③ DEPARTURE ANGLE	8°	9°	9°	14%	16%	16%	5.7°	10%
④ ROLLOVER ANGLE	8°	9°	9°	14%	16%	16%	5.7°	10%

NOTE: DESIGN SLOPES ARE BASED ON MAXIMUM SPEED OF 15 MPH

GRADE TRANSITION (SAG OR CREST)

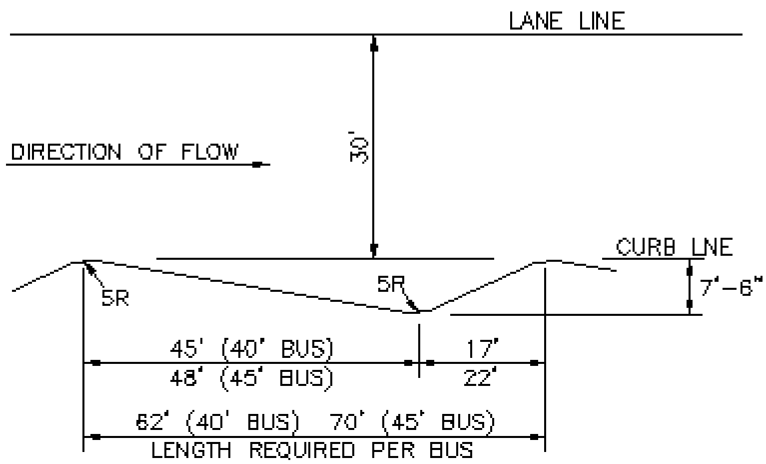




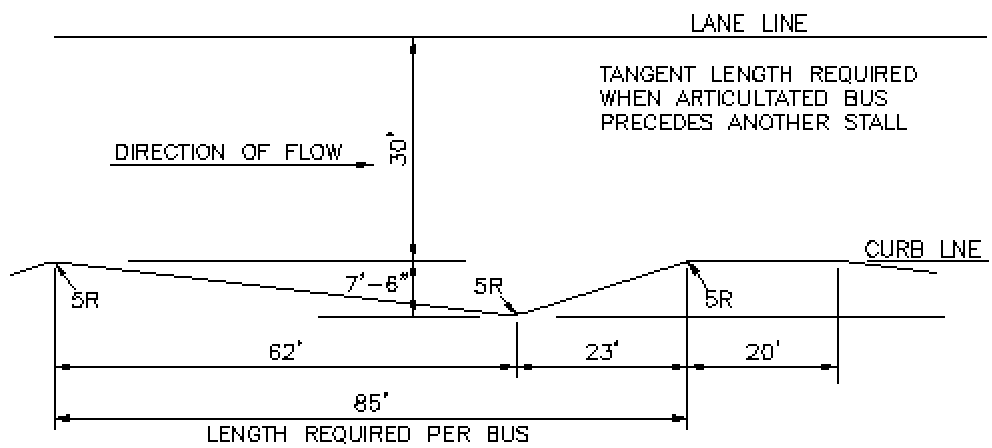
ROUND OFF AT GRADE BREAK
(SAG OR CREST)

SAG OR CREST ANGLE (SLOPE)	GRADE CHANGE
2.5° (4.5%) OR MORE AND SPEED OVER 15 MPH	USE VERTICAL CURVE
⑤ 2° (3.5%) OR MORE SPEED 6 MPH TO 15 MPH 2.5° (4.5%) OR MORE SPEED 5 MPH & LESS	USE GRADE TRANSITION AND ROUND OFF AT GRADE BREAK
⑥ 2° (3.5%) OR MORE SPEED 6 MPH TO 15 MPH 2.5° (4.5%) OR MORE SPEED 5 MPH & LESS	USE ROUND OFF AT GRADE BREAK ONLY
1° (1.8%) OR LESS AND SPEED 15 MPH & LESS	DIRECT CHANGE

Figure 3.1.7
SAWTOOTH BUS BAY

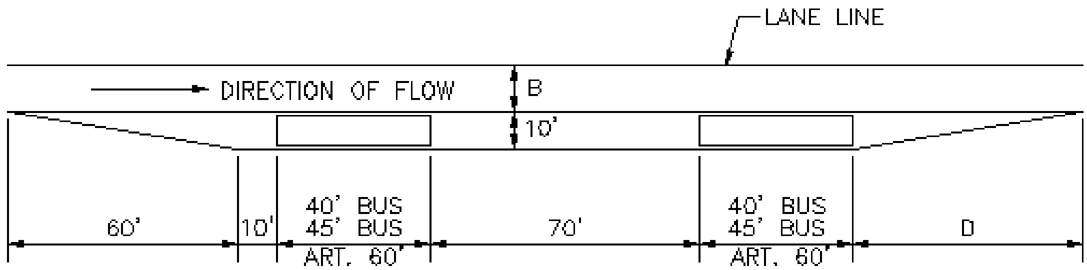


40' & 45' REGULAR BUSES



60' ARTICULATED BUS

Figure 3.1.8
RECESSED BUS BAY

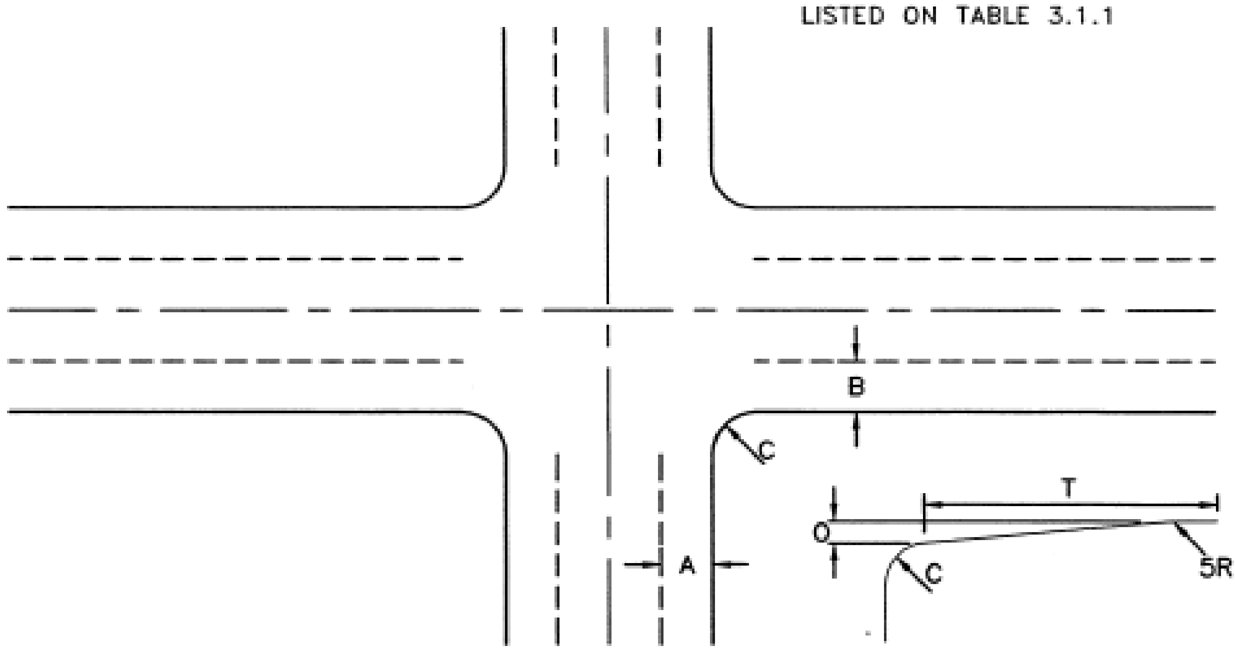


* 35' MAY BE USED IN BUS LAY OVER AREAS, IF 2 FT. OVERHANG BEYOND CURB LINE IS ALLOWED

DIMENSION "D" FOR DIFFERENT LANE WIDTH							
LANE WIDTH B	27'	24'	22'	20'	14'	13'	12'
REG. BUS D =	15'	20'	25'	30'	50'	55'	60'
ART. BUS D =	25'			30'	50'	55'	60'

FIGURE 3.1.9
RECOMMENDED CORNER RADII

CLEARANCES REQUIRED FOR THE OPERATION OF THE METRO BUSES LISTED ON TABLE 3.1.1



A	B	C	O	T	MAX. SPEED
LEAVING LEG WIDTH	ENTERING LEG WIDTH	RADII	OFFSET	TAPER	M.P.H.
12'	12'	140'	0	0	20
		60'	4'	16'	15
		45'	5.5'	22'	10
		35'	7'	28'	7
		30'	8.5'	34'	5
	14'	85'	0	0	17
		60'	2'	8'	15
		45'	3.5'	14'	10
		35'	5'	20'	7
		30'	6.5'	26'	5
	16'	60'	0	0	10
		35'	3'	12'	7
		30'	4.5'	18'	5
	19'	35'	0	0	7
	21'	30'	0	0	5
	24'	25'	0	0	5
	27'	20'	0	0	5

FIGURE 3.1.10
BUS TWO-BAY TURNING
OVER 90°
SCALE: 1"=20'
SPEED 15 MPH

THIS TEMPLET IS A MINIMUM DESIGN, BASED ON THE CLEARANCES REQUIRED FOR THE METRO BUSES LISTED ON TABLE 3.1.1. FOR MORE INFORMATION, SEE TABLE 3.1.2 (CONT'D)

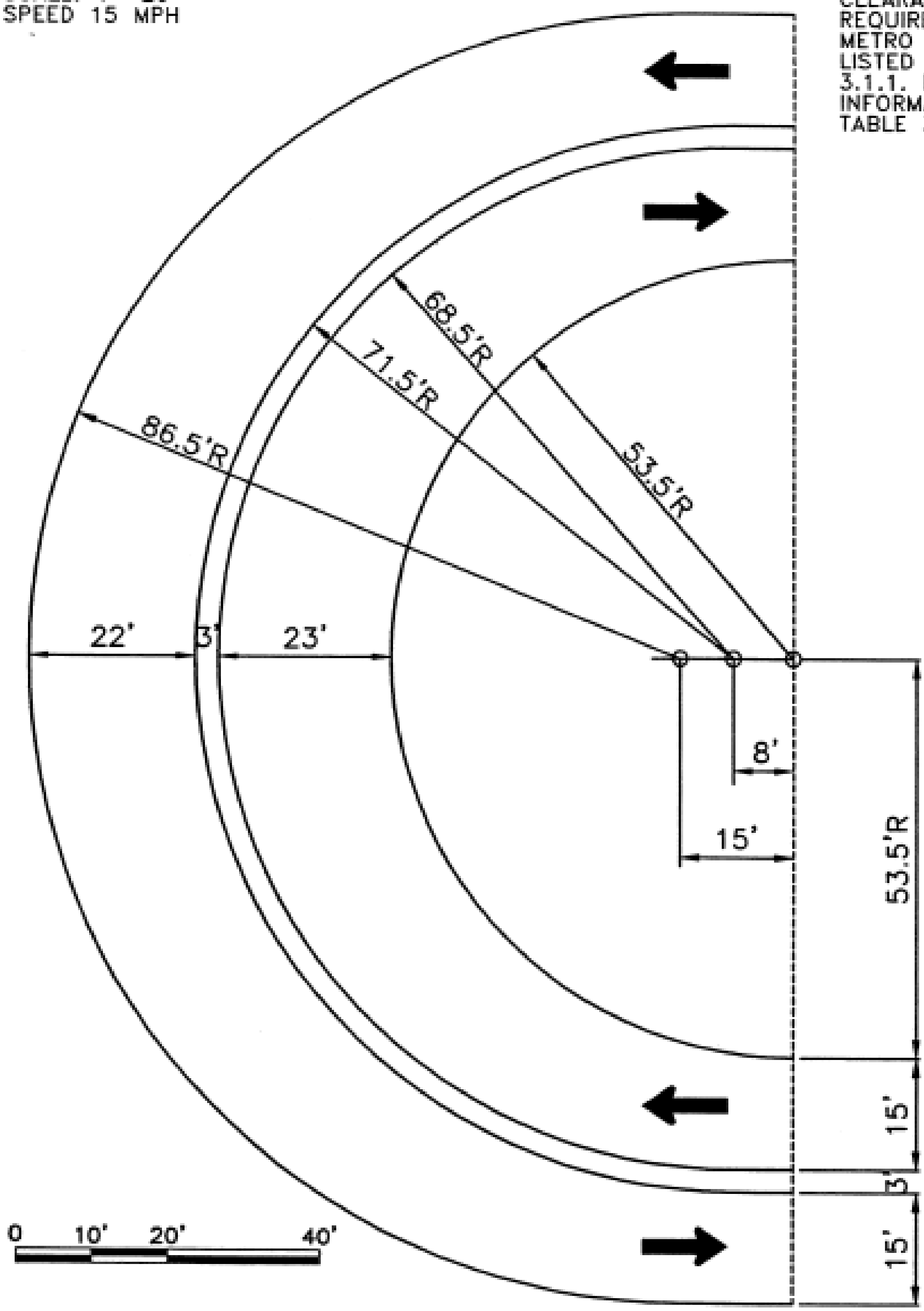


Figure 3.1.11
BUS TWO-BAY TURNING, 90° OR LESS, SPEED 15 MPH
THIS TEMPLET IS A MINIMUM DESIGN, BASED ON THE CLEARANCES REQUIRED FOR THE METRO BUSES LISTED ON TABLE 3.1.1. FOR MORE INFORMATION, SEE TABLE 3.1.2.

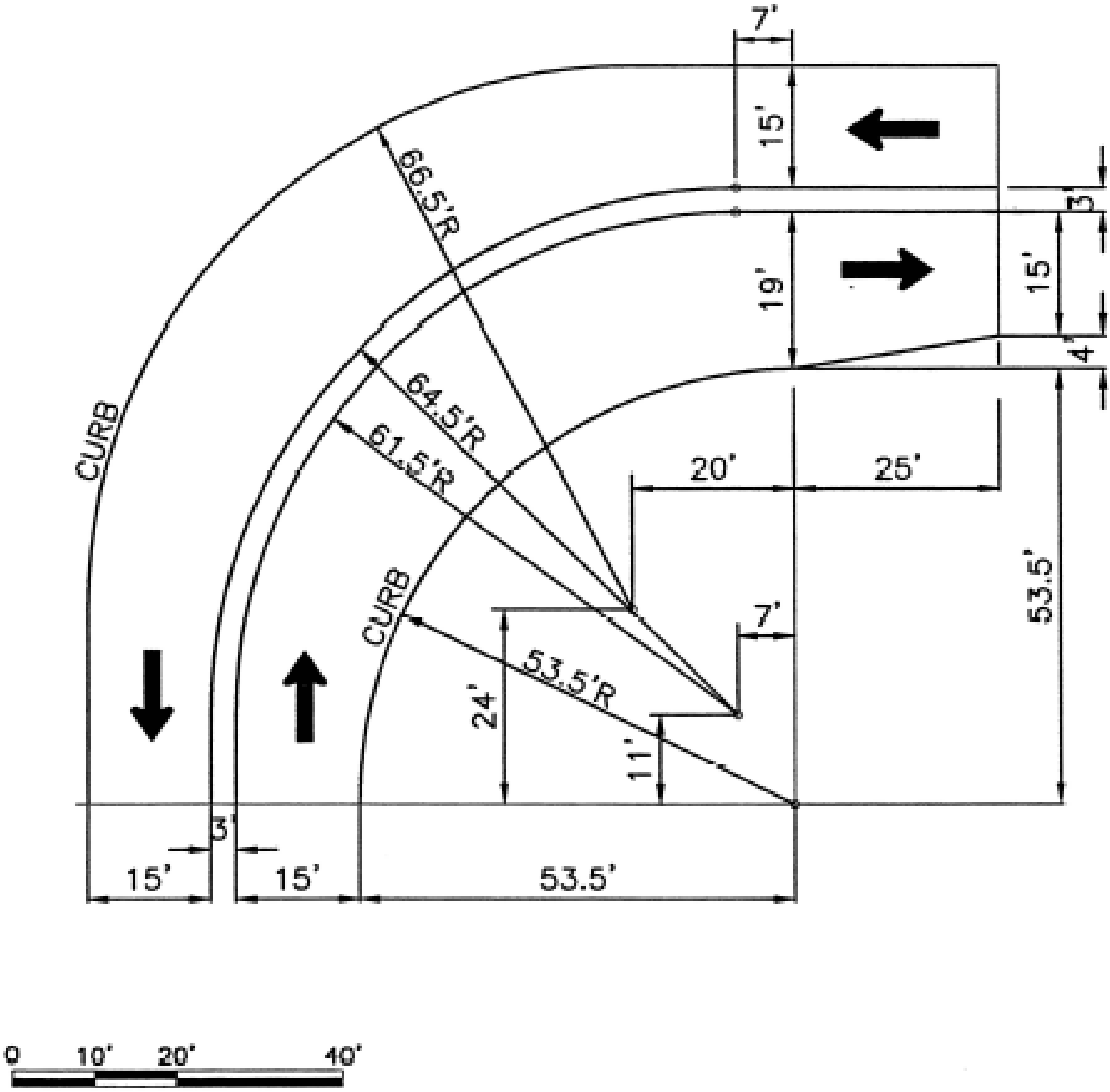
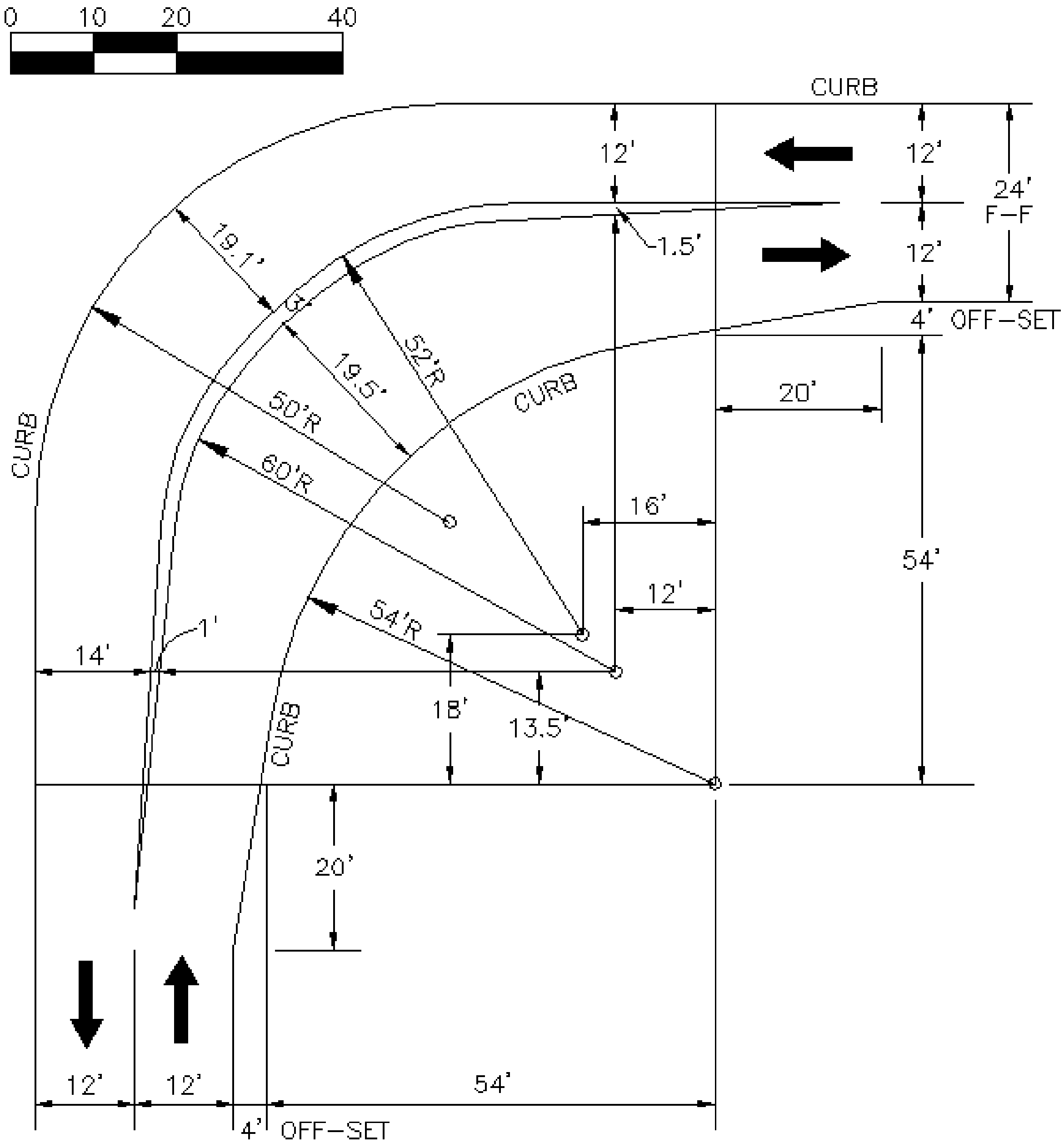


Figure 3.1.12
BUS TWO-BAY TURNING, 90° OR LESS, SPEED 15 MPH
THIS TEMPLET IS A MINIMUM DESIGN, BASED ON THE CLEARANCES REQUIRED FOR THE METRO BUSES LISTED ON TABLE 3.1.1. FOR MORE INFORMATION, SEE TABLE 3.1.2.



END OF SECTION 3.0

4.0 STRUCTURAL

4.1 BASIS OF STRUCTURAL DESIGN

A. The structural design of all footings, foundations, concrete slabs and structures shall be economically designed based on the Uniform Building Code (UBC) or the building code requirements of the agency having jurisdiction in the area of the Site whichever is greater.

B. Provide sealed design calculations for verification of design.

4.2 DESIGN LOADS

A. Self weight of the structure

B. Structure design should be based on a FM-I-90 design rating

C. Wind loads: 110 MPH, 3 second wind gusts

D. Pedestrian live load: 150 psf

E. A 2.0 uplift safety factor should be utilized

F. Snow loading calculations should use a minimum of 5 PSF at all elevations

G. A 1.15 building importance factor shall be used

H. Seismic Loading in accordance with Seismic Design and Construction Requirements of 49 CFR, Part 41, per FTA Regional Notice No. 167 or a statement stating that seismic loading is not critical signed and sealed by a Professional Engineer licensed in the State of Texas.

4.3 FOUNDATION DESIGN

A. The design of foundations shall be based on the allowable soil bearing pressures determined by the Geotechnical Consultant as outlined in the Geotechnical Report. Light pole foundations shall be designed to resist overturning utilizing the passive resistance of the soil after discounting the top 3 feet. The passive and active pressures shall be those determined by the Geotechnical Consultant. The minimum factor of safety for all types of failures shall be 2.0.

4.4 STRUCTURAL STEEL BUILDING DESIGN

A. All structural steel design of buildings shall be in accordance with AISC Standard S326 and M011, using the Load and Resistance Factor Design Method.

4.5 STRUCTURAL STEEL BRIDGE DESIGN

A. All structural steel design of bridges shall be in accordance with TxDOT's Bridge Manual and AASHTO's "Standard Specifications for Highway Bridges" using the TxDOT Bridge Design Manual LRF D, revised December 2011 and AASHTO LRFD Bridge Design Specifications, STD Edition with 2010 Interim Revisions.

4.6 CONCRETE BRIDGE DESIGN

A. All concrete design of bridges shall be in accordance with TxDOT's Bridge Manual and AASHTO's "Standard Specifications for Highway Bridges" using the TxDOT Bridge Design Manual LRFD.

4.7 CONCRETE BUILDING DESIGN

A. All concrete design of buildings shall be in accordance with ACI 318, 381R and other applicable ACI Standards using the Ultimate Strength Design Method and in compliance with local governmental building codes.

4.8 MINIMUM REQUIREMENTS

4.8.1 Steel

A. All structural steel shall be ASTM A-36 or greater.

B. All reinforcing steel shall be a minimum of Grade 60 except for spiral reinforcing which may be a minimum of Grade 40.

C. No field welding of structural member splices or connections shall be allowed on any METRO structure, without written approval from METRO.

D. All holes required for manufacturing of structural members shall be sealed prior to the application of the factory finish over the entire member.

4.8.2 Concrete

A. Paving Concrete: 3,000 psi, called Class 3000, minimum 28-day strength.

B. Structural Concrete: 4,000 psi, called Class 4000, minimum 28-day strength.

C. The minimum size reinforcing bar shall be a number 4 deformed bar.

D. The maximum size aggregate shall be 1.5 inches.

E. Minimum cover for any concrete above finished grade shall be 2 inches to the closest reinforcing steel, (e.g . stirrups, ties or spirals) at the smallest cross-sectional area.

F. All columns with a circular pattern of the main reinforcing having more than 4 vertical bars shall have it enclosed with spiral reinforcing having a pitch not greater than 6 inches. All columns with 4 vertical bars shall have the main reinforcing enclosed with ties with a spacing not to exceed 12 inches. All other shapes of columns shall have the main reinforcing enclosed with ties with a spacing not to exceed 12 inches.

4.9 VERTICAL CLEARANCES

A. If an entrance to the facility is from a ramp, the minimum clearance over any roadway shall be a minimum of 16 feet 0 inches or the clearance required by the agency over which the ramp passes, whichever is greater.

B. If an entrance to the facility is from a ramp over a railroad, the minimum clearance shall be that required by the Railroad Company.

4.10 LOCATION OF SUBSTRUCTURE UNITS

A. If an entrance to the facility is from a ramp over a City of Houston Street, no substructure unit shall be located within the City's right-of-way.

B. If an entrance to the facility is from a ramp over a railroad, no substructure unit shall be located within the railroad's right-of-way.

4.11 WINDSCREENS

A. Windscreens shall be constructed with a stainless-steel frame (unless approved otherwise by METRO's Project Manager), anchored to a reinforced concrete foundation designed to UBC FM -I-90 design rating. See Section 5.5.5 Glass Block Windscreens, for field information.

END OF SECTION 4.0

5.0 ARCHITECTURAL

5.1 GENERAL

A. This Section establishes general guidelines and specific standards for the design of METRO facilities. It includes space requirements, approved materials and finishes, standards for planning, and other pertinent information. The METRO Urban Design Guidelines, furnished under separate cover, are intended to provide direction and standardization in Project Design.

B. METRO's Urban Design Guidelines incorporate the necessary design strategies that are sensitive to developing CPTED applications.

C. Working within the framework of the Design Criteria for METRO facilities, Consultants shall be expected to use imagination and skill to design the facility, yet meet all established requirements to produce functional aesthetic and safe structures that address particular site conditions.

D. The Consultant shall be familiar with the general aspects of the entire facility, in order to see how individual elements relate and integrate. It is essential, for example, that the natural relationships between pedestrian flow, space design, and equipment layout is maintained throughout the facility for the convenience of passengers. Safety, operational and maintenance requirements shall also be taken into account.

E. Throughout the design of all facilities, the Consultant shall bear in mind the general objective of METRO is to secure the optimum in patron convenience, safety, and pleasure, within the constraints of the construction budget, ease of maintenance and minimal operational costs.

F. General design of all facilities shall be such that each will be aesthetically pleasing and immediately identifiable as a METRO facility, yet shall be in harmony with its surrounding environment, inclusive of adjacent permanent structures or planned developments, and neighborhoods. These relationships shall be considered in the selection of colors, textures, and materials. Unique permanent topographical and neighborhood cultural characteristics shall be recognized and utilized in the design, insofar as practicable

G. The general design shall address crime, fear, vandalism, safety and security following CPTED principles.

H. Sustainability considerations, per LEED principles, shall be applied.

5.2 FACILITY FUNCTIONAL REQUIREMENTS

A. The role of the Consultant for METRO is to develop facilities, which meet standards and requirements, established for METRO facilities.

B. Much of METRO facilities' success will depend on the attractiveness and efficiency of the individual facilities. The quality of the design is a subtle matter; it must reflect a balanced relationship with the immediate environment, and at the same time provide facilities that will function smoothly from the standpoint of patrons and bus operations.

C. In the process of developing the facility design, subjective aesthetic considerations and judgments shall be made and agreed upon by METRO. The broad viewpoint of METRO is expressed here for the information of the Consultants:

1. All elements of the facility shall reflect the use of modern techniques to achieve safe, efficient, convenient, and pleasant rapid transit for all patrons, with due regard for operation and maintenance.
2. The design shall take in to consideration the opportunities for crime and vandalism and apply techniques to remove or reduce these opportunities to create a safe secure environment for METRO patrons and staff.
3. The design of all elements shall reflect the best use of the technology available, anticipating an economic life of 25 years.
4. Design novelties, clichés of the moment, and architectural fads shall be avoided. The materials of construction shall be selected with particular attention to durability, availability, sustainability, cost and maintenance.
5. These factors will be considered by METRO in all design reviews and approvals.

CI. Standardization throughout the facilities is desirable to establish an identity for the METRO system as a whole. This standardization will enable patrons to find their way easily, even in a facility new to them. Standardization of certain elements throughout all facilities is also necessary from the standpoint of economy and function. These standards, which include use of specific materials, certain standard items and prefabricated units, kinds and sizes of spaces, and relationships between spaces, shall be followed in all facility design.

CII. Standardization of materials and manufactured components will reduce material inventory, simplify and reduce the cost of making repairs.

CIII. Circulation throughout METRO facilities shall be planned so that handicapped and elderly patrons can move easily toward their destinations. Consideration shall be given to the use of light, sound, color, and orientation edges to accomplish this objective.

CIV. Sustainability considerations, per LEED principles, shall be applied to all facility designs.

5.3 SITE DEVELOPMENT

A. The location and boundaries of Sites will be established by METRO and will be set forth on the Conceptual Site Plan. The Conceptual Site Plan will outline the location of the loading/unloading platform, bus ingress and egress movements, patron traffic movements, parking areas (regular parking, short-term parking and handicap parking) and landscaped areas.

B. The site layout and traffic flow shall relate to the surrounding area and its traffic patterns. Provisions for handling patrons arriving and departing by bus, car, or motorcycles, on foot, on bicycles, and as drop-off patrons, shall be provided.

C. Entrances and exits to the facilities shall be located as shown in the Conceptual Site Plan. Design of the entrances and exits shall be such that they are obvious to the approaching patron.

5.4 PLATFORM SHELTER

A. The platform shelter, shall consist of a column supported, steel structure with flat surface ceiling and standing seam metal roof or similar structural canopy.

B. The roof of the platform shelter shall extend a minimum of 10 feet over the loading doors and discharging doors of an articulated bus. The shelter roof shall be as long as required to accommodate simultaneous loading and/or discharging of passengers at all designated bus bays.

C. A minimum vertical clearance of 13 feet 0 inches shall be provided from the top of curb to the lowest member of the canopy.

D. Shelters shall have solid soffits (ceilings) to ease cleaning of shelter.

E. Shelter design shall eliminate locations where birds can roost.

F. Column supports shall not be located in the queuing path of passengers boarding and alighting from buses.

G. Shelter design and selection shall incorporate LEED principles.

H. Acoustics: No long distance echoes shall be audible. Flutter echo between parallel surfaces shall be minimized. Consideration shall be given to the effect generated by the buses.

5.5 PLATFORM AMENITIES

5.5.1 Emergency Assistance Station Phones (EAS)

A. Provide a minimum of one at the platform and one for each 250 parking spaces strategically located throughout the Park & Ride lot, or as directed by METRO Project Manager as a result of the review process and feedback from METRO Police and Safety.

B. For Transit Centers, there should be a minimum of two, one at the platform and one strategically located.

5.5.2 Public Address and Passenger Information Signs (PA/PIS)

A. PA/PIS shall be provided at passenger station platform.

B. Public Address (PA) shall consist of amplifier-driven loudspeaker and double-sided Passenger Information Signs (PIS) installed in compliance with ADA requirements. All PIS shall have an amber strobe light integrated into the display when an emergency message is being displayed.

C. The PA equipment shall be provided with automatic and manual volume adjustment for local conditions.

D. Acoustics shall be considered when designing the platform shelter to provide for clarity of announcements from the PA system.

5.5.3 Newspaper Vending Machines

A. Provide space for a minimum of four (4) newspaper vending machines (vending company provided). Number of machines may vary and should be coordinated with METRO's Project Manager. Locate near central axis of platform, clear of foot traffic patterns.

B. Provide a means to secure the vending machines to the loading/unloading platform.

5.5.4 Waste Containers

A. Provide for a minimum number of waste containers to match the number of bus bays at the Site. Additional waste container s may need to be added on a case-by-case study of each facility. The design of waste containers and interior liner shall complement other site furnishings and shall reiterate the overall design concept of the rapid transit system. The waste containers shall be engineer ed to withstand high levels of abuse and vandalism. Containers style shall be wire mesh or perforated metal and interior liners shall be 80% clear and usable so that explosive devices or other hazardous objects can be readily seen from the exterior. Containers shall not obstruct access to building entrances, METRO stations, or pedestrian circulation. Receptacles shall be a minimum 30 gallon in size to accommodate frequency of trash collection.

5.5.5 Windscreens

A. Provide windscreens for patrons waiting for buses or waiting to be picked up. The number of windscreens shall be coordinated with METRO's Project Manager.

B. Basic design should follow previous METRO projects that utilized the solid glass blocks. Windscreens must follow CPTED guidelines by minimizing the sight obstruction.

C. The framing material shall be stainless steel. The lower section of the windscreen (below the benches) should be brick or concrete block with spectra-glazed surface or other type of material approved by METRO. The upper section of the windscreen (above the benches) shall be solid glass blocks. See Section 4.11 Windscreens, for structural information.

5.5.6 Benches

A. Benches shall be located in areas where patrons are waiting for the buses or waiting to be picked up. Coordinate the number of benches with METRO.

B. Prefabricated concrete benches should be utilized. Benches shall have a factory seal to prevent penetration of paint and inks from graffiti markings.

5.5.7 Supervisor Booth (if required)

A. Generally METRO provides a supervisor booth at all Park & Ride and Transit Center facilities, provided there is enough floor space for one. Follow METRO's Standard Drawing for size, shape, etc. Supervisor booth should be centrally located for easy patron access. Supervisor Booth shall be equipped with an A/C roof top unit.

B. The specifications for the supervisor booth shall include provisions to facilitate the sale of fare media and access slot with speaker.

5.5.8 Observation Mezzanine (if required)

A. Observation Mezzanines shall be used at all Park & Ride facilities and some Transit Center facilities. The observation mezzanine is a prefabricated fiberglass/ glass booth elevated on steel frame, see METRO's standard drawing for observation mezzanine and specifications for details.

B. Location of the observation mezzanine shall be coordinated with METRO Police through METRO's Project Manager.

5.7 OTHER AMENITIES

5.7.1 Bike Racks

A. Parking racks specially designed for bi cycles shall be provided c lose to the bus loading/unloading platform or near the observation mezzanine (if provided), to allow for natural surveillance. A minimum of two (2) bike racks that can each accommodate five (5) bikes shall be placed near the observation mezzanine or pedestrian waiting area. No enclosed bike racks shall be used. The bike rack location and type shall be approved by METRO Police Department.

5.8 UTILITY BUILDING

A. Minimum requirements are shown on METRO's Directive Drawings for the utility building. Utility building shall consist of three rooms; toilet, electrical & SC&C.

B. Doors shall face the loading/unloading platform and/or observation mezzanine. Doors located on the side of the utility building shall open in such a manner that the person entering the building can be seen at all times.

C. The restroom door shall have a card swipe type lock on door with single-key deadbolt override. Follow METRO's Specification 08710 for details.

D. Utility building to have roof top air conditioning, see Section 7.2 ENVIRONMENTAL REQUIREMENTS for details.

E. The electrical and SC&C doors shall be vandal resistant and equipped with tamper and intrusion detection alarms. These alarms shall be annunciated at Police Dispatch.

5.8.1 Restroom

A. Shall provide a wall mounted commode, urinal, sink, floor drain, mirror, hand dryer, exhaust fan and heater/air conditioning unit.

5.8.2 Electrical Room

A. Provide adequate space for all electrical panels, raceways, conduits, and transformers.

5.8.3 Surveillance, Communication & Control (SC&C) Room

A. Provide adequate space for all SC&C equipment including; telephone backboard, patch panel backboard, electrical panels, rack mounted communications and video equipment, access control panel for restroom card reader and electronic information systems (EIS).

5.8.4 Concessions

A. METRO policy allows manned and unmanned concessions at any of its facilities.

B. The Consultant shall design the platform area to be able to accommodate, four (4) vending machines, and one (1) manned concession, which occupies approximately 4 foot x 6 foot floor space. These concession areas shall be located near the central axis of the platform, clear of major foot traffic patterns.

5.9 ARCHITECTURAL SIGNING (SEE SECTION 3.6.2 FOR TRAFFIC SIGNING)

A. Direction and information signing is one of the most important elements in the smooth functioning of a METRO facility. However, whenever possible, the architecture itself shall be used to simplify and direct passenger movement.

B. For ease of identification, the type and style of signs, graphics, system maps, and other directional instructions shall be uniform throughout METRO facilities.

C. For facilities with 1000 or more parking spaces, locating signs shall be used throughout the parking lot. Utilize capital letters to identify parking sections (i.e., A, B, C, etc.).

5.10 MATERIALS AND FINISHES

5.10.1 General

A. This section specifies the basic requirements and criteria that have been established for the finish of public areas and ancillary areas within METRO facilities. These guidelines will provide the basic goals of safety, convenience, comfort, durability, maintainability, economy, visual appearance, vandal and graffiti resistance.

5.10.2 Basic Goals

A. Life and Safety

1. Non-combustible insulation is always recommended in place of foam-based products (polyurethane, polystyrene, etc.), and is especially important in unprotected, concealed spaces, such as attics and crawl spaces, or in hollow-core walls that will be penetrated by electrically rated equipment. For combustible construction in concealed spaces, fire protection is still recommended.
2. Use of exterior-insulation and finishing system (EIFS) is not recommended because of fire, high wind, and hail hazards. EIFS is considered a lateral support system and fire-resistive substrate topped by insulation, covered by a reinforced, protective weather coating. This includes decorative trim for architectural detailing, such as columns or cornice moldings
3. Hazard from fire shall be reduced by using fire-resistant materials.
4. Products shall have minimum fuel contribution and shall generate minimum products of combustion, consistent with code requirements
5. Floor materials shall have slip-resistant qualities.

B. Durability

1. Materials shall be specified that provide for long and economical service with wear, strength, and weathering qualities consistent with initial and replacement costs and their location.
2. Materials shall be colorfast and maintain their intended appearance throughout their useful life.
3. Materials shall be specified which have a life expectancy of at least 25 years and shall have a factory-installed finish. Materials requiring a field-app lied finish shall not be specified.

C. Weatherability

1. The materials employed shall be those which are normally considered suitable for outdoor use. The entire system, for practical purposes, shall be considered outdoor space.

D. Maintainability

1. Materials shall not soil or stain easily, shall have surfaces that are easy to clean in a single operation, and on which minor soiling is not apparent. Materials shall be cleanable with standard equipment and cleaning agents.
2. Materials that become damaged shall be of manufacture or construction such that they can be easily repaired or replaced without undue interference with bus operation.
3. Designer shall include in specifications a requirement for contractor to provide 1% to 5% additional tiles, glass blocks and other Site specific materials to be delivered to METRO for storage as spares for future use. The exact quantity shall be determined by the Consultant in cooperation with METRO's Facility Maintenance Division.

E. Resistance to Vandalism and Graffiti

1. Materials shall be chosen to discourage vandalism. Finish materials shall be vandal and graffiti resistant. These materials shall be difficult to deface, damage, or remove. All porous materials, such as exposed concrete, with potential for contact by the public shall be finished in such a manner that the results of casual vandalism can be readily removed with normal janitorial maintenance techniques. The Consultant shall describe procedures for the repair of more serious defacement for each finish used in public areas within eight (8) feet of height above the floor surface.

F. Aesthetic Qualities

1. Materials shall be chosen to create a feeling of warmth and quality, to minimize fear and opportunity for crime and to instill civic pride in the facility.

G. Sustainability

1. Where feasible and economically viable, building materials, composed of renewable resources which meet the following criteria, shall be used:
   a. Recycled Content: Products with identifiable recycled content, including postindustrial content, with a preference for post-consumer content.
   b. Natural, plentiful or renewable: Materials harvested from sustainably managed sources and preferably having an independent certification (e.g., certified wood) and are certified by an independent third party.
   c. Resource-efficient manufacturing process: Products manufactured with resource-efficient processes, including reducing energy consumption, minimizing waste (recycled, recyclable and/or source-reduced product packaging) and reducing greenhouse gases.
   d. Locally available: Building materials, components, and systems found locally or regionally, saving energy and resources in transportation to the project site.
   e. Salvaged, refurbished, or re-manufactured: Includes saving a material from disposal and renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product.
   f. Reusable or recyclable: Select materials that can be easily dismantled and reused or recycled at the end of their useful life.
   g. Recycled or recyclable product packaging: Products enclosed in recycled content or recyclable packaging.
   h. Durable: Materials that are longer-lasting or are comparable to conventional products with long-life expectancies.

5.10.3 Finish Qualities

A. Surface

1. Hard, dense, non-porous, non-staining, acid, and alkali-resistant surfaces shall be provided for long life and low maintenance. Surfaces up to eight (8) feet above the finished floor shall be more resistant to damage than that required for surfaces above that point.

B. Color

1. Tard, dense, non-porous, non-staining, acid, and alkali-resistant surfaces shall be provided for long life and low maintenance. Surfaces up to eight (8) feet above the finished floor shall be more resistant to damage than that required for surfaces above that point.

C. Texture

1. Rough surfaces shall be provided where a non-slip feature is important and are acceptable where surfaces may absorb dust without its being apparent, thereby minimizing the need for frequent cleaning.

D. Unit Size

1. Unit size shall be large enough to reduce the number of joints, yet small enough to conceal minor soiling and scratches and to facilitate replacement if damaged. Monolithic materials may be used if they have inherent soil hiding characteristics and can be easily repaired without the repair being readily noticeable.

E. Joints

1. Required joints shall be small, flush, limited in number, and of the best possible materials within the cost constraints of the project. Horizontal joints in walls shall not be raked but shall be flush. All materials shall have adequate control and expansion joints at the proper spacing to prevent surface cracking.

2. Joints in floor surface materials (such as concrete pavers) shall be made level and joints in continuous floor surfaces (such as patterned concrete) shall be only as deep as needed to define the proposed pattern.

F. Life Cycle Cost

1. Life cycle cost shall be considered in all material selections. Custom or special designs, patterns, or colors, available only at a cost premium, shall not be used. These factors, along with overall aesthetic and functional qualities, shall be considered in order to design the facility within its budget.

G. Availability

1. The various elements shall be designed in sufficient quantity and in standard sizes such that their delivery, availability, and installation will not involve cost penalties or delays for either materials or labor.

H. Proprietary Materials

1. In order to obtain competitive bids and comply with federal regulations, proprietary items shall be specified only where it has been established that no other materials exist that would meet the design requirements and only then with the prior approval of METRO.

I. Installation Standards

1. Materials shall be detailed and specified to be installed in accordance with industry standards and manufacturers' printed directions for long-life, low maintenance installations. The Consultant is responsible for the physical and chemical compatibility of the specified materials that are to be placed in contact with each other.

II. Testing

1. Approved materials listed in this criteria, shall be subjected to standardized tests by a qualified testing laboratory, for the purpose of comparing the relative merits of different materials and of similar materials produced by different manufacturers. Testing shall be accomplished prior to the completion of Final Design Drawings. Manufacturers conducting independent tests shall abide by standard methods adopted by METRO.
2. Testing information shall include the following:
   a. Composition and manufacturing process
   b. Installation procedure and specification
   c. Dimensions and tolerances
   d. Color and texture range (actual samples)
   e. Maintenance requirements.

5.10.4 Finish Materials for Bus Loading/Unloading Platform Area

A. Platform Materials

1. Concrete as-cast, sealed.
2. Full depth colored concrete, sealed.
3. Stamped pattern, full depth colored concrete, sealed. Utilize around the platform perimeter to meet ADA code requirements.
4. Exposed aggregate concrete, sealed.
5. Concrete paver brick (dense, hard), sealed and shall be placed in a mortar bed to prevent displacement. All edges shall be confined to prevent loosening of paver brick.

B. Canopy Column Materials

1. Form-liner textured concrete.
2. Sandblasted concrete.
3. Bush hammered concrete.
4. Saw grooved concrete (sufficient surface texture to conceal minor soiling and damage without complicating maintenance procedures or constituting a hazard to clothing or skin of patrons).
5. Exposed aggregate concrete.
6. Structural steel, painted finish.

C. Canopy Soffit Materials

1. Preformed Metal Interlocking Panels.
2. Concrete (finish-rubbed, sandblasted, and painted).

D. Skylight Materials (limited applications)

1. Frames
   a. Stainless steel.
   b. Anodized aluminum.
2. Glazing
   a. Tempered plate glass, solar-tinted.
   b. Laminated safety glass, solar-tinted.
   c. Acrylic, solar-tinted.
   d. Polycarbonate plastic, solar-tinted.

DI. Canopy Structure Material

1. Painted galvanized structural steel.
2. Space frame systems, painted.

DII. Canopy Roof Material

1. Standing seam metal interlocking panels
2. Architectural fabric (METRO written approval required)

DIII. Bench Materials

1. Precast concrete
2. Steel wire frame

DIV. Wind Screen Materials

1. Glazed or decorative masonry units.
2. Brick
3. Solid glass block.
4. Stainless Steel frame.

DV. Railing Materials

1. Stainless steel
2. Painted galvanized steel

DVI. Supervisor Booth (if required)

1. Prefabricated booth

DVII. Observation Mezzanine (if required)

1. Prefabricated booth

DVIII. The Consultant shall select the finish materials from the list above with due consideration of the location and environment of the application.

M. The Consultant shall specify anti-graffiti coating on all expose aggregate concrete

5.10.5 Finish Materials for Utility Building

A. Exterior Wall Materials

1. Glazed concrete masonry units
2. Decorative concrete masonry units. Surface shall be seal ed as-is or painted with epoxy paint with epoxy block filler, along with topcoat of polyurethane-based paint.
3. Porcelain Enamel Panels

B. Roof Materials

1. Standing seam metal interlocking panels
2. 4-Ply, built-up roof system

C. Interior Floor Materials

1. Ceramic or quarry tile in toilet area
2. Monolithic concrete with hardened finish in electrical and SC&C areas

D. Interior Wall Materials

1. Electrical and SC&C room walls shall be concrete masonry units (CMU). CMU's shall be painted with acrylic latex paint with compatible block filler added to the paint.
2. Restroom walls shall be glazed or ceramic tile.

E. Ceilings

1. Restroom ceiling shall be water-resistant gypsum backing board with gloss acrylic latex paint.
2. Electrical and SC&C room ceilings shall be gypsum wallboard with acrylic latex paint.

F. Doors

1. Utility Building doors and frames shall be color-tinted fiberglass
2. Stainless steel flush hollow doors (limited use)

G. Builders Hardware

1. Builders hardware shall be US32D Stainless Steel, Dull Finish.

H. Hand Rails

1. Stainless steel.
2. Anodized aluminum

I. Plumbing

1. High-efficiency/Energy Star fixtures

J. HVAC

1. High-efficiency/Energy Star equipment

K. Electrical

1. High-efficiency/Energy Star fixtures

END OF SECTION 5.0

6.0 LANDSCAPING

6.1 INTRODUCTION

A. METRO's implementation of a capital improvement program and a regional transit system will have physical as well as visual impacts on the Houston environment. The actual planning and construction of transit facilities shall involve Licensed Landscape Architects. These professionals shall be an integral part of the design team.

B. Due to the scope of the system to be designed and the involvement of many team players, METRO is providing a set of guidelines for landscape design. These landscape design criteria shall provide a basic philosophy of landscape concepts that comply with the goals set by METRO. These goals are set so that the various landscape professionals involved will ensure METRO of a finished site quality and will produce a consistent landscape system that readily identifies the image METRO desires. Landscape Architects shall comply with these standards, City of Houston Tree and Shrub Ordinance and Americans with Disabilities Act (ADA).

C. It will be the Consultants responsibility to address the following landscape aspects of design:

1. Thorough understanding of the Site and an understanding of the relationship between landscape design, safety, and security.
2. Coordination of design with all project team members
3. Consideration of economy
4. Consideration of maintenance
5. Consideration of environmental sustainability

D. The Consultant shall follow the City of Houston ordinance on landscaping which includes a formula to determine the minimum requirements for landscaping the Site. The Consultant shall submit these calculations to METRO. The Consultant shall adhere to these requirements as close as possible. Variations will require written permission from METRO’s Project Manager.

6.2 GOALS AND OBJECTIVES

A. Landscape installations and plant spacing shall be designed to minimize maintenance and reduce water use. Limited plant varieties must be used to reduce maintenance requirements. Maintenance cycles must be compatible among plant material to reduce the number of required site visits as well as irrigation requirements.

B. Trees in lawn areas must not be grouped to impede mowing. Shrub masses must not act as a collector of trash.

C. Automatic irrigation systems shall be used. The scope of irrigation shall be related to the public exposure of each area of the project as well as the size of the project, whereby irrigation requirements may range from total irrigation to minimal irrigation. Since turf areas require the majority of water usage, designers shall consider native turf species that do not require irrigation. Turf species will need to be selected based up on local jurisdictional requirements.

D. Irrigation systems should utilize high-efficiency systems.

E. Landscape areas shall be limited with respect to the desired visibility impact. Areas which have a high exposure to the public such as a main entrance along a busy thoroughfare or a boarding area plaza where people gather, and queue shall receive more landscape emphasis than an area in which public contact or public visual exposure is minimal. The public shall be provided with a pleasing, comfortable environment in which they are safe and secure. Safe design recognizes the need for surveillance from one area of the site to another, and to and from the site. Limit landscaping within street Right -of-Ways to grass sod. Variations must be approved by METRO's Project Manager in writing.

F. The landscaping design shall be fully coordinated to meet the needs and objectives of METRO's Police Department. Landscaping shall be design ed in a way that will not cause sight obstruction or electronic interference to METRO's surveillance system.

G. Landscape installations shall minimize capital costs. Standard plant sizes shall be used to ensure that the minimum plant size is used to achieve the desired effect upon installation. Plants shall be readily available in sufficient quantities to produce a uniform planting. No special provisions by METRO shall be made to cultivate and/or store plant material prior to installation.

H. Types of trees, shrubs and ground cover shall be approved by METRO. METRO's approved plant material listed in Section 6.7 may be used as a guide. Selection of plant material shall be based upon hardiness, minimal maintenance, availability, water requirements and design character.

6.3 SITE ANALYSIS

A. The Landscape Architect shall send soil samples for analysis. Sampling and testing shall be in accordance with the current methods of the Association of Official Agricultural Chemists. If deficiencies in the soil are found because of an analysis, they shall be corrected in accordance with Landscape Architect's recommendations.

B. Due to Houston's high annual rainfall amount, drainage is a main concern to be addressed. Problem slopes and poor landscape surface drainage conditions shall be identified and corrected. Subsurface grading shall be provided in all shrub beds at a minimum of 3% slope. Walkways and plaza areas shall not retain water at any time. Drainage measures shall be coordinated with the other design team members.

C. The Landscape Architect s hall coordinate with other subconsultants the location of proposed utilities to minimize impacts on existing plant material during installation of utilities and proposed plant material for future maintenance of utilities. Limit landscaping in utility easements and properties to those species approved by the utility owner.

D. Landmark features of aesthetic and/or historical nature, which are located on-site or near the site, shall be identified. Off-site features of architectural significance shall also be noted with respect to views that shall be designated as part of the landscaping.

E. All existing site vegetation shall be assessed. A determination shall be made as to which plant material will be kept or transported on-site or to another location as approved by METRO. (See Section 6.4 - Tree Preservation)

F. The Landscape Architect shall consider bus, auto, and especially pedestrian circulation access to the site and circulation patterns within the site. Work shall be coordinated with others so as not to disrupt the efficient circulation of all users of the site. Work shall be coordinated with others so as not to disrupt the efficient circulation of all users of the site.

G. Land uses surrounding the site shall be identified with respect to impact on the final design. Certain areas will also affect the safety the public perceives and experiences about a site; therefore, the design shall address off-site safety influences. These influences in large part will determine whether screening is appropriate. Opportunities for surveillance are critical for safety.

H. Industrial areas, retail areas, residential areas, all require their own set of design requirements. Sensitivity to these requirements shall be reflected in the final plan.

I. Apply LEED principles for site and landscape designs.

6.4 TREE PRESERVATION

A. The Landscape Architect shall perform a tree survey of the Site and determine which trees and other valued plant types can be saved. Plant mate rial to be saved shall be disease free, require low maintenance and not restrict or impede the use of the Site. All selected trees shall be tagged with a 4" x 6" yellow numbered tag permanently attached to the tree. A drawing showing the saved plant material, location, name and tag number for a tree shall be submitted to METRO's Project Manager for review and approval. In addition to plant material on-site, plant material, mainly trees, located off-site whose branching or root systems protrude onto the site must be shown on the sketch.

B. METRO desires that whenever a parcel of land be purchased for a project, as much natural vegetation as possible shall be saved. All undisturbed natural areas shall be identified graphically with a description of plant types and sizes in each area.

C. In some instances, trees of merit will exist in areas that must be developed. On-site trees of desired quality should be relocated if it is economically feasible to do so. All conflicts shall be identified and coordinated between existing and proposed utilities before relocating trees.

D. Guidelines for the protection of trees during design and construction phases shall be provided. These guidelines shall meet METRO standards:

1. The Landscape Architect shall insure that the natural grade for existing vegetation is maintained. In cases where grading requirements require raisin g or lowering the grade, mitigation measures shall be developed by designer and approved by METRO.
2. A system of barricades around trees to prevent damage during construction shall be provided. Barricades shall be located on drawings. It must be impressed upon all design/construction team members that no one is to penetrate these barricades for any reason and noted on drawings.
3. In some cases, the preservation technique standards may not be possible to meet. Many times, a specimen plant such as a 36-inch caliper oak tree will exist in an area where development is necessary. If the tree can be saved, tree mitigation methods shall be developed and approved by METRO. Efforts such as root pruning, top pruning, deep watering, and feeding must be performed prior to initial site development and construction. Timing must be reflected in the construction contract. In the event the tree does not live, the design must accommodate the planting of a replacement.
4. Trenching operations shall not impair the health of trees. Trenching which may damage roots shall be accomplished with special provisions to minimize damage. Any damaged roots shall be treated immediately. Mechanical trenching devices for piping installation may be us ed in landscape areas where no obstructions such as tree roots or utilities exist. Sensitive areas containing roots or buried cables will require other construction methods, such as hand digging or boring. Avoid locating pipe across root systems. Instead, show piping to run radially from at minimum the drip line towards the tree's center and stopping before branching of the tree’s roots from trunk to minimize the number of roots cut.

E. The Landscape Architect shall suggest replacement criteria based upon size and quality of tree removed, with METRO approval. Quality trees shall be those associated with hardwoods such as the oak family. Each tree to be removed shall be judged in regard to aspects of quality, health, size and aesthetics. Tree replacements shall be based on the City of Houston's Tree & Shrub Ordinance.

6.5 LANDSCAPE CONCEPTS

A. To produce a system of landscaping that is economical and low maintenance oriented.

B. Design shall be complimentary and compatible with the following on-site features:

1. The security and operation of gates shall not be impeded by any landscaping. When pedestrian access is separated from the main entrance, a pedestrian gate in the fence must be provided. Maintain 24" between plant material and gate to ease operation.
2. The landscaping and planting shall be designed in a way that does not obstruct the view from the security cameras. Further consideration shall be given in the selection of plants to minimize the impact of obstruction by growing plants. Additional annual maintenance recommendations shall be included to avoid such situation.
3. Areas around lights shall not contain tall or columnar plant material, which will obstruct lighting.

4. If bollards are used, as pre-approved by METRO, for lighting or as a barricade, the Landscaping should reinforce their use, such as shrub masses to block access.
5. If planter walls are used as pre-approved by METRO, they shall be compatible with circulation patterns as well as with the architectural materials used in the site.
6. Security shall be addressed in the arrangement of plant material. Plant materials shall not block security sight-lines from the observation mezzanine if used on site. Guard should be able to observe the bus loading/unloading platform, utility building, bicycle racks and main pedestrian walkways.
7. All passenger vehicle and pedestrian sight-lines shall be clear of any obstruction to provide safety at intersections and crosswalks. Plant material taller than 30" above the curb shall not be planted inside a triangle with two entry curbsides being 25 feet. Bus driver views shall not be impeded too.
8. Plant material shall not intrude into platform canopy to prevent injury or damage due to falling limbs in windstorms. Maintain sufficient distance between trees and the canopy to prevent interference and damage from movement of the limbs against the canopy.
9. Tree varieties shall be selected that allow them to be maintained to a minimum of 12 feet from running surface to the bottom of the tree's canopy to allow for bus clearance.
10. A landscape buffer of at least 10 feet shall be provided between fences and parking lots, or other features. A concrete maintenance strip of at least one-foot with the fence centered on this must be included in the design in all turf areas.
11. Maintain low planting around all signs and pylon so that the view is not obstructed in any direction. Coordinate with Traffic Engineer.
12. Low public exposure areas shall receive minimal landscaping.
13. Apply sustainability principles per LEED.

C. Plant material to be used shall consist of the following:

1. Trees should provide 6'-0" vertical clearance to branching structure of tree for pedestrians' clearance. Broad leaf trees shall not be used near drains to prevent leaves from clogging the drainage system. Pine trees shall not be used near paving since pine straw is difficult to lift from concrete.
2. Shrubs should be planted in -groups within shrub beds and used for ground cover. Provide dimensions of bed widths. Do not show individual shrubs in turf.
3. Grass areas near the bus platform should be solid sod. Large expanses of low public exposure areas should be hydro-mulched-seeded. All curbs or concrete surfaces that have water draining upon them from hydro-mulched areas shall be planted with a solid sod strip of at least 3-foot width to prevent sedimentation of pavement. (See Section 6.6 C)

CI. The Landscape Architect is responsible for coordinating pedestrian circulation with all project team members. All site circulation shall be integrated with the parking lot and the boarding platform.

6.6 LANDSCAPE GRADING AND DRAINAGE

A. The Landscape Architect shall coordinate contours in all landscape areas with the design engineer and show all high and low point elevations with arrows indicating grading. Designers are strongly encouraged to show contours to help illustrate proposed landscape grading.

B. In cases where grading must be done to achieve aesthetics or proper surface drainage, cut and fill shall be kept to a minimum. Cut and fill shall be balanced as closely as possible to minimize the purchase of fill dirt and the removal of excess soil. Soil excavated from on-site parking lot grading or other on-site grading may be utilize d for the sub-grading of landscape berms. (See Section 6.6 I for berm information.)

C. In order to maintain a clean image and neat appearance, erosion problems shall be eliminated. Site edges shall be maintained with no sedimentation from runoff accumulating at curbs and sidewalks. Erosion control measures shall be employed during the construction phases as well as in the ongoing operation of the finished site. All slopes shall be contoured to be easily maintained with respect to mowing and mulch retention. Mulch on a steep slope will be a constant maintenance problem due to washout. Turf areas bordering curb line and paved areas shall receive special considerations to prevent wash out after construction.

D. The use of retaining walls for purely aesthetic purposes shall be discouraged and must receive METRO prior approval if used. Retaining walls shall be avoided if possible, grading can be achieved by contouring the land. Any use of retaining walls will require logical justification to METRO. Details and sketches must be provided when retaining walls are required. Construction materials must be compatible with other architectural features on-site. Placement of retaining wall and subsequent grading shall be coordinated with all other design elements of the site.

E. Gradients in Houston can present big problems in the landscape due to the relative flatness of most sites in Houston. Use cut from other areas of the site to achieve positive drainage through the landscape.

F. On-site landscape drainage shall be handled by swales instead of subsurface drainage or ditches. Swales are more desirable in the landscape due to the cost involved in constructing a concrete ditch or installing piping to control water runoff. Swales must be designed to be unobtrusive and gentle while allowing for positive drainage. Severely engineered swales are difficult to mow and shall be avoided. Concrete linings for swales shall be avoided. Positive drainage shall be achieved using grass areas or other planted surfaces.

G. Conditions in which the use of swales is not sufficient to produce adequate drainage require logical justification to METRO. The use of subsurface drainage to correct insufficient surface drainage shall be justified by the Landscape Architect. Coordination with the Civil Engineers shall be the responsibility of the Landscape Architect. Where possible, swales should drain to existing drainage systems.

H. In order to alleviate problems due to ponding, slopes shall not fall below the minimal standards for the following surfaces:

1. Grass Lawn - 2%
2. Shrub Beds - 3%

I. The Landscape Architect is encouraged to use berm like features to create interesting landscape topography where the area is large enough to accommodate them. Small hump like berms are not accept able. On-site fill should be utilized to minimize the cost of this sitework and trucking in additional soil is not acceptable unless pre-approved by METRO. Berm design must consider both height and relative orientation and should allow opportunities for surveillance from both sides or along the length of the berm. In no instances can berms impair security about sightlines. Berms shall be designed to be gentle, flowing landscape features. Side slope s of berms shall not exceed 4 to 1. Berms, including plant mate rial, shall not exceed a height above the curb of 3 feet so as not to obstruct security sightlines. Shrub and groundcover shall not be planted on berms if the shrub or groundcover at maturity exceeds a height of 3 feet above the curb line. Planting on berms shall be carefully planned to insure that plant s capture water. Planting on steep slopes is discouraged since water tends to runoff of slopes without penetrating the soil.

J. The existence of detention ponds will be determined by other members of the design team and be coordinated with the landscape design. Detention ponds shall be designed to blend naturally with the landscape. A buffer landscape area of at least 10 feet must be provided between the parking lot and the detention pond. All grass detention ponds shall be solid sodded, the sod shall be staked in place and there shall be a concrete low flow channel. The design of detention ponds shall address the following considerations:

1. Safety
2. Slopes
3. Mud Problems
4. Drainage
5. Aesthetics

6.7 PLANT MATERIAL

A. Plant material used in METRO projects shall be of the hardiest quality available for use in the Houston area. The success of any project lies not only with the visual impact upon installation, but also with the continuous appearance in the ongoing operation of the site. Utilitarian plants should be utilized to achieve lo w maintenance as well as pleasing aesthetics. Drought-resistant as well as resistance to climate extremes of heat and cold is a definite requirement. Plant material with a moderate to fast growth rate is preferred since small size pl ants may be installed for economy. METRO projects shall not be an experimental laboratory for the introduction of new and untested plant material for use in the Houston area. This goal can be accomplished along with creative and appealing use of many plant varieties that thrive in Houston.

B. Some of the major conditions that plant material must satisfy are:

1. Resistant to disease
2. Pest free
3. Be typical of their species or variety
4. Have a normal well-developed branch structure with a vigorous root system
5. Be indigenous or naturalized to the Texas Gulf Coast Area
6. Be in accordance with CPTED guidelines.

C. Plant List (Also refer to City of Houston Tree and Shrub Ordinance.)

1. Trees

Bald Cypress	Redbud
Crepe Myrtle	River Birch
Cedar Elm	Shummard Oak Variety
Live Oak	Southern Red Oak
Magnolia	Sweet Gum
Mexican Plum	Sycamore
Pine	Water Oak and other Oak varieties

2. Shrubs

Cleyra	Nandina Varieties
Dwarf Crepemyrtle	Pittosporum Varieties
Glossy Abelia	Texas Mountain Laurel
Hawthorn Varieties	Texas Sage
Holly Varieties	Waxleaf Ligustrum
Juniper Varieties	Yaupon Varieties

3. Groundcover (limited to pre-approved locations)

Liriope Varieties	Juniper Varieties
Asian Jasmine	Native grass varieties – encourage in turf areas to reduce mowing and irrigation

4. Small woody landscape plant acceptable in HL&P Transmission Right-of-Way.

Abelia	Yaupon
Bottlebrush	Ligustrum
Camellia	Privet
Silky Dogwood	Southern Wax Myrtle
Parsley Leaf Hawthorn	Trifoliate Orange
May Haw	Purple Leaf Plum
Texas Hawthorn	Common Cherry Laurel
Loquat	Fragrant Sumac
Deciduous Holly	Shining Sumac

D. Plant sizes and forms shall comply with standards set by Texas Association of Nurserymen, Grades and Standards, 1976 or latest edition. Selections of plant material must provide for the minimum size plant to achieve the desired effect upon installation. Such selections shall be made to minimize capital costs.

E. All plant material shall be correctly identified as to quantity, name (common and botanical), size, spacing, and whether or not specimen or standard on the landscape plans in plant list form. Designer shall note on drawings that contractor is responsible for providing the quantity that is largest number between quantity shown on plant list versus those needed to achieve correct spacing.

6.8 PLANT DETAILS AND SPECIFICATIONS

A. Spacings shall be specified to ensure a fairly established look upon installation.

B. Due to Houston's soil conditions, the proper construction of tree wells is essential to the survival of new trees. Tree wells shall have proper irrigation and drainage. If the tree well is surrounded by concrete, adjacent concrete shall be designed to support itself above planting soil. A soil separator and gravel aeration piping s hall be used between concrete and planting soil.

C. Minimize landscape areas on the plaza. Tree grates, as a solution to planting trees within a plaza is not acceptable. Room shall be allocated for trees to be grouped in shrub or turf areas within a plaza.

D. The Landscape Architect is responsible for proper drainage in landscape areas including plant containers. Coordination of all landscape drainage requirements with Civil Engineers shall be the responsibility of the Landscape Architect.

E. Installation requirements should be provided for the following:

1. Soil mixtures for tree and sh rub planting shall be specified. All soil mixes must be approved by METRO.
2. Mulch shall be provided for trees, shrub beds, and groundcover beds. Mulch shall be specified and mulch selections must be approved by METRO.
3. Soil separator shall be used in planters with sealed bottoms and drainage equipment. Soil separator shall be approved by METRO.
4. Tree staking shall be done for all trees and tree form shrubs to ensure the correct posture. Staking must be as inconspicuous as possible in the landscape. Utilize METRO’s Standard Drawing for tree staking system.
5. Slope planting shall be such that erosion is controlled. Erosion cloth must be used on steep slopes (greater than 4:1) planted with groundcover or shrubs.
6. Planters, particularly movable plant containers, shall be avoided; however, in some cases where the landscape area may be minimal, planters may be used to add plant material that will s often the architectural impact of broad paved areas with METRO approval. Planters shall contain proper irrigation and drainage with soil separator and gravel. Soil mixes shall comply with soil mix standards. Plant containers recommended shall be vandal resistant. Water from plant containers shall not be allowed to seep onto any paved pedestrian areas. The designer shall refrain from using planters on the platforms.

7. Fertilizer shall be used to encourage plant material to survive the initial shock of installation and to encourage growth, fertilizer shall be used for all plant material with the installation. Proper fertilization can help to ensure the vitality and growth of plant material with minimal plant loss. Commercial fertilizers hall be a complete fertilizer for groundcover, shrubs, and trees. Consider the manufacturer's directions and specifications as part of these guidelines.

6.9 IRRIGATION

A. Irrigation in the landscape has a direct relationship to the visual exposure of the area to be landscaped. The Design shall concentrate landscaping to lessen the requirements of irrigation. No irrigation lines shall be laid outside of METRO property. The Consultant shall provide dimensions to underground irrigation lines on the irrigation plans.

B. The Consultant shall physically check the available water pressure at the site and provide METRO with this information. Civil Engineer to provide water main tap and valve/meter box location. Two meters shall be provided, one meter shall be labeled, “Irrigation Only”.

C. Shrub masses shall be limited and grouped with considerations of irrigation economy and reduced maintenance requirements. Irrigation system shall be designed such that trees, planters and shrub areas are drip-irrigated, by separate stations from turf stations, so that lawn watering can be eliminated 4 to 5 years after the Project has been completed.

D. The irrigation system shall be designed to operate and to complete all cycles during hours the site is least busy (10:30 PM to 5: 00 AM). The system shall also have cut-off valves for each zone so irrigation can operate without a zone.

E. Consultant shall provide METRO’s Project Manager with a watering schedule for each station for year 1 through year 10.

F. Ponding from landscape irrigation in paved pedestrian areas shall not be allowed. Sprinkler systems shall be designed so as not to cause drainage problems in the landscape. Avoid overspraying.

G. Provide backflow preventer devices per building code of agency having jurisdiction over Site. Locate backflow preventer in an unobtrusive location near the water meter vault.

H. Sprinkler heads shall be durable and located so that they are not disturbed by maintenance or pedestrians. Maintain at least (6) six inches behind back of curb.

I. All irrigation piping underneath paved areas shall be encased and adequately protected. Above ground piping shall receive protection and be unobtrusive to prevent vandalism and to ease maintenance repairs. A complete plan for sleeving under the paved areas will be coordinated with the Civil Engineer and made part of paving layout with cross-references to irrigation plans. The design shall specify and coordinate all piping protection measures. Maximum depth of irrigation main shall be 3 feet.

J. Controllers shall be a digital type with a device capable of shutting the irrigation system off when appreciable amounts of rainfall have been detected. Controllers shall be located on the outside, back wall. Automatic systems must have the ability to be operated manually without disrupting the automatic cycle. Irrigation systems must be designed for a minimum number of stations for economy yet providing optimum water pressure for each station served by the controller. In addition, each system shall be designed with a master control valve.

K. Hydrants shall be provided on the platform and shall be located approximately 50 feet apart in lockable receptacles mounted flush with the platform floor. All planters located at the ends of the bus platform shall have quick disconnects located within them. Provide 3/4-inch Type ‘K’ copper in 2-inch Schedule 40 PVC sleeve under the platform. From the edge of platform to irrigation main, use schedule 40 PVC.

L. Utilize high-efficiency irrigation system.

6.10 MAINTENANCE

A. So that METRO facilities will remain economical to maintain during the ongoing operation of the site, the landscape design shall encompass low maintenance features. The Landscape Architect shall be responsible for setting up a landscape program for maintenance with the following issues addressed:

1. Water/Irrigation Monitoring
2. Fertilizer
3. Pruning/Sucker Growth
4. Staking
5. Pest Control/Insecticides
6. Disease Control, Chemical Applications
7. Edging
8. Mowing
9. Litter Pickup

B. A maintenance schedule with manpower estimates based on the final landscape plan s shall be provided to METRO’s Project Manager.

C. The Consultant shall specify that the Contractor shall be given one (1) year from the date of Substantial Completion to fully establish and guarantee the continued healthy condition of plant material, which is the key to a successful project. In keeping with this objective, METRO demands a program of replacement of unhealthy and dead plant material.

END OF SECTION 6.0

7.0 MECHANICAL

7.1 GENERAL

A. This section describes the basic minimum design criteria for heating, ventilating, air conditioning, water, sanitary sewer and storm water drainage systems for METRO Park & Ride and Transit Center facilities.

B. Provide temperature and ventilation to achieve a physical environment to METRO employees for comfort with a minimum initial cost and subsequent maintenance costs.

C. Provide necessary conditions of environment as required for the proper operation of facilities.

D. Provide optimum size water-meter for potable and irrigation services.

E. Provide safe, economical, maintainable, reliable and adequate features for the plumbing system, including the storm and sanitary sewer systems.

F. Prior to the commencement of detail design of the water and sanitary sewer system for the facility, the Consultant shall submit the following to METRO for review and approval:

1. Complete analysis of the plumbing requirements for the facility.
2. Water and sanitary sewer rate schedules for the agency providing the water and sanitary sewer services.

G. All plumbing fixture locations shall meet or exceed Americans with Disabilities Act code requirements.

H. Use high-efficiency/Energy Star fixtures.

7.2 ENVIRONMENTAL REQUIREMENTS

A. HVAC systems shall be provided for the entire utility building, the observation mezzanine and the supervisors' booth.

B. Provide a ventilation fan in the restroom. Fan shall be wired into the light switch.

7.2.1 Design Parameters - Ambient Conditions

Summer Outside Peak Design Conditions

1. Dry Bulb Temperature. (Based on ASHRAE 2½% frequency of occurrence)	95 F
2. Wet Bulb Temperature.	77 F
Winter Outside Minimum Dry Bulb Temperature	20 F

7.2.2 Ancillary Space Design Conditions (See Table 7.1)

7.2.3 HVAC Calculations

A. HVAC calculations shall be in accordance with the requirements of ASHRAE (fundamentals volume) latest edition. Calculations shall consider optimizing energy consumption through orientation, amount of glass, insulation, and any other available means.

7.3 PLUMBING SYSTEMS

A. Each facility shall be served with a water main sized for the total plumbing fixture and irrigation demands. In a typical Park & Ride or Transit Center facility the water demand for landscape irrigation far exceeds other plumbing demands within the facility.

B. Separate water meters shall be installed for the potable and irrigation systems. Many water supply authorities will allow a smaller meter than the line itself. Consultant shall verify and design the systems accordingly. Main shut-off valve, water meters, isolation valves, back flow preventors (per local code) and fittings shall be placed in concrete handhole with steel access panel s at ground level. If possible, handhole shall be located within the street right-of-way, if not provide water line easement for meter handhole. Work is to conform to water supply authority requirements.

C. Provide wall hydrants on the passenger platform (see Section 6.9 K).

7.3.1 Cold Water System

A. The Consultant shall ensure that water service provided will have sufficient pressure to operate the plumbing fixtures within the utility building.

B. Isolation valves shall be provided in each major branch line to facilitate maintenance in individual areas without losing service for the entire facility.

C. Any pipes subject to freezing shall be provided with adequate means for freeze protection.

7.3.2 Hot Water Systems

A. The restroom in the facility shall utilize “instant hot” hot water heaters, hot water distribution piping and piping accessories. All hot water piping shall be a minimum pipe size of 3/4". All piping shall be arranged in a systematic manner, with provisions made for thermal expansion and drainage. All hot water pipes shall be insulated.

B. Isolation valves shall be provided for all branches to facilitate maintenance.

C. Analyze potential of using solar hot water systems.

7.3.3 Soil, Waste and Vent Systems

A. Soil, waste, and vent systems shall include all piping and venting not subject to water containing oil or grease connected to the sanitary sewer system of the authority providing the service.

B. All soil, waste and vent pipes shall be sized for fixture demand as required by applicable plumbing codes and ordinances, to the first manhole outside the utility building.

C. Soil drainage pipes will be pitched at 1/4 inch per foot whenever possible but not less than applicable code requirements.

D. All horizontal vent pipes will be kept as short as possible, pitched 1/4 inch per foot towards soil and waste pipes, then rising to the outside in the most direct way. Each vent riser will be properly flashed at the roof penetration and terminated by a vandal-proof vent cap.

E. All commodes shall be wall mounted.

F. The sanitary sewer line, manholes, clean-outs and slopes shall follow applicable building codes.

G. The sewer pipe shall be a minimum diameter of 6-inches from the first manhole (outside the utility building) to the sanitary sewer main of the authority providing the service.

H. The sewer line shall be schedule 40 PVC.

I. If proper slope cannot be maintained for gravity line, design a sanitary force main sized for fixture demand.

J. Provide notes to cover the testing and certification of the sanitary sewer system to comply with the City of Houston requirements or agency having jurisdiction over the area.

7.3.4 Roof/Canopy Drainage Systems

A. The roof/canopy drainage systems of this section are defined as all the piping and appurtenances from the roof to a point 5 feet outside the roofline of the canopy. Beyond that point, the storm drainage is part of the facility storm drainage system.

B. Design of the storm drainage system for the passenger shelter shall be based on a 10-minute duration and 9.36 inch/hour of water accumulation.

C. The storm water runoff from the platform shall drain to the facility storm drainage system.

D. Utility building roof drainage system shall be designed to divert storm water runoff away from doorways and pedestrian walkways.

E. Mechanical equipment drains will be connected by an air gap to the storm sewer system.

7.3.5 Plumbing Calculations

A. Consultant shall provide calculations for plumbing systems to comply with latest applicable codes and standards.

7.4 FIRE AND LIFE PROTECTION SYSTEMS

A. All fire protection equipment shall be METRO approved, including but not limited to piping, mechanically grooved couplings, fittings, sprinklers, valves, alarm panels and components, etc.

B. Mechanical/HVAC Equipment/Utility and Equipment Rooms are considered a Hazard 2.

C. Electrical Rooms/Switchgear Rooms: Are not required to have fire protection systems if:

1. The electrical rooms are provided with a 2-hr fire rated enclosure
2. METRO approved Monitored Heat/Smoke Detection is provided
3. All wall penetrations are properly sealed with fire-rated material
4. The area is kept free of combustibles, and housekeeping polices must be in effect.

TABLE 7.1

HEATING AND COOLING REQUIREMENTS

	INDOOR PEAK DESIGN CONDITIONS WITH SYSTEMS ENERGIZED			MINIMUM AIR CHANGES				
SPACE	WINTER	SUMMER		SPACE PRESSURE	CIRCULATE	OUTSIDE AIR	VENT TYPE	HEAT TYPE
	F	FDB	%RH					
Surveillance, Communication and Control	65	76	50	P	85%	15%	S&R	Note C, 1
Observation Mezzanine	70	76	50	P	85%	15%	S&R	Note C, 1 & 2
Supervisors Booth	70	76	50	P	85%	15%	S&R	Note C, 1 & 2
Restroom	65	76	50	P	85%	15%	S&R	Note C, 1
Electric Room	60	76	50	P	85%	15%	S&R	Note C, 1

NOTES:

A. Space Pressure: N = Slightly Negative, P = Slightly Positive
B. Vent Type: S = Supply, E = Exhaust, R = Return

C. Heat Type

1. Electric heat coil in A.H. unit
2. Electric wall convector or unit heater.

END OF SECTION 7.0

8.0 ELECTRICAL

8.1 GENERAL

A. These criteria describe the design requirements for electric power, lighting, controls, lightning protection, telephone, and surveillance, communication and control (SC&C).

B. The design shall accomplish the following:

1. Provide for safe, economical and reliable operation.
2. Promote uniformity and standardization in design and equipment.
3. Minimize maintenance.
4. Provide reasonable spare capacity.

C. The electrical system design shall comply with all applicable laws, rules, regulations and ordinances of Federal, State and local governmental agencies having jurisdiction including Americans with Disabilities Act (ADA) code

D. Service shall comply with electrical providers service standards requirements. Service outlet location and data statement shall be coordinated through METRO's Project Manager.

E. Incorporate applicable sustainability principles per LEED.

8.2 ELECTRICAL SERVICE

8.2.1 Voltage

A. Service voltage shall be 480Y/277 volts, 3-phase, 4-wire.

B. A generator transfer switch Nema 3R, 480V shall be included in the design.

8.2.2 Spare Capacity

A. Service conductors shall have a spare capacity of not less than 25% of the total connected load.

8.2.3 Load Analysis

A. A load analysis shall be provided including connected loads, spare loads, and available spare capacity based on the difference between service entrance conductors capacity and connected loads.

B. A one-line diagram shall be provided including main components of the electrical distribution system.

C. Estimated power requirements for t he observation mezzanine are 10,000 volt-amps at 120/240 volts, single-phase, 3-wire.

D. Estimated power requirements for the supervisors booth are 10,000 volt -amps at 120/240 volts, single-phase, 3-wire.

E. Estimated power requirement s for eac h electronic information display is 750 watts at 120/240 volts, single-phase, 3-wire.

8.3 ELECTRICAL SYSTEMS

8.3.1 Conductors

A. Conductors shall be of copper.

B. Conductor insulation for systems up to 480 volts shall be NEC Types THHN-THWN or XHHW for feeders and branch circuits, and Type XHHW for service entrance conductors.

8.3.2 Panelboards

A. All panelboards shall be provided with a minimum of 25% spare circuits. Size of panelboard feeders shall include estimated loads for spare circuits.

B. A150A, 120/240V, single-phase, four-wire, 60HZ, panelboard shall be installed in the SC&C room. Provide a minimum of 8 - 15A, double-pole circuit breakers; 4 - 15A, single-pole circuit breakers; 4 – 10A, single-pole circuit breakers; and 8 -20A single-pole circuit breakers. Also provide a surge protector for the main service. All power conduits shall be terminated in this panelboard where SC&C electric loads shall be connected. SC&C electric loads are cameras, Automated Barrier Gate Controls (ABGC), electronic information signs, displays, call boxes, and loads within the SC&C room.

C. A 100A, 120/240V, single-phase, three wire, 60HZ, panelboard shall be provided for both the supervisors booth and the observation mezzanine (when applicable).

8.3.3 Conduits

A. Wiring shall be in rigid metal conduit above ground and GRS PVC coated conduit underground. All above ground conduit shall be mounted as high as possible above finish floor elevation to prevent tampering or vandalism. All below ground conduits shall be marked with a warning tape located 1 foot above the conduit duct bank.

B. All spare conduit(s) pull rope(s) shall be labeled with a permanent metal tag at each end of the conduit, identifying the conduit number and termination points of said conduit. Each spare conduit(s) shall be capped or plugged. If junction boxes are required in conduit run, spare conduit(s) shall be plugged in each box.

C. Two 4-inch conduits shall be provided for the main power service. Conduits shall be run from electrical providers outlet lo cation to the service dis connect switch location on the outside of the back wall of the utility building. One of the 4-inch conduits shall be a spare.

D. All electrical distribution shall be distributed through conduit duct banks, encased with red concrete. Each conduit duct bank shall contain 25% spare conduits, with a minimum of one (1) spare conduit.

E. Provide one (1) 1 ½" spare electrical conduit in each of four (4) different columns of the passenger shelter. Conduits shall be stubbed-up at top of columns and in the electrical room of the utility building

8.3.4 Underfloor Duct System

A. Provide a 3-duct underfloor duct system at the passenger shelter floor. One duct will be for power, one for telephone, and one for electronic information. Provide three empty conduits from underfloor duct junction box to the Utility Building. Conduits shall be 1- 1/2-inch for power and 2-inc h each for telephone and electronic information. Conduits for SC&C equipment including power shall terminate in the SC&C room of the utility building.

8.3.5 Corrosion Prevention

A. Electrical design shall minimize corrosion. Contact between dissimilar materials shall be prevented. Disconnect switches, cabinets and panelboards installed outdoors shall be of stainless steel mounted on stainless steel brackets with stainless steel bolts and nuts.

8.3.6 Grounding

A. An equipment-grounding conductor sized in accordance with the NEC shall be provided in each feeder and branch circuit conduit. Electrical system neutrals, lighting fixtures, receptacles, metallic raceways, and equipment frames shall be grounded using the grounding conductor.

B. Provide a grounding conductor within the SC&C room for the telephone patch panel and SC&C equipment.

C. All chain link fences and gates shall be grounded to ground rods spaced not greater than 200 feet apart.

D. All light poles shall have a ground wire tied to a ground rod (see METRO's standard detail for light poles).

8.4 ELECTRICAL DISTRIBUTION

8.4.1 Observation Mezzanine

A. Electrical distribution shall be provided for lighting, AC/heater, wall-mounted heater, SC&C and receptacles. Provide NEMA junction box located under the observation mezzanines floor structure.

8.4.2 Supervisor Booth

A. Electrical distribution shall be provided for lighting, AC/heater and receptacles.

8.4.3 Utility Building

A. General

1. AC/heater shall be provided for the entire Utility Building. Electrical service shall be hardwired. The MEP Consultant shall determine the location and size of AC/Heater unit.

B. Outside

1. Lights shall be provided near each doorway and shall be activated by security photocell and time switch.
2. Provide an electronic lock with card reader at the restroom door. Controller to be located within the SC&C room adjacent to the telephone backboard. See specification 08710 for details.
3. Irrigation controller shall be located on the backside of the utility building. Controller to be hard-wired.

C. Restroom

1. Ceiling lights and exhaust fan shall be controlled by same sensory/timer switch located near door. Maximum time on timer shall be 30 minutes.
2. Electric hot water heater located under sink.
3. Hand dryer located near sink to be hardwired.
4. Two (2) GFI receptacles, one (1) near the door and the other near the sink.

D. Electrical Room

1. Ceiling lights should be controlled by switch located near door.
2. One (1) GFI receptacle located near the door and one (1) other receptacle for maintenance.

E. SC&C Room

1. Ceiling lights should be controlled by switch located near door.
2. One (1) GFI receptacle located near the door, two (2) receptacles located on either side of the telephone backboard, one (1) receptacle located near the electronic card reader (for restroom door), and one (1) additional receptacle for maintenance. All future outlets for SC&C equipment shall be installed with the SC&C equipment.

8.4.4 Bus Canopy/Platform

A. Receptacles

1. Provide GFIC, duplex, 120 volt, receptacles with weather resistant cover plates, for maintenance. Receptacles shall be located on top of columns or in columns at 8 feet above the finished floor elevation of the bus platform. Receptacles shall be spaced no more than 100 feet apart.

2. Provide four (4), GFIC, 120-volt, vertical flush mounted receptacles in tamper proof boxes for vending machines. Also provide one (1) 240 volt and one (1) 120-volt flush mounted receptacles in tamper proof boxes for concessions vendor. Architect to locate vending machines and concessions vendor on platform.

B. Lighting

1. Provide 1/3 of the canopy lights on separate circuit for security, with photocell, HOA switch and time switch. Photocell to be located under the canopy.
2. Provide 2/3 of the canopy lights on separate circuits from security circuit. Provide photocell, HOA switch and time switch.
3. Use high efficiency/Energy Star fixtures.

8.4.5 Parking Lot and Perimeter

A. Parking lot lights

1. Parking lot lights shall be designed so that a minimum of 1.0 foot-candles will be provided with any one circuit out.
2. Provide 1/3 of the parking lights on separate circuit for security, with photocell, HOA switch and time switch.

B. Pylon Lighting

1. Ground mounted lights shall be provided on all four sides of pylon. Lights are to be concrete-encased and should be located 3 inches above the final grade.

8.5 LIGHTING

8.5.1 Objective

A. Lighting shall be adequate to provide a sense of amenity, comfort, safety and security to patrons, safe movement of traffic, satisfactory vision for pedestrians and guidance for vehicles and pedestrians.

B. Entrances to facilities shall be illuminated for ready identification of the facility by providing a minimum of twice the minimum foot-candle level specified for the parking area, see Section 8.5.6 for illuminance levels.

C. Lighting shall illuminate signage for easy reading.

D. Spillage of light to areas adjacent to METRO facilities shall be prevented.

E. Use lighting products that produces white light, which aids in the recognition of persons and activity. In most cases, metal halide is desired but other types like fluorescent and LED may be considered as approved by METRO.

8.5.2 Calculations

A. Lighting calculations shall be in accordance with the requirements of the

Illumination Engineering Society of North America (IES) Lighting Handbooks (application and reference volumes) latest editions.

8.5.3 Printouts

A. Computer electronic printouts indicating illumination levels in maintained foot-candles, or its equivalent in initial foot-candles including light loss factors, shall be provided.

B. Provide METRO with electronic print outs, showing foot-candles levels, with different circuits out (see Section 8.5.8 Circuiting).

8.5.4 Luminaries

A. Luminaries shall be selected to enhance the appearance of the facility and shall harmonize with the architectural style of the facility.

B. All luminaries shall be made in the USA, with parts distribution outlets within 50 miles of Houston.

C. Luminaries for parking areas, drop-off areas, bus loops, ramps, entrances and exits shall be metal halide, 400W, 480V, mounted on poles.

D. Each luminary shall be protected by in-line fuses. In-line fuses shall be accessible by access panel, located at the base of each pole.

E. Luminaries in passenger shelters shall be commercial type, metal halide, 250W, 277V. Luminaries shall be mounted to prevent swaying due to wind.

F. Luminaries for pylon signs shall be pad mounted, 3 inches above ground, cast bronze with incandescent, spot krypton KR-38, 250W, 120V lamps.

G. Luminaries for low ground signs shall be incandescent or metal halide.

H. No landscape lighting shall be included in the facility.

8.5.5 Lighting Poles

A. Lighting poles shall be of steel, square non-tapered section and shall have a maximum length of 35 feet in par king areas; drop-off areas; ramps; entrances/ exits, and a maximum length of 20 feet in; bus loops; and within 35 feet radius of the passenger shelter.

B. Steel poles shall be hot-dip galvanized with no paint finish.

C. Elevation of each concrete base shall be indicated on the drawings. Concrete bases for lighting poles in parking lot or narrow landscaped areas, where subject to vehicle impacts, shall be 2 feet 6 inches above the pavement. Concrete bases for lighting poles in landscaped areas or where protected from vehicle impacts by curbs, shall be 3 inches above landscaped area.

D. Center of pole shall be located not less than 3 feet from back of curb.

E. Lighting poles shall be located using coordinates shown on the drawings and identified by numbering P1, P2.

F. All lighting poles shall have Kellems wire grips installed at the top of the poles to hold wiring to lamps.

G. All three (3) phase service to lights shall be color-coded; brown, purple and yellow, and continue to the light fixture.

H. Provide a minimum of 1-inch clear space between lighting pole base and concrete footing.

8.5.6 Illuminance

A. Calculated illuminances shall be as follows:

1. Maintained minimum at any point at the following areas:
   - a. Parking — 1.5 to 2.0 foot-candles
   - b. Drop-off — 3.0 to 4.0 foot-candles
   - c. Parking for Handicapped — 3.0 to 4.0 foot-candles
   - d. Entrances and Exits — 3.0 to 4.0 foot-candles
   - e. Bus Loops, Ramps & Access Roadways — 1.0 to 1.5 foot-candles
2. Average maintained:
   - a. Platform Shelter — 10.0 to 12.0 foot-candles
3. Light loss factors:
   - a. Metal Halide, 250w — 0.75
4. Uniformity: Illuminance values for all areas, except under the passenger canopy, shall not exceed the following ratios:
   - a. Average-to-Minimum — 2.5:1
   - b. Maximum-to-Minimum — 5:1
   - c. Average Deviation — 33% max

8.5.7 Controls

A. Parking area luminaries, (including drop-off, parking for handicapped, entrances and exits, bus loops, ramps, and access roadways) and pylon and low ground signs luminaries shall be turned on by a photocell and turned off by a time switch. Provide hand-off-auto selector switch to override system.

B. Pedestrian canopy luminaries shall be controlled independently of the parking area.

1. 2/3 of the luminaries shall be turned on by photocell, located under the pedestrian canopy and turned off by a hand-off-auto (HOA) selector switch or time switch.

2. 1/3 of the luminaries & the outside lights of the utility building shall be controlled by the photocell only (label ed Security). Provide HOA selector switch to override system.

C. Time switches shall be intermatic, electronic, programmable, full-year, 2 channel type.

8.5.8 Circuiting

A. Passenger canopy luminaries shall be connected to a minimum of three circuits in order to provide for partial, uniform illumination if one circuit fails.

B. Pole-mounted luminaries shall be circuited such that if a circuit fails the entire area will still have a minimum of 0.5 foot-candles of illumination .

8.6 LIGHTING PROTECTION

A. A passenger shelter lightning protection system shall be provide d in accordance with NFPA 78, LPI and UL-96A.

B. Air terminals shall be solid copper, except where in contact with aluminum roofing or galvanized steel then they shall be aluminum, nickel-tipped, minimum ½” diameter & 18” long.

C. Roof conductors shall be bare stranded copper except on aluminum roofs or in contact with galvanized steel where roof conductor shall be of aluminum. Roof conductor size shall indicate number and size of strands, weight per length and cross-sectional area.

D. Down conductors shall be No. 2/0 AWG copper in 1-inch PVC conduit embedded in concrete columns. Down conductors shall be connected to the reinforcing steel member at its upper and lower extremities and to the grounding loop conductor by exothermic welding covered with waterproof coating.

E. Ground loop shall be No. 2/0 AWG copper stranded conductor installed 2 feet beyond the passenger canopy and 2 feet below grade.

F. A minimum of two test wells evenly spaced shall be provided along the ground loop.

G. Roof penetrations for lightning rods shall be coordinated with roofing manufacturer.

H. Design for Construction Contractor to provide METRO with UL Master Label.

8.7 TELEPHONE SYSTEM

8.7.1 Requirements

A. The telephone company providing service will install all wiring, patch-panel and pay telephones.

B. Consultant shall design conduit system along with panel backboard to serve METRO’s telephone requirements and shall comply with the telephone companies design requirements.

C. Service location and data statement shall be coordinated through METRO's Project Manager.

D. Park and Ride and Transit Center facilities require phones in the supervisor booth, observation mezzanine, SC&C room and public phone(s) located on the bus platform.

E. All conduits shall have pull ropes. Pull ropes shall be labeled with a permanent metal tag at each end of conduit, identifying the conduit number and termination points of said conduit.

F. All spare conduits that stub up shall be capped. All spare conduits in handholes or manholes shall be plugged. Conduits for telephone company installation shall be taped closed to prevent foreign objects from getting into conduits.

8.7.2 Service

A. Two 2-inch conduits shall be provided from the telephone service location to the telephone patch panel backboard. One of the 2-inch conduits shall be a spare. Conduits shall be located 6-inches off the wall directly below the backboard and stubbed up 6-inches above finish floor. Conduits shall be encased in cement stabilized sand. Both conduits shall have pull ropes installed with the spare conduit being capped off at both ends.

B. Patch panel backboard shall be located in the SC&C room of the utility building. Backboard shall be constructed out of 4’ x4’x3/4” plywood, painted and attached to wall.

C. Grounding provisions shall be provided at the backboard.

8.7.3 Utilization

A. Two 1-inch conduits from the telephone backboard, stubbed up at all telephone locations. One of the 1-inch conduits shall be a spare.

B. Two 1-inch conduits from the telephone backboard, stubbed up at the top of a canopy column for future use.

C. For public telephone information, see Section 5.5.2.

D. One 1-inch conduits from the SC&C electric panel shall be provided to all pay telephones located on the platform for telephone lights.

8.8 SURVEILLANCE, COMMUNICATIONS AND CONTROL (SC&C)

8.8.1 General

A. These criteria describe the design requirements for empty conduits and underfloor duct for future installation of equipment and wiring for SC&C which consists of Electronic Information Systems (EIS), Closed Circuit Television (CCTV), Fiber Optics Interface, and Automated Barrier Gate Control (ABGC).

B. Coordinate location of conduits and under-floor ducts with METRO. When ties to TxDOT fiber optic backbone are required, METRO tie will need to be coordinated with TxDOT.

C. Signal and Power wiring shall be installed in separate conduits, under-floor boxes and pull boxes. Individual conduit or under-floor duct shall carry signal wiring for one signal system only. Signal conduits for more than one system may share the same pull box. Signal and Power conduits shall be encased in cement stabilized sand with a minimum separation of 6 inches.

D. Conduit runs should be made as direct as possible. Conduit runs should be designed for pulling tension of 600 pounds for fiber optic cable. When required, junction boxes shall be used. Junction boxes shall be provided at all gate and camera locations both present and future locations. Maximize radius where possible. Minimum radius shall be 18 inches unless approved in writing by METRO.

E. Future camera’s, automated barrier gate controls, call boxes and other SC&C devices requiring electrical distribution shall be determined by the SC&C Consultant. Group all electrical conduits into duct banks as much as possible. Provide separation between electrical and communication/video cabling. SC&C electrical conduits shall be located below the electrical panels located within the SC&C room. Communication/video cabling conduits to be stubbed up in the SC&C room located under SC&C backboard.

1. The number of cameras and locations are to be determined by the SC&C Consultant.
2. At each gate location, provide conduits for future call boxes inside and outside the fenced area. The exact lo cation and style are to be determined by the SC&C Consultant.
3. SC&C Consultant to identify any additional power distribution needs.

F. All SC&C conduits s hall be encased in cement stabilized sand. Each conduit duct bank shall contain 25% spare conduits, with a minimum of one (1) spare conduit.

8.8.2 Electronic Information System (EIS)

A. Generally there will be one kiosk for every two bus bays. Provide 1-1/2 inch conduits for power and 2-inch conduits for signal from the SC&C room of the Utility Building to the passenger shelter as follows:

1. Where locations of electronic information kiosks are known, provide one

conduit for power and one for signal at each kiosk location. Conduits shall be terminated in threaded plugged conduit flush with finished floor.

2. Where locations of electronic information kiosks are not known, provide one under-floor duct for power and one for signal at locations determined by METRO. Provide power and signal conduits to under-floor ducts.
3. Provide one power conduit and one-signal conduit stubbed-up 3 inches from the top of each of two columns located at approximately on e-third the length of the shelter from each end.

8.8.3 Closed Circuit Television (CCTV) Cameras

A. For future installation of CCTV cameras under the pedestrian canopy, provide from the SC&C room one 1- 1 ½" power conduit and one 1 ½" signal conduit stubbed-up 3 inches above the top of two columns located at two opposite corners of the platform. Where platforms have more than five (5) bays on one side, provide an additional power and an additional signal conduit to the top of a column located near the middle of the platform. Provide a weatherproof junction box at the end of each power conduit. Provide a separate circuit for each CCTV camera location. Load will not exceed 100 watts per location. Minimum conduit bend radius shall be 36 inches, with a maximum of 180 degrees total bends between junction boxes.

B. For future installation of CCTV pole mounted cameras in the parking lot area, provide one 2-inch power conduit and one 2-inch signal conduit from the SC&C room to each location. Conduits shall terminate in pull boxes located within 5-feet of the camera pole location. Coordinate with METRO locations of future CCTV camera poles and conduit runs. Mini mum conduit bend radius s hall be 36 inches, with a maxim um of 180 degrees total bends between junction boxes. Provide for an electrical circuit for each camera location.

8.8.4 Fiber Optics Interface

A. Generally METRO's facility will be tied to TranStar via fiber optics. Most Park & Ride facilities are located along TxDOT's right-of-way (ROW) and will utilize TxDOT's fiber optic cable. Other facilities will utilize either RCTSS fiber or leased fiber generally accessible at nearby street ROW. METRO shall review each facility on a case-by-case study, to determine the use of TxDOT or RCTSS fiber, and will coordinate with TxDOT or RCTSS for use of that fiber.

B. For facilities located adjacent to the TxDOT ROW, provide two (2) 4-inch conduits with inner ducts from the SC&C room to TxDOT's hub building located in TxDOT's ROW or terminate at the property line. All other facilities not adjacent to TxDOT ROW shall have two (2) 4-inch conduits with inner ducts from the SC&C room to METRO's property line.

C. At METRO's property line provide a 48 inch by 48 inch by 36 inch deep pull box.

D. Design conduit runs so that fiber optic cable pulling tensions do not exceed 600 psi. Minimum conduit bend radius shall be 36 inches.

8.8.5 Automated Barrier Gate Controls (ABGC)

A. All entrance and exit points to the facility shall have sliding aluminum gates with the ability to have ABGC. These actuator s are electrically operated, locally and remotely.

B. Provide one 2-inch power conduit and one 2-inch control conduit from the SC&C room to each gate location. Place junction box on gate side of drive located within METRO's property.

C. If a new HOV lane access point is created ABGC will be required to prevent access to HOV lanes during non-operation hours, and to prevent wrong-way traffic. Access control should be coordinated with METRO and TxDOT.

8.8.6 Pedestrian Barrier Gate Controls

A. Provide a junction box located within 5-feet of the pedestrian gate. 1-1 ½" power conduit and 1-1 ½" communication conduit shall be provided from the nearest gate junction box for routing back to the SC&C room.

B. From the pedestrian junction box provide one (1) - ¾" power conduit and one (1) –¾" control conduit from the gate junction box to the access gate latch post. Stub conduits up 3-inches and cap. Locate within the concrete mow strip.

8.8.7 Call Boxes

A. Call boxes will be provided at all vehicle and pedestrian access points. Provide one 3/4-inch power conduit and one 3/4-inch communication conduit for emergency call boxes. Conduits to be stubbed up at preferred call box locations. Electrical conduit shall come from electrical panel in SC&C room and communication conduit shall come from the communications panel boa rd. Coordinate with METRO's Project Manager.

8.8.8 Observation Mezzanine

A. Design of the underground system shall be such that the SC&C system can be fully monitored and operated from the observation mezzanine.

B. Provide three (3) – 2" communication/video conduits from the SC&C room to the observation mezzanine (when applicable). Conduits shall terminate under the observation mezzanine in a NEMA junction box. Mount junction box approximately 12-inches above the concrete slab.

END OF SECTION 8.0

9.0 FARE COLLECTION

9.1 BACKGROUND

A. The fare collection structure for METRO consists of a cash transaction component and a smart card component known as a Q-Card. Patrons may pay fares through use of the Q-Card, acquired from a variety of sites through the region, or with cash. The patron may also add additional value to their Q-Cards at Cashless Point of Sell (CPOS) devices, located on the Park & Ride and Transit Center facilities.

B. The CPOS units are linked to METRO's Central Management System and Revenue System through the communications network. This link provides real-time communications for credit/debit card transactions.

9.2 SITE PREPARATION DESIGN

A. The Designer shall include in the design, electrical and telecommunications corrections on the platforms or on other agreed-upon locations for the CPOS. The Designer's installation and integration plan shall provide real-time links to the METRO Revenue System Servers.

B. Conduits shall be used to provide power and communications cabling to the CPOS. The conduits must meet all local electrical code requirements.

9.2.1 Power

A. Each CPOS requires its own dedicat ed 20-amp circuit with one hot conductor, one neutral conductor, and one ground conductor. The wire size must conform to the electrical code requirements, with a 3-foot service loop at the CPOS location.

9.2.2 Communications

A. Each CPOS will require a dedicated network termination point or termination to an A.S. (Assist Station) Phone, if it is within 5 feet of the CPOS.

9.3 Design Considerations

A. The preferred location for fare collection equipment shall be a well-illuminated high activity area with consideration of not obstructing visibility from off-site vantage points. The equipment shall be under security camera surveillance and monitored from Police Dispatch.

B. The equipment shall be vandal resistant and equipped with tamper and intrusion detection alarms. These alarms shall be annunciated at Police Dispatch.

END OF SECTION 9.0

10.0 SECURITY

10.1 INTRODUCTION

A. The criteria in this sect ion describe the minimum design requirements for mitigation of security risks to passengers, employees, contractors, and other members of the public who may come in contact with the METRO Park & Ride and Transit Center facilities. Security risks include (but are not limited to) acts of terrorism, crimes and vandalism against persons and property committed on transit property.

B. The criteria described in this chapter are written to be complementary to all other security requirements contained in this document.

10.2 ACRONYMS AND DEFINITIONS

- SECURITY CAMERA - Internet Protocol; Video (IPV)
- CFR - Code of Federal Regulations
- FTA - Federal Transit Administration
- NEC - National Electrical Code
- PA - Public Address System
- EAS - Emergency Assistance Station
- OCC – Operation Control Center
- MPD – METRO Police Department

10.3 GENERAL REQUIREMENTS

The most current versions of the following documents shall be reviewed for all applicable codes and recommendations, which must be incorporated into security design for each Park & Ride and Transit Center facility:

- Code of Federal Regulations (CFR), Title 49, Section 659.333 et seq. Security Requirements for State Oversight
- Federal Transit Administration – Handbook for Transit Safety and Security Certification, November 2002
- Federal Transit Administration – The Public Transportation System Security and Emergency Preparedness Planning Guide, January 2003
- Federal Transit Administration – Perspective on Transit Security
- Federal Transit Administration – Transit Security Handbook, May 1998
- Federal Transit Administration – Transit Security: A Description of Problems and Countermeasures, March 1997
- Federal Transit Administration – Transit Security Procedures Guide, November 1997
- Federal Transit Administration – Transit System Security Program Planning Guide, November 1997
- Federal Transit Administration – Recommended Emergency
- National Parking Association, Security Design for a Parking Facility, September 2002
- Transit Cooperative Research Program (TCRP) Synthesis 21, Improving Transit Security, 1997

- Transit Cooperative Research Program (TCRP) Synthesis 27, Emergency Preparedness for Transit Terrorism, 1997
- National Fire Protection Association, Standard 130

10.4 ADDITIONAL GENERAL SECURITY DESIGN REQUIREMENTS

A. The following general security principles shall be adhered to in the design of METRO Projects:

1. The principles of Crime Prevention Through Environmental Design (CPTED) shall be employed in the physical design.
2. Security vulnerabilities shall be systematically identified and evaluated
3. A systems approach shall be used in the design of security related countermeasures.
4. Security vulnerabilities shall be minimized through design, to the extent possible.
5. Security systems shall be integrated, for example, security cameras with intrusion detection.
6. Materials used in transit stations and other passenger waiting areas shall minimize injury severity to transit customers or personnel or damage to facilities/equipment as a result of a security incident, i.e. extensive spans of glass.
7. A layered approach shall be used in controlling access to restricted areas.
8. To the extent possible, facilities shall be hardened to minimize the potential damage from acts of terrorism.
9. Redundancy of security critical systems shall be considered and implemented wherever possible.

B. A comprehensive set of security deployment standards must be established and provided to METRO. The standards and corresponding design shall support video surveillance and emergency phones with automatic notification. They shall also support video response from local cameras to allow situation awareness for TranStar Watch Command, such that appropriate responses may be issued. The deployment standard and corresponding design must provide for and extend to perimeter fencing. These standards must be approved by the contractor’s CPTED certified specialist(s) as well as METRO.

C. The design shall support the following requirements, applicable to all electronic security devices (e.g. video surveillance cameras):

1. All devices must be fully integrated with existing METRO centralized monitoring and/ or alarm systems. This includes (but is not limited to) required network device additions/modifications and any associated UI and database updates to be made to existing control software.
2. All electronic security devices and any required interface devices utilized must meet or exceed the technical specifications of the most modern of equipment currently in use across the METRO system. The technical specifications to be considered for each element shall be determined by METRO and shall not be limited to Park & Ride and Transit Center facilities (e.g. existing cameras at rail stations may be identified.

by METRO as having the minimum acceptable specifications). Additionally, all devices installed must be fully compatible with currently existing METRO equipment.

D. Ample signage shall be included throughout the facility that indicates the presence of applicable security elements on site as deterrents to potential perpetrators.

E. The final security system design must be reviewed and formally approved by the contractor's CPTED certified specialist(s) as well as METRO.

10.5 SITE REQUIREMENTS

While no single design feature can be totally effective in creating a secure environment, careful attention to all aspects of the design can have a positive effect in deterring, detecting, and limiting injury and damage caused by criminal activities. The cumulative effect of the following design features is to enhance security as viewed by transit customers and operating employees or contractors.

10.5.1 Site

10.5.1.1 Landscaping

A. Plantings and site design may offer considerable aesthetic appeal but can also restrict lines of sight and serve as possible hiding places. At a minimum, plantings and design features shall be coordinated with lines of sight so as not to obstruct or interfere with electronic or visual surveillance or result in a potential hiding place for criminals, vandals, or intruders.
B. Landscaping may be used, where appropriate, to direct the movement of people or keep people away from an area. Consideration shall be given in the selection of plants that will not cause sight obstructions when mature.

10.5.1.2 Lighting

A. The selective use of lighting can increase the perception of security while providing better visibility of the surroundings. Lighting shall (at a minimum):
   1. Support security camera surveillance.
   2. Be underground and have tamper resistant conduits and fixtures if within reach of the public.
   3. Be supported by an emergency power supply system or on a redundant independent power grid.
   4. The illumination of station elements shall be guided by Fire/Life Safety requirements.
   5. Emergency power and lighting requirements shall be developed as part of the overall security and safety requirements.
   6. Emergency lighting systems shall be designed, installed and maintained in accordance with the National Electrical Code, Article 70.
B. Further lighting requirements are found in section 8.5 and throughout this design criteria document.

10.5.1.3 Parking

A. Transit customers have a concern for the security of their automobiles when left at a Park & Ride site. Protected parking (when provided) enhances the reality and customers' perception of security. At a minimum:
   1. Camera surveillance shall be provided that includes complete interior and perimeter coverage. The designer along with a MPD representative shall determine where the PTZ and fixed cameras will be positioned.
   2. Entrances and exits shall be limited so as to control entry/exiting from the parking area. Gates shall be cont rolled remotely from TranStar via the fiber backbone to the Operations Control Center (OCC).
   3. Parking lots shall be fenced, where appropriate, and open-spaced to provide a high degree of visibility by passers-by and roving law enforcement personnel. It shall be designed to maintain natural surveillance (openness) and territorial reinforcement.

10.5.1.4 Access

A. A carefully planned, well-laid out entrance site and parking area can improve the movement of security forces in and around the facility site. As a minimum, traffic patterns and site layouts shall be structured to permit rapid and easy access to all portions of the site by law enforcement personnel, whether on foot or by vehicle. All portions of the interior of the facility shall be accessible to emergency personnel, with the use of a master key system.

10.5.2 Architectural Features

10.5.2.1 Visibility

A. By making customers more visible to one another, to operating employees, and to the general public, mu ch of the opportunity for criminal activity is removed. Should criminal activity occur, the high visibility facilitates detection and rapid response by law enforcement personnel. At a minimum:
   1. All levels of the public areas shall be as open as possible with long, unbroken lines of sight, eliminating all dark or obscure areas.
   2. Columns and other stru ctures shall be kept to a minim um so as not to impair sightlines within the station areas.
   3. Obstructions to visual and electronic surveillance shall be minimized.
   4. Horizontal surfaces and "shelves" shall be sloped so as not to permit the placement of packages or other objects.
   5. Special attention should be paid to areas where there are changes from one area to another. Avoid 90^{o} corners by angling corners where possible.
   6. Entrances shall be readily identifiable.

7. MPD Police dispatch phone number shall be clearly posted in the boarding and fence gate entrances.

10.5.2.2 OCC and METRO Police Dispatch

A. Any electronic security components furnished shall be compatible with and fully integrated into the appropriate existing METRO systems. The existing system shall be extended by the contractor as necessary to accomplish this. A non-exhaustive description of such expected functionality is described below.
B. The METRO Police Dispatch functions are the focal point for the transit security system. Telephone messages, annunciations, and alarms com e into the OCC and appear on a display monitor. In this manner, those individuals responsible for the safe, secure operation of the transit system are continuously aware of the status of all elements on a realtime basis. For security purposes, terminal usage shall be controlled using multi-level passwords.
C. The computer terminal support software shall provide accounting records for computer terminal usage and computer processing times for each user session, including user logon and log-off times. The records shall be kept by user identity keys and terminal access codes and shall be available for output to user-selected printers and predefined auxiliary memory files. Minimum considerations are as follows:
   1. The OCC and METRO Police Dispatch shall be able to receive intrusion alarms and trouble signals from wayside facilities and stations.
   2. Separate radio frequencies shall be designated for METRO Police Services.
   3. Communication systems shall be interoperable with METRO Department of Public Safety, METRO Bus and Rail Operations.
   4. All security cameras shall be monitored primarily at METRO Police Dispatch and secondarily by OCC or other suitable location with an attendant.
   5. Security camera monitoring locations shall have security camera call-up capability to monitor any security camera.

10.6 COMMUNICATIONS AND SECURITY

10.6.1 Security Cameras

A. Complete electronic surveillance is required and fully integrated with existing METRO centralized monitoring and/or alarm systems. Minimum requirements listed in Section 10.4C with regards to integration and components utilized apply to the security camera system.

B. The security camera system shall be designed with the following minimum considerations in addition to those already mentioned or recommended/required by CPTED and/or the documents listed in Section 10.3:

1. PTZ cameras with overlapping or 360° capabilities shall be used. Cameras shall be strategically positioned. MPD shall approve locations of all cameras.
2. Security cameras shall be encased in vandal and weather resistant housings. Lenses shall be easily replaceable with the proper tools.
3. Cameras shall be mounted as high as possible to maximize the field of view and reduce accessibility by vandals.
4. The security camera system shall have digital video recording capability with 72 hour storage, based on first in/first out.
5. Camera monitors shall function for a minimum of two (2) hours on emergency power during loss of primary power.
6. Security cameras should have a dark or reflective tint to conceal the direction of the lens focus.

10.6.2 Intrusion Detection System

A. An intrusion detection system shall be provided to protect against unauthorized entry into sensitive areas, including:

1. CPOS equipment
2. Utility Building
3. Critical asset areas as determined by a security risk assessment

B. Signals from individual detectors shall be sent to all METRO centralized monitoring facilities for annunciation and alarm.

10.6.3 Emergency Assistance Stations (EAS)

A. Security is improved when a patron reports potentially hazardous or serious conditions quickly and easily. As a minimum:

1. All EAS messages answered at the METRO Police Dispatch shall be automatically recorded. The EAS answering positions shall provide a means to record emergency calls.
2. Means shall be provided for establishing two-way voice communications or hearing-impaired message transmission between METRO Police Dispatch personnel and customers located at selected points. At a minimum, these means shall be provided at selected fare vending areas, on the passenger loading areas, and parking facilities. The EAS shall function on emergency power during loss of primary power.
3. Direct-line telephone communications with the dispatch facilities of all emergency service organizations serving the transit system shall be provided at METRO Police Dispatch.
4. The design shall include failure detection and analytics. If any component (sound, connectivity, and video) fails the system shall automatically notify OCC and METRO Police Dispatch.
5. All EAS stations shall be equipped with blue lights.

10.6.4 Public Address and Passenger Information Signs (PA/PIS)

A. The PA/PIS is an added layer of security letting patrons know an area is being visually monitored remotely by METRO Police by announcing and displaying specific and random announcements. The system shall be capable of performing the following functions:

1. The system shall allow audible and visual messages from the OCC, and METRO Police Dispatch and from the local observation mezzanine and the supervisor booth.
2. The system shall be integrated with current METRO's system for PA/PIS services.

END OF SECTION 10.0

APPENDIX A

CODES AND REFERENCE STANDARDS APPLICABLE TO THIS DESIGN CRITERIA

1. AASHTO: American Association of State Highway and Transportation Officials
   a. Standard Specifications for Highway Bridges, Latest Edition including Supplementary Interim Specifications.
   b. A policy on Geometric Design of Highways and Streets, Latest Edition.

2. ACI: American Concrete Institute
   a. ACI 318: Building Code Requirements for Reinforced Concrete, Latest Edition.
   b. ACI 318R: Commentary on Building Code Requirements for Reinforced Concrete, Latest Edition.
   c. ACI 330R: Guide for Design and Construction of Concrete Parking Lots.

3. ADA: Americans with Disabilities Act
   a. All METRO facilities shall be in compliance with the latest requirements.

4. AISC: American Institute of Steel Construction
   a. Standard S326: Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, Latest Edition.
   b. M011: Manual of Steel Construction, Latest Edition.

5. ANSI: American National Standards Institute.

6. Architectural Barriers Act, Article 9102, Texas Civil Statutes
   a. Texas Accessibility Standards, Latest Edition.

7. ASHRAE: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.

8. ASTM: American Society for Testing and Materials.

9. COH: City of Houston
   a. Infrastructure Design Manual (July 2011) or latest edition.
   b. Design Manual for Wastewater Collection Systems, Water Lines, Storm Drainage and Street Paving, September 1996, with Latest Revisions
   c. Landscape Ordinance No. 91-1701, Latest Revisions.

10. COB: International Conference of Building Officials.
    a. Uniform Mechanical Code, Latest Edition.
    b. Uniform Plumbing Code, Latest Edition.

11. HCFCD: Harris County Flood Control District
    a. Policy Criteria & Procedure Manual (adopted Oct 2004 updated Dec 2010) or latest edition.

12. IEEE: Institute of Electrical and Electronics Engineers.

13. IES: Illuminating Engineering Society of North America.

14. LPI: Lightning Protection Institute.

15. MSS: Manufacturer's Standardization Society of the Valves and Fittings Industry.

16. National Electric Safety Code

17. NEMA: National Electrical Manufacturers Association.

18. NESC: National Electrical Safety Code.

19. NFPA: National Fire Protection Association
    a. 70: National Electrical Code (NEC)
    b. 780: Lightning Protection Code

20. NPDES: National Pollutant Discharge Elimination System

21. State of Texas
    a. Texas Fire Escape Law (Vernon's Civil Statutes), Title 63, Articles 3955-3972.
    b. Health and Safety Code Volume 2, (Vernon's Civil Statutes) Chapter 752, High Voltage Overhead Lines.

22. TxDOT: Texas Department of Transportation
    a. Standard Specifications for Construction of Highways, Streets and Bridges, Latest Edition.
    b. TMUTCD, Texas Manual on Uniform Traffic Control Devices for Streets and Highways, Latest Edition.
    c. Texas Foundation Design Manual, Latest Edition.
    d. Texas Bridge Design Manual, Latest Edition.
    e. Texas Drainage Manual, Latest Edition.

23. Texas State Purchasing and General Services Commission, Building and Property Services Division.
    a. Elimination of Architectural Barriers, 028.13.03.575-585 (referenced as Texas State Code in this Section).

24. UBC: Uniform Building Code
    a. Uniform Building Code with City of Houston Amendments

25. UL: Underwriters Laboratory.
    a. 96 Lightning Protection Components.
    b. 96A Master Labelled Lightning Protection Systems, Installation Requirements

26. Uniform Federal Acc essibility Standards, July 31, 1984, as amended and 36 CF R, Architectural and Transportation Barriers Compliance Board.
    a. Part 1190: Minimum Guidelines and Requirements for Accessible Design.

27. Leadership in Energy and Environmental Design (LEED)
    a. U.S. Green Building Council (USGBC)
    b. Standard for the Design of High Performance Buildings, Standard 189.1

END OF APPENDIX A

APPENDIX B
Park & Ride and Transit Center Program
Design Criteria Variance Request Form

Variance #: ________________

Project Name:
Contract Number: Date:

Submitted By:

Name: Firm:

Current Design Criteria for which variance is requested:

Chapter No.: ______ Page No.:_____ Section Title: ______________________________
Briefly Describe Current Criteria:

Reasons for Change

☐ Life Cycle Cost ☐ Correction of Deficiency ☐ Interface ☐ Administrative

☐ Cost Reduction ☐ Regulatory Requirement ☐ Enhancement

Requested Variance from Current Design Criteria and Alternative Solution:

Note: ***The following information must be provided before this variance request will be considered by METRO, also when referencing industry standards or practices all supporting documentation must be attached to this variance.***

Technical reason/justification for the requested change:

1) Describe the technical details why this variance is an appropriate design solution?

Safety implications - Provide a summary statement for questions below “In my/our professional opinion”.

1) Will granting the variance be detrimental to the public health, safety or welfare or injurious to other properties in the area?
2) Describe how the proposed variance provides an equal to or greater safety factor than that of the design criteria.

Park & Ride and Transit Center Program
Design Criteria Variance Request Form

Variance #: ___________________

Cost analysis and/or life cycle cost analysis, schedule im pacts: (attach life cycle cost analysis for ever y variance that would impact life cycle cost.) Provide a summary statement for questions below “In my/our professional opinion”

1) Any other relevant information necessary to properly evaluate the necessity and request for the variance.
2) Will granting of this variance improve the function of the intended use of this element and the project?
3) Describe why the proposed variance provides equal or adequate cost effectiveness.
4) Describe why the proposed variance will not adversely impact schedule.
5) Describe why the proposed variance will not adversely impact life cycle costs.

Disposition:

METRO use only

In order for an action to take place, ALL Committee Members must concur with decision of “approved” or “denied”.

Park & Ride and Transit Center Program
Design Criteria Variance Request Form

Variance #: ___________________

METRO Action: ☐ Approved ☐ Denied

Originator:____ Date: ___________________

Engineer of Record: ____ Date: ___________________

Project Manager:____Date: ___________________

Safety:____Date: ___________________

Dir. Program Management
Support Services/Configuration Mgmt:______________________________ Date: ___________________

Sr. Dir./Chief Engineer:____Date: ___________________

Sr. Program Director:____ Date: ___________________

Sr. Dir. State of Good Repair: ____________________________________ Date: ___________________

Sr. Dir. Bus Operations: ____Date: ___________________

AVP Engineering
and Major Capital Programs:______________________________________ Date: ___________________

End of Appendix B

Technical Memorandum

To:	Yuhayna Mahmud, AICP, LEED AP – Houston METRO
From:	Brad Brey, AICP – Alliance Transportation Group
Date:	December, 17th 2019
Subject:	Walking and Biking Improvements for METRO Design Criteria for Park and Ride and Transit Center Facilities

1.0 Introduction

This memorandum builds off the previous review of the Houston METRO Design Criteria for Park and Ride and Transit Center Facilities and addresses opportunities to improve language regarding walking and biking based on industry best practices. Per ongoing collaboration between METRO departments, it is imperative that the design criteria and standards also reflect the prioritization of people as the center of the design process. Houston METRO has initiated this process of improving pedestrian and bicycle amenities within their park and rides and transit center facilities with their recent updates at the Northwest Transit Center, Magnolia Transit Center, Downtown Transit Center and Hillcroft Transit Center. The project team reviewed all documents concerning the aforementioned transit centers and conducted a thorough review of current national best practices for design standards at transit center and park and ride facilities.

The recommendations in this memo outline where the addition of the current best practices can improve the Houston METRO Design Criteria for METRO Park and Ride and Transit Center Facilities document. These recommendations will help legitimize people-oriented design as official guidelines and priorities for Houston METRO.

2.0 High-Level Bicycle and Pedestrian Recommendations

After the review of current METRO design standards for transit center and park and ride facilities and industry best practices, ATG created high-level recommendations (as presented on June 27th) for improving access for those arriving and departing by bicycle, by foot, or mobility device. These high-level recommendations are illustrated in Table 2-1 below. Each recommendation is assigned a code (B1, B2, P1, P2, etc.) that corresponds with the suggested change in language. These recommendations can also be found in the corresponding Excel document provided along with this memo.

Table 2-1: Recommendations for Bicycle and Pedestrian Improvements

Code	Bicycle Recommendations
B1	Redevelop language to prioritize access for those who are walking and biking to and from the park and ride facility
B2	Provide secure long-term bicycle parking at park and ride facilities and follow bicycle parking best practices. Review proposed document changes (as shown in Table 2) for best practice recommendations related to long-term bicycle parking.
B3	The number of long-term storage units should be based on expected ridership and take into consideration unique transit center needs rather than being based on a minimum. Review best practice standards in proposed document changes (Table 2).
Pedestrian Recommendations	
P1	Redevelop language to prioritize access for those who are walking and biking to and from the park and ride facility.
P2	Pedestrian facilities should be well lit, especially at vehicular crossings.
P3	Where necessary as speed, pedestrian counts, and traffic volumes dictate, and in accordance with local requirements, pedestrian activated crossings should be considered within and around park and ride facilities.
P4	High pedestrian volume during peak hours may require wider walkways than the current standard to accommodate traffic flow. It is recommended that the sidewalk width guidelines are updated from the 5 feet standard to an 8 feet minimum to reflect prioritized access for pedestrians. A range of standards can be introduced to fit pedestrian needs specific to each station type.
P5	Fencing around the ground floor of park and ride and transit center facilities should be used only where absolutely necessary such as separation between pedestrians and vehicles. Fencing can deter access to the facility by those on foot or by bicycle. Fencing on the ground floor should be considerate of the flow of bicycle and pedestrian movement into and out of the facilities.

3.0 Proposed Document Changes

The recommendations in Table 3-1 and Table 3-2 below are the proposed changes to the language in Houston METRO's Design Criteria for METRO Park and Ride and Transit Center Facilities. Table 3-1 and Table 3-2 include the recommended language revisions as well as the original language and where it can be found the Design Criteria for METRO Park and Ride and Transit Center Facilities document. These recommendations are based on best practice findings with consideration given to the context of the original document. Although operating conditions can be very similar at transit centers and other transitways, these recommendations are specific for park and ride and transit center facilities. Sections 4 and 5 of the Houston METRO Transit Design Guidelines should be referenced for conditions at locations other than park and ride or transit center facilities.

Table 3-1: Bicycle Related Language Recommendations

Section	Original Language	Proposed Revised Language
5.3, (b) Site Development	The site layout and traffic flow shall relate to the surrounding area and its traffic patterns. Provisions for handling patrons arriving and departing by bus, car or motorcycles, on foot, on bicycles, and as drop-off patrons, shall be provided.	**B.** People are at the center of the design process for all Houston METRO facilities. By prioritizing the movement of people of all ages and abilities, even the most vulnerable users including but not limited to, those experiencing disabilities, elderly, or young children will be able to navigate the built environment at transit centers and park and ride facilities with ease and safety. Using this all ages and abilities approach to facility design naturally creates a hierarchy of access. Those arriving to Houston METRO facilities shall be prioritized using a hierarchy of access, which occurs in the following order, starting with top priority; people arriving via wheelchair or mobility device, on foot, on bicycles, in transit vehicles, in pick up or drop off vehicles, in vehicles parking at Houston METRO facilities.
5.7.1, (a) (Original Section Title: Bike Racks) Proposed Section Title: Bicycle Parking and Amenities	Parking racks specially designed for bicycles shall be provided close to the bus loading/unloading platform or near the observation mezzanine (if provided), to allow for natural surveillance. A minimum of two (2) bike racks that can each accommodate five (5) bikes shall be placed near the observation mezzanine or pedestrian waiting area. No enclosed bike racks shall be used. The bike rack location and shall be approved by METRO Police Department.	**A.** Short-term bicycle parking should be provided as close to each transit loading zone as possible and is recommended to be no farther than 50 feet from the loading zone. The quantity, location, and rack specifications of short-term bicycle parking shall be in accordance with the Association of Pedestrian and Bicycle Professionals *Bicycle Parking Guidelines, 2nd Edition* (or most current). **B.** Secure, sheltered, long-term bicycle parking shall be provided based upon anticipated ridership of each specific transit center or park and ride facility. Generally, transit users who wish to leave their bicycle at a transit facility for long periods of time, prioritize safety of their property over convenience of parking location, therefore, long-term parking may be located further from the loading zone than short-term. However, every effort should be made to place long-term parking as close to loading zones as space dictates. The quantity, location, and rack specification of long-term bicycle parking shall be in accordance with the Association of Pedestrian and Bicycle Professionals' *Bicycle Parking Guidelines*, *2nd Edition* (or most current).

		C. Transit centers and park and ride facilities with demand for bicycle parking may install amenities such as bicycle repair stations. The amenities should be easily visible from bicycle parking locations but not impede pedestrian throughways.

Table 3-2: Pedestrian Related Language Recommendations

Section	Original Language	Proposed Revised Language
3.1.3, (d) General Site Design Consideration	Crosswalks shall have a minimum width of 8 feet.	**D.** Crosswalk width shall be equal to the adjacent sidewalk or walkway but no less than 10 feet in width. Where necessary, or beneficial, pedestrian activated crossings shall be considered at pedestrian or shared use crossings.
3.1.3, (e) General Site Design Consideration	Sidewalks shall be provided along the adjacent public streets. The width of the sidewalk shall conform to the applicable governmental or relevant community standards, but shall not be less than 5 feet wide.	**E.** Sidewalks **1.** Sidewalks shall be provided along adjacent public streets at a width of no less than 6 feet in width. However, it is recommended that sidewalks in high traffic areas, such as sidewalk leading to transit center or park and ride facilities shall be 8 feet or more in width. **2.** Sidewalks adjacent to moving traffic or a solid structure, such as a fence or wall, should be 10 feet in width. Sidewalks may be 8 feet in width provided that a buffer of 2 feet is present along the curb for utilities and additional separation from traffic. **3.** Sidewalks adjacent to a transit loading zone shall maintain a throughway of 6 feet for pedestrian traffic and provide 8 feet at the curbside loading zone for passenger loading activities. A minimum of 14 feet shall be provided, while 16 to 20 feet is recommended for high traffic areas.
3.1.3, (i) General Site Design Consideration	The perimeter of the Site shall be fenced. Vehicle access points shall be controlled with cantilever sliding gates. Pedestrian access points shall be controlled with swing gates. Fence shall consist of 6 foot high chain link fence with black polyvinyl coating. Fence	**I.** Where necessary, and for security concerns, the perimeter of the transit center or park and ride facilities may be fenced. If the site is fenced at ground level, pedestrian and bicycle movements and access points should be considered. Pedestrian and shared-use access points to the facility should be maintained by a break in fencing. A break in fencing may consist of a gate, swing gate, or gap in fence with a bollard. If fencing is deemed necessary, fences shall consist of a 6-foot-high chain link fencing with black polyvinyl coating. Fences shall be centered on a 1-foot wide concrete mow strip.

Section	Original Language	Proposed Revised Language
	shall be centered on 1 foot wide concrete mow strip.	
3.1.6, (a) Pedestrian Traffic	Dedicated raised pedestrian walkways shall be provided at every third parking aisle. Walkways shall be a minimum of 11 feet wide (face of curb to face of curb).	**A.** Walkways **1.** Pedestrian walkways must provide a minimum unobstructed width of 6 feet from each side of any point of obstruction within the walkway. **2.** Where pedestrian traffic flow occurs primarily in one direction during peak hour, walkways shall be no less than 8 feet in width. **3.** Where pedestrian traffic flow occurs primarily in opposing directions during peak hour, walkways shall be no less than 12 feet in width. **4.** Where pedestrian traffic flow occurs in multiple and intersecting directions, walkways shall be no less than 16 feet in width.
3.1.6, (b) Pedestrian Traffic	Pedestrian movements from parking areas to the bus loading/unloading platform shall be arranged to minimize the crossing of vehicle lanes. This shall be accomplished with the use of low (3 foot high maximum) fences and landscaping. Pedestrian walkways shall be given priority over vehicular routes.	**B.** Pedestrian movement from the parking area to transit loading platforms should be designed in a manner that prioritizes pedestrian safety and ease. Pedestrian walkways should minimize crossing vehicular pathways where possible. This may be accomplished by using natural landscaping features to guide pedestrian movement, and when necessary, the use of low 3-foot-high (max) transparent fencing.
3.1.6, (e) Pedestrian Traffic	Walkways shall have a minimum unobstructed width of 5 feet	Deleted and moved to 3.1.6, (a)-1
(Original Section Title: n/a) Proposed Section Title: **3.1.11**	n/a	**A.** Universal Design Though all federal, state, and local ADA standards shall be complied with in Houston METRO projects, additional Universal Design elements may be used to provide an adequate level of service for those who experience visual, hearing, or developmental disabilities.

Section	Original Language	Proposed Revised Language
Universal Design		**1.** Audible crossing signals shall be considered at all intersections within one half mile of and within the transit center or park and ride facility. Audible crossing signals provide adequate service for those with visual impairments. **2.** Detectable warning pavers shall be used at all applicable areas as required by federal, state and local codes, in addition to all transit loading platforms where grade separation occurs. Detectable warning pavers shall be used specifically to mark the location of transit vehicle doors, at bus bays and light rail or BRT platforms, but may be used across the entire length of the loading platform. **3.** Braille signage shall be used to provide those with visual impairments with adequate service. Braille signage should be used at all common areas such as transit kiosks, bus bays, ticket kiosks, etc. **4.** Proper lighting shall be used along all pedestrian walkways, sidewalks, crosswalks and waiting areas within one half mile of transit center or park and ride facilities to allow safe pedestrian usage during times of low natural light. Proper lighting also allows motorists clear visibility of pedestrian crossings. Overhead lighting and bollard lighting should be considered. Lighting specifications in Section 8.5 shall be refenced.
3.6.3, C Pavement Markings	Crosswalks for pedestrians shall be defined by pavement markings or contrasting pavement treatment at all points where pedestrians will cross vehicular traffic routes.	**C.** Pavement markings used for crosswalks shall be the “ladder style” White High Visibility markings as used by the City of Houston. Where both bicycle and pedestrian use is shared at an intersection or mid-block crossing, a Dual Use Marking may be installed, as used by the City of Houston. The City of Houston Infrastructure Design Manual can be referenced for pavement marking dimensions. See Standard Detail 01510-10 for White High Visibility Crosswalk and 01510-09A for Dual Use Markings.

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