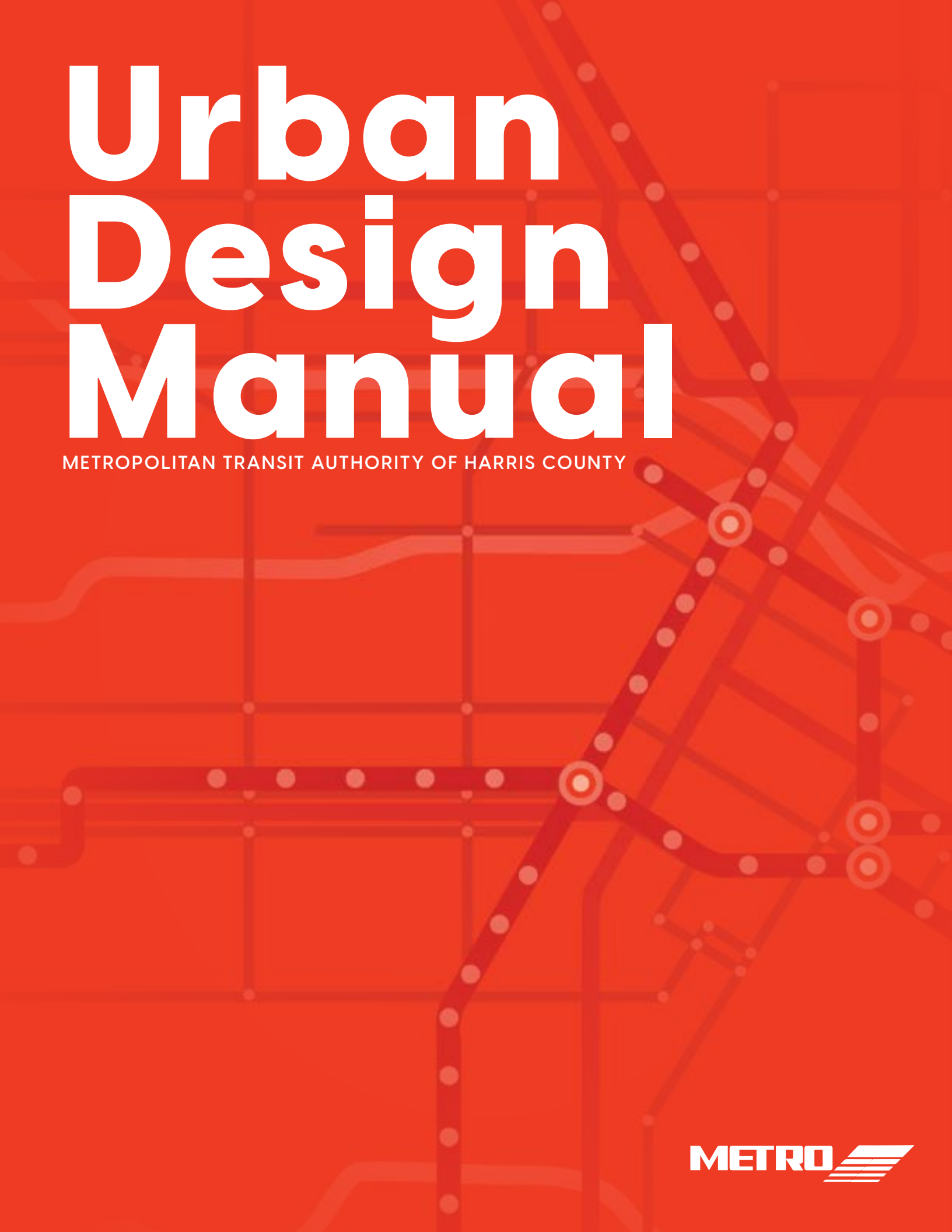
Urban Design Manual

METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY

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1. REFERENCE/General.
2. TRANSPORTATION/General.

All photos are courtesy of Metropolitan Transit Authority of Harris County unless otherwise noted.

The most current version of this Manual is available for download at www.rideMETRO.org/urbandesign

Readers may register on the website to receive updates by email.

The Houston region is on the move and METRO is there every step of the way. We are investing in our fleet, our facilities, our team, and our communities to move people faster, safer, more comfortably, and to more places than ever.

Our eight-county region is poised to nearly double in population to 10 million people by 2040. This dynamic will have exciting and transformative effects on our region's economic prosperity, social resilience, development patterns, and environmental sustainability. A strong transit system that gets more people to more places is an integral part of the successful growth of our region and of residents' ability to share in the benefits.

Today, METRO covers just over 1,300 square miles with more than 9,000 bus stops, 2,100 shelters, and 21 Transit Centers. In the years ahead, METRO will implement over 40 projects with 500 miles of travel improvements through our METRONext long-range transportation plan. The METRO Board wants to ensure that these transit investments bring value to our riders and the region as a whole.

This Transit Urban Design Manual will help us achieve that goal. It provides actionable recommendations for every element of a project. It is a guide for METRO and our partners as we work together to build new transit facilities and improve existing ones that enhance customer experience, reflect our region's unique character and diversity, incorporates innovation, and support sustainable growth.

We look forward to the value great urban design and high-quality transit facilities will continue to make in our region.

Sincerely,

Sanjay Ramabhadran, PE

METRO Board Chair

"THIS IS THE FUTURE OF HOUSTON,

Where every Houstonian will have the ability to choose to walk, bike, roll, drive, or our preferred choice, be driven by METRO to their destinations.

That is the future we aspire to."

Sanjay Ramabhadran, PE
METRO Board Chair

"Transit today is really about building an environment where people feel

COMFORTABLE & SAFE. IT IS ABOUT CREATING WALKABLE, LIVABLE COMMUNITIES

and connecting people to opportunities."

Thomas C. Lambert
President / Chief Executive Officer

Each day, METRO works diligently to provide public transportation services to connect transit riders to the places they work, shop, learn, play, and live. An integral component of our ability to deliver these services is the many METRO transit facilities where our riders begin their trip, transfer, or reach their destination. We recognize that the quality of these facilities and the surrounding environment impact customer experience and METRO's ability to attract and serve new riders.

In 2021, METRO initiated its BOOST Network design guidelines to improve bus stops on many of our highest ridership corridors. However, we didn't stop there. With this Transit Urban Design Manual, we have expanded our efforts to enhance the look, the feel, and the function of all facilities in our network whether it's a METRORail/METRORapid station, a transit center, one of our Park & Rides, or a local bus stop. Our transit facilities are woven into the fabric of our region. This manual supports our core mission and the important role we play in supporting sustainability, resilience, quality of life, and civic pride.

This Urban Design Manual is filled with practical guidance that is based on our region's aspirational goals. It should inform each stage of a transit project from planning to design, construction, operation, and maintenance whether it's a new facility–like those that will be developed as part of METRONext–or the retrofit or redevelopment of existing facilities. Most importantly, it should serve as an essential reference to our team here at METRO as well to our agency partners, neighborhood stakeholders, and the consulting community. Only together can we create a transit system representative of the vibrant, diverse, growing region we all serve.

Sincerely,

Thomas C. Lambert

President / Chief Executive Officer

Preface

Note from the Urban Design Lead

Two ambitions for the Urban Design Manual are to be the go-to resource for those envisioning transit environments and to amplify the experience of public transportation in metropolitan Houston. This design manual provides thorough guidance on programming transit spaces with the direction of project type and process, a walk-through of project scales, guidance on amenity selection, low-impact development practices, coverage of vital transit components including bike lanes, inclusive transit design, material selection, and cost efficiency and management.

The Urban Design Manual works to bring mass transit to the commuter's front door. It collects transit design challenges into one resource addressing issues of activated and comfortable transit spaces and designing desirable routes for pedestrians to access their preferred mode of alternative travel. These urban solutions benefit people first by helping to reduce vehicle traffic impacts and to enhance daily life well-being.

This First Edition of the Urban Design Manual is the result of note-worthy intra- and interagency collaboration with the following leading agency support: the City of Houston (COH) Public Works, Planning Department, Mayor's Office, Environmental Public Health (EPH), Houston Galveston Area Council (H-GAC), and the design leadership of SWA Group.

We encourage planners, designers of all backgrounds, policymakers, and neighborhood keepers to use this document to implement change for safe and comfortable transit environments. Partners can use the METRO-preferred strategies outlined in this manual to propose informed solutions for better transit and active transportation solutions that contextually improve community quality of life.

It is an honor for us to bring this urban manual to our partners and we hope to bring insight and design inspiration beyond the norm to work for and with all people.

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The City of Houston (COH), Houston Public Works (HPW), Multi-Modal Safety & Design Branch (MSD), Planning & Development Department (PD), Mayor's Office of Cultural Affairs, Harris County Public Health, (HCPH) Environmental Public Health, Built Environment (EPH).

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Urban Design Guidelines, 1989

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2 FOUR LENSES OF URBAN DESIGN

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7 NEW HORIZONS FOR URBAN DESIGN

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Introduction & Purpose

1 2 3 4

Scale
regional | neighborhood | site

Learning Objective
Effectively navigate the UDM and understand the mission of the manual

Summary
METRO issued the Urban Design Manual (UDM) as part of its suite of guidelines to enhance the planning, design, and maintenance of its public transit facilities at different geographics scales in a fast-growing region.


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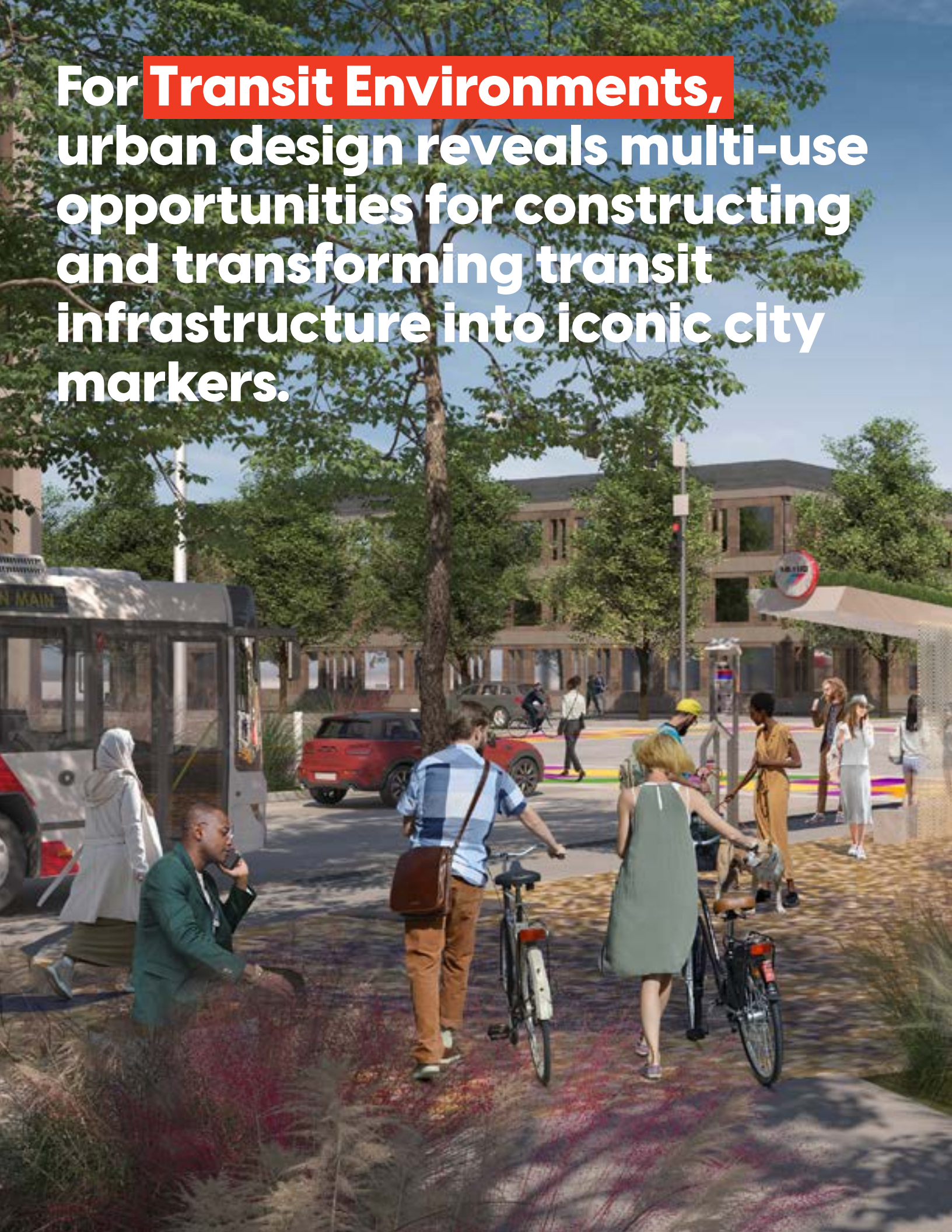
Urban Design is an interdisciplinary approach to creating the look, the feel, and the function of public spaces.

Urban Design defines what makes transit facilities and their surroundings feel safe, comfortable, convenient, and enjoyable.



For Transit Environments, urban design reveals multi-use opportunities for constructing and transforming transit infrastructure into iconic city markers.

Purpose

Transit use can deliver important benefits to the well-being of transit riders and their communities, the economy, and the environment. The safety, frequency, speed, comfort, accessibility, connectivity, and cost of transit service are elemental to a strong transit system. Yet, the importance of transit facility design to the customer experience and perception of transit–and hence ridership–is often underestimated.

Urban Design describes the spatial arrangement of our cities and towns. It is concerned primarily with public spaces and seeks to organize groups of buildings, plazas, parks, streetscapes, and infrastructural elements. Urban design happens at a variety of scales, from a single site to an entire urban region. Urban Design is an interdisciplinary approach to creating the look, feel, and function of public spaces.

For transit environments, urban design reveals multi-use opportunities for constructing and transforming transit infrastructure into iconic city markers. Urban design for transit operates at many scales, from the regional scale of METRO's service area to the site scale of street furniture and lighting at specific stop locations to create transit facilities as functional public spaces that will be resilient and maintained in appearance, relevancy, and need over time.

Three decades since METRO's first Urban Design Manual in 1989, the greater Houston area has faced defining challenges related to catastrophic climactic flooding disasters and heat island effect, unrestrained sprawl, social inequity, and misconceived perceptions of transit as a less desirable alternative to vehicular transportation.

Opposing these unique contextual challenges to transit, METRO's public transit environments can highlight the unique character of the region and impact the image of the entire agency. Whether planning an entire transit development, a transit route, or landscaping at a bus shelter along a corridor, no other organization is currently in a more opportune position to impact Houston's unique urban environment. Urban transportation planning and design determines the form and character of adjacent communities–thus having a tremendous impact on quality of life.

In 2022, METRO issued this Urban Design Manual (UDM) as part of its suite of Standards and Guidelines. The METRO Urban Design Manual serves as a set of design and implementation strategies and illustrations guiding design and implementation teams towards higher quality urban design solutions for the greater Houston region.

This manual aspires to challenge planning and design excellence at regional, neighborhood, and site scale. In order to foster environmental resilience, promote sustainable growth, celebrate diverse communities, and elevate customer experience, the Urban Design Manual (UDM) provides guidelines that support the delivery and maintenance of a high standard of quality development that contributes to safety, comfort, and quality of life throughout the METRO service area.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How to Use this Manual

ESTABLISHING A CLEAR URBAN DESIGN FRAMEWORK

A LOGICAL AND FLEXIBLE FRAMEWORK

There are no singular design solutions that will work in all contexts given such a vast and diverse service area. METRO invites staff, partners, stakeholders, and consultants to become familiar with the carefully crafted framework for transit urban design and to utilize the recommendations and resources included in this Urban Design Manual (UDM).

FOUR LENSES

The UDM's four lenses of ***environmental resilience, diverse communities, sustainable development,*** and ***customer experience*** make up the organizational framework and design principles for the UDM. These lenses guide objectives to confront the defining challenges of Houston's unique regional context.

THREE SCALES

This UDM aspires to inspire planning and design excellence at three scales of urban design–***regional scale, neighborhood scale***, and ***site scale***.

The ***regional scale*** encompasses METRO's entire service area and is focused on the efficiency and connectivity of the transit network overall, broad objectives that apply across the network, and the regional transit identity. The ***neighborhood scale*** of urban design promotes accessibility of facilities, enhances community identity, and provides amenities that benefit both transit and the local community. The ***site scale*** is specific to individual facilities and focuses on internal connections, site amenities, and the anticipation of future needs.

Each scale leverages coordination and partnerships amongst regional, neighborhood, and internal METRO stakeholders to achieve high quality urban design.

FIVE FACILITY TYPES

The UDM seeks to promote creative thinking by providing design resources for the ***retrofit***, ***redevelopment***, or ***new construction*** of METRO facilities that capture the vision and mission of METRO as well as goals and aspirations of residents and stakeholders as expressed in recently published plans from across the region. ***Bus Stops***, ***Light Rail Transit (LRT)***, ***Bus Rapid Transit (BRT)***, ***Park & Rides***, and ***Transit Centers*** reflect the METRO brand and are by nature an extension of the public urban design environment.

SEVEN TOOLS

Designing safe, secure, accessible, and comfortable facilities with amenities including shelter, places to sit or lean, shade trees, and nearby business activity can create a positive pedestrian realm and improve both the experience and perceptions of transit service. Branding and distinctive stations can serve to advertise service and support a sense of place. Clear information saves people time. High quality facilities enhance the rider experience and can further bolster ridership. All seven tools–***amenities & furnishings, pedestrian pavements, lighting, landscape & green infrastructure, wayfinding & art,*** and ***architecture***–are diagrammatically illustrated as color-coded systems within the UDM.

THREE OUTCOMES

The ultimate objective of the UDM is the delivery and maintenance of a high standard for development contributing to *safety*, *comfort*, and *quality of life* throughout the METRO transit service area.

Read on to learn how to transform the look, feel, and function of transit in the region's public realm.


Environmental Resilience
Diverse Communities
Sustainable Development
Customer Experience
Regional Scale
Neighborhood Scale
Site Scale
Bus Stop
BRT / LRT
Park & Ride
Transit Center
Amenities & Furnishings
Pedestrian Pavements
Lighting
Landscape & Green Infrastructure
Technology
Architecture
Wayfinding & Art
Safety
Comfort
Quality of Life

METRO's Urban Design History

Transit Guideline Context

Over its operational years, METRO has become a key driver of the Urban Design environment within the Greater Houston region and recognizes the connection between its facilities and the opportunity for thoughtful, high quality urban design to positively impact METRO riders, local communities, and the region as a whole.

Since 1978, METRO has been an integral part of the regional transportation network. It provides transit services to a vast service area–over 1,300 square miles–encompassing most of Harris County and portions of Fort Bend and Waller Counties, the City of Houston, and 14 incorporated communities. METRO operates local and express buses, special commuter services, HOV lanes, and light rail. The METRO network currently includes nearly 115 fixed routes, more than 9,000 bus stops, over 2,100 shelters, and 21 transit centers, as well as maintenance and operations facilities.

This network contains a sizable footprint of real estate, easements, transit corridors, partnerships, and coordination efforts that have heavily shaped the urban fabric of Houston and surrounding communities. The standards, plans, studies, and guidelines that METRO has implemented to date have impacted the quality, comfort, and safety of transit environments they have developed. The UDM is the "go-to" resource that thoroughly explores design approaches to promote sustainability, advances design excellence, supports local land use goals, and creates safe transit environments.

Pivotal METRO Documents

METRO Next

The METRONext Moving Forward Plan is designed to help ease traffic congestion. It includes 500 miles of travel improvements with the goal of giving area residents more ways to move around the region. The goals of METRO Next are: To Serve More People, and More Places, Faster, More Reliable, and More Often, and Better Access and Customer Experience.

Transit Design Guidelines

The purpose of the document serves as a one-stop design reference for multi-modal transportation environments and METRO facilities that improve safety, accessibility, and comfort. The Transit Design Guidelines focus on technical information regarding spatial arrangements, configurations, and layouts.

BOOST Basis of Design

This program was created to holistically improve the transit experience along METRO's busiest bus routes. The document serves as a roadmap to create a better walk, stop, and ride.

METRO Climate Action Plan

METRO's Climate Action Plan outlines METRO's commitment to tackling climate change through emissions reduction, operations efficiency, and sustainable resources and energy management.

Metro History

1973

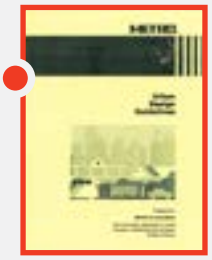
Texas Legislature Authorizes Creation Of Local Transit Authorities

1979

METRO Opens as Houston's Metropolitan Transportation Authority

1989

Urban Design Guidelines are Adopted

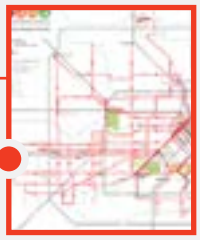


2004

METRO Rail Opens to the Public

2015

METRO Conducts System Reimagining Study and Reshapes Entire Network

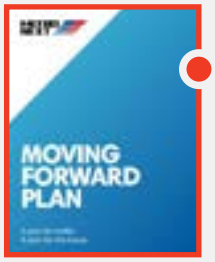


2018

First BRT Station is Constructed in Uptown

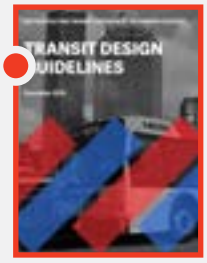
2019

METRO Next is Designed to Reduce Traffic Congestion



2019

METRO Produces Transit Design Guidelines



2020/2021

BOOST Network Basis of Design Document Is Introduced

2021/2022

BRT Design Criteria are Issued

2021/2022

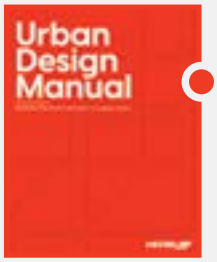
Climate Action Plan is Issued

2021/2022

METRO Programming Catalog is Created

2021/2022

Urban Design Guidelines are Reimagined



2023

Arts in Transit Program is Created

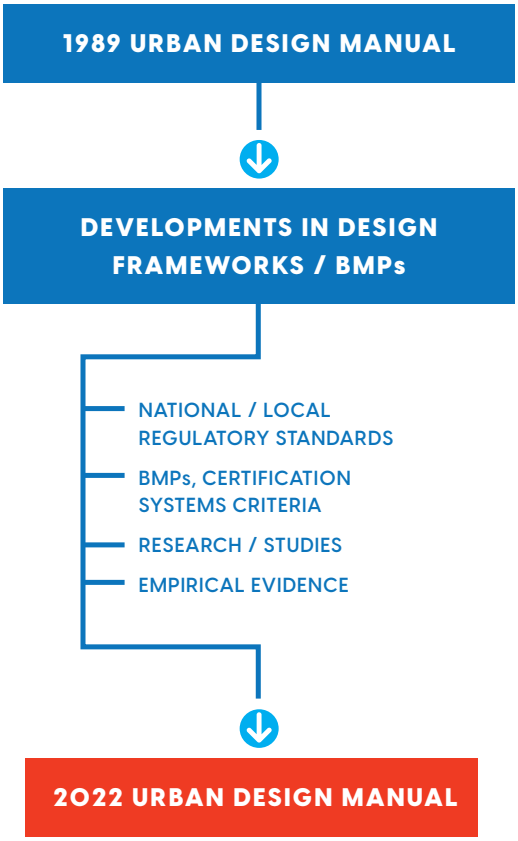
METRO Guidelines & Standards

The Demand for an Urban Design Manual

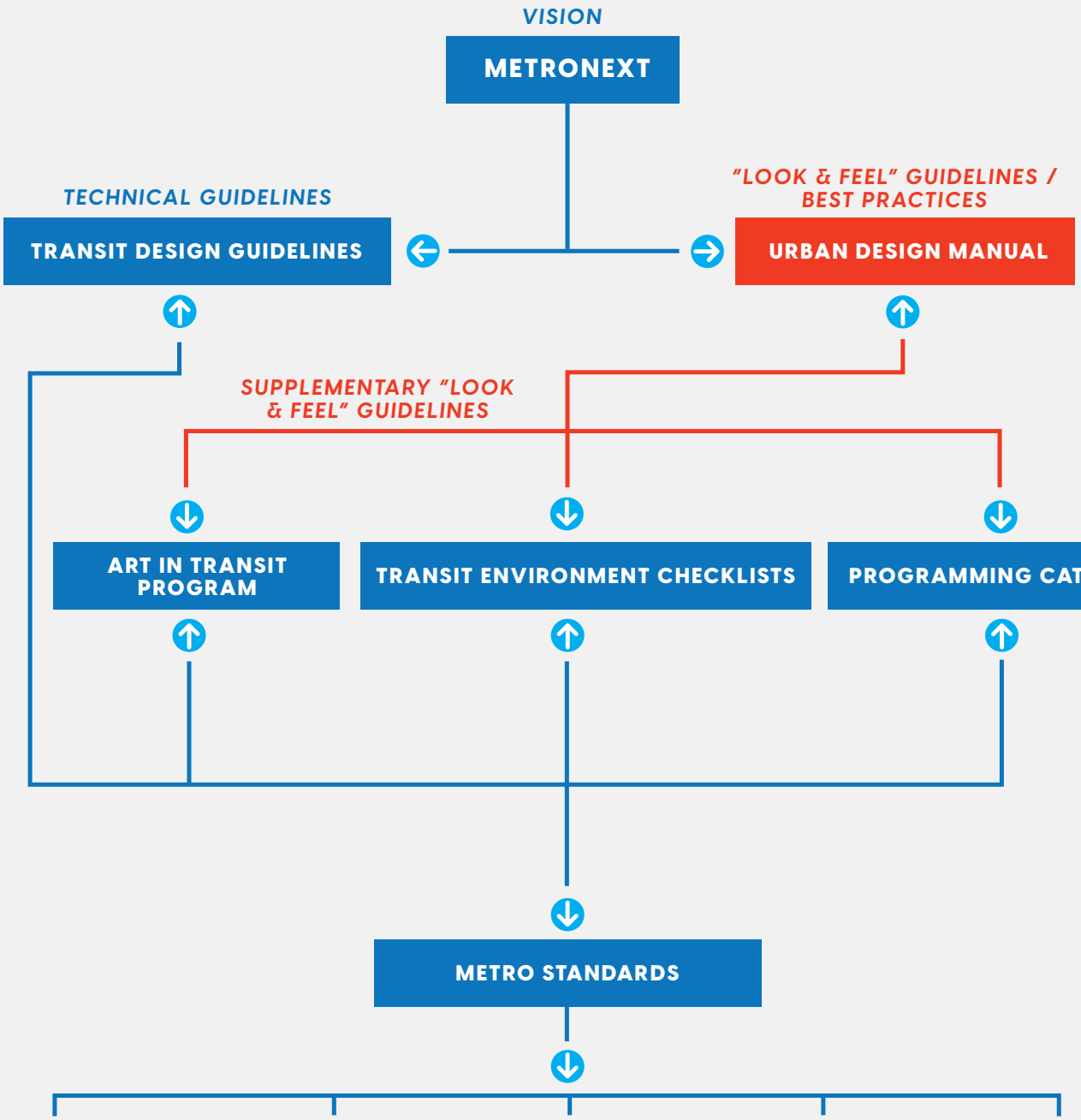
METRO developed the original Urban Design Manual in 1989. This manual promoted METRO's objectives to facilitate the transit system as an expression of community identity, encourage the transit system as a public catalyst, create coherent circulation patterns, and promote a positive city image. The manual's guidelines focused on creating a cohesive quality for the METRO brand and provided guidelines as a series of design considerations related to various site elements within METRO facilities.

Since the original UDM was created, METRO has vastly expanded its operations. Many national and local agencies have produced regulatory standards, best management practices (BMPs), and certification systems with elective criteria that have heavily influenced acceptable and aspirational standards of design systems within urban design environments. Additionally, internal and external research, studies, and empirical evidence related to the transit urban design environment have greatly challenged the way cities develop their transit systems (for a detailed list of developments in design frameworks / BMPs, refer to page 210).

The 2022 METRO Urban Design Manual seeks to push the quality of METRO facilities beyond basic requirements of national / local regulatory standards to establish a framework for quality urban design within the unique contexts of the greater Houston region.



Family of METRO Documents



METRO has developed various planning, guideline, and operational documents aimed at controlling the quality of design of METRO facilities. METRONext serves as a guiding roadmap for the future of METRO operations.

While the Transit Design Guidelines offer technical guidelines for facility design to safely and efficiently delineate space for automobiles, trucks, buses, light rails, and people, **the Urban Design Manual addresses look, feel, and function of urban design for transit for both METRO facilities and the public realm** to improve safety, comfort, and quality of life.

The Transit Design Guidelines and Urban Design Manual – in addition to supplementary "look and feel" guidelines – both play unique and vital roles within the development of METRO facilities and coordinating integration within their surrounding contexts. While these documents are informed by METRO's previous standards, they also seek to improve the next generation of facility standards.

Citywide Planning Themes

Houston's Planning Ecosystem

Due to a lack of traditional planning controls, Houston's urban fabric is heavily influenced by a unique mixture of development regulations and interagency coordination—often leading to insufficient integration and implementation of a high quality urban design environment. Despite a complex planning ecosystem, neighborhood and regional agencies have implemented a vast set of plans and guidelines that aim to alleviate common challenges to Houston's urban design realm.

Just as the UDM is informed by METRO's planning precedents, it is similarly guided by significant planning efforts at the neighborhood, city, county, and regional level. Many plans were reviewed and mined for goals, objectives, and specific recommendations relevant to transit urban design.

The UDM's Four Lenses of Urban Design (Environmental Resilience, Diverse Communities, Sustainable Development, and Customer Experience) are intrinsically connected and mutually supportive of the plans highlighted on the following timeline, as well as other plans not listed.

METRO connects public, private, and civic destinations where people live, work, play, learn, and access services. METRO's transit services must be integrated into the physical fabric of the region. Through the implementation of the UDM, METRO can play a vital role in solving the region's unique challenges.

Reoccurring Planning Themes

Climate, Environment, & Resiliency

Hurricane Harvey (2017) prompted many plans related to climate environment and community resiliency. In addition, many of these plans highlighted stormwater management, flood control, coastal protection, air quality, water quality, and habitat preservation / restoration.

Social Equity & Diversity

Social equity, accessibility, complete communities, neighborhood identity, aesthetics, amenities, parks and trails, waterfront access, and proximity to jobs, goods, and services, economic competitiveness, and innovation are high priorities within Houston's planning ecosystem. The Covid-19 Pandemic highlighted transit's role in combatting social inequities.

Sprawl & Unsustainable Development

Collaboration of public, private, and not-for-profit sectors in planning and project implementation is emphasized in planning documents to reducing sprawl, reducing urban heat island effect, prioritizing pedestrian / bike experience, and encouraging sustainable development patterns.

Transportation Mobility, Connectivity, & Safety

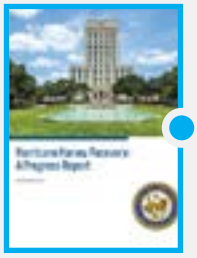
Traffic congestion, vehicular mobility, public transit, complete streets, bicycle networks, pedestrian safety, and public realm amenities were emphasized in order to promote alternative transportation and increase mobility choice.

Local Planning Coordination

2015
PLAN HOUSTON

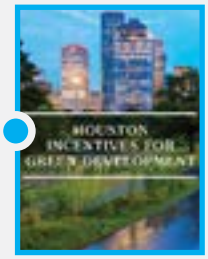
2017
HOUSTON BIKE PLAN

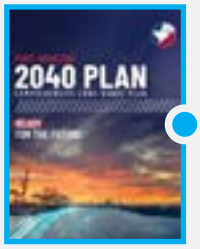
2017
COMPLETE COMMUNITIES



2018
HURRICANE HARVEY RECOVERY: A PROGRESS REPORT

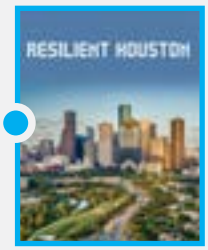
2019
HOUSTON INCENTIVES FOR GREEN DEVELOPMENT

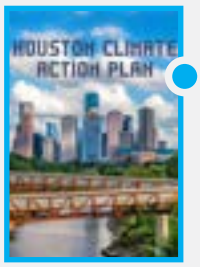




2020
PORT HOUSTON 2040

2020
RESILIENT HOUSTON





2020
HOUSTON CLIMATE ACTION PLAN

2020
VISION ZERO ACTION PLAN

2022
METRO URBAN DESIGN GUIDELINES

Mobility & Public Health*

Beyond Aesthetics, Convenience, & Efficiency

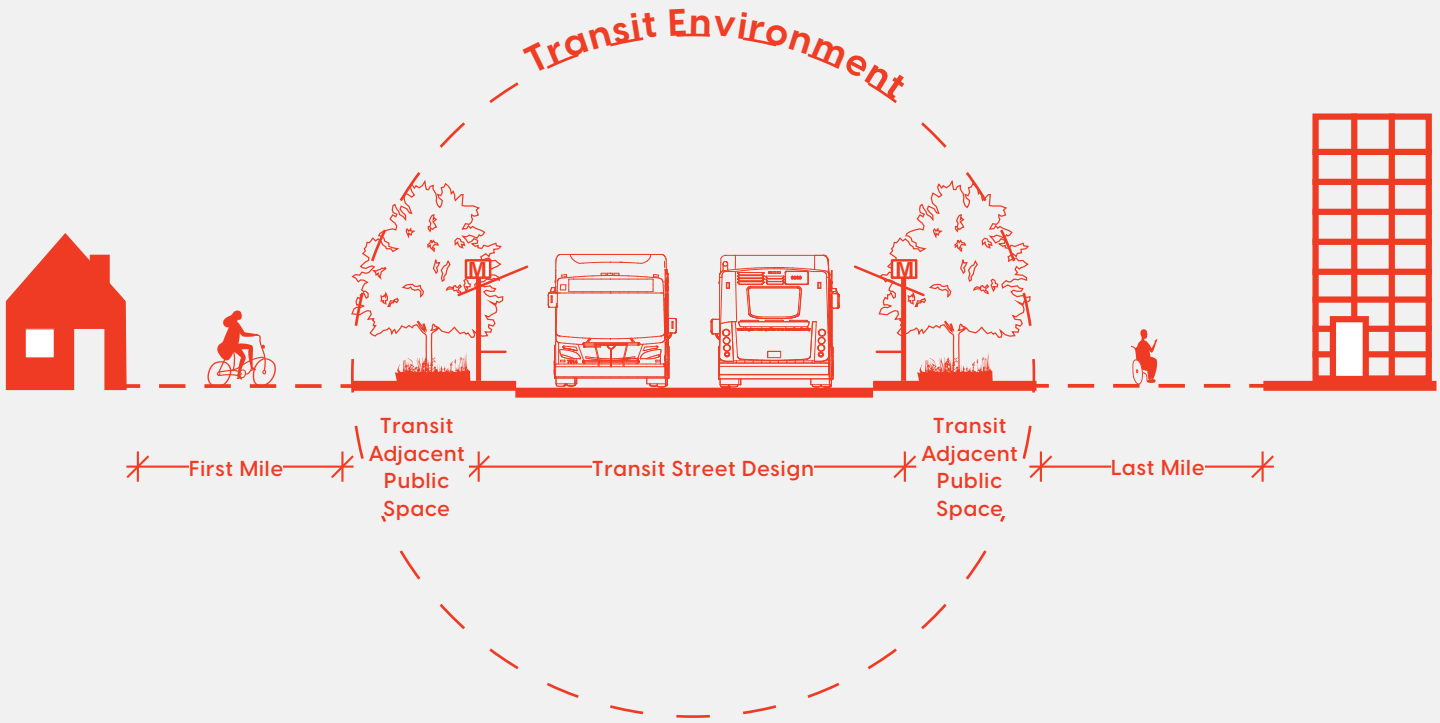
In 2020, less than 5% of commuters in the Houston metro area walked, biked, or took public transportation to work (HCED, 2020). The low utilization rates of multimodal transportation contribute to the area's heavy traffic and Houston's ranking as the eighth most congested metro area in the United States (Pishue, 2020). The demand for multi-modal transportation options is growing across the U.S. and disrupting traditional travel and development patterns. The resulting change in travel patterns requires safe infrastructure for pedestrians, bicyclists and other wheeled users, like strollers and wheelchairs.

Residents want to be able to walk, bike, or use public transportation to get to restaurants, parks, schools, and businesses, but the supply of multimodal transportation options in Houston does not meet demand. According to the Houston Area Survey (HAS), 50% of residents consistently say they would prefer to live in a smaller home in a more walkable neighborhood, but fewer than 50% of neighborhoods in the greater Houston area are considered walkable (Olin, 2021).

Multi-modal transportation is a key component of a healthy built environment. Car dependency has known negative health and environmental consequences. People living in car-dependent communities are less likely to meet recommended physical activity levels (NSW, 2020) and, in areas where vehicle travel is prioritized, pedestrians often do not feel safe. Vehicle-centric planning and design also leads to residents with higher rates of mobility disabilities and higher likelihoods of being overweight (Berry et al. 2010; Clarke et al. 2009).

Land use, design, and density impact a community's mobility options. Communities with greater density and diversity of land uses encourage walking and cycling and support the use of public transportation (NSW, 2020). These forms of active transportation can improve health outcomes by integrating physical activity into daily life. Research shows that people who use public transportation are more likely to meet recommended physical activity levels by walking and / or biking to and from public transportation stops (Rissel et al. 2012). Overall, people are more likely to be physically active in well-connected, walkable neighborhoods with safe sidewalks and intersections, high intersection density, and physically enticing designs (Forsyth, 2015; Rahman et al. 2011; King et al. 2011; Lin & Moudon, 2010).

Active commuters are also the most vulnerable road users, so investing in robust safety infrastructure to reduce vehicle speeds, improve visibility, and protect pedestrians is critical (Giles-Corti et al. 2016). Focused investments in safe design features can encourage more people to walk, bike, and take public transportation.



DESIGNING TRANSIT ENVIRONMENTS TO SUPPORT ACTIVE TRANSPORTATION

The Houston-Galveston Area Council, which covers Harris County and seven adjacent counties, projects the daily vehicle miles traveled (VMT) to increase by 50% to nearly 300 million miles traveled daily by 2045 (H-GAC, 2019). As VMT increases, daily vehicle hours traveled increase and the speed of traffic declines. Without serious investments in alternative modes of transportation, the amount of time spent traveling in serious or severe traffic will go up from 15% of daily travel in 2020 to 52% in 2045 (H-GAC, 2019).

Urban heat is one of the most serious health hazards that results from the built environment. Densely built urban areas with few trees and large amounts of impervious surfaces not only radiate the sun's heat during the day, but also absorb heat and release it at night. This creates an urban heat island. These urban heat islands can be substantially hotter than communities with shade trees and more green space. Effects of urban heat include increased mortality and morbidity from cardio-pulmonary diseases, kidney disease, and mental illness. The health risks related to urban heat are likely to intensify over the coming decade, as climate change proceeds and urbanization increases. Changes to the built environment, buildings, and urban design are urgently required to cope with and prevent the harms of extreme heat (Tong, et al., 2021). Access to safe and robust pedestrian infrastructure is also an equity issue. Walking, biking, and public transportation are less expensive alternatives to vehicle ownership, and low-income households tend to have limited vehicle access. In a Brookings study, Houston was found to underperform in its provision of public transportation and job access for low-income, zero-vehicle households (Tomer, 2011).

Increasing access to multi-modal transportation options, particularly in underserved communities with higher percentages of zero-vehicle households, improves social equity by creating connections to job centers, health services, and other essential goods and services. A fully integrated light rail and bus system can significantly improve job access, particularly for low-wage workers (Fan et al., 2012).

Developing more densely can reduce emissions, developing outside of the floodplains or elevating buildings to prevent flooding can save money long-term, and integrating native plants and trees as much as possible can sequester carbon, reduce urban heat, and protect against flooding.

**Contributed by Harris County Public Health, Environmental Public Health Division*

Four Lenses of Urban Design

1 2 3 4

Scale
regional | neighborhood | site

Learning Objective
Understand the factors related to the Four Lenses of Urban Design that influence design decisions made in the Urban Design Environment

Summary
Environmental resilience, community diversity, sustainable development, and customer service are influenced by geographic zones, ecological zones, urban design transect, regional connectors, neighborhood connectors, universal accessibility,

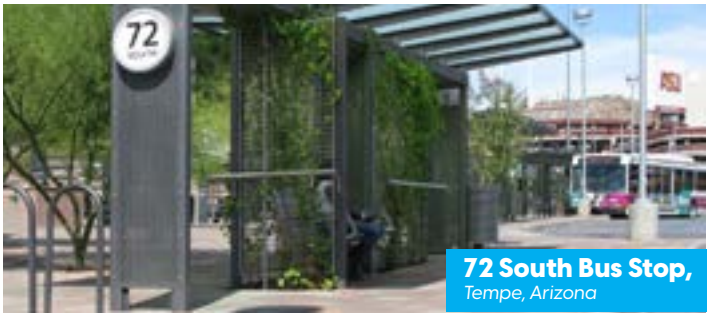

METRO
5
6
7
8

Urban Design Lenses

Environmental Resilience

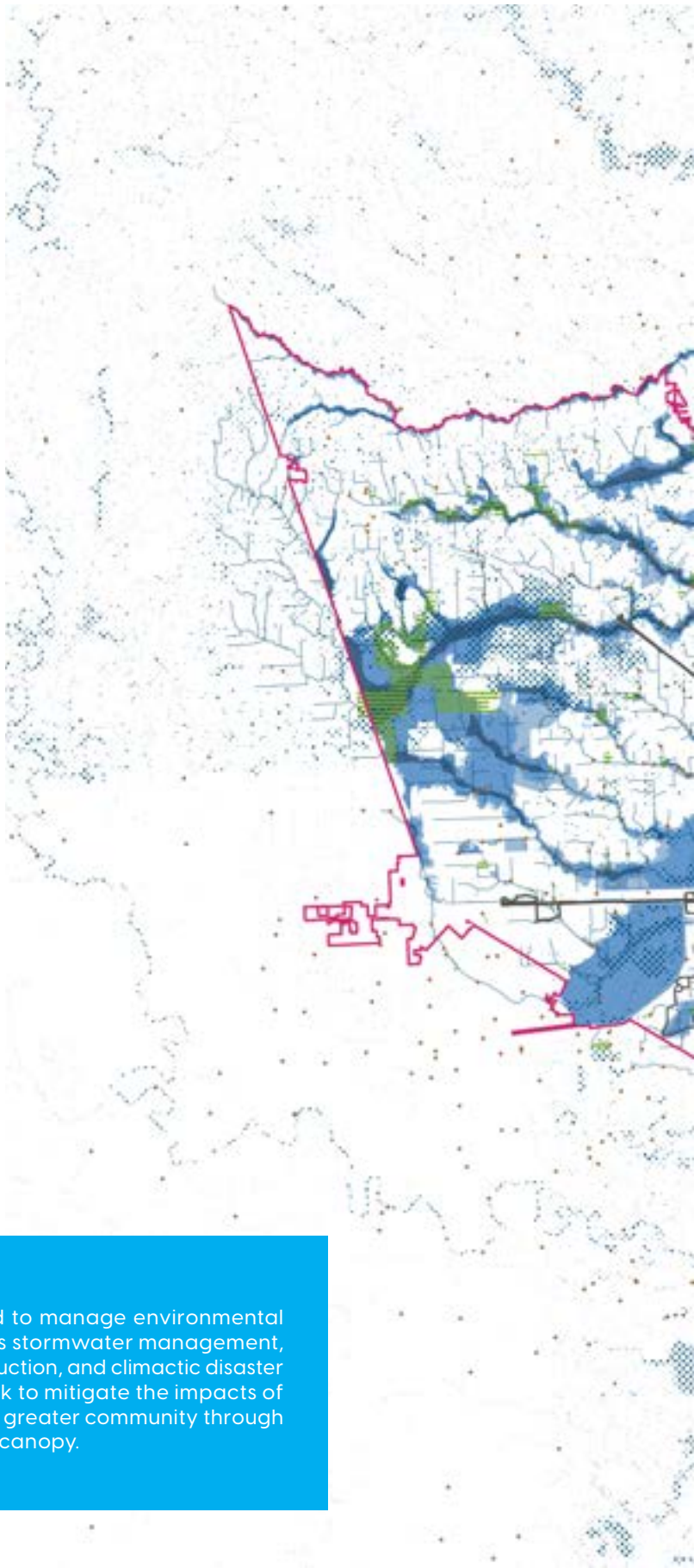
The region has unique features that impact environmental design considerations from its bayous to soil conditions, weather, climate, native vegetation, ecological zones, and aesthetic character. These considerations vary throughout the service network. METRO's large service footprint creates a unique opportunity to positively impact the region through sustainable and resilient design solutions applied holistically.

Lausanne-Flon Station
Lausanne, Switzerland



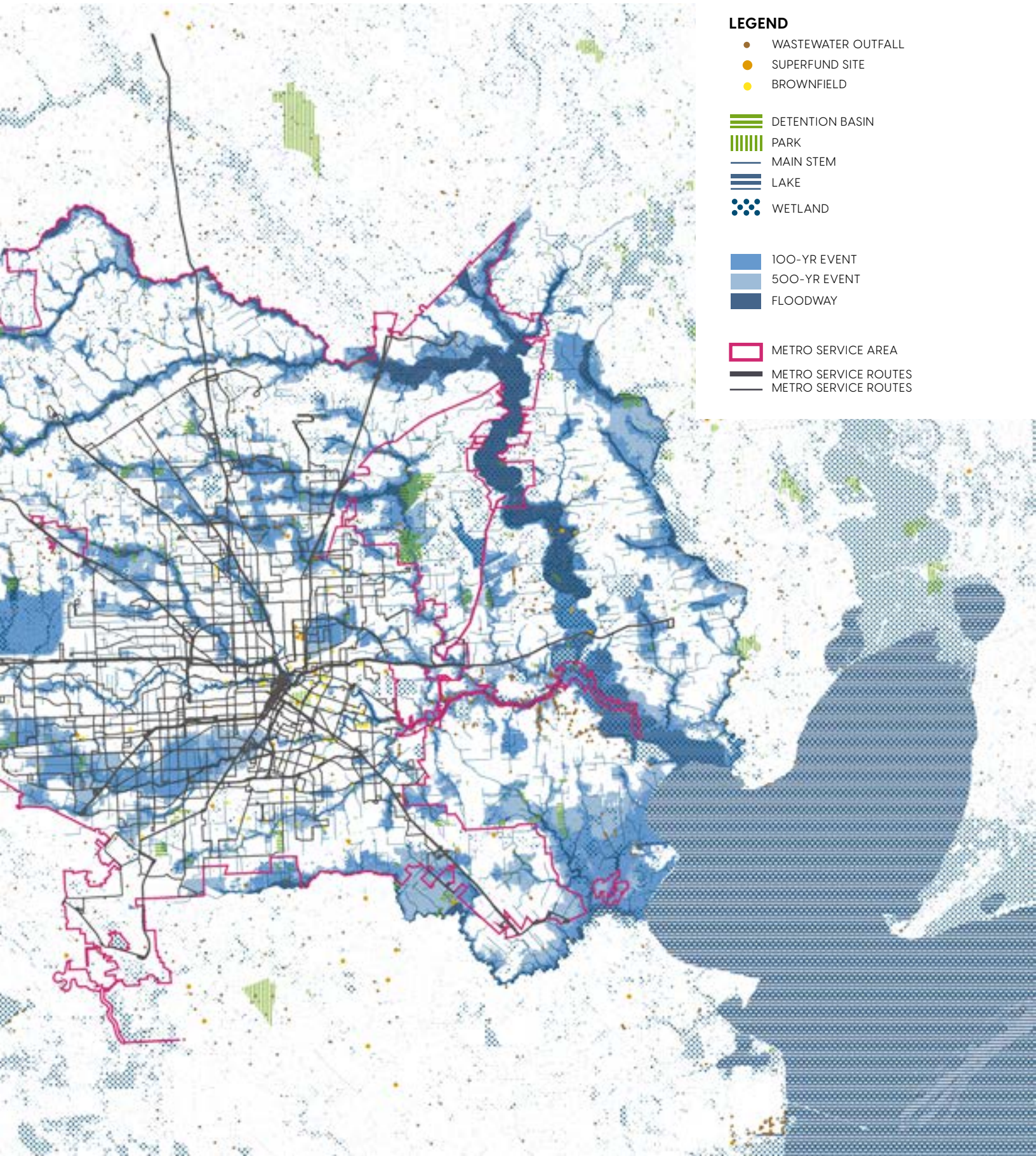
72 South Bus Stop,
Tempe, Arizona

mkt Heights
Houston, TX



METRO Impact

Urban design strategies can be deployed to manage environmental considerations at METRO facilities, such as stormwater management, energy consumption and light pollution reduction, and climactic disaster response. In addition, these strategies seek to mitigate the impacts of heat island effect on METRO riders and the greater community through green infrastructure, shelters, and shade canopy.


LEGEND
WASTEWATER OUTFALL
SUPERFUND SITE
BROWNFIELD
DETENTION BASIN
PARK
MAIN STEM
LAKE
WETLAND
100-YR EVENT
500-YR EVENT
FLOODWAY
METRO SERVICE AREA
METRO SERVICE ROUTES
METRO SERVICE ROUTES

Urban Design Lenses

Diverse Communities

The greater Houston region is diverse and rich with culture both in terms of its population and its institutions. The vast ethnic, cultural, and demographic variabilities of communities of the region add a unique set of identities and challenges. Shaped by unique vernacular aesthetics, community connectors, and cultural amenities, METRO facilities and transit corridors can reflect and enhance the communities they serve.

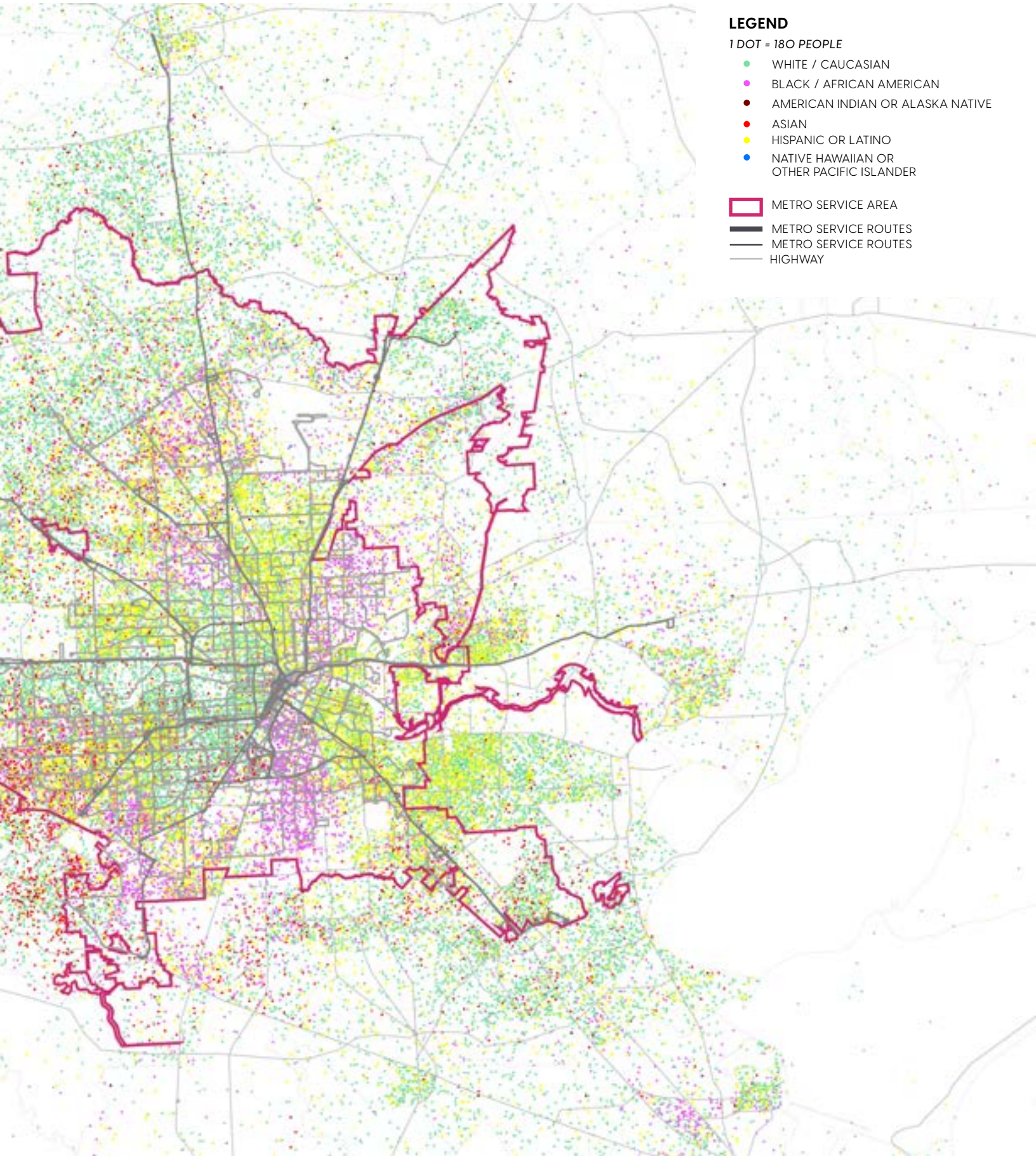
Bus Shelter Mural Program
Seattle, Washington

Fresh MARTA Market
Atlanta, Georgia

Northside Transit Center
Cincinnati, Ohio

METRO Impact

METRO's facilities and operations can respond by incorporating language accessibility into physical and digital communications as well as by branding facilities with design elements and art that support and celebrate the diverse ethnic and cultural communities of the region. METRO also provides connectivity to a broad range of civic, educational, and cultural institutions throughout the region to serve, entertain, and inspire residents and visitors alike.


LEGEND
1 DOT = 180 PEOPLE
WHITE / CAUCASIAN
BLACK / AFRICAN AMERICAN
AMERICAN INDIAN OR ALASKA NATIVE
ASIAN
HISPANIC OR LATINO
NATIVE HAWAIIAN OR
OTHER PACIFIC ISLANDER
METRO SERVICE AREA
METRO SERVICE ROUTES
METRO SERVICE ROUTES
HIGHWAY

Urban Design Lenses

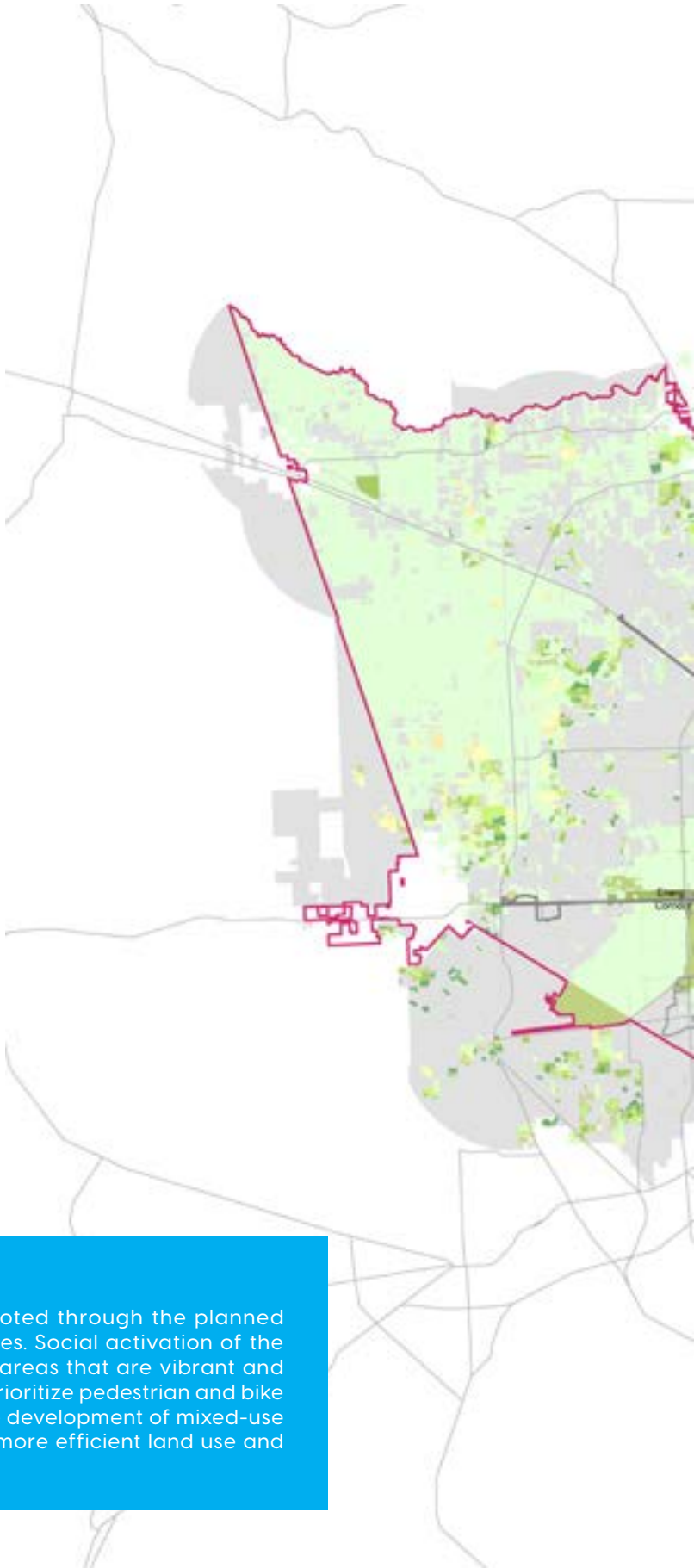
Sustainable Development

Increased ridership of transit services promotes more sustainable patterns of development within the service area through the prioritization of multi-modal use. Transit Oriented Developments, through joint partnership opportunities, influence the urban design environment directly through the thoughtful consideration of building setbacks, parking orientation / footprint, and micromobility.

Fruitvale Village
Oakland, California

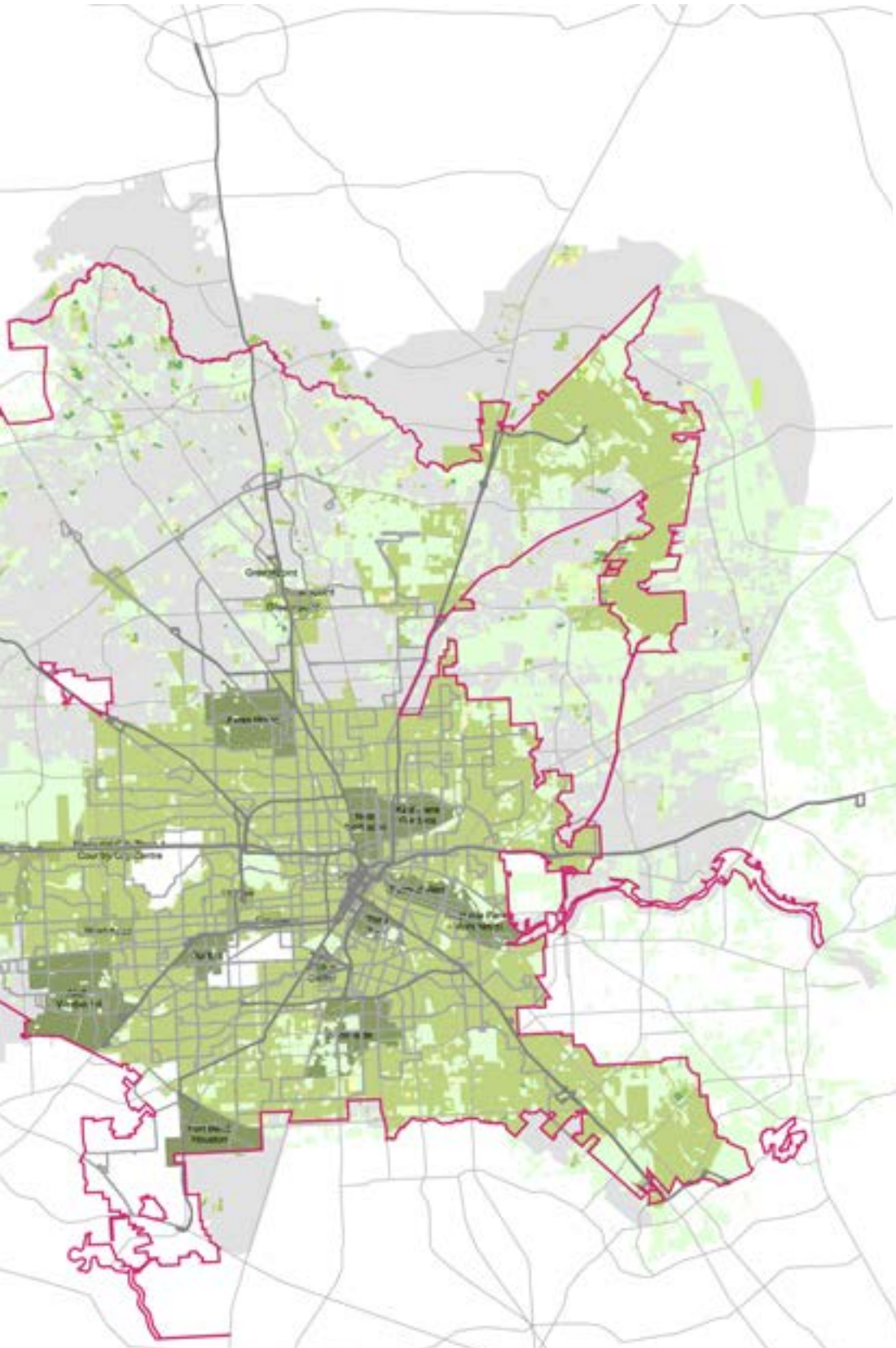
Willowbrook Rosa Parks Station
Los Angeles, California

Adelaide Street
Adelaide, Australia



METRO Impact

Sustainable development can be promoted through the planned phasing of METRO facilities for future uses. Social activation of the pedestrian realm encourages walkable areas that are vibrant and experiential. Traffic calming techniques prioritize pedestrian and bike access to and within METRO facilities. The development of mixed-use centers within METRO facilities provides more efficient land use and draws customers to facilities.



LEGEND

PLAT APPLICATION YEAR

- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

AVAILABLE LAND

- AVAILABLE LAND OVER 15 ACRES
- COH COMPLETE COMMUNITIES
- COH MAJOR ACTIVITY CENTER
- COH ADMINISTRATIVE BOUNDARY
- COH ADMINISTRATIVE BOUNDARY

- METRO SERVICE AREA
- METRO SERVICE ROUTES
- METRO SERVICE ROUTES
- HIGHWAY

Urban Design Lenses

Customer Experience

The type, location, and design of transit stops affects reliability, travel time, safe crossings, transfers to other routes, access to local destinations, and integration with the surrounding community. Connectivity is the relative location of origins and destination centers. A multi-modal transportation network includes integrated systems for pedestrian, bicycle, and vehicles with transit to promote flexibility, choice, mobility, and connectivity.

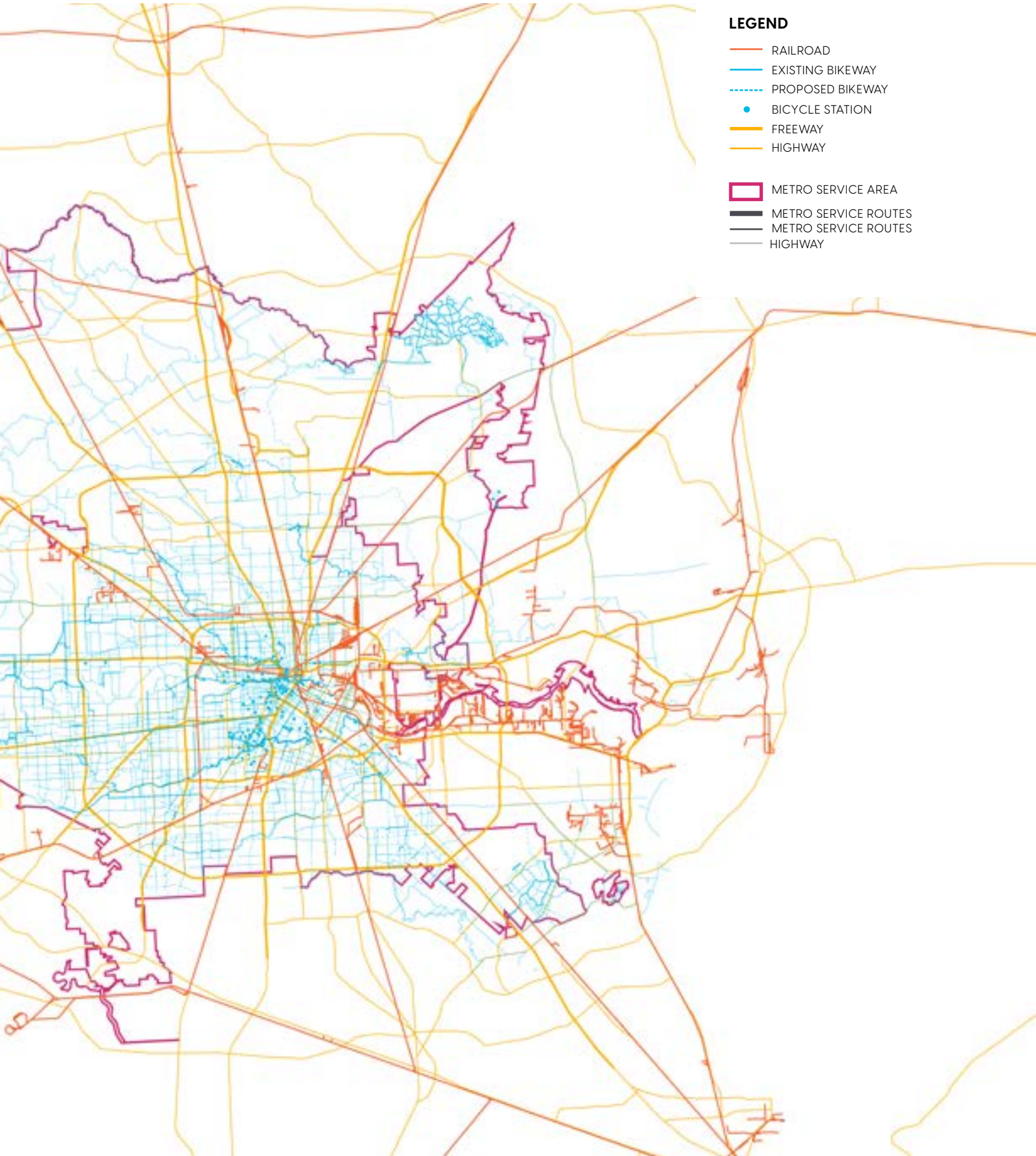
Umeå Vasaplan
Umea, Sweden

ARTIC Transit Center
Anaheim, California

Portland Pedestrian Mall
Portland, Oregon

METRO Impact

Barriers to transit use often include difficulty of access, climate related discomfort, visibility concerns, technology barriers, confusing system navigation, and poor brand consistency. METRO's facilities should be inspiring to the METRO brand in visual quality and durability, while the journey to the facility should be comfortable and accessible. Transit should not only be seen as a positive experience, but a preferred mode of travel within the city.


LEGEND
RAILROAD
EXISTING BIKEWAY
PROPOSED BIKEWAY
BICYCLE STATION
FREEWAY
HIGHWAY
METRO SERVICE AREA
METRO SERVICE ROUTES
METRO SERVICE ROUTES
HIGHWAY

METRO Service Area Urban Design Zones

UNDERSTANDING THE HIERARCHY OF GEOGRAPHIC INFLUENCE ON DESIGN

Geographical Zones

METRO's service area fits within expansive urban context. Together, political boundaries, urban form, and local geography create a varied and influential context for the transit network that helps develop a methodology by which the vast system can be understood in smaller parts.

METRO's large service area has been organized into sectors for a variety of METRO activities including, but not limited to, METRO Police Department operations and METRONext planning and design activities.

In addition, there are a variety of planning, operations, environment, and community character considerations that can be assigned to specific geographic areas of the region. As such, the urban design recommendations in this manual are presented primarily based on five zones: four quadrants of Northeast, Northwest, Southeast, Southwest, and Central.

Each quadrant is further shaped by differing environmental conditions shaped by climate, geographic location, amount of hardscape infrastructure, and soils. These environmental differences influence the ecoregional character of each zone. Green Infrastructure recommendations by zone are listed in Chapter 08 of the METRO Urban Design Manual.

Figure 01. METRO Service Area and Houston Super Neighborhoods

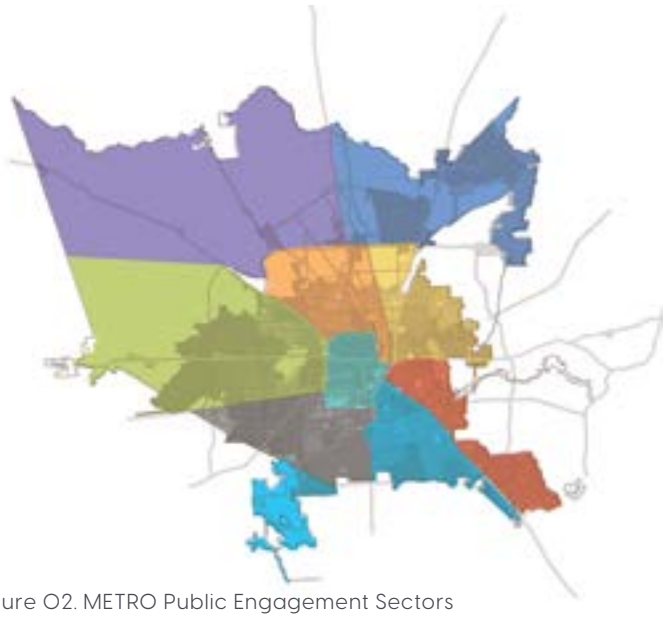


Figure 02. METRO Public Engagement Sectors

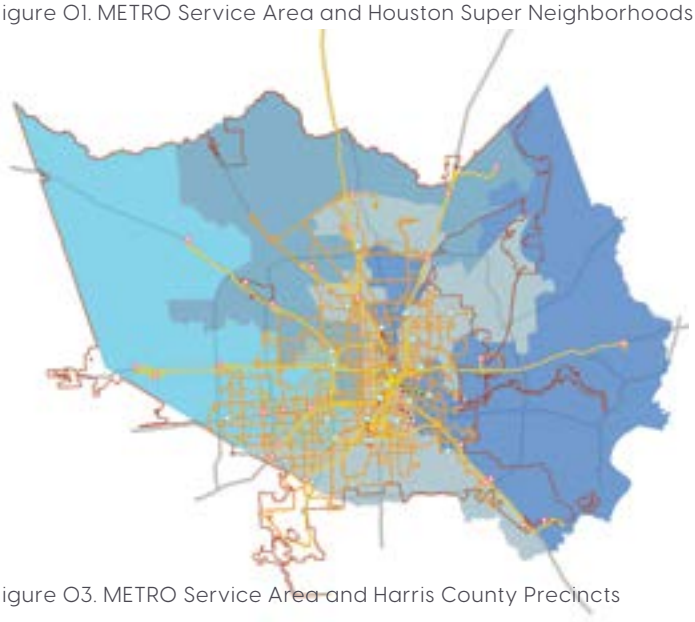


Figure 03. METRO Service Area and Harris County Precincts

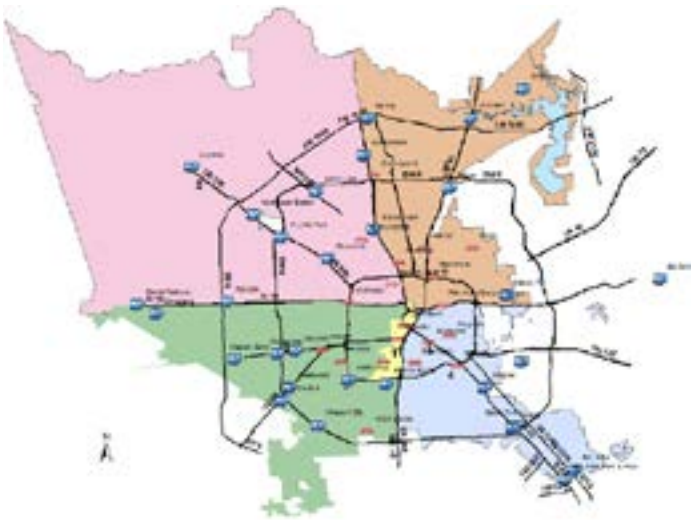


Figure 04. METRO Service Area and MPD Operation Zones

Environmental Zones

Central

The Central zone is a heavily developed urban area with with varying shade cover, green space, and stormwater infrastructure improvements.

Northwest

The Northwest zone has large areas of undeveloped land. In addition to Piney Woods further east, it contains mostly Prairie that transitions to Post Oak Savannah.

Northeast

This zone has is the most ecologically diverse zone characterized primarily by Piney Woods, Prairie, and Big Thicket.

Southeast

The Southeast zone is a historically coastal-adjacent Prairieland but contains large areas blighted by heavy industrialization and hardscape.

Southwest

The Southwest zone is primarily Prairieland that slowly transitions towards Columbia Bottomlands.

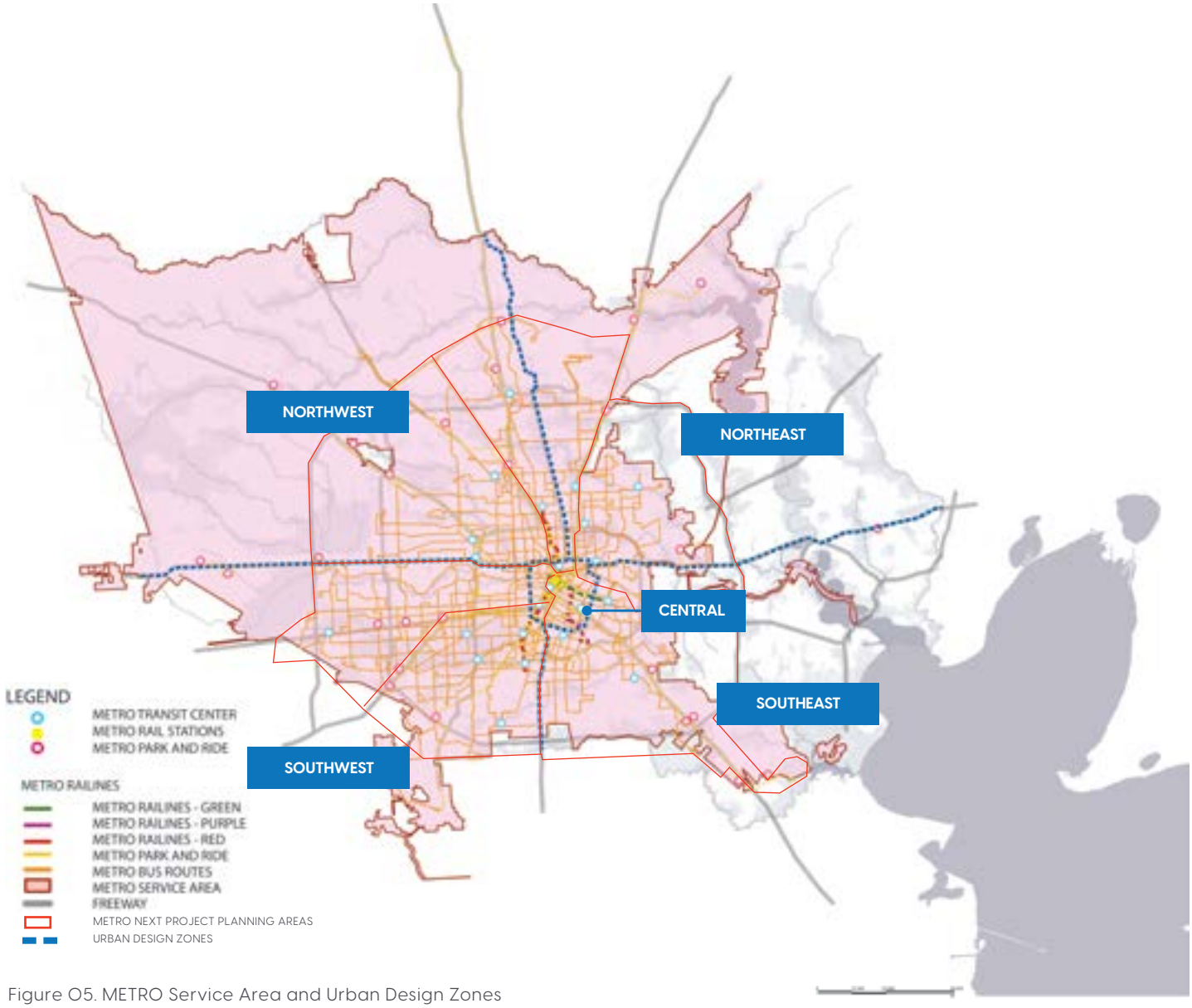


Figure O5. METRO Service Area and Urban Design Zones

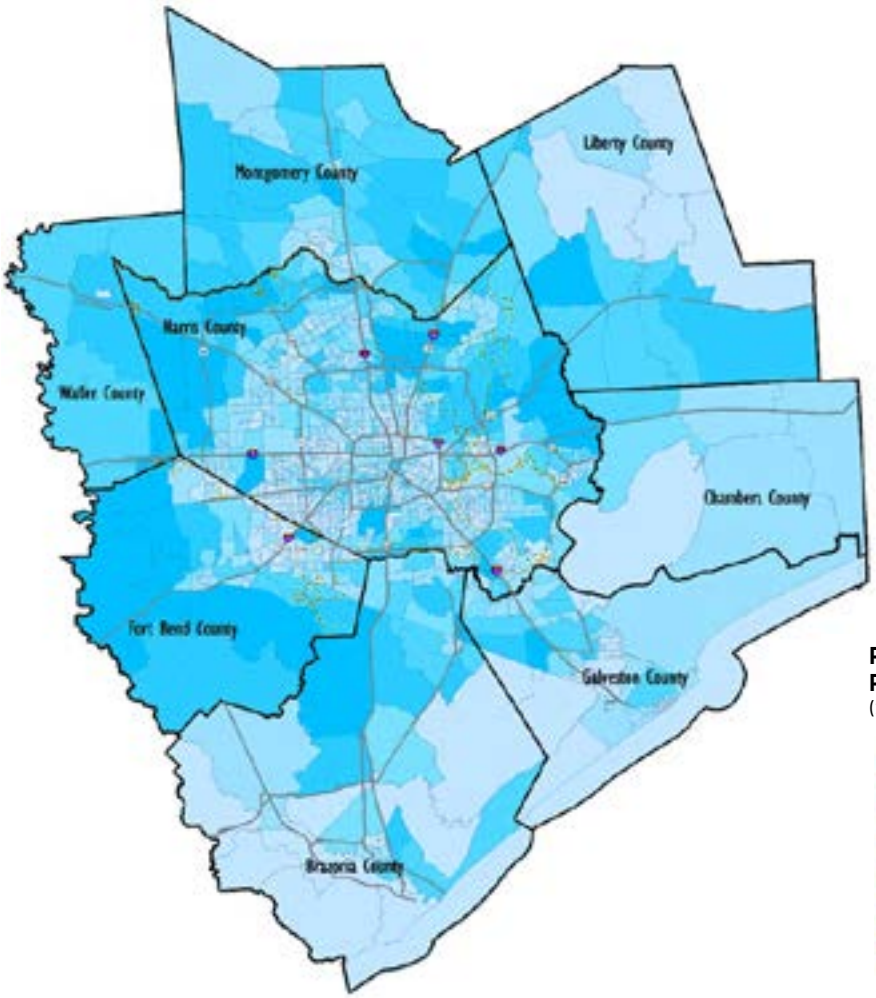
METRO Urban Design Transect

IRREGULAR DENSITIES

Houston's complex urban fabric evades an oversimplified notion of a gradual transect of dissipating density from the center. There are discontinuous pockets of high-rise development next to single-family residential, transitional industrial lands next to mid-rise mixed-use districts, etc. At the same time, it is useful to consider how association of transit lines with particular developments has potential to restructure their patterns in the region over time. As the population of Harris County keeps growing, urban infill development will respond to the economic pressure of rising land values in the urban core with densification.

Mixed-use destination town centers will aggregate community activity in the suburbs. Facilitated by the presence of transit, prospects for denser transit-oriented development typologies will fulfill the ultimate purpose of METRO to connect the region while promoting its more sustainable future.

The manual adopts five types of urban density for the Houston region to correlate responses within the urban design context of METRO facilities: downtown, urban, urban edge, dense suburban, and developing suburban.



PROJECTED REGIONAL POPULATION GROWTH
(2015-2040)

- < 1%
- 1% - 44%
- 45% - 74%
- 75% - 149%
- 150% - 249%
- > 250%
- METRO Service Area

DOWNTOWN | URBAN | URBAN EDGE | DENSE SUBURBAN | DEVELOPING SUBURBAN

URBAN DESIGN FORMS THE FABRIC OF OUR CITY.

Despite the term "urban," urban design shapes the built environment at every density. Each classification of density within the city presents differing challenges, character, and functions. The way these densities collide in an unconventional manner offers unique opportunities for Houston.

DOWNTOWN

Downtown environment has a specific density profile and role in the region as the primary destination employment center serviced by transit. A node for Bus, LRT, and Transit Center services, it also presents street-side commercial activity to be considered in the design responses around those facilities. Due to the high volumes of pedestrians in Downtown and high levels of peak-hour traffic volumes, pedestrian safety must be emphasized.

URBAN

Urban environments often have high density development, important cultural destinations, and a concentration of retail, office, or mixed-use developments. Houston has several urban areas that are not associated with Downtown. Some examples include Uptown, The Medical Center, and The Energy Corridor District. Most residential uses are multi-family. Similar to Downtown, these areas require high amounts of multi-modal safety.

URBAN EDGE

Urban edge environments contain the greatest mixture of popular retail destinations, dining, open space amenities, multi-family residential, and single-family residential homes. Neighborhood identity, clear pedestrian hierarchy, and tree canopy cover are highly valued as part of the transit environment. Placement of transit nodes around popular destinations enhances neighborhood character and improves safety. Some examples include The Heights, Montrose, Midtown, EADO, and the Third Ward.

DENSE SUBURBAN

Dense suburban environments are typically located on the outer edges of the city with a low density pattern of commercial town centers and community facilities. They are concentrated around interstates and interchanges with connections to high capacity transit of frequent bus services. Some examples include Meyerland, Magnolia Park, Spring Branch, Sharpstown, and Aldine.
Pedestrian and multi-modal access to suburban facilities are often disconnected by roadway infrastructure.

DEVELOPING SUBURBAN

Developing suburban environments provide the lowest density context for transit facilities which are typically located along high capacity freeway interchanges, greenfield development, and large areas of undeveloped rural or infrastructure land. Over time, the urban fabric grows up around facilities, necessitating new considerations of access and connectivity. Large scale applications of green infrastructure are recommended due to the availability of land and concerns of mitigating new development.

Regional Connectors

REGIONAL CHARACTER GRADIENTS

Corridors within the city often have a strong visual language unique to the community. The scale between roadways, buildings, and streetscape plays an important role in the aesthetic, safety, and experience of the transit environment.

A diversity of roadway configurations and scales provides challenges and new opportunities for the Houston transit environment. The identity of a neighborhood is directly influenced by the type of roadway environment and use. More travel lanes create an increased urgency for a safe and walkable environment, but provide the greatest potential for improvement through the reallocation of vehicular right-of-way for pedestrian access and dedicated transit lanes. Fewer vehicular lanes typically promote a safer and slower vehicular lane, but pose difficulty when there is a limited pedestrian realm.

Although there are specific easements that METRO utilizes for guided rapid transit or fixed guideway transit systems, all roadway classifications are intrinsically connected to the transit environment.

FREEWAY / TOLLWAY

Freeways and tollways are dedicated to vehicular circulation only. Pedestrian and bike circulation is limited to underpass locations and relies heavily on signalized crossings. There is an increased need for legible access and identification of facilities from the freeway.

PRINCIPAL THOROUGHFARE

Principal thoroughfares are designed for high volumes of traffic and often form distinct corridors. They generally serve commercial / economic corridors, heavily concentrated office areas, densely populated neighborhoods, and suburban commercial developments.

MAJOR THOROUGHFARE

Major thoroughfares accommodate medium to high traffic volume in areas with mixed-use, office, small community retail centers, and residential areas. As connectors to the freeway system, special considerations to speed must be addressed in urban design.

MAJOR COLLECTOR

Major collectors provide access to vibrant mixed-use centers, commercial, or residential uses. These have the greatest potential for pedestrian / bike connectivity.

MINOR COLLECTOR

Minor collectors are typically smaller stretches of roadway at slower speeds of travel that connect lower density residential areas to neighborhood services.

LOCAL STREETS

Local streets are most often connected to residential areas and connect the network of other roadway classifications.

Neighborhood Connectors

NEIGHBORHOOD CHARACTER GRADIENTS

COMMERCIAL / ECONOMIC

Commercial / economic corridors contain a high level of vehicular and pedestrian activity. Retail, restaurants, bars, and office space add to the vibrant identity of the community. Bold amenities are often present. Transit opportunities should prioritize safety and efficiency through proper placement of facilities and crosswalks, while adding to the character of the site through the careful selection of materials.

HISTORIC

Cultural and historic corridors highlight architecturally important features. Lighting and amenities tend to be more traditional and subdued in color. These areas tend to have higher levels of pedestrian activity, high sentimental value, and are popular destinations for learning, living, and dining. Transit should seek to respect the character of these corridors while embracing their history.

GREEN / SCENIC / ECOLOGICAL

Natural features and gateways often serve as a greenway or boulevard. These corridors are emphasized through tree canopy and large buffers of adjacent landscape. These green threads serve as iconic neighborhood connectors. Transit facilities should seek to add to the ecological value of these communities and provide safe access to recreational facilities.

SERVICES

Neighborhood services are typically connected through vehicular-centric streetscapes. Community character is defined more clearly by the architectural nature and materiality of residential-adjacent developments. Transit facilities should respect the quiet nature of residential areas while providing safe, comfortable, and convenient access to important community resources. Special attention to driveways must be considered in the transit environment.

HIGH-SPEED ACCESS

High-speed access corridors are located adjacent to the highway system and contain a mix of large scale commercial and multi-family residential. High Speed corridors must factor in the heavy vehicular nature of surrounding entrances / exits. Sound, heat island effect, and pedestrian safety/connectivity are important considerations within these corridor environments. Pedestrian access in these areas must safely transverse underpasses.

CIVIC / CULTURAL

Civic and cultural corridors are often defined by museums, libraries, universities, educational centers, historic buildings, recreational areas, government buildings, and multi-service centers. As popular destinations for tourists and visitors alike, these corridors have strong identities and have a large concentration of pedestrian traffic. Transit facilities and corridors should highlight the character of civic and cultural institutions, and can partner to educate through facility design.

Universal Accessibility Principles

DIVERSE INDIVIDUALS

Users of the transit system vary in age, size, abilities, and situational hinderances that may affect how they navigate the urban design environment. There are seven commonly accepted principles of Universal Accessibility (*Center for Universal Design at North Carolina State*) that can inform the urban design environment: ***equitable use, flexibility in use, simple & intuitive use, perceptible information, tolerance for error, low physical effort, and size & space for approach / use.***

Equitable use ensures spaces are accessible and enjoyable for everyone. ***Flexibility in use*** accommodates a wide range of preferences and abilities.

Simple & intuitive use ensures that spaces that are easy to understand regardless of knowledge, linguistic preferences, or concentration levels. Communicating ***perceptible information*** allows facilities, streetscapes, and amenities to be easily understandable regardless of sensory abilities. Allowing ***tolerance for error*** minimizes hazards from unintentional actions. Designing for ***low physical effort*** can increase the comfort for users to access with minimal fatigue. Designing for ***size & space for approach / use*** ensures greater flexibility for all users regardless of size or hand-preference.

PHYSICAL

Many transit users vary in mobility. Wheelchair users, walker users, elderly patrons, and parents with strollers need adequate space in the travelway for both passing and resting. Designing beyond minimum requirements enables a higher level of comfort for all users and their proximate interactions.

VISUAL

The use of tactile paving, detectable warning strips, tactile and high contrast signage, and auditory signals / real-time arrival announcements enhances the safety and perception of those with visual impairments.

AUDITORY

Users with hearing impairments can benefit from the use of digital signage that communicates real time arrival information. Additionally, those with hearing aids can benefit from audio announcements through the inclusion of designated hearing loop areas in larger facilities.

LINGUISTIC / LITERACY

Differing linguistic or literacy abilities can be accommodated through the use of bilingual translations and iconography to denote key station functions and processes.

COGNITIVE

The creation of legible, hierarchical, and intuitive spaces enhances safety and perception for users with differing cognitive abilities and memory retention. Designing designated quiet spaces can aid users with sensory sensitivities.

SIZE

Spaces are typically designed for adults of average size. Users of transit vary greatly in both height and width. Passing widths, vertical head clearances, and heights of amenities should be designed or selected to offer greater flexibility.

Diverse Communities

DIVERSE GROUPS

HOUSTON IS ONE OF THE MOST DIVERSE CITIES IN THE USA.

Houston is consistently ranked as the most or one of the most ethnically and culturally diverse cities in the United States. While many areas in the city have a wide distribution of multi-ethnic and cultural groups, others have unique identities that can be expressed in the urban design environment.

CULTURAL TOWNS

Cultural towns are areas with high concentrations of a particular cultural or ethnic group. These areas reflect popular cuisine, language, shopping, and civic destinations of singular or multiple cultures. These form important nodes of activity that can be celebrated. Several cultural towns reflect bilingual signage that can be integrated into neighboring transit facilities.

LINGUISTICALLY SIGNIFICANT

Many communities within Houston have pockets within communities that speak a primary language other than English. Wayfinding & art can be reflective of these linguistic distinctions in the urban design environment. Common languages spoken in Houston other than English include Spanish, Vietnamese, Chinese (Mandarin & Cantonese), West African languages, and French Cajun.

ETHNICALLY SIGNIFICANT

Communities throughout Houston have unique histories and stories shaped by ethnic communities. These are historic identities that are often reflected in demographic population, architectural style, food and culture, as well as community art. Preservation of identity is an important priority of these communities. Community engagement is vital in these communities to fully capture the identity of ethnically significant neighborhoods.

CULTURALLY SIGNIFICANT

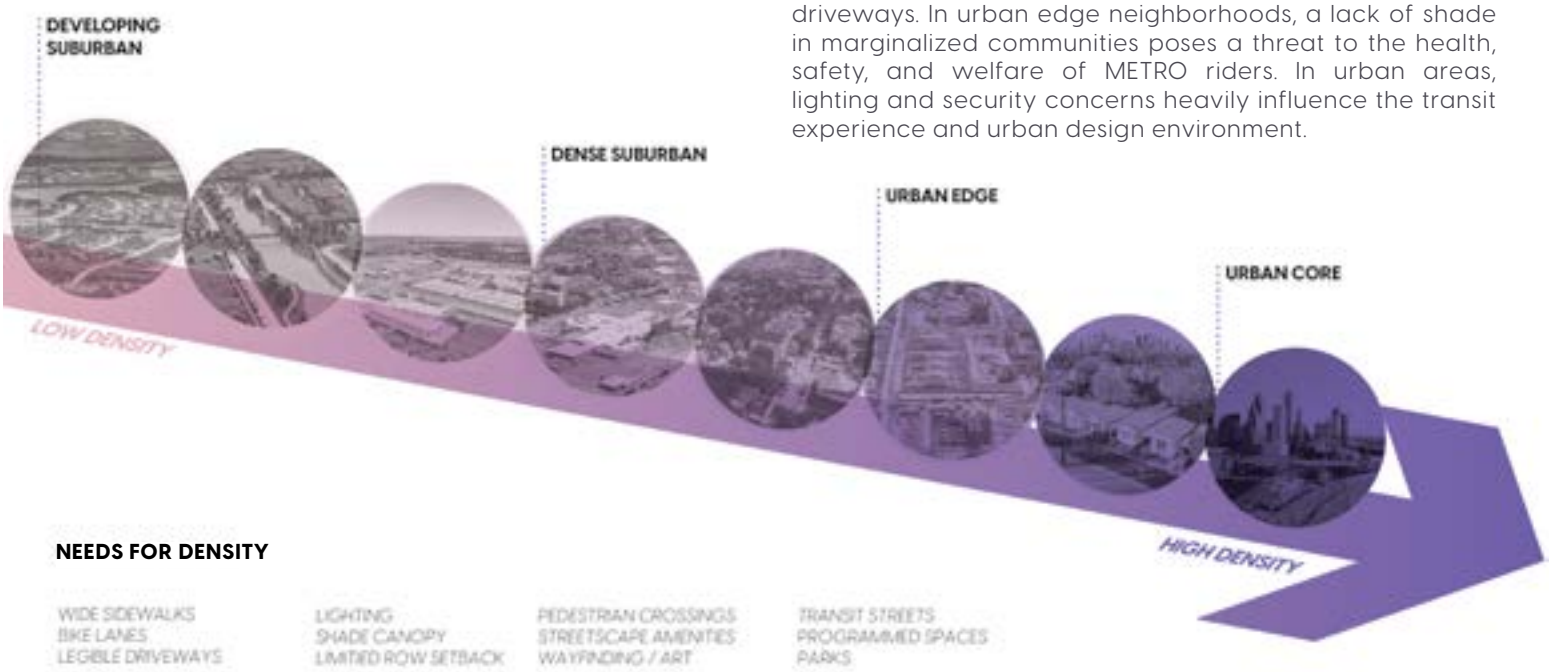
Over time, many cultural groups have settled in areas throughout the city. These character settlements may be historic or contemporary in nature. These culturally significant communities have a prominent culture expressed within the community. Community markets and art are important features of culturally significant communities. In many cases, communities are both diverse in terms of ethnicity and culture.

MULTI-ETHNIC

Much of Houston is multi-ethnic in nature and does not have one significant ethnic or cultural identity. This means that every facility should be navigable and welcoming to all Houstonians. Art, wayfinding, and materiality can reflect the service area as a whole while highlighting individual community character.

DESIGNING FOR NEEDS AT DIFFERENT DENSITIES

Neighborhood density plays a big part in defining the urban realm. Neighborhood densities vary widely on a spectrum between developing suburban to the urban core. Houston's sprawling growth and eclectic land use adjacencies create unique stressors and opportunities for its transit environment. In less dense neighborhood environments, wider roadways and car-centric developments place a strain on pedestrian connectivity as sidewalks are perforated by a series of driveways. In urban edge neighborhoods, a lack of shade in marginalized communities poses a threat to the health, safety, and welfare of METRO riders. In urban areas, lighting and security concerns heavily influence the transit experience and urban design environment.



NEEDS FOR DENSITY

WIDE SIDEWALKS
BIKE LANES
LEGIBLE DRIVEWAYS

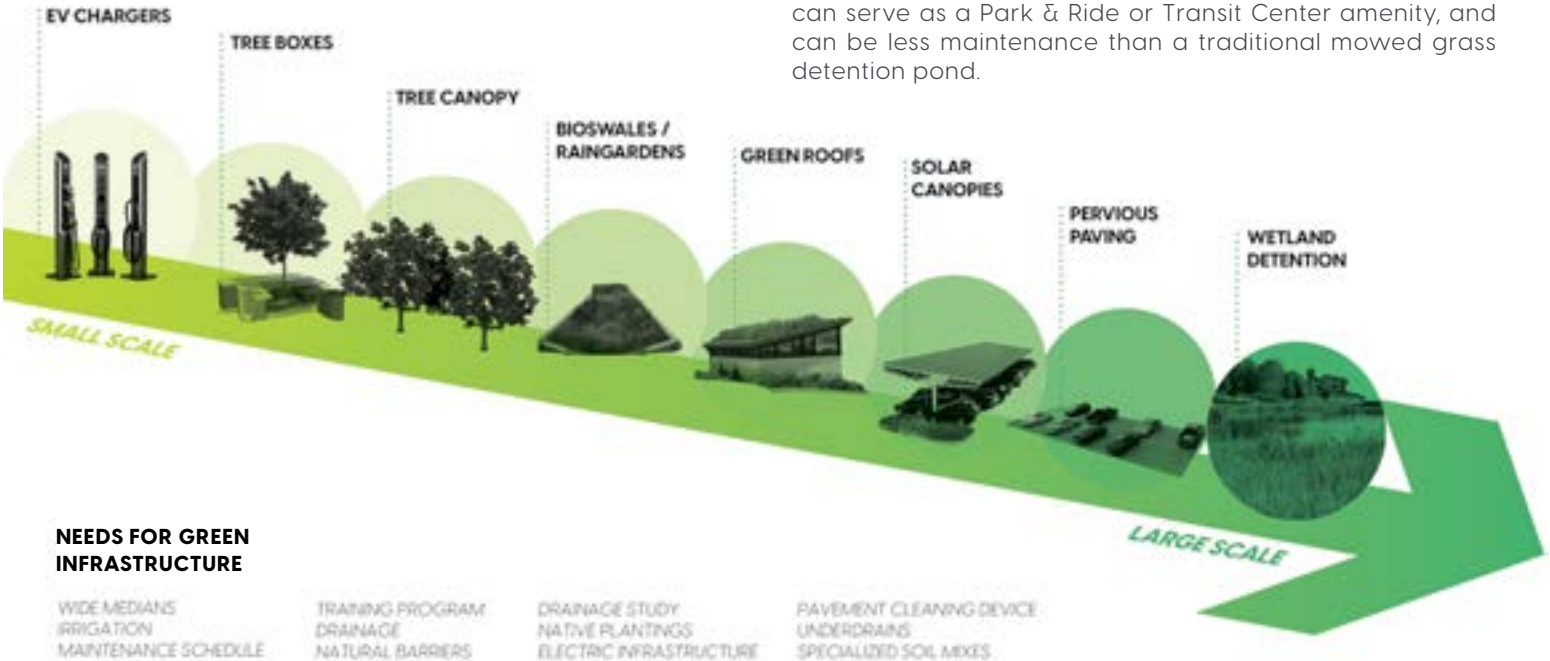
LIGHTING
SHADE CANOPY
LIMITED ROW SETBACK

PEDESTRIAN CROSSINGS
STREETSCAPE AMENITIES
WAYFINDING / ART

TRANSIT STREETS
PROGRAMMED SPACES
PARKS

DESIGNING FOR ENVIRONMENTAL NEEDS

Green infrastructure can be applied at a variety of scales in the urban design environment. Shade equity can be improved through the planting of a robust tree canopy along main bus stop routes. Stormwater runoff can be infiltrated and purified through the use of tree boxes, bioswales, and wetland detention. Wetland detention can serve as a Park & Ride or Transit Center amenity, and can be less maintenance than a traditional mowed grass detention pond.



NEEDS FOR GREEN INFRASTRUCTURE

WIDE MEDIANS
IRRIGATION
MAINTENANCE SCHEDULE

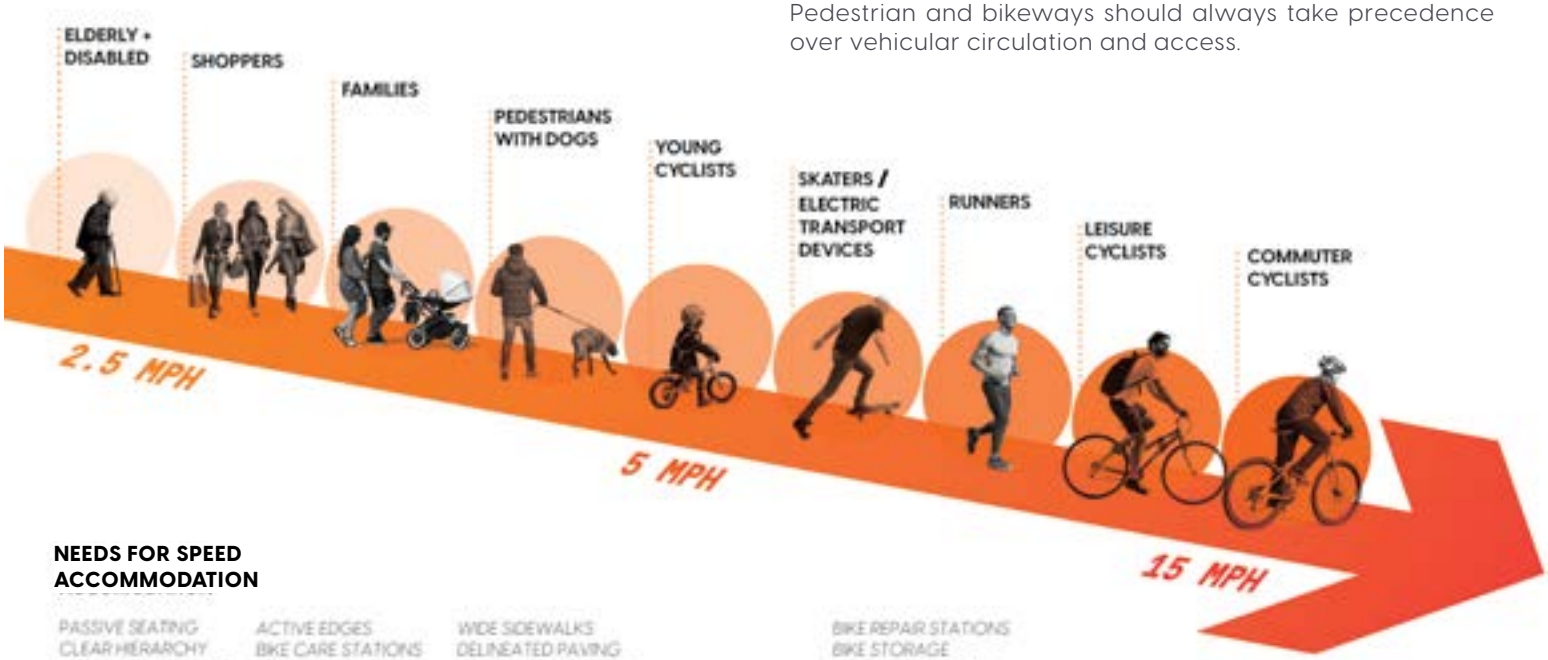
TRAINING PROGRAM
DRAINAGE
NATURAL BARRIERS

DRAINAGE STUDY
NATIVE PLANTINGS
ELECTRIC INFRASTRUCTURE

PAVEMENT CLEANING DEVICE
UNDERDRAINS
SPECIALIZED SOIL MIXES

DESIGNING FOR HUMAN SCALE OF NEEDS

The word "pedestrian" is often used in a general sense, but pedestrians by nature are a diverse set of users with various needs that must be accommodated in the public realm. From elderly and disabled METRO riders to commuter cyclists, a dynamic range of speeds must be accounted for at the human scale. Customer experience is based on both the access and comfort of pedestrian and bikeway systems. Pedestrian and bikeways should always take precedence over vehicular circulation and access.



NEEDS FOR SPEED ACCOMMODATION

PASSIVE SEATING
CLEAR HIERARCHY
SCALED WAYFINDING

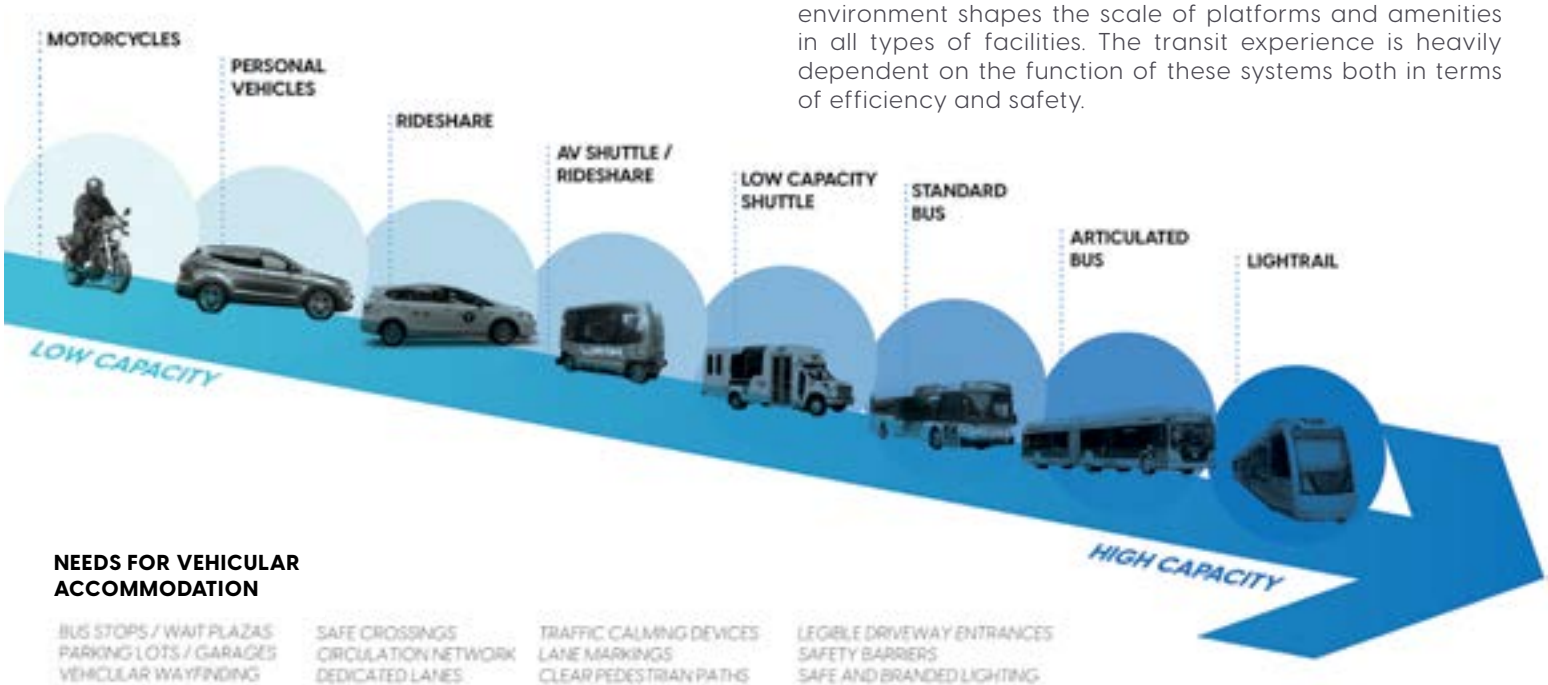
ACTIVE EDGES
BIKE CARE STATIONS
SAFETY BARRIERS

WIDE SIDEWALKS
DELINEATED PAVING
DEDICATED BIKE LANE

BIKE REPAIR STATIONS
BIKE STORAGE
SHADE STRUCTURES

DESIGNING FOR TRANSPORTATION SCALE

Roadways are most often designed to accommodate personal vehicles. This often results in large ROW footprints composed of many vehicular lanes, which in turn affects pedestrian circulation and transit integration. In addition, the variety of vehicular size and scale in the transit environment shapes the scale of platforms and amenities in all types of facilities. The transit experience is heavily dependent on the function of these systems both in terms of efficiency and safety.



NEEDS FOR VEHICULAR ACCOMMODATION

BUS STOPS / WAIT PLAZAS
PARKING LOTS / GARAGES
VEHICULAR WAYFINDING

SAFE CROSSINGS
CIRCULATION NETWORK
DEDICATED LANES

TRAFFIC CALMING DEVICES
LANE MARKINGS
CLEAR PEDESTRIAN PATHS

LEGIBLE DRIVEWAY ENTRANCES
SAFETY BARRIERS
SAFE AND BRANDED LIGHTING

Urban Design Process

1 2 3 4

Scale
regional | neighborhood | site

Learning Objective
Learn how METRO, its partners, and stakeholders participate in each stage of the the transit facility project lifecycle

Summary
Urban Design is integrated into the entire lifecycle of transit facility projects from programming through maintenance. Roles and responsibilities of METRO, partners, and stakeholders are presented.


METRO
5
6
7
8

Overall Planning & Design Process

A Dynamic & Interactive Design Process

Planning and design of transit corridors and facilities for a more than 1,300 square mile service area is a dynamic and integrative process for many reasons.

The METRO transit system operates at multiple geographic scales with a network of regional and sub-regional corridors and transit facilities at specific sites within neighborhoods and local communities. METRO's service area continues to grow in terms of both population and the geographic distribution of development. It is a system that must continuously evolve to meet the changing needs and demands of current and future riders, to incorporate new technologies and innovation, to comply with regulations, and to incorporate stakeholder input. All of this must be achieved while METRO is operating transit services for its current riders.

As such, the planning and design process for transit services and facilities is a continuous, ongoing process with continuous interaction between the three scales of urban design (regional scale, neighborhood scale, and site scale). There are a multitude of interdependent inputs and outputs that inform METRO's services and related transit facilities. These inputs and outputs—in the form of plans, policies, regulations, projects, services, or developments—may be led by METRO or by other public agencies, the private sector, civic institutions, or community stakeholders.

At the regional scale, transit corridor and facility planning can be initiated by METRO or may be in response to external regional efforts, large-scale infrastructure investments, or significant development projects. These regional transit plans then inform both neighborhood-scale transit and specific projects at the site scale.

Neighborhoods, management districts, and Tax-Increment Reinvestment Zones (TIRZ) in the METRO service area include multiple transit facilities. In addition to working with METRO to integrate these METRO facilities seamlessly within their boundaries, neighborhoods must also communicate their own plans, projects, and initiatives that may influence METRO transit programming. In addition, neighborhood scale efforts—such as management district design guidelines—provide inputs into site specific facility planning and design.

Finally, it is at specific sites where riders and the broader community access and interface with METRO transit services at bus stops, stations, Transit Centers, and Park & Rides. At the same time that the regional and neighborhood levels inform the location and design of these site scale transit facilities, the surrounding community context for each individual facility influences plans and designs. There are important lessons to be learned at the site scale in terms of functionality, design system performance, and rider preferences that can be reflected in future neighborhood and regional efforts.

REGIONAL

Let's create a consistent & accessible wayfinding systemwide!

What are ways we can equitably distribute high quality amenities?

How can we reduce METRO's ecological footprint system-wide?

Can we coordinate pedestrian connectivity between the new BRT station and the neighboring TIRZ streetscape project?

NEIGHBORHOOD

Let's partner with a private developer to create a joint TOD opportunity.

Let's find ways to light the neighborhood corridor to improve safety to transit.

What streetscape improvements will improve safety for the deaf community?

What are ways green infrastructure can create connective corridors for stormwater management?

How can the cultural identity of the neighborhood create a seamless transit experience?

SITE

Can we orient ticket kiosks differently to eliminate hiding places?

Let's program flexible parking space into the design of the site to serve as a public amenity during off-hours.

How can we maximize tree canopy within the design of the site?

What is a safe and logical pedestrian experience from facility entry to station platform?

Adjacent Planning Coordination

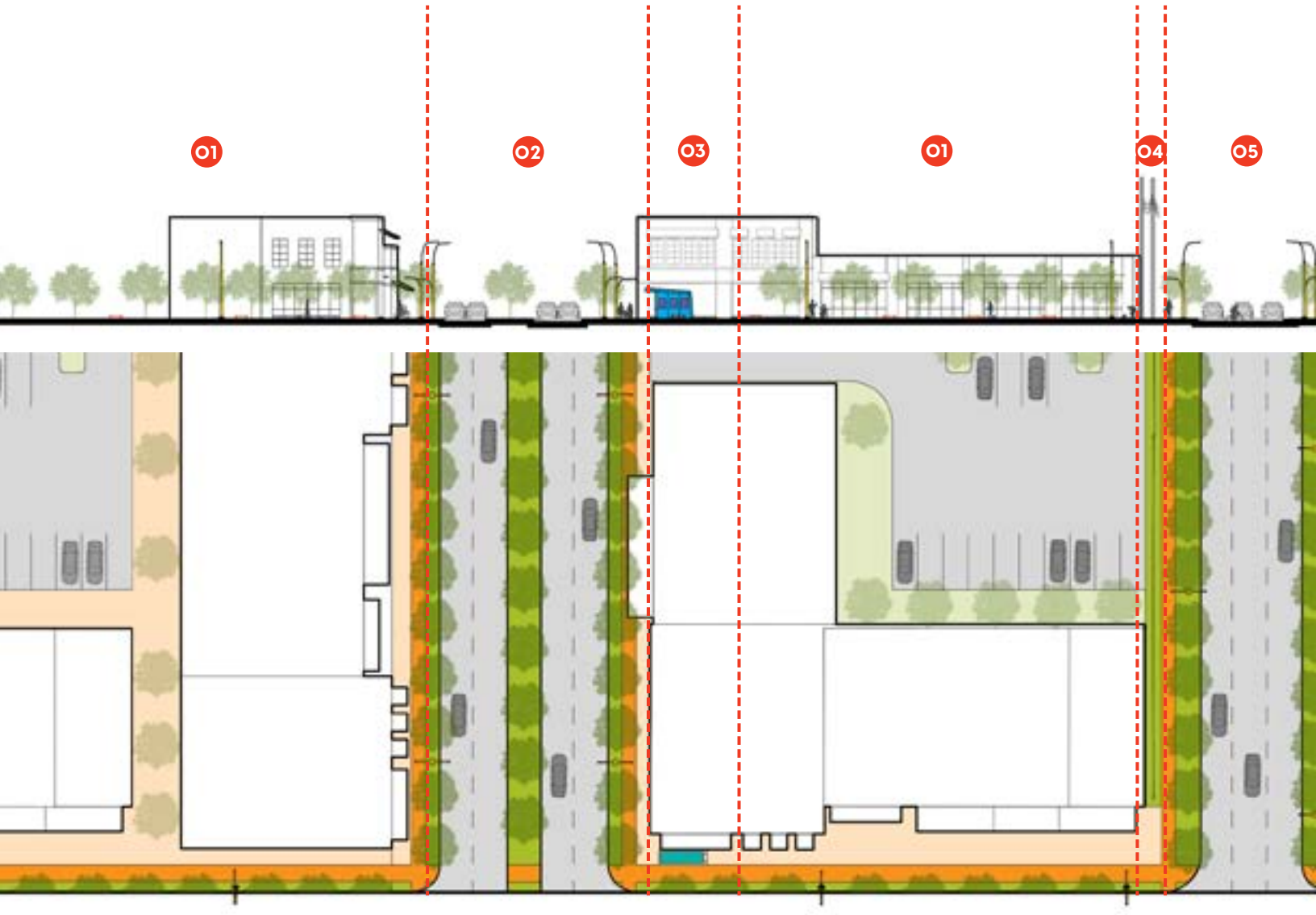
ENGAGING EXTERNAL STAKEHOLDERS

Before customers arrive to a METRO facility, they must take another form of transit–by foot, bicycle, or car. This means that the transit experience is not only influenced by the look, feel, and function of METRO facilities themselves, but also the environment customers must transverse to get there.

Different geographic areas will have additional potential partners such as local management districts and Tax-Increment Reinvestment Zones (TIRZs). There are more than 65 of these organizations in the METRO service area that are organized to allow commercial property owners to work together to supplement City and County services and improvements. As such, they may be able to assist in project planning or implementation and may also have their own capital investment projects in the vicinity of METRO service corridors and facilities.

Early and ongoing coordination with these groups will allow METRO to identify relevant plans, projects, and partnership opportunities.

In addition, there are a variety of other private sector stakeholders, non-profits, and neighborhood organizations, civic organizations, academic institutions, and healthcare and other community service providers that should be consulted early in the process to incorporate input and identify opportunities for coordination or collaboration.



01 Private Developer

02 TIRZ Street Project

03 METRO Bus Stop

04 Centerpoint Utility Corridor

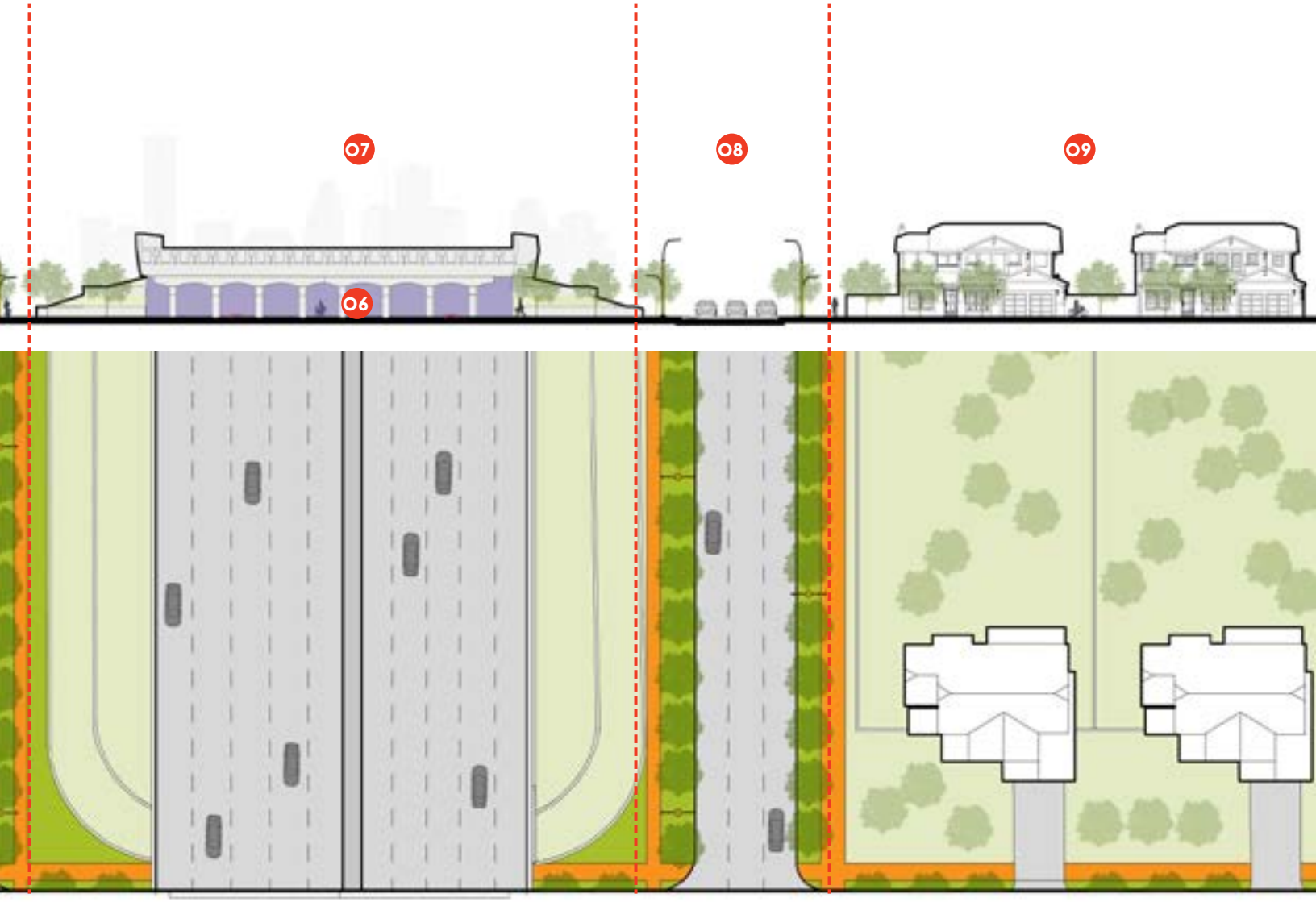
05 City of Houston Capital Improvement Project

06 Non-Profit Mural Project

07 TXDOT

08 City Roadway

09 Neighborhood Association



Implementation Partners

PROJECT COORDINATION, ENGAGEMENT, FUNDING, & PROGRAMMING

METRO's coordination with regulatory agencies, management partnerships, community partnerships, private-development, innovative partnerships, and educational partnerships can help identify and prevent gaps and overlaps within the planning and implementation of the urban design environment.

Shared engagement efforts offer more streamlined communication with communities, build stakeholder trust, and ensure communication across multiple platforms.

Funding partnerships can vastly improve the quality of the urban design environment and implement projects that promote shared goals between METRO and other agencies.

Programming partnerships encourage creative use of METRO facilities during off-periods, as well as provide opportunities to reflect community character, provide essential community services, and support emergency management.

REGULATORY AGENCY PARTNERS

Agency	Coordination Type	Coordination Need
CITY OF HOUSTON (COH)	Coordination Engagement Programming	Right-of-Way (ROW) and / or Redevelopment in COH Right-of-Way, Traffic Control, Permits, Street Design (Houston Public Works and Planning and Development), Public Affairs and Engagement, Project Document Reviews (Houston Public Works Interagency Branch), Planning Studies
HARRIS COUNTY	Coordination Engagement Programming	Regulatory Engineering Design of County Right-of-Way, Permitting for Development in County Including within ROW
TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT)	Coordination Engagement	Right-of-Way Design or Redevelopment in the TxDOT ROW, Regional Connectors Including Bike and Pedestrian
HOUSTON-GALVESTON AREA COUNCIL (H-GAC)	Coordination Engagement Funding	Regional Connectors Including Bike and Pedestrian, Major Investment Grant Opportunities, Inter-Agency Collaboration with METRO for Major Infrastructure Projects and Support

MANAGEMENT PARTNERS

Agency	Coordination Type	Coordination Need
MUNICIPAL MANAGEMENT DISTRICTS (MMDs)	Coordination Engagement Funding Programming	Maintenance and Funding of Project Design Outside of METRO
TAX INCREMENT REINVESTMENT ZONES (TIRZs)	Coordination Engagement Funding	Funding of Project Design Outside of METRO

PUBLIC-PRIVATE DEVELOPMENT PARTNERS

Agency	Coordination Type	Coordination Need
PRIVATE DEVELOPERS	Coordination Funding Programming	Joint-Development, Transit Oriented Development, Transit Adjacent Development (Retrofit of Existing Developments Adjacent to Transit Facilities or New Developments Near Existing Facilities)

INNOVATIVE PARTNERS

Agency	Coordination Type	Coordination Need
PHILANTHROPIC ENTITIES & NON-PROFITS	Funding Programming	Aid in Obtaining Local and Federal Funding, Support Projects Tied to Research or that Promote Health and Physical Activity
PARKING BENEFIT DISTRICT	Funding	Funds Collected from Parking Charges Go Directly to Community Improvements
THE HOUSTON ENDOWMENT	Funding	Provides Grants for general operating support, project support, capital improvements, capacity building, innovative approaches, public policy and engagement, and research.
ART IN TRANSIT	Coordination Engagement Funding Programming	Art in Transit Program, Vision Programs, Art and Wayfinding Studies, Community Engagement
ART LEAGUE HOUSTON	Funding Programming	Art Integration / Shelter Branding, Community Character Enhancement, Art Tours

EDUCATIONAL PARTNERS

Agency	Coordination Type	Coordination Need
K-12 SCHOOLS	Programming	Educational Art / Wayfinding Programming, Pilot Demonstrations, Sustainability Education, Community Character
UNIVERSITIES	Coordination Engagement Programming	Educational Art / Wayfinding, Shelter Branding, Technology Pilots, Sustainability Education
MUSEUMS	Funding Programming	Educational Wayfinding, Art Integration, Branding, Cultural Advertising, and Pilot Demonstrations

Task Force Roles & Responsibilities

Urban Design Task Force

METRO's Urban Design Task Force includes representatives from each of the concerned departments listed on the following page. The role of the Task Force is to review and provide feedback for all Urban Design related considerations for each of METRO's facilities. The Task Force is entrusted with promoting a quality urban design environment throughout the project lifecycle – from planning and design to project construction and installation, operations, maintenance and repair, and post-operational assessments (lessons learned and customer feedback).

Led by the Urban Design Lead and Planning Engineering Department, the Urban Design Task Force will ensure that all departments are engaged in providing feedback in a wholistic fashion at the conclusion of pivotal stages within the Project Task Force Feedback Loops mentioned on pages 62 and 63 of the METRO Urban Design Manual. Activities provided at each phase aid in ensuring proper coordination steps are taken, as well as providing opportunities for departments to pose questions and concerns as facility development and delivery occur. These activities are described on pages 64-67 of the Urban Design Manual, and are provided within the appendix.

Each member of the Task Force is encouraged to advocate their department's urban design mission, as developed internally within the table on page 59.

In the initial phases of development for the METRO Urban Design Task Force in 2022, the consultant team held a series of focus group meetings with METRO representatives from each department covering a range of urban design related topics such as: customer service and experience, security and safety, IT and innovation, cost / budget considerations, and operations and maintenance.

In addition to clear and concise guidelines, the focus group participants indicated that they would like a clear process for facility development that includes urban design from the beginning – rather than as an afterthought. While each of the departments commented that the Planning, Engineering, and Construction Department should take ownership of the METRO Urban Design Manual, each department shared interests that they also had an integral, attributing role in implementing high quality urban design by the end of focus group engagement. A report of this focus group engagement can be found in the appendix.

The Urban Design Task Force was developed as a response to the METRO internal departments' desire in maintaining early and continued involvement within the facility development process. Through this new approach, the Urban Design Task Force will plan for the future, collaborate and partner towards shared goals, communicate and coordinate, ensure quality throughout project lifecycles, and facilitate evidence-based learning .

METRO URBAN DESIGN TASK FORCE

METRO DEPARTMENT	UD TASK FORCE RESPONSIBILITIES
EXECUTIVE LEADERSHIP AUTHORITY COMPLIANCE LEGAL **RECORDS MANAGEMENT**	Be thoughtfully informed on project purpose and need in order to speak to the impact of project through support and aid.
AUDIT DEPARTMENT OF ADMINISTRATION **PROCUREMENT AND MATERIAL** **STATE OF GOOD REPAIR**	Ensure design direction is cost-effective and responsive to operational transit service without impacting design vision and implementation strategy.
COMMUNICATIONS **MARKETING AND CORPORATE COMMUNICATIONS**	Support the delivery of project purpose and need to the public. Lead the role in communicating the vision and impact of projects of all scales.
FINANCE **OFFICE OF INNOVATION**	Lead decisions on highest quality of design and innovation in transit infrastructure.
GOVERNMENT AND PUBLIC AFFAIRS **DIVISION OF PUBLIC ENGAGEMENT**	Ensure design strategies are led by people-based data – findings from public workshops are prioritized to construct equitable, healthy and sustainable transit environments.
OPERATIONS, FACILITIES MAINTENANCE, & CUSTOMER SERVICE **OPERATIONS** **FACILITIES MAINTENANCE** **CUSTOMER SERVICE**	Review the physical design and participate in the development of transit spaces with aim to build competitive and healthy surroundings with a high quality of infrastructure and place-making.
OPERATIONS, PUBLIC SAFETY **OPERATIONS** **PUBLIC SAFETY**	Review design strategies to be aligned with fleet visibility and accessibility needs and to review recommendations that supplement METRO Police Department and public safety.
PLANNING, ENGINEERING, CONSTRUCTION & REAL ESTATE **PROJECT MANAGEMENT/ ENGINEERING** **SYSTEM PLANNING** **URBAN DESIGN**	Establish project vision and implementation strategy founded on METRO design principles – Four Lenses of Urban Design.

METRO UD Task Force Guidelines

O.a Plan for the Future

Focus Beyond the Finish Line

- Ensure vision, mission, stated goals, and objectives of METRO leadership that relate to urban design are applied in all transit service and facility plans, programs, and projects
- Conduct METRO Taskforce exercises to ensure the quality of the planned, designed, built, and maintained urban design environment over time
- Document preferences of riders, neighbors, partners, and METRO departments early in projects to inform planning and design
- Actively engage in long-range regional transportation planning and design initiatives
- Evaluate and incorporate design elements that contribute to futureproofing transit facilities so that the lifespan of facilities aligns with anticipated innovations or requirements
- Integrate maintenance programming early in the planning and design process since the maintenance plan will determine success of urban design efforts and how METRO facilities are experienced and perceived over time

O.b Collaborate & Partner

Collective Action Towards Shared Goals

- Institutionalize the interdisciplinary METRO Urban Design Task Force and maintain regular, productive meetings that meet its mandate
- Align plans / regulations and maintain strong working relationships with City of Houston & Harris County to promote high quality urban design in the public realm

- Educate and engage METRO facility partners (e.g. Management Districts, TIRZs) to align urban design objectives in design, delivery, and maintenance of urban design environments neighboring transit facilities

O.c Communicate & Coordinate

Coordinate Internally and Externally on Initiatives led by METRO or its Partners

- Promulgate point of contact and protocol for issuing, receiving, and responding to inquiries or opportunities from METRO departments, partners, and stakeholders
- Maintain open lines of communication, timely responses, and opportunities for coordination
- Engage early and often with local communities when planning services or facilities
- Ensure METRO brand is visible and consistent across all transit facilities

O.d Ensure Quality

Promote the Value of Quality Urban Design Throughout The Project Lifecycle

- Invite active participation of METRO Departments on the Urban Design Task Force to ensure quality is attained and maintained throughout the project lifecycle
- Evaluate lifecycle costs and return on investment in terms of both capital investment as well as operation and maintenance costs to inform METRO decision making and material selection
- Utilize quality assurance / quality control (QA/QC) field teams to monitor and document the quality of urban design elements during construction, installation, maintenance, and repair
- Leverage Building Information Modeling (BIM) to enhance maintenance and management of METRO's built assets over time

O.e Evidence-Based Learning

Continual Improvement Through Lessons Learned and Best Practices

- Document METRO's lessons learned–both positive and negative–and incorporate into planning and design documentation and related processes
- Trouble-shoot or reverse engineer prior problems and document lessons learned to provide useful evidence-based guidance for corrective action or informing future projects
- Review and incorporate applicable best practices from transit agencies and communities in the U.S. or globally
- Utilize customer feedback collected through public outreach and market research to better understand and further enhance the rider experience
- Measure and compare performance criteria in terms of amenity selection, public space value, tree canopy cover, green infrastructure performance, plant health, pervious surface cover, energy consumption, mobility access / safety, and urban vitality that assess METRO's impact at both facility and regional scales

METRO UD Task Force Feedback Loops

PLANNING

MARKET RESEARCH

- Review of Customer Complaints from Comparable Facilities (New Construction) or Existing Facility (Redevelopment / Retrofit)
- Perform Allied Research, Direct and Indirect Surveys, and Pilots
- Report of Performance Criteria from Similar Facilities
- Neighborhood and Regional Coordination
- Culture Mapping Exercise

1 TASK FORCE ACTIVITY:
Project Timeline Coordination

2 TASK FORCE ACTIVITY:
Facility Profile Analysis

PROGRAMMING

- Identify Project Need
- Identify Funding Sources
- Maintenance Limitations & Challenges
- Platform Research & Analysis of Project Site
- Hold Public Engagement to Define Project Vision & Strategy
- Identify Strategy and Opportunities
- Spatial Design Report & Internal Review

3 TASK FORCE ACTIVITY:
"Headlines from the Future"

DESIGN

0-15% DESIGN

- Designate Design Resources and Consultants
- Preliminary Design of Project Need and Scope
- Refine Project Vision and Strategy
- Preliminary Design Report

15-30% DESIGN

- Technical Design Development
- Develop Maintenance Plan
- Preliminary Design Report

4 TASK FORCE ACTIVITY:
Systems Checklist Review

30-60% DESIGN

- Technical Design Development
- Develop Maintenance Plan
- Preliminary Design Report

5 TASK FORCE ACTIVITY:
Materials Selection Review

60-100% DESIGN

- Finalize Maintenance Plan
- Prepare In-Progress Design Report
- Project Design Review & Submittal

6 TASK FORCE ACTIVITY:
Overall Design Review

EVIDENCE-BASED LEARNING FROM POST OPERATIONS INFLUENCES MARKET RESEARCH AND FACILITY PLANNING

MARKET RESEARCH INFORMS PERFORMANCE METRICS CRITERIA

IMPLEMENTATION

CONSTRUCTION

- Procurement / Selection of Contractor to Perform Work
- Preconstruction Activities and Project Kick-Off Meeting
- Notice to Proceed
- Review / Approve Construction Submittals
- Project Construction and Inspection
- Project Punch List and Closeout

7 TASK FORCE ACTIVITY:
QA/QC Review

OPERATIONS & MAINTENANCE

- Maintenance Manuals / Warranties / As-Builts
- Maintenance Plan
- On-Going Maintenance

8 TASK FORCE ACTIVITY:
Continued Performance Plan

POST OPERATIONS

FEEDBACK

- Marketing Promotions
- Ridership Satisfaction Surveys
- Program Activation (Pop-Up Markets, Public Space Activation, Partnerships)

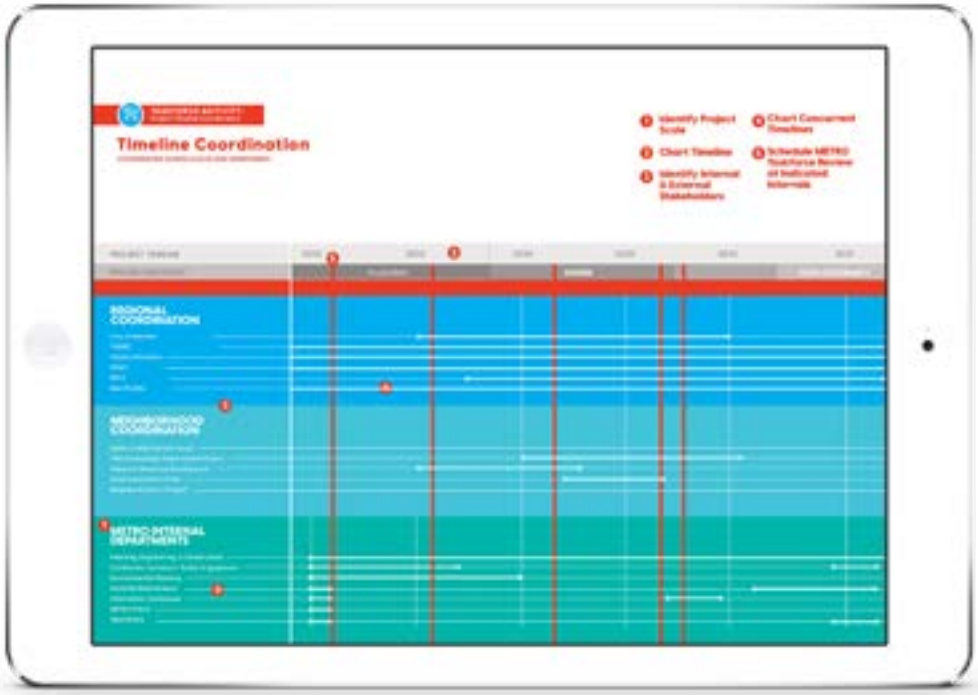
PERFORMANCE MEASUREMENT

- Post-Operations Site Analysis
- Green Infrastructure Metrics (Pervious Surface Calculations, Sustainable Detention Volumes, Tree Canopy Cover, Carbon Sequestration)
- Energy Reduction Calculations
- Assessment of Maintenance Lifecycle Costs
- Return on Investment Analysis
- Procedural Reporting (Database of Information)
- Checklist Performance Measures

1 Project Timeline Coordination

The Project Coordination Timeline is a tool to map out present and future projects that require or would benefit from coordination with neighborhood and regional stakeholders. Once plotting a facility schedule and timeline, METRO should proactively seek key coordination opportunities within relevant project phases.The METRO Task Force should identify any barriers to a quality Urban Design Environment within the adjacent context and advocate, coordinate, and leverage opportunities for improvement.

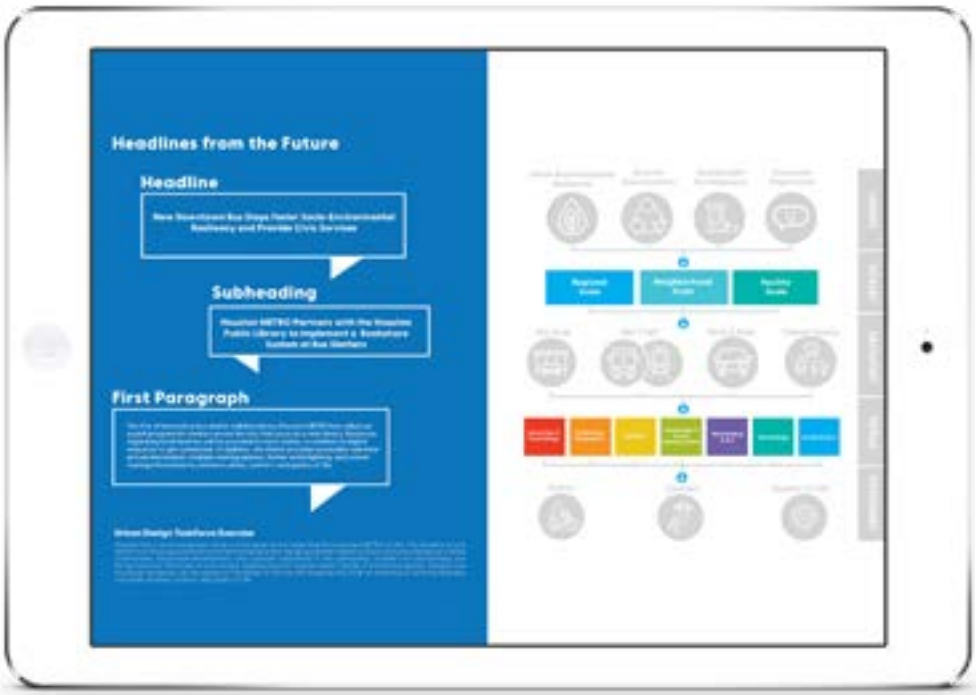
This activity document is found in the appendix of the UDM.



2 Proposed Facility Profile

The Proposed Facility Profile is a site analysis tool that identifies contextual influencers of urban design. These contextual influencers contribute to the Four Lenses of Urban Design and aid in the prioritization of community needs and facility design decision-making. In addition, unique site conditions can give important insights into neighborhood character considerations. Finally, the profile provides an additional opportunity to seek out creative stakeholder engagement.

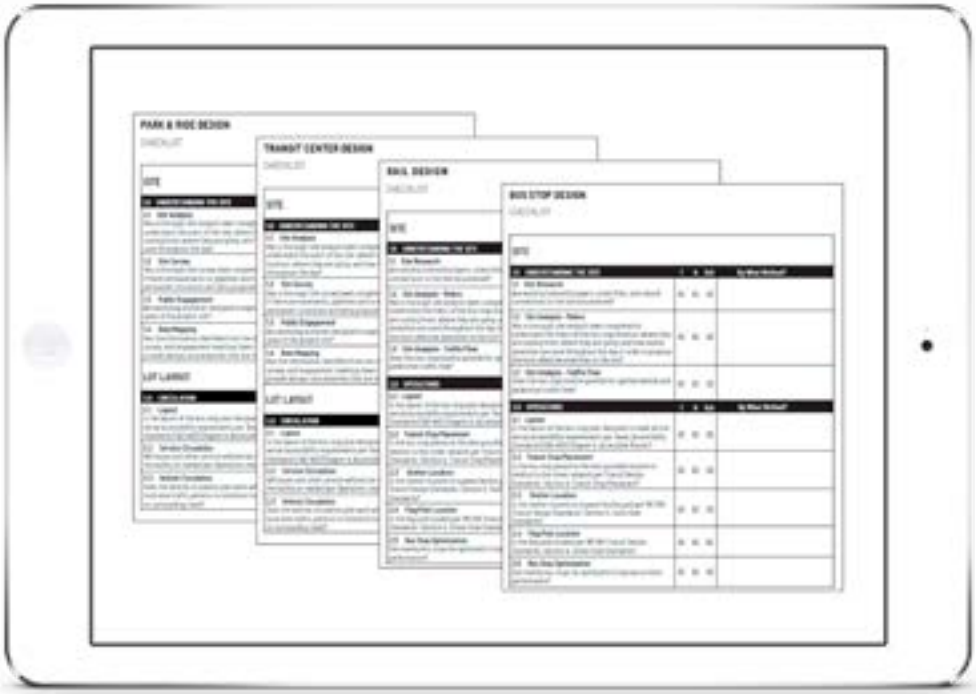
This activity document is found in the appendix of the UDM.



3 Headlines from the Future

The Headlines from the Future exercise is a creative writing exercise that identifies aspirational impacts for the METRO facility. This tool should be used to help guide decisions that lead to customer safety, comfort, and quality of life improvements not only within planning and design phases – but within the value engineering process as well.

This activity document is found in the appendix of the UDM.



4 Systems Checklist Review

The METRO Transit Design Checklists contain a series of design criteria that can be evaluated per project type. These checklists should be used as a design aid and quality control measure to ensure that the planned design meets criteria from the METRO Urban Design Manual that supports the goals of the proposed facility, as well as positively attributes and coordinates with neighborhood and regional considerations. It is recommended that these lists are continually revised to align with criteria within the METRO UDM.

Systems Checklists to be updated following the first edition of the METRO Urban Design Manual.

Task Force Activities

5 Materials Selection Criteria

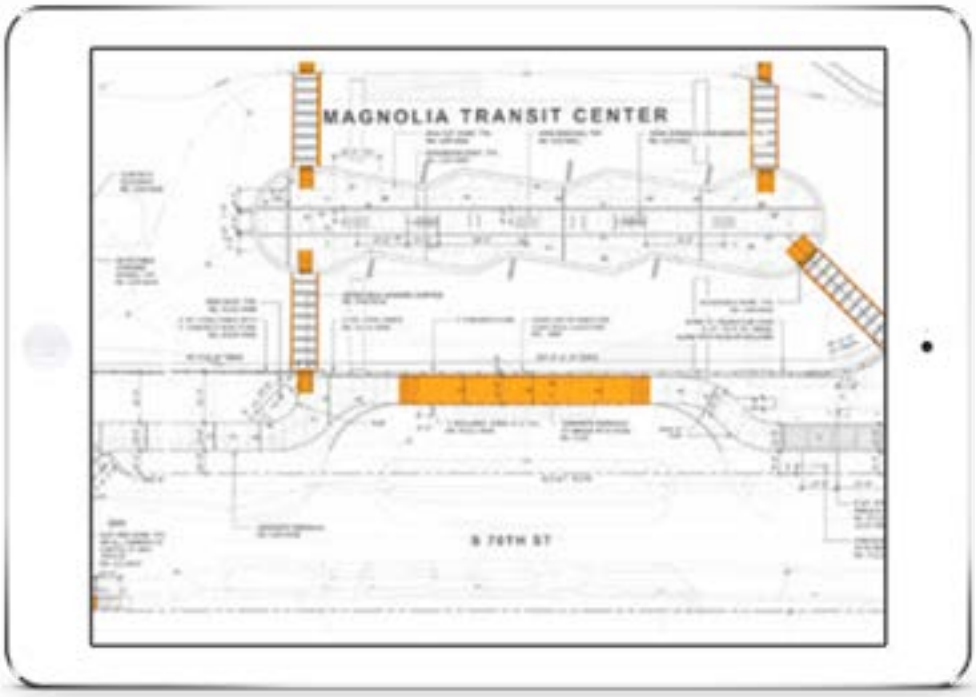
Internal METRO workshops for the creation of the Urban Design Manual revealed that METRO often spends more money on maintenance in the long-term than the money saved in the purchasing of cheaper furnishings in the value-engineering process. Additionally, satisfaction with appearance and performance of materials yields a positive return on investment among customers. The METRO taskforce can use the Materials Selection Criteria to compare materiality in terms of resilience, comfort, character, and sustainable life-cycle costs.

This activity document is found in Chapter O6 of the UDM.

6 Overall Design Review

During the final stages of the Design process, the METRO UD Task Force will review the final Issue for Bid set to review the design of the facility to ensure that the final design reflects guidelines from the Urban Design Manual as well as prioritizes primary facility goals as identified in previous exercises. The design review is an important step to ensure that each department has an opportunity to voice concerns regarding the safety, comfort, or quality of life implications of design decisions.

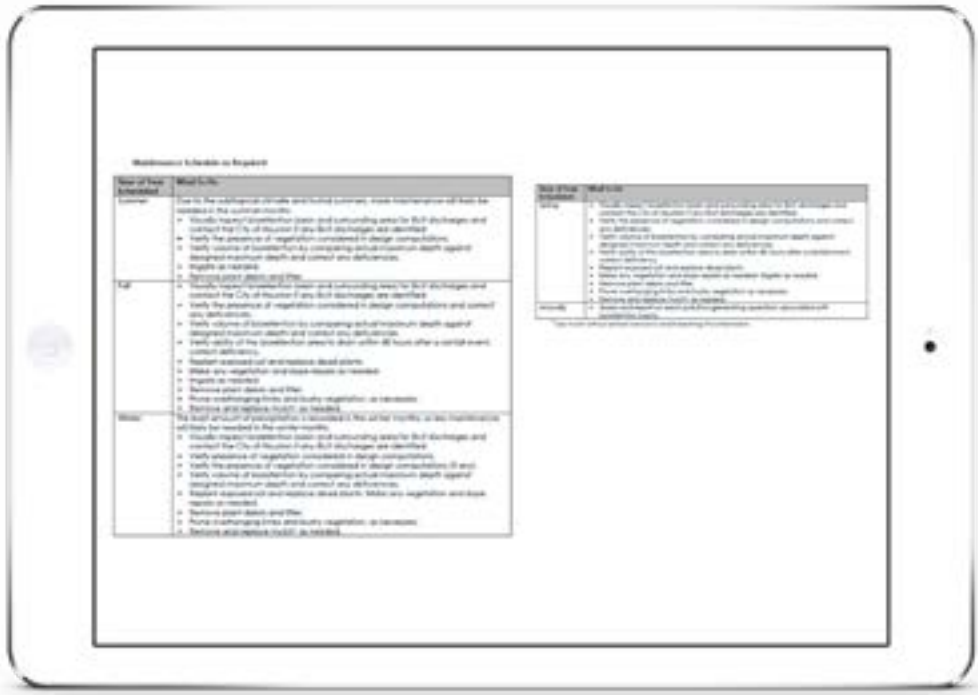
No additional worksheet; Task Force members will review bid documents and formally submit comments following discussion.



7 QA/QC Review

Prior to the final punch list and project close-out, the METRO UD Task Force will visit constructed facilities to identify any in-field errors that could preclude the quality of the urban design environment and impacts to safety, comfort, or quality of life. Proper construction and in-field coordination ensures both a high quality urban design environment and reduces long-term lifecycle costs.

No additional worksheet; Task Force members will conduct a site visit to review design and submit formal comments.



8 Continued Performance Plan

Upon project completion, the METRO Urban Design Task Force will complete a Continued Performance Plan that will implement a maintenance schedule for the facility as well as place parameters on performance evaluation of the urban design environment that can contribute data to inform the design of new METRO facilities. Long-term management and performance monitoring will be managed by Operations & Maintenance and Urban Design divisions respectively.

Continued Performance Plan to be updated following the first edition of the METRO Urban Design Manual.

Scalar Urban Design Guidelines

1 2 3 4

Scale
regional | neighborhood | site

Learning Objective
Understand the unique context and considerations that influence urban design of transit at different geographic scales

Summary
The dynamics of regional, neighborhood, and site scale planning and design vis-a-vis transit are presented. Guidelines are provided to address the Four Lenses for each of the Three Scales.


METRO
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Regional

Guidelines at the regional scale focus on system-wide actions and regional partnerships that holistically enhance environmental resilience, diverse communities, sustainable development, and customer experience.

Environmental Resilience guidelines highlight METRO's unique role and approach in combatting flooding and heat island effect across its facilities and the transit corridors that connect them to reduce the overall carbon footprint of transit. Diverse Community guidelines enhance community identities while addressing needs of vulnerable populations. Sustainable Development guidelines minimize sprawl and create walkable environments through destination connections and the planning of mixed-use Transit Oriented Developments. Customer Experience guidelines combat stigmas associated with public transit through enhancing the connectivity, legibility, and quality of METRO facilities.

Environmental Resilience

Diverse Communities

Sustainable Development

Customer Experience


FIRST & LAST MILE CONNECTIVITY
SHADE TREES ALONG ROUTES
BRANDED CONNECTIONS
TOD HUBS

Environmental Resilience

Regional

O1.a Ecoregions

Create a System-Wide Ecoregional Approach for Facilities

- Prioritize green infrastructure strategies based on Ecoregional Quadrant (refer to the METRO Urban Design Manual Technical Appendix)
- Plan sustainability goals and periodically assess environmental contribution, anticipate stormwater management metrics, and respond to changes in city-wide policy requirements
- Develop a planting list in coordination with the City of Houston for all facility types and neighborhood contexts that take into consideration ecoregional character, landscape types, and maintenance considerations
- Provide a system-wide maintenance training program for third party or internal landscape maintenance teams to adequately care for green infrastructure elements

O1.b Green Infrastructure

Create a Cohesive and Integrated Green Infrastructure System

- Create detailed, system-wide facility standards for the implementation of green infrastructure across the METRO service area for all facility types; refer to Chapter O6 of the METRO Urban Design Guidelines
- Aim to benchmark hardscape reduction to across the system to minimize urban heat island effect
- Prioritize natural detention in lieu of concrete-lined detention and pipes for water quality improvement in METRO standards and funding
- Create a post-construction report process for measuring the performance of green infrastructure across METRO facilities

COORDINATION OPPORTUNITIES
Resilient Houston, *Houston Climate Action Plan*, LEED, SITES, Envision, Forestry Service, COH Capital Improvement Projects

O1.c Shade Equity

Promote Shade Equity Across System Network

- Identify vulnerable areas with the least equitable access to shade within walkable distances of facilities
- Develop a system-wide goal for implementing shade trees along system routes prioritized by need
- Develop a system-wide goal for implementing shade canopy cover within METRO facilities
- Explore alternative shading methods for creating shade value

O1.d Resilience Hubs

Plan a Connective Evacuation Route Along a Network of Resilience Hubs

- Coordinate with the City of Houston Resilience Hub Master Plan to align evacuation routes along network of Resilience Hubs; plan sequence of evacuation routes to avoid gridlock
- Coordinate with State of Texas Emergency Assistance Registry (STEAR), METROLift, and Houston PD Homeless Outreach Team (HOT) to create an inclusive, universally accessible, and need-based approach to efficiently evacuating Houstonians to hubs who may otherwise have difficulty self-evacuating
- Coordinate with TranStar, Ready Harris, and Ready Houston to create a cohesive, accessible, and legible approach for communicating the evacuation system and key routing information, as well as provide emergency preparedness training (environmental) and resource distribution at transit facilities

O1.e Energy & Emissions

Reduce Carbon Footprint and Energy Consumption System-Wide

- Reduce energy consumption through the deployment of a system-wide lighting and energy management system, as well as a centralized control system that identifies need for utility maintenance
- Partner with the City of Houston to pilot a recycling program with educational signage at specific locations to work towards a future system-wide program
- Replace all pedestrian, streetlight, supplemental light, and interior building lights within METRO facilities with LEDs system-wide (refer to Chapter O6 of the Urban Design Manual)
- Employ the use of solar energy generation technology across METRO facilities
- Locate bus EV charging stations across the network

Diverse Communities

Regional

O2.a Universal Accessibility

Make METRO Facilities Universally Accessible

- Create legible and comprehensive digital navigation system system-wide through the equitable distribution of visual, audio, and technical aids at METRO facilities
- Include tactile signage, multi-lingual translations and / or clear iconography within METRO wayfinding systems (refer to Chapter O6 of the UD Manual)
- Revise / recreate facility standards that include universal accessibility guidelines outlined in the Neighborhood and Site Scale sections of the METRO Urban Design Manual
- Coordinate with the Houston Mayor's Office For People with Disabilities to continually revise universal accessibility requirements within METRO facility standards

O2.b Accessible Health

Promote Social Resiliency Through Access to Healthcare

- Partner with the City of Houston Health Department, READY Houston, Ready Harris, and third party healthcare and testing agencies to provide pop-up health services, emergency preparedness training (health related) on transit facility sites
- Identify and accommodate routing to healthcare facilities, social services, emergency clinics, and hospitals
- Provide equitable access to multi-service centers, courthouses, educational centers, occupational resources, libraries, universities, local schools, arts and cultural centers, voting centers, and grocery stores

COORDINATION OPPORTUNITIES
Mayor's Office for Cultural Affairs, Houston Mayor's Office For People with Disabilities, HAA, HFC, NEA, Envision, *H-GAC Regionally Coordinated Transportation Plan (RCTP)*

O2.c Equitable Distribution

Equitably Distribute Amenities Across the Transit Network

- Equitably distribute high quality standard amenities throughout the transit network by considering wait times, safety, and presence of vulnerable populations to prioritize the replacement, retrofit, and distribution of amenities
- Distribute pilot programs across all quadrants of the city rather than exclusively at new facilities

O2.d Contextual Sensitivity

Adapt Typical Transit Interventions to Respond to Development Scale, Context, and Character

- Park & Rides and Transit Centers should not be planned on properties that would require large-scale tree removal

O2.e Regional Connectors

Provide Accessibility to Transit Across Regional Connectors

- Create legible and branded connections across freeway systems to METRO facilities
- Connect neighborhoods to principal thoroughfares by creating transit facilities that enhance economic growth
- Major thoroughfares and collectors should be connected to a larger framework of walkable roadway network that connects riders to their neighborhoods
- Regional connectors should be branded by their cultural transects

O2.f Cultural Transects

Connect and Thematically Enhance Important Cultural Destinations

- Connect ethnocultural hubs with strong identities (i.e., connections from the Mahatma Ghandi District to Houston's Chinatowns)
- Preserve diverse charactered landscapes along transit routes
- Link innovation centers, hospitals, medical research hubs, universities, and maker-spaces to enhance Houston's innovation ecosystem
- Provide clear access routes to arts, cultural, and civic destinations

O2.g Character Continuity

Consider Character Continuity within a Quilt-Like Legibility System

- Weave thematic character and services into a legible and hierarchical transit system
- Layer regional branding elements to identify facility branding opportunities

Sustainable Development

Regional

O3.a Key Destinations

Connect Popular Destinations within Houston

- Connect METRO services to constellations of key city-wide destinations
- Connect urban workplace and retail destination centers within the city
- Enhance transit network to popular sports and event venue destinations
- Provide quality transit connections to airports
- Employ a central spine network of BRT / LRT facilities that connect key destinations
- Create hierarchy for Transit Centers as central stations that connect directly to key destinations

O3.b Transit Oriented Development Hubs (TOD)

Encourage Walkable and Mixed-Use Developments Around the City

- Internally plan for the design, building, and maintenance of vibrant pedestrian environments per the City of Houston's *User's Guide for Walkable Places and Transit Oriented Design* standards
- Coordinate with the City of Houston Planning Department to create more *Walkable Places and Transit Oriented Development* street designations within the METRO service area, particularly within key destination areas
- Per previous recommendations in *METRO Transit Oriented Development Studies* (Volumes 1-4), coordinate with the City of Houston to identify TOD opportunities, advocate for stronger TOD requirements within the City's Land Development Ordinance, work with H-GAC to align project funding to support TOD projects, develop TOD pilot projects, identify and

COORDINATION OPPORTUNITIES
Mayor's Office for Cultural Affairs, Houston Mayor's Office For People with Disabilities, HAA, HFC, NEA, Envision, H-GAC, Harris County, TxDOT, Private Sector, Management Districts, TIRZs

support opportunities that provide multi-modal access to key transit nodes, and plan for the joint-development of mixed-use TOD destinations

- Consider TOD hubs as opportunities to create Transit Oriented Communities through coordination with neighborhood stakeholders
- Each TOD hub should have a diversity of uses within each building and within the development, but each TOD hub should have its own character and balance of uses that differs from other METRO TOD hubs

O3.c Micromobility

Enhance Bike and Pedestrian Access to Transit

- Work with traffic engineering consultants to reduce traffic lanes in transit corridors by efficiently timing lights, optimizing network goals, dedicating transit lanes, and increasing programmable pedestrian zones
- Partner with the City of Houston to reduce parking requirements for new developments and renovated properties
- Encourage shared parking models that enhance walkability through the reduction of interrupting driveways
- Refer to the Houston Bike Plan and METRO Bike and Ride Plan for system-wide specific bike network recommendations
- Consider bike and pedestrian connectivity on a regional, neighborhood, and site scale for the planning of all METRO facilities; coordinate with adjacent neighborhood entities to prevent interruptions
- Consider system-wide funding, planning, and partnerships to expand opportunities for bike and pedestrian amenities
- When bike and pedestrian connectivity are further inhibited by external influences, expand area of influence or primary TOD street requirements to provide continuous service in areas that would otherwise be interrupted rather than terminating connectivity at the obstruction
- Create incentives for walking or biking to transit and charge parking fees for public parking

O3.d Infill Development

Promote Density of Development

- Per previous *METRO Transit Oriented Development Studies* (Volumes 1-4), identify and plan land banking for TOD opportunities, identify capital projects that can be funded from land sales / swaps, and explore shared parking opportunities
- In lieu of developing surface parking for Park & Rides, consider parking garages to support adjacent land partnerships that can be leased to private developers for mixed-use developments

O3.e Multi-Use Transit Hubs

Create Diverse TOD Experiences

- Partner with local public and private entities to plan transit hubs that are tied to high quality public spaces (i.e., parks, plazas, pedestrian malls, retail developments)
- Program alternative uses for METRO facilities after service hours; refer to the *METRO Programming Catalog*

Customer Experience

Regional

O4.a First & Last Mile Connectivity

Enhance Continuity of Experience

- Coordinate with regional and neighborhood entities to align adjacent planning efforts around pedestrian and bike connectivity
- Assess the safety, accessibility, and comfort within a 1/2 mile radius of proposed METRO facilities
- Location of METRO facilities must be safe and convenient
- The transit network should be integrated with the Houston Bike Plan, existing bikeways, and trail systems within initial planning stages
- Prioritize micromobility and retain a hierarchy of travel modes throughout the transit network
- Support roadway improvement projects along transit routes that currently hinder the safety of riders

O4.b System Legibility & Trip Planning

Make the Transit Network More Intuitive

- Create a hierarchical, consistent, and intuitive system of wayfinding maps, app-based maps, and routing information that enables riders to easily navigate the transit system
- Provide simplified versions of the overall site map at all facilities that are relevant to the location where it is positioned
- Streamline digital apps into one for clarity and intuitiveness
- Provide digital trip planning kiosks at facilities and revise the app-based system to provide "turn-by-turn" directions to facilities and "stop-to-stop" instructions for transfers

COORDINATION OPPORTUNITIES
COH Parks, COH Bike Plan, Vision Zero, TXDOT 5O Plan, Walkable Places

O4.c Brand Equity

Provide Recognizable Quality of Design

- Design and deliver a high quality of urban design across all METRO facilities
- Provide consistent use METRO brand elements at facilities while providing flexibility to reflect materials, finishes, colors, art, and architectural style based on neighborhood character
- Enhance the image of transit through marketing, surveys, and educational programs
- METRO facilities should be distinctive and should be immediately recognizable as part of the "METRO brand" despite character and materiality differences

O4.d System Pilots

Raise Awareness of Transit's Evolving Role

- Pilot new amenities for METRO facilities that achieve a high quality of urban design
- Provide educational signage for green infrastructure elements, recycling programs, solar panels, and electric vehicle charging to highlight METRO's role positively contributing to regional challenges
- Pilot new technology to gauge operating costs, potential drawbacks, and ridership perception

O4.e Customer Feedback

Track Evidence-Based Learning

- Partner with businesses, museums, civic centers, etc. to entice people to use METRO services to not only travel to work, but utilize public transit to get to other destinations
- Perform ridership surveys that assess the quality of the urban design environment that can provide constructive feedback for the design of future facilities
- Make transit beautiful, fun, and convenient through the system-wide enforcement of METRO Urban Design Guidelines
- Work with external stakeholders to create a streamlined process for a shared framework of goals and evidence-based solutions for community engagement and feedback loops

Neighborhood

Guidelines at the neighborhood scale emphasize actions and neighborhood partnerships that enhance environmental resilience, diverse communities, sustainable development, and customer experience within a 1/2 mile walkable distance of transit.

Environmental Resilience guidelines seek to link transit streets into a connected system of green infrastructure and corridors of shade canopy. Diverse Community guidelines enhance the existing character of streets and transit facilities. Sustainable Development guidelines recommend partnering with neighboring development to create engaging streetscapes and integrated transit. Customer Experience guidelines support a seamless experience from METRO rider's front doors to transit facilities.

Environmental Resilience

Diverse Communities

Sustainable Development

Customer Experience


MAKE THE NETWORK MORE INTUITIVE
PROVIDE ACCESS ACROSS CONNECTORS
PROMOTE SHADE EQUITY
PLAN INFILL DEVELOPMENT
CONSIDER CHARACTER CONTINUITY

Environmental Resilience

O5.a Stormwater Management

Design to Attenuate Large Scale Flooding Impacts

- Within transit corridors, look for possibility to incorporate high capacity underground detention facilities underneath roadways to convey stormwater runoff for large scale flood events
- Prioritize linear green infrastructure systems as the first step approach to stormwater conveyance and infiltration to treat first flush runoff

O5.b Green Infrastructure

Integrate Green Infrastructure Interventions Along Corridors

- Implement linear green infrastructure systems into the design of transit corridors such as bioswales, tree cells, pervious pavement, and vegetated swales into the design of streetscapes, transitway barriers, and medians in lieu of traditional mowed landscape strips
- Tie linear green infrastructure into adjacent linear systems to create a connective corridor of stormwater management and infiltration
- Outlet long systems of green infrastructure into vegetated detention basins or to the city storm drain
- Refer to green infrastructure design resource systems per Chapter O6 of the METRO Urban Design Manual
- Utilize curb cuts to treat runoff from both vehicular and pedestrian / bikeway pavements

COORDINATION OPPORTUNITIES

Scenic Houston, City of Houston *Users' Guide for Walkable Places and Transit-Oriented Development*, LEED, SITES, Envision, Forestry Service, COH Capital Improvement Projects, TIRZ Funded Projects, Joint-Development

O5.c Shade Equity

Provide Quality Shade Within Walkable Distances of Transit Facilities

- Provide quality shade canopy within a 1/2 mile radius of transit facilities and transitways
- Refer to Chapter O6 for tree selection and spacing guidelines
- Prevent the root disruption of pedestrian zones through proper tree placement and species selection
- Consider the use of tree cells, tree boxes, and structural soil to enhance the growth and ecological health of shade trees
- When right-of-way conditions are not wide enough for the use of street trees, consider alternative shading methods such as adjacent building shading, canopies, and awnings
- Consider lighter colors and pervious materials in the selection of pedestrian pavements to reduce heat island effect
- Consider providing planting within tree basins or bioswale planters to maximize streetscape character and reduce urban heat island effect

O5.d Tree Placement

Coordinate the Location of Trees in Respect to Transit & Utility Infrastructure

- Place trees in a manner that does not interfere with LRT cables
- Properly select tree species for placement underneath overhead utilities
- Coordinate tree spacing and location with the placement of roadway and pedestrian lighting including associated infrastructure
- Do not shade solar panels or green roofs with tree canopy; particularly bus shelters

O5.e Natural Resources

Protect & Connect to Natural Resources Adjacent to Transit Facilities

- Protect viewsheds to parks, adjacent bayou systems, forested areas, and undeveloped prairieland
- Provide safe and convenient neighborhood connections from transit to nature trail systems, neighborhood park space, and bayou greenway trails
- Treat stormwater runoff within the streetscape of the transit environment and within METRO facilities through green infrastructure before it impacts adjacent natural resources

O5.f Sustainable Lighting & Energy Use

Reduce Energy Consumption and Prevent Light Pollution in Neighborhood Contexts

- Use Dark-Sky compliant LED lighting for streetscapes and transit lighting for LRT/BRT transit lanes
- As a guide, select lighting fixtures with the lowest BUG (backlight, uplight, and glare) rating possible without exceeding the appropriate MLO lighting zone to adhere to LEED accreditation standards
- Choose shielded pedestrian and street light fixtures with a cutoff to reduce glare and reduce light pollution
- Choose fixtures 3OOOk or warmer to reduce blue light pollution that can be harmful to community and ecological health
- Utilize solar panels on shelters and site structures for self-illumination energy generation

Diverse Communities

O6.a Universal Accessibility

Provide Accommodations for Physical, Cognitive, Literacy, Linguistic, Audio, and Visual Impairment Accessibility

- Adhere to all ADA Requirements
- Provide seating at regular intervals along thoroughfares and collectors within a 1/2 mile radius of transit
- If seating is divided, ensure that arms are located far enough to accommodate a wide variety of sizes / abilities and can provide assistance to those with mobility impairments
- Prevent uneven or heavily textured walking surfaces to prevent tripping hazards or uncomfortable conditions to those with spinal injuries
- When possible, provide additional passing space than the minimum ADA requirement to accommodate personal assistance devices, caretaker assistance, or to provide tolerance when someone is seated or standing adjacent to the accessible pedestrian travelway
- Prevent utility obstructions such as poles, utility covers, and protruding objects in the accessible travelway
- Align ramps at crosswalks to reduce strain of wheelchair users
- Ensure METRO facilities are immediately recognizable at a distance
- Provide "Walk / Don't Walk" pedestrian crossing signals at every intersection leading to a transit facility
- Ensure all street name signage is clearly legible from the pedestrian travelway and vehicular roadway
- Streetscape and corridor branding serve as wayfinding strategies for leading METRO riders with cognitive disabilities to facilities; consider small wayfinding opportunities or intermittent variations

COORDINATION OPPORTUNITIES
Mayor's Office for Cultural Affairs, Houston Mayor's Office For People with Disabilities, HAA, HFC, NEA, Envision, H-GAC Regionally Coordinated Transportation Plan (RCTP)

in streetscape design / elements to help with cognitive recollection such as subtle changes in paving patterns

- Provide clear and hierarchical wayfinding with multilingual translations or iconography, particularly in areas where a non-English language is commonly spoken
- For accessibility recommendations for wayfinding, refer to Chapter O6 of the METRO Urban Design Manual
- Provide pedestrian crossing signals at intersections that provide vibration indicators and auditory announcements
- Use detectable warning pavers at the end of curb ramps in a contrasting color
- Consider tactile paths to guide visually impaired riders to METRO facilities and ensure they are used sparingly to avoid confusion with tactile warning pavers; tactile warnings must be maintained in intersections to avoid disorientation
- Prevent obstruction of pedestrian visibility at intersections where oncoming traffic is blocked by parallel parking, signage, or other obstructions to protect visually and auditorily impaired pedestrians who may be unable to see or hear oncoming traffic
- Design a pedestrian lighting scheme that prevents harsh shadows that decrease the visibility in changes of elevation or separated uses
- Provide pedestrian refuge medians at intersections where pedestrians cross many travel lanes

O6.b Diverse Corridors

Respond to Diverse Character of Neighborhood Corridors

- Streetscapes leading to transit facilities or transitways should reinforce existing neighborhood circulation patterns or further enhance safety
- Transitway streetscapes should be designed to protect historic tree canopies and the character of historic communities
- Interventions to streetscape redevelopments for transit facilities should respect the character, important viewsheds, and needs of the corridor

O6.c Neighborhood Culture & Identity

Infuse Neighborhood Character into Corridor

- Consider arrival gateways into neighborhood corridors as part of the transit experience
- Choose colors, materials, finishes, wayfinding / art, lighting, paving, and amenities that complement site character and enhance the transit experience
- Complement retail centers, historic character, green space / ecology, cultural and ethnic diversity, civic, arts, and vernacular character

Sustainable Development

Neighborhood

O7.a Adjacent Development Setbacks & Driveways

Promote Transit Oriented Development (TOD)

- Refer to the City of Houston *User's Guide for Walkable Places and TOD* for requirements for designated TOD streets
- Minimize driveways to reduce interruptions to pedestrian access
- Orient parking lots on the side or at the rear of the development rather than along the right-of-way
- Orient building facades adjacent to the right-of-way and place main building entries along the primary sidewalk
- Provide minimal building setbacks along the primary streetscape while providing adequate visibility; consider first floor corner clips to enhance pedestrian and vehicular visibility
- Consider designing one 30' wide two-way driveway or two 15' wide one-way driveways per 300' of development
- Pedestrian crossings should be provided every 500 - 700 feet for new development on large blocks
- Provide engaging ground-floor retail and restaurants with glass facades adjacent to the streetscape to invite pedestrians into the development
- Provide outdoor dining space, street trees, furnishings, entry plazas, awnings, or park space at the streetscape edge to activate the development

O7.b Micromobility

Enhance Neighborhood Bike and Micromobility Systems & Infrastructure

- Refer to Chapter O6 of the METRO Urban Design Manual for required and recommended bike lane guidelines
- Connect bikeways to existing and planned

COORDINATION OPPORTUNITIES

Mayor's Office for Cultural Affairs, Houston Mayor's Office For People with Disabilities, HAA, HFC, NEA, Envision, H-GAC, Harris County, TxDOT, Private Sector, Management Districts, TIRZs

dedicated bike lanes, shared on-street conditions, or off-street lanes and trails

- Provide bike amenities such as racks, repair stations, and bike rental along transit streetscapes
- Consider storage and dedicated passing zone, or dedicated lanes for skateboards and personal electric vehicles such as electric scooters, hoverboards, or electric bicycles
- Bike lanes should be clearly delineated, buffered, and branded distinctly from the pedestrian zone; refer to Chapter O6 (UDM)
- Integrate bike lanes to minimize conflict at bus shelters through the use of station islands or shifted bike lanes

O7.c Pedestrian Realm

Creating Engaging Streetscapes

- Refer to Chapter O6 of the METRO Urban Design Manual for required and recommended pedestrian realm offsets
- Consider varying the width of pedestrian and amenity zones to increase opportunities for green infrastructure, landscape and tree planting variety, and a diversity of pedestrian and bike amenities
- Consider temporary streetscape activation such as the closures of lanes with planter bollards, parklets, on-street parking, or painted bikeways prior to streetscape redevelopment projects adjacent to transit
- Provide pedestrian-scale lighting, furnishings, and other amenities that add to the comfort and experience of the streetscape; refer to Chapter O6 of the METRO Urban Design Manual for guidelines
- Engage with neighborhood developers to encourage Adopt-A-ROW programs to furnish and maintain branded corridor streetscape elements when a management district is not present

O7.d Social Activators

Create Public Space Adjacent to Transit

- Consider utilizing the underside of elevated transitways as linear park space
- Consider programming community events such as farmers markets, community meetings, disaster relief, bike rodeos, etc. within the parking lots of METRO Park & Rides and Transit Centers during weekends
- In joint-development opportunities, consider the development of plazas and park space that can be integrated into the design of transit facilities as open public space
- Refer to the METRO Programming Catalog for more program elements

O.7e Traffic Calming

Provide Traffic Calming Measures to Enhance Separation of Modes and Safety

- In reduced lane conditions, consider midblock crossings adjacent to transit facilities and across from METRO Transit Oriented Development Hubs
- Plant rows of street trees to reduce vehicular speeds
- Study the reduction of traffic lanes and the timing of traffic lights to reduce vehicular speeds and accidents without creating further congestion
- Incorporate lane shifts and vary lane widths approaching transit facilities to provide more room for facility amenities while slowing vehicular speeds
- Utilize medians as opportunities for pedestrian islands paired with signalized crosswalks
- Design intersection corners with smaller radii to protect pedestrians

Customer Experience

O8.a First & Last Mile Continuity

Enhance Connections from Neighborhood Amenities to Transit Destinations

- Provide direct and convenient paths of pedestrian travel to transit facilities
- Create short crossing distances at intersections
- Coordinate for short traffic light cycles at intersections and longer walk times to make crosswalks safer and more efficient
- Design and coordinate streetscape redevelopment projects to accommodate existing and future METRO facilities
- Coordinate streetscape and bikeway to extend past barriers such as freeways, elevated BRT lanes, raised guideways, or bayou systems
- Coordinate the entrances of bikeways into facility entrances
- Coordinate removal of obstructions within the pedestrian travelway
- Avoid sidewalk and roadway repairs that reduce accessibility or impede drainage patterns
- Ensure that trees and plants are properly placed and maintained to ensure continuity of travelway as well as keep it free of vertical protrusions

O8.b Neighborhood Wayfinding

Ensure the Transit Environment is Intuitive to Navigate

- Provide neighborhood maps along streetscape wayfinding to orient visitors to transit facilities and popular retail, dining, and open space amenities

COORDINATION OPPORTUNITIES
COH Parks, COH Bike Plan, Vision Zero, TXDOT 5O Plan, Walkable Places

O8.c Facility Visibility & Access

Ensure Visibility of METRO Facilities from Vehicular and Pedestrian Scales

- Ensure vehicular sight visibility triangles are unobstructed by buildings, signage, plantings, trees, art, or parking at intersections and intermittent crossings
- Ensure transit facility is visible from the roadway and pedestrian streetscape
- Facility wayfinding monuments or station signage should clearly denote the METRO facility name

O8.d Utility Coordination

Prevent Ground and Vertical Obstructions

- Set large above-ground utilities back from street intersection corners to improve visibility and more open corridor aesthetic
- Minimize above-ground mechanical structures when possible and orient to prevent the creation of blind corners
- Coordinate light pole spacing with trees
- Ensure traffic light poles, fire hydrants, and overhead electrical poles are located free of the pedestrian travelway and accessible ramps or landings
- Minimize overuse of vertical poles; combine signage, pedestrian "Walk / Don't Walk" signals, and existing utility poles when possible
- Consolidate above-ground utilities and avoid duplication of vertical elements
- Ensure utilities do not block views to oncoming motorists, driveways, or pedestrian crossings
- Coordinate the location of underground utility covers to situate entirely within 6" from the edge of paving or planting areas; prevent partially locating within and outside of paving to avoid pavement cracking
- Ensure that covers for underground utilities are flush with the top of paving or preferably within planting areas to prevent uneven surfaces that could pose as tripping hazards

O8.e Lighting & Sightlines

Increase Safety & Security

- Ensure that the pedestrian realm is well-lit with pedestrian lighting approaching METRO facilities
- Do not over-illuminate to create harsh shadows; coordinate lighting with the location of trees
- Provide clear sightlines to facilities and ensure planting and wide vertical obstructions are no taller than 3' high
- Ensure streetscape and adjacent developments do not block or overshadow facility cameras
- Provide adequate pedestrian lighting at all side streets and intersections approaching facilities so METRO riders can distinguish individuals coming from a distance
- Utilize landscaping and planting to create natural access and territorial reinforcement; create boundaries between public and private areas that are not engaged with the streetscape
- Consider lighting levels at adjacent properties in the design of pedestrian and roadway lighting nearing transit facilities

Site

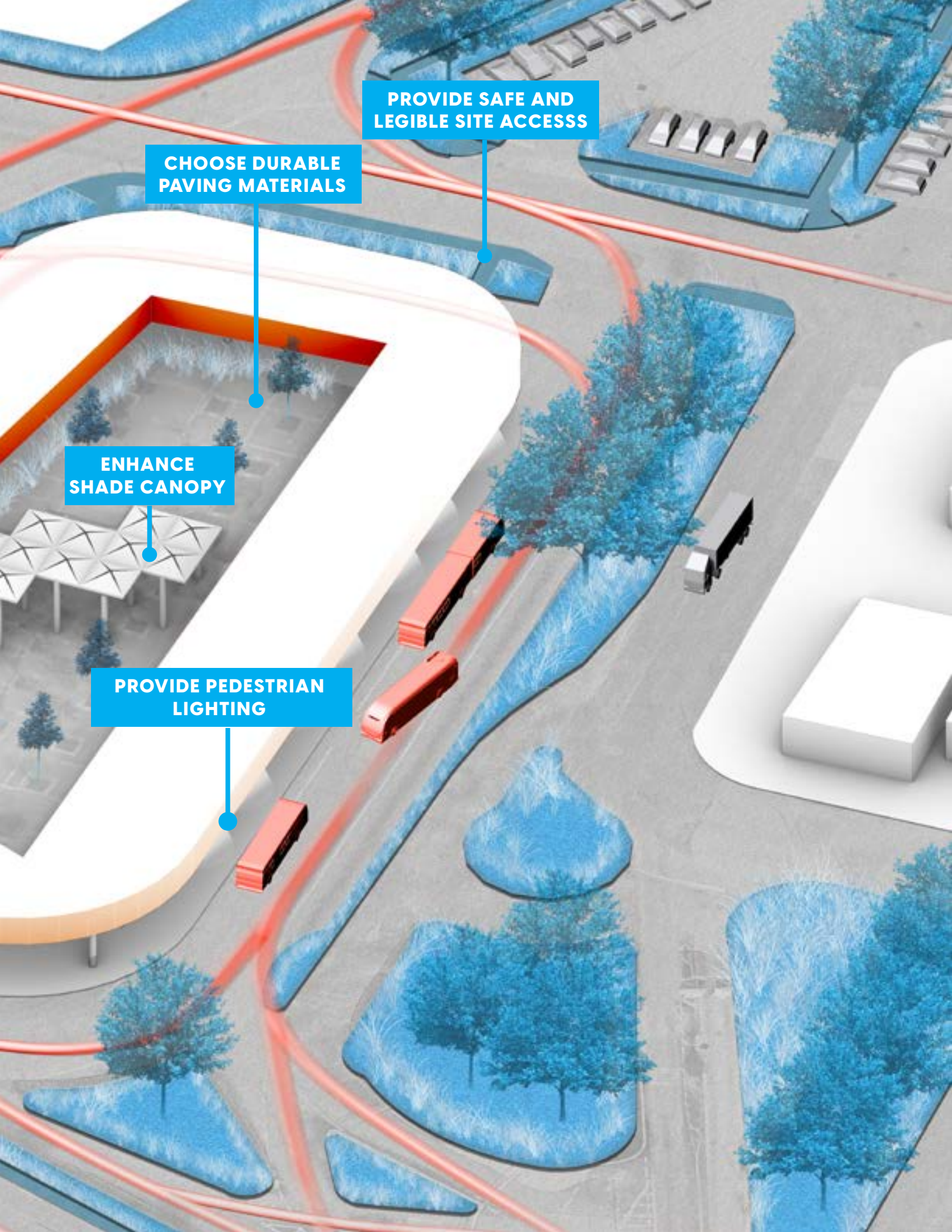
Urban design considerations at the site scale connect directly to the individual transit customer's experience, and because of that, play the most significant role in retaining and growing ridership. A personal experience of transit environments happens in multiple modes of travel: while crossing the street to a transit shelter, unboarding a bus, riding a bike to a stop, or dropping off a car at a Park & Ride. Disruptions to a continuous positive experience of a transit environment may come from feeling unsafe, uncomfortable, and isolated from community life. The three objectives for urban design at a site scale are conceived to address a continuum of customer need for safety, comfort, and quality of life simultaneously. Safety is the foundational objective, with comfort and quality of life defining the important role facilities play as nodes of human-centric design and urban social activity.

Environmental Resilience

Diverse Communities

Sustainable Development

Customer Experience


PROVIDE SAFE AND LEGIBLE SITE ACCESSS
CHOOSE DURABLE PAVING MATERIALS
ENHANCE SHADE CANOPY
PROVIDE PEDESTRIAN LIGHTING

Environmental Resilience

O9.a Stormwater Management

Design to Attenuate Large Scale Flooding Impacts

- Ensure facilities are graded to avoid the pooling of stormwater, particularly in primary accessible routes, bus travelways, intersections, and adjacent to sidewalk ramps
- Anticipate future stormwater storage needs in the planning of new METRO facilities
- Prioritize green infrastructure and "soft detention" facilities over concrete underground structures
- When underground detention is required, consider integrating rainwater harvesting systems for on-site irrigation
- Connect underground detention to small scale green infrastructure solutions elsewhere within METRO facilities
- Ensure that curb and gutter systems do not extend to wheelchair and sidewalk ramps, as the grading for these systems often reduce accessibility
- Ensure stormwater drains are flush to the pavement; any maintenance repairs where vehicular paving is cut should consider drainage and accessibility once replaced

O9.b Green Infrastructure

Capture, Remediate, and Infiltrate to Attenuate Stormwater and Reduce Heat Island

- Implement site scale green infrastructure solutions such as bioretention, vegetated detention basins, vegetated swales, green roofs, tree cells, tree boxes, permeable paving, and drivable landscape into the design of METRO facilities
- Integrate biorentention and swales into connective systems that feed into a larger vegetated basin or detention facility for further treatment

COORDINATION OPPORTUNITIES

Scenic Houston, City of Houston *Users' Guide for Walkable Places and Transit-Oriented Development*, LEED, SITES, Envision, Forestry Service, COH Capital Improvement Projects, TIRZ Funded Projects, Joint-Development

- Prioritize landscape planters that perform stormwater management to those with purely aesthetic functions, such as flow through medians as opposed to traditional raised parking islands
- Ensure curb cuts are large enough to admit stormwater flows without capturing debris
- The design of transit facilities should capture, remediate, and infiltrate stormwater beyond minimum city requirements
- Green rails or permeable paving can be demonstrated in particular locations of importance to reduce the amount of pervious paving and provide branding opportunities within LRT or BRT guideways
- Low impact development landscapes can be integrated as a landscape barrier in lieu of a rail to add aesthetic and performative value
- Heat island effect should be reduced through the reduction of pavement and integration of environmentally-productive landscape areas
- Refer to Chapter O6 of the METRO Urban Design Manual for Guidelines on Landscape & Green Infrastructure and the Technical Appendix in Chapter O8 for maintenance guidelines

O9.c Tree Canopy

Provide Quality Shade within METRO Facilities

- Preserve trees on-site to the greatest extent possible
- Consider transplanting viable heritage trees on-site or elsewhere within a METRO facility when they cannot be saved through design changes
- Where METRO facilities meet the public right-of-way, place shade canopy trees along the pedestrian travelway
- Parking lots should be adequately shaded for both parking areas and pedestrian travelways
- Consider reforestation areas and tree planted sound berms to reduce impact on the surrounding community and provide additional cooling opportunities
- Do not place trees directly underneath overhead electric utilities

O9.d Landscape Design

Design for Appropriate Character, Application, and Performance

- Consider plant selection based on ecoregional character, performance criteria, and ecological value
- Minimize applications of traditional mowed lawn; consider native grasses with wildflower mixes away from station platforms
- Utilize gateway planting, corridor planting, planters, hedge buffers, and shaded seating areas to improve facility aesthetic while reducing hardscape; refer to Chapter O6 of the Urban Design Manual

O9.e Sustainable Lighting

Reduce Energy Consumption and Prevent Light Pollution within Facilities

- As a guide, select lighting fixtures with the lowest BUG (backlight, uplight, and glare) rating possible without exceeding the appropriate MLO lighting zone to adhere to LEED accreditation standards
- Choose Dark-Sky compliant shielded pedestrian and street light fixtures with a cutoff to reduce glare and reduce light pollution
- Choose LED fixtures 3000k or warmer and that meet Dark-Sky compliance to reduce the harmful health and environmental impacts of blue light

Diverse Communities

10.a Universal Accessibility

Provide Accommodations for Physical, Cognitive, Literacy, Linguistic, Audio, and Visual Impairment Accessibility

- Adhere to all current ADA Requirements
- When possible, provide additional passing space than the minimum ADA requirement to accommodate personal assistance devices, caretaker assistance, or to provide tolerance when someone is seated or standing adjacent to the accessible pedestrian travelway
- Prevent uneven or heavily textured walking surfaces to prevent tripping hazards or uncomfortable conditions to those with spinal injuries
- Always provide 24" wide tactile warning pavers / strips at curb ramps, pedestrian crossings, and boarding platforms for all facility types in a contrasting color
- Prevent vertical obstructions in the travelway such as poles, utility covers, lighting, amenities, and protruding objects in the accessible travelway
- Align ramps at crosswalks to reduce strain of wheelchair users
- Ensure all facility signage is legible, clear, and unobstructed
- Design intuitive pedestrian circulation with a distinct hierarchy of colors and materials; consider integrated wayfinding opportunities or branded paving design / elements to help with cognitive recollection
- Provide clear and hierarchical wayfinding with multilingual translations, tactile formats, and iconography; for recommended guidelines on accessible wayfinding, refer to Chapter 06 of the METRO Urban Design Manual
- All facility real-time arrival, ticketing, and regulatory information should have

COORDINATION OPPORTUNITIES
Mayor's Office for Cultural Affairs, Houston Mayor's Office For People with Disabilities, HAA, HFC, NEA, Envision, *H-GAC Regionally Coordinated Transportation Plan (RCTP)*

audio and visual announcements; if this is not feasible for a particular facility then it should be accommodated through a digital app

- Push-button activated audible cues or accessible pedestrian signals (APS) should be located near curb ramps at each crossing direction (*NACTO*)
- Consider tactile paths to guide visually impaired riders to METRO facilities and ensure they are used sparingly to avoid confusion with tactile warning pavers; tactile warnings must be maintained in vehicular roadways to avoid disorientation
- Design a pedestrian lighting scheme that prevents harsh shadows that decrease the perception of changes in elevation; sudden changes in lighting levels should be gradual to allow for eye adjustment
- Provide distinctive colors and materials to delineate modal separations and crossings; provide consistency for legibility
- Provide tolerance for error in conditions that could potentially be hazardous, such as allowing additional space where platforms drop off or change grade even in instances where guardrails are not required
- Consider reach range and viewing height of those in mobility assistance devices in the selection and design of facility elements; particularly buttons, doors and ticket machines
- Provide slip-free surfaces both indoors and outdoors
- Place stairs and escalators next to one another for continuity of experience
- Provide a highly visible designated "quiet space" within METRO facilities for customers with sensory sensitivities that is secluded from audio assistance devices and bus activity
- Consider the integration of hearing loops, infrared systems, or radio frequencies to provide hearing assistance for those with hearing aids

10.b Neighborhood Culture & Identity

Infuse Neighborhood Character into Site

- Transit facilities should seamlessly blend into the adjacent neighborhood and should be ecologically, materially, architecturally, and stylistically
- Facilities should contain a high standard of design to reflect the METRO brand but should reflect unique histories, cultures, and identities
- Public art should be used as a tool to promote civic pride within METRO facilities
- Larger facilities should be programmed to serve civic functions within the community to create transit neighborhoods; refer to the METRO Programming Catalog

10.c Facility Edges

Protecting Neighborhood Contexts

- The transit environment should respond to the density and scale of the neighborhood
- The design of the facility should respect adjacent residential areas and mitigate sound and light pollution through enhanced landscape elements such as tree buffers, sound berms, and Dark-Sky compliant lighting
- Barriers between the facility and adjacent land uses should respect neighborhood identity, limit unwanted access, and should be attractive in appearance

Sustainable Development

11.a Joint Development Setbacks & Driveways

Joint Development Orientation

- Refer to the City of Houston *User's Guide for Walkable Places and TOD* for requirements for designated TOD streets
- Minimize driveways to maintain continuous pedestrian access
- Orient parking lots on the side or at the rear of the development rather than along the right-of-way or along the front face of the development
- Orient building facades adjacent to the right-of-way and place main building entries along the primary streetscape
- Provide minimal building setbacks along the primary streetscape while providing adequate visibility; consider first floor corner clips to enhance pedestrian and vehicular visibility
- Provide designated parking areas for joint developments that are separated from gated parking dedicated to transit facilities to provide access after operational hours
- Consider the use of parking garages in lieu of surface lots within Park & Rides and Transit Centers to allow for better integrated development opportunities; program retail on the first floor to engage the urban design environment

11.b Mixed-Use Development

Coordinate Station Use and Joint Development Opportunities

- Design, build, and maintain vibrant pedestrian environments per the City of Houston's *User's Guide for Walkable Places and Transit Oriented Design* standards regardless of TOD street designation
- Provide engaging ground-floor retail and

COORDINATION OPPORTUNITIES

Mayor's Office for Cultural Affairs, Houston Mayor's Office For People with Disabilities, HAA, HFC, NEA, Envision, H-GAC, Harris County, TxDOT, Private Sector, Management Districts, TIRZs

restaurants with glass facades adjacent to the streetscape to invite pedestrians into the development

- Provide outdoor dining space, street trees, furnishings, entry plazas, awnings, or park space at the streetscape edge to activate the development
- When developing affordable housing on METRO property, activate the first floor or immediately adjacent development with retail or dining space

11.c Phased Development

Anticipate Future Site Development

- Plan for the anticipated future needs and uses of METRO facilities for operational flexibility, technology growth, future detention requirements, and phased development within initial site planning
- Design Park & Rides to accommodate future Transit Center conversions as ridership increases
- Provide additional conduit beyond existing technological needs to extend the lifespan of the facility and potential technology integration
- Program space planned for future development with outdoor markets and neighborhood activities
- Within the design of the shelter platform, design for operational flexibility by allowing multiple bus berthing positions

11.d Micromobility

Enhance Bike and Pedestrian Access to Transit

- Work with traffic engineering consultants to reduce traffic lanes in transit corridors by efficiently timing lights, optimizing network goals, dedicating transit lanes, and increasing programmable pedestrian zones
- Refer to the City of Houston Bike Plan, the City of Houston Infrastructure Design Manual, and METRO Bike and Ride Plan for system-wide specific bike network recommendations
- Design bike, pedestrian, and other micromobility access to align with the adjacent community
- Provide pedestrian circulation around the public perimeter of METRO facilities
- Consider the growing popularity of micromobility devices in the design of METRO facilities; provide storage, designated travelways, and regulatory signage denoting appropriate areas of use
- Encourage the use of bicycles by providing safe, shaded, and comfortable bike amenities in prominent areas
- Consider bike share facilities within facilities in areas that are more bikeable

11.e Traffic Calming

Prioritize Pedestrian Environments within METRO Facilities

- Prioritize pedestrian and bike safety over vehicular circulation networks in the design of all METRO facilities
- Provide raised, signalized, or enhanced crossings where pedestrian circulation at bus lanes at Park & Rides and Transit Centers cannot be avoided
- Continue crosswalk markings or paving anywhere pedestrian circulation crosses a vehicular roadway
- Utilize facility medians as opportunities for pedestrian islands paired with raised and signalized crosswalks
- Provide pedestrian refuge islands at BRT and LRT stations near vehicular intersections

Customer Experience

12.a Facility Circulation & Access

Provide Convenient and Safe Access within Facilities

- Careful thought regarding customer site access must be addressed within the design of facilities
- Provide direct, visible, and convenient paths of travel within facilities leading to station platforms and primary station elements
- Separate modes of circulation within the design of facilities to avoid multi-modal conflicts
- In facilities with large areas of surface parking, provide pedestrian walkways that lead to a centralized pedestrian spine to prevent pedestrians from walking in the parking lot during busy facility hours
- Ensure vehicular sight visibility triangles are unobstructed by buildings, signage, planting, trees, art, or parking at intersections and intermittent crossings
- Ensure transit facilities are visible from the roadway and pedestrian streetscape

12.b Facility Wayfinding

Make the Transit Network More Intuitive

- Facility wayfinding monuments or station signage should clearly denote the METRO facility name and should be visible from primary roadways
- Wayfinding should be designed with a clear hierarchy across the site
- Vehicular and pedestrian scale wayfinding should be located at key decision points to lead pedestrians to facility destinations
- Informational and regulatory signage should be clearly displayed in consistent locations

COORDINATION OPPORTUNITIES
COH Parks, COH Bike Plan, Vision Zero, TXDOT 5O Plan, Walkable Places

12.c Utility Coordination

Prevent In-Ground and Vertical Obstructions

- Minimize above-ground utilities when possible and orient away from / parallel to the pedestrian travelway to prevent the creation of "hiding places" to improve the feeling of safety
- Ensure that traffic light poles, fire hydrants, overhead electrical poles, above-ground utility boxes, and other vertical elements are located free of the pedestrian travelway and accessible ramps or landings
- Ensure that utilities and vertical elements do not block views to oncoming motorists, driveways, or pedestrian crossings
- Coordinate the location of underground utility covers to situate entirely within 6" from the edge of paving or planting areas; prevent partially locating within and outside of paving to avoid pavement cracking
- Ensure that covers for underground utilities are flush with the top of paving or preferably within planting areas to prevent uneven surfaces that could pose as tripping hazards

12.d Site Amenities

Provide Amenities for Customer Safety, Comfort, and Quality of Life

- For complete guidelines on site amenities, pedestrian paving, lighting elements, landscape, technology, architecture, and wayfinding & art, refer to Chapter 06 of the Urban Design Manual
- Ensure site elements enhance customer experience in terms of weather protection, universal accessibility, comfort, and aesthetic functions
- Consider spatial relationships between site amenities and design for an engaging experience
- Integrate the use of amenities, pedestrian paving, lighting elements, landscape, technology, architecture, and art & wayfinding to enhance ridership experience rather than placing elements in isolation
- Ensure that site amenities do not block accessible pedestrian travelways
- At Park & Rides and Transit Centers, include employee restrooms, a METRO PD office space, and maintenance operation buildings for staff
- Seating areas and amenity spaces should be located to promote both prospect and refuge; locate seating elements in visible areas where the customer's back is protected by screens or structures to enhance the feeling of safety

12.e Lighting & Sightlines

Increase Safety & Security

- Provide clear sightlines within all waiting areas of the facility and ensure planting and wide vertical obstructions are no taller than 3' high
- Ensure that the pedestrian, roadway, and platform areas are consistently illuminated; utilize correct lighting levels created by multiple fixtures of the appropriate temperature and coverage in lieu of more powerful fixtures that create harsh shadows and pockets of darkness
- Utilize landscaping and planting to create natural access and territorial reinforcement; create boundaries between public and private areas that are not engaged with the streetscape
- Provide visibility to adjacent areas to enhance community perceptions of safety

Transit Facility Case Studies

Scale
site

Learning Objective
Reflect the unique considerations and employ applicable recommendations for each facility type

Summary
Design recommendations including partnership opportunities, configurations / layouts, design elements, site selection criteria, and case studies for the five transit facility types (Bus System, BRT, LRT, Park & Rides, and Transit Centers) are presented.


METRO
5
6
7
8

METRO Facility Typologies

Bus System

The METRO Bus System consists of various types of bus stops, bus infrastructure, and adjacent design elements. Standard METRO buses (40'), articulated buses (60'), and LIFT vehicles shape much of the vehicular and pedestrian scale systems. At the neighborhood scale, accessibility, tree canopy, and lighting are crucial for the safety of METRO riders and other members of the community.

BRT & LRT

BRT and LRT, although different systems, both have the transformative effect to turn vehicular-centric roadways into transit corridors. These high-capacity transit opportunities provide an important link to key destinations within METRO's network. They are also an economic driver of new development and catalyst of walkable environments.

Park & Ride

Park & Rides are located in developing or dense suburban communities. They provide an opportunity to quickly commute as buses utilize HOV lanes. Whether parking lots or garages, Park & Rides have a high potential for the implementation of green infrastructure as well as the enhancement of site scale amenities. Park & Rides are primarily used by downtown commuters.

Transit Centers

Transit Centers consist of many types of configurations of parking, LRT, bus, and BRT systems. Transit Centers are complex, and are at the highest risk for the conflict of pedestrian and vehicles as METRO riders move between transportation types. Green infrastructure and smart technology have the potential to enhance the efficiency of Transit Centers.

Facility Design

Retrofit

Existing METRO facilities are often retrofitted to accommodate new site improvements, update facility appearance, and upgrade facilities to current METRO standards.

Retrofit projects should adhere to current standards and properly address site modifications to increase the longevity of the site. "Temporary fixes" can degrade over time and become a safety hazard to METRO customers and the community. All site modifications should enhance the look and feel of the urban design environment as an integral part of the METRO brand–no matter how small the repair or design intervention. All interventions should enhance or unobstruct urban design.

Redevelopment

Existing METRO facilities that no longer meet their intended function can be redeveloped to accommodate greater design flexibility. Park & Rides are often redeveloped to become Transit Centers as ridership capacity increases over time.

While some of the existing facility design can often be salvaged in redevelopment to reduce cost and material waste, holistic evaluation must be given to the site in its entirety to ensure proper drainage, green infrastructure solutions, tree canopy cover, pedestrian circulation, and site legibility.

Additional opportunities for Transit Oriented Development can be integrated into existing Park & Ride sites through the integration of a parking garage and / or joint development opportunities.

New Construction

New METRO facilities offer the most flexibility for quality urban design, but must respect the site and its neighborhood context. New facilities should contribute to a positive city image through thoughtful planning, design, integration, and social activation.

Newly constructed facilities should reflect the latest thinking in best management practices (BMPs) and should proudly reflect METRO's brand quality. Facilities should be constructed to anticipate future use, expansion, technological improvements, and sustainability goals.

Case Studies

Facilities Overview

The following spreads give an overview of each facility type including considerations and layout configurations, and additional information for creating safe, comfortable, and quality urban design environments. While these conditions are not exhaustive, they provide context for facility design.

Case Studies

Case studies have been illustrated for Bus Stops, BRT, LRT, Park & Rides, and Transit Centers to demonstrate guidelines applied to example facilities. Each illustrated facility represents a condition relating to an existing or potential METRO facility that has been retrofitted, redeveloped, or newly constructed. These examples serve as a visual guide for designing METRO facilities in adherence to urban design guidelines. While all case study facilities contain fictional roadway names, they are based on real conditions and reflect unique contexts to Houston.

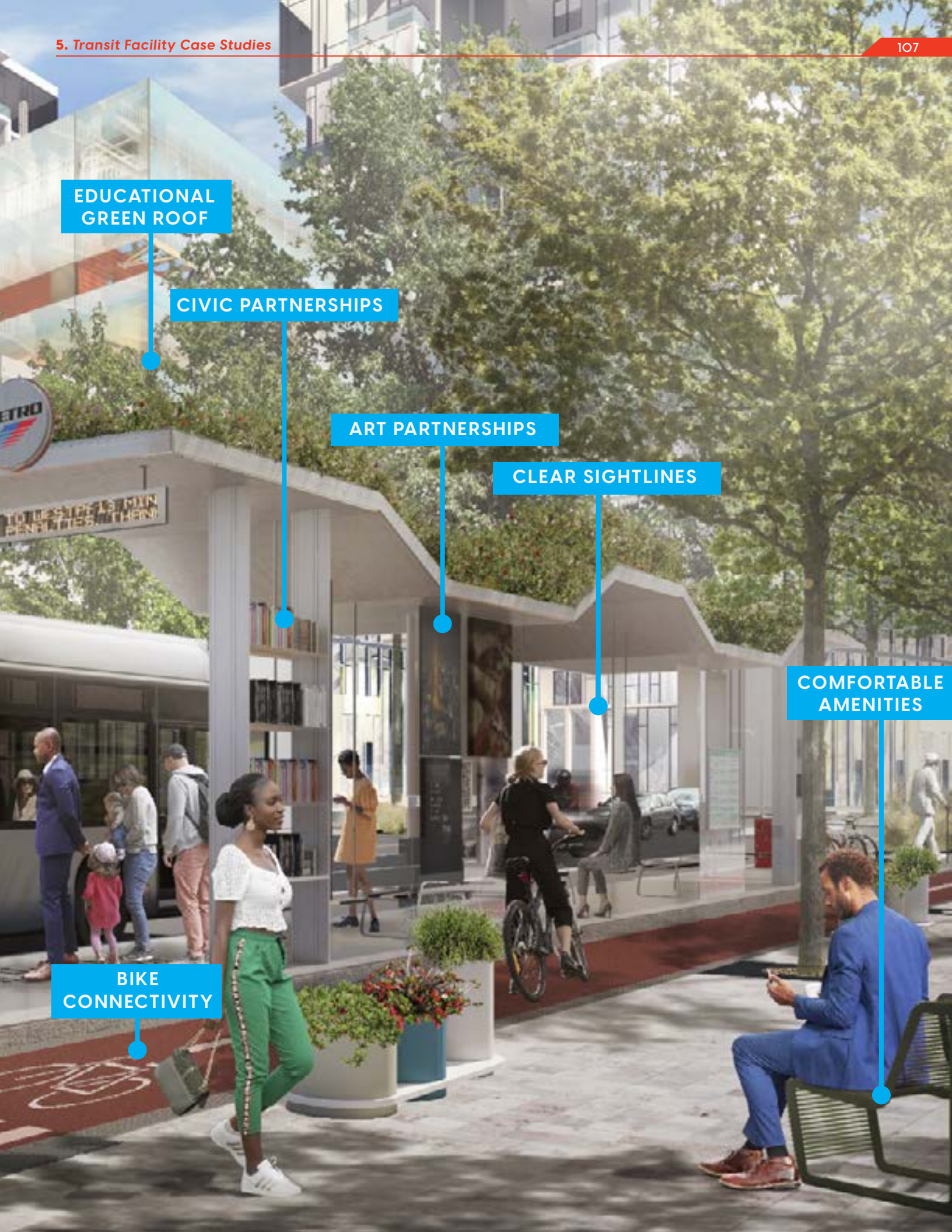
Each case study illustration also contains a facility profile depicting the facility's unique influencers on urban design considerations. A "Headline from the Future" demonstrates the impact of the METRO facility to the surrounding community and greater METRO system through the application of the urban design guidelines.

Bus System

The bus system offers the greatest opportunity to further the public perception of the METRO brand through the creation of high quality and accessible stops. The bus system can enhance community identity through the quality and cohesiveness of bus stops and their adjacent transit environment. While BOOST improvements favor communities with higher ridership, the bus system network should equitably serve communities throughout Houston by partnering with management districts, redevelopment authorities, and municipal entities to create a cohesive quality of design across the network.

The bus system should be integrated with the Houston Bike Plan, existing bikeways, and other community bikeway systems within early planning stages. Additionally, the bus stop system has the highest demand for cohesive accommodations for physical, audio, visual, cognitive, and linguistic accessibility throughout the navigation of the transit environment.


SHADE CANOPY
METRO
MICRO-MOBILITY HIERARCHY


EDUCATIONAL GREEN ROOF
CIVIC PARTNERSHIPS
ART PARTNERSHIPS
CLEAR SIGHTLINES
COMFORTABLE AMENITIES
BIKE CONNECTIVITY

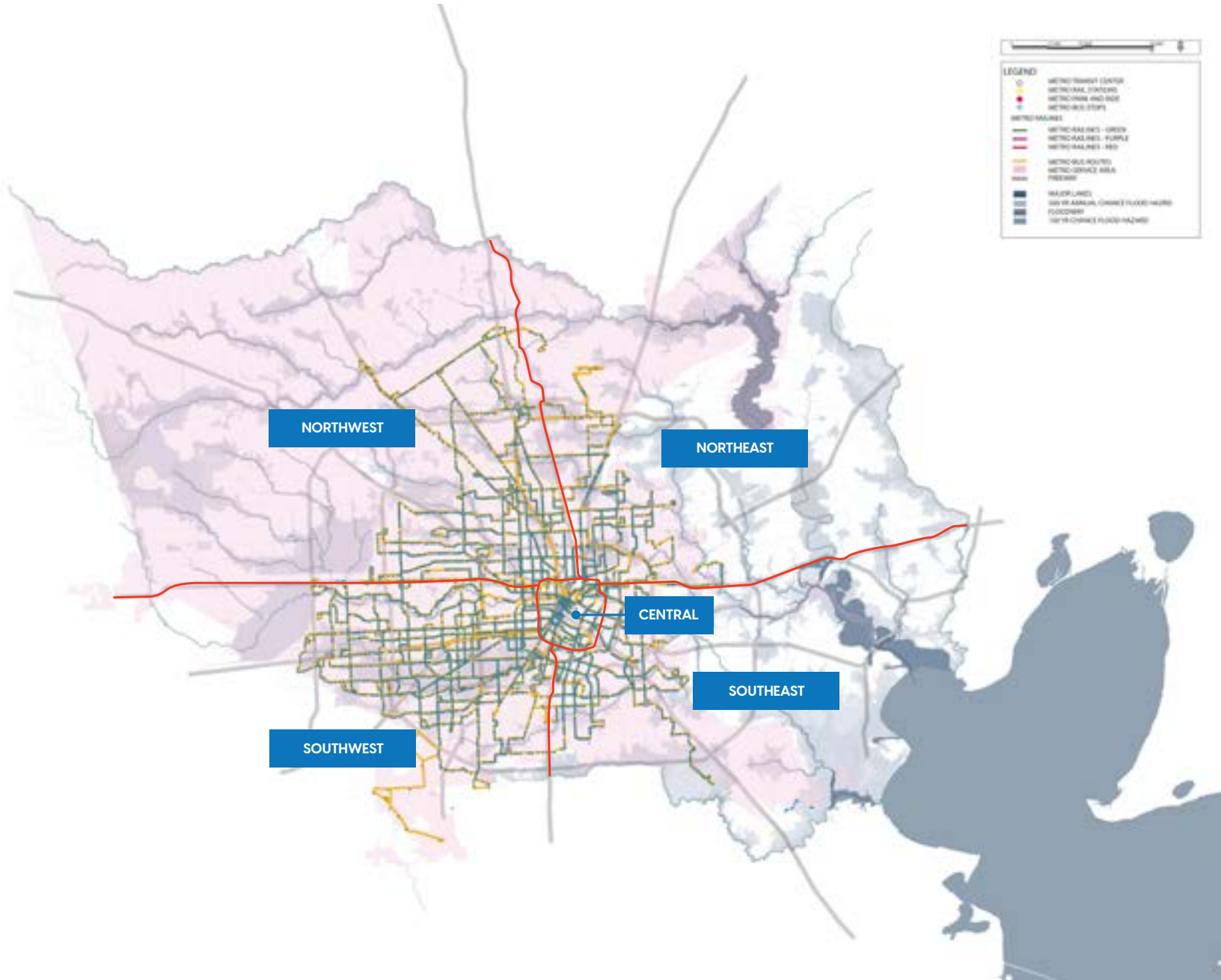
Bus System

1,285
SQUARE-MILE SERVICE AREA

22
HIGH FREQUENCY ROUTES

2,071
BUS SHELTERS

58.2M
RIDES IN 2017











Bus stops are often rendered inaccessible by poor trash can and flagpole placement, above-ground utility obstructions, and inadequate sidewalk widths. Additionally, poor grade separation solutions and poorly maintained sidewalks make traversing the facility difficult for many users. Poor lighting and sightlines can create the perception of insecurity for users, particularly in the evening. Inadequate passing distance in the travelway creates safety hazards adjacent to busy roadways.

Proper coordination of adjacent utilities during streetscape renovations or thoughtful stop placement in retrofit conditions can make a considerable difference. Bus stop placement of trash cans and integration of supplementary amenities should be informed by the bus stop's adjacent context. Bus stop locations should continually be assessed and revisited as external conditions change over time.

Partnership Opportunities

Bus Station Typologies

URBAN	**Standard Flagpole Stop**
	Standard 60' Stop
	BOOST Inspired Stops, Bike Lanes as Applicable
URBAN EDGE	**Standard Flagpole Stop**
	Standard 60' Stop
	BOOST Standards, Bike Lane (Based on Ridership / Amenities)
SUBURBAN (Dense & Developing)	**Standard Flagpole Stop**
	Standard 40' Stop
	BOOST Standards, Bike Lane (Based on Ridership / Amenities)

Partnership Opportunities

Management District

- Bus Shelter Location
- Sidewalk
- Crosswalk
- Transit Environment Development
- Medium to high maintenance capacity
- TOD as development guidelines

Redevelopment Authority (TIRZ)

- Streetscape redevelopments
- Funding source for pedestrian improvements
- No maintenance capacity
- Adopt-A-ROW joint effort with developers

City of Houston

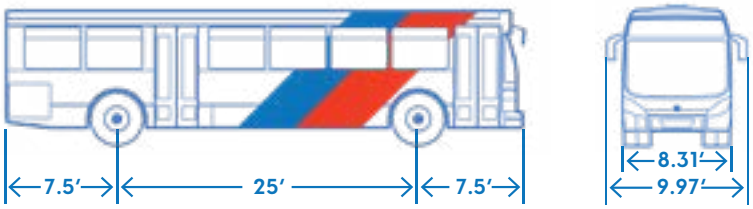
- Capital improvements
- Sidewalk and Safety improvements
- Bus / Park Integration
- Planning Coordination
- Transit Oriented Development potential
- Resilient Houston / CAP Interface

Joint/Private Development

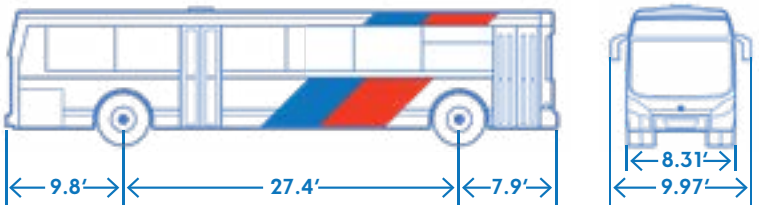
- Marketing Opportunities
- Green Roofs
- Solar Panels
- Art

Bus Layout

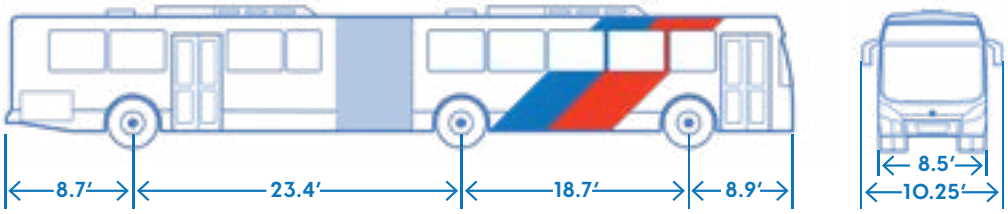
40' BUS



45' BUS



60' BUS



Variety of Vehicular Types

- Bus stops must accommodate the appropriate bus types
- Bus stations can be designed to include future uses, such as integration of BRT
- Curb height and berthing location are influenced by vehicular configuration
- New recommendations for curbs at bus stops are 9" to accommodate higher occupancy vehicles
- Preparing for an autonomous future: curbs may disappear as vehicular safety improves
- Curb details can help guide buses into the correct location

Standard Stops and Special Conditions

- Standard stops should be located at a minimum of 8' from the roadway, though most riders feel that 10' is more comfortable when possible
- Clear amenity locations should be defined as part of the standard
- New standards should be based on BOOST plans and adapted for other streetscape conditions
- Utilities should be integrated free and clear of pedestrian accessway and at-grade bike lanes

BOOST & Special Condition Stops*

- BOOST Corridors are selected based on high levels of ridership
- A clear process for planning, design, public outreach, and stakeholder feedback loops is set forth in the scope of BOOST projects
- Required, recommended, and optional features are described through Corridor Capital Improvements Design Criteria
- Standard shelters were developed in several sizes
- ROW width determines station setback, amenities, and shelter sizes
- Planters, furnishings, trees, planting, and bike amenities are accounted for in the design of the ROW condition
- Identity, branding, and wayfinding are explored as integrated stop elements
- Flexibility for branding, art, and site character are programmed into various configurations
- Emphasis on First and Last Mile connections
- 10', 12' and 25' setback typologies

*Refer to The *BOOST Basis of Design* Guidelines for all BOOST Corridors

Bus Stop Configurations

Bus Plans Legend

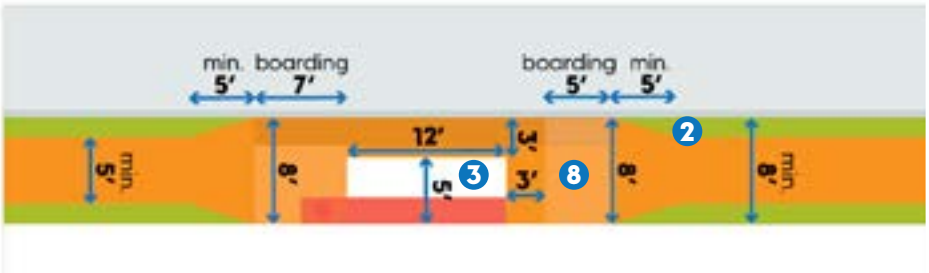
1. Detectable Pavers
2. Flagpole
3. Shelter w / Trash Can
4. Leaning Rail
5. Vegetation
6. Bike Lane
7. Bike Area / Racks
8. Patron Area

Standard Flagpole Stop

The current standard for METRO stops includes a single flagpole sign. These stops can be enhanced through the addition of detectable warning pavers for visually impaired riders.

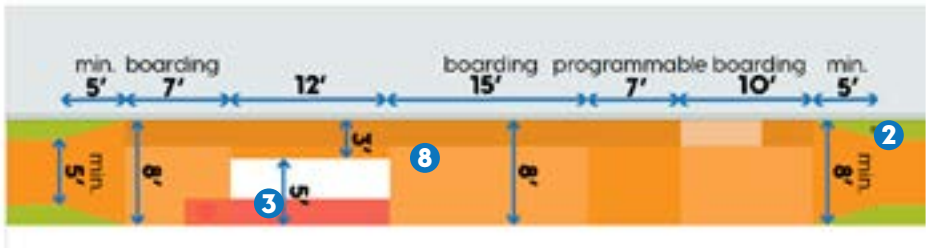
40' Standard Shelter Stop

Standard 40' stops can be utilized in areas with low ridership that only require 40' buses. Additions include detectable warning pavers and a minimum 8' setback.



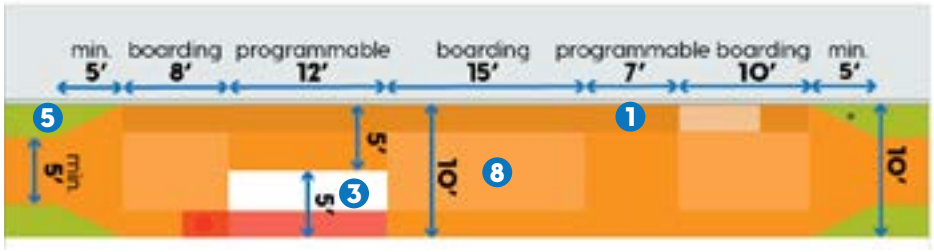
60' Standard Shelter Stop (8')

Standard 60' stop includes an 8' setback, detectable warning pavers, and accommodates all scales of METRO buses.



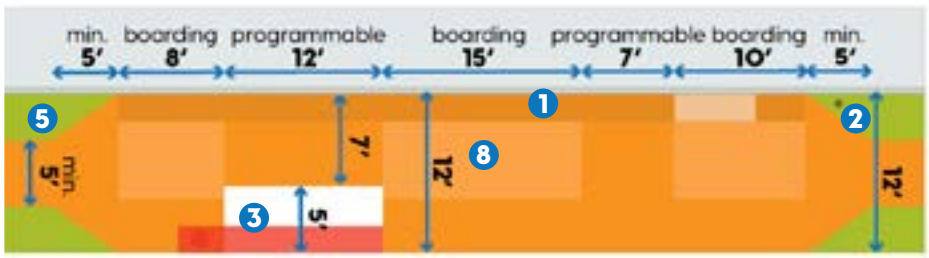
60' Standard Shelter Stop (10')

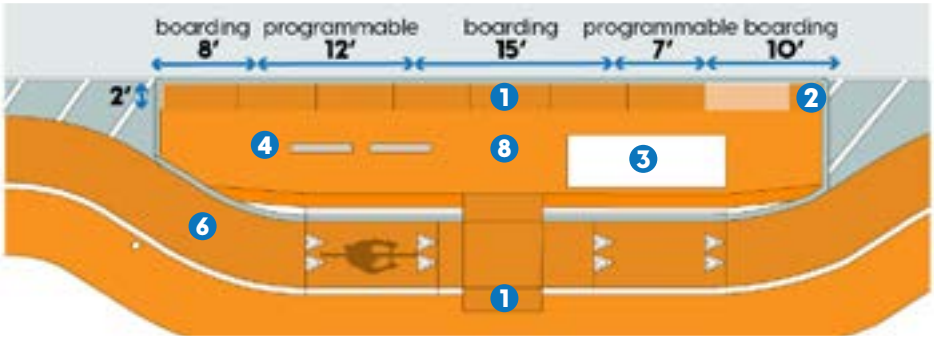
This is the most optimal arrangement for a bus stop within a limited ROW area. Detectable warning pavers line the 2' edge of curb.



60' Standard Shelter Stop (12')

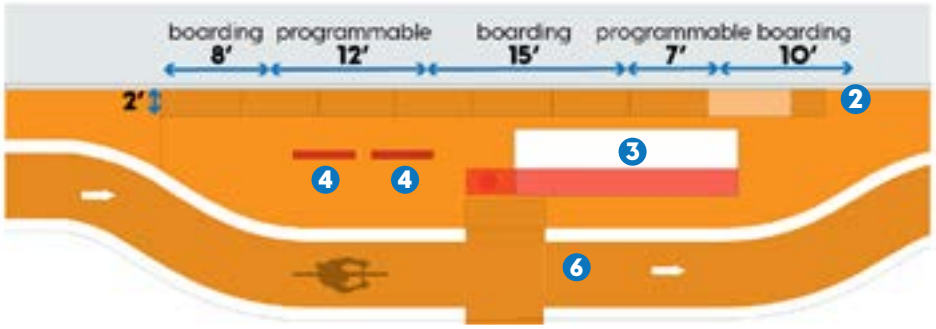
When a larger setback is available, 12' provides plenty of space for circulation in front of the bus shelter for people to comfortably pass one another.





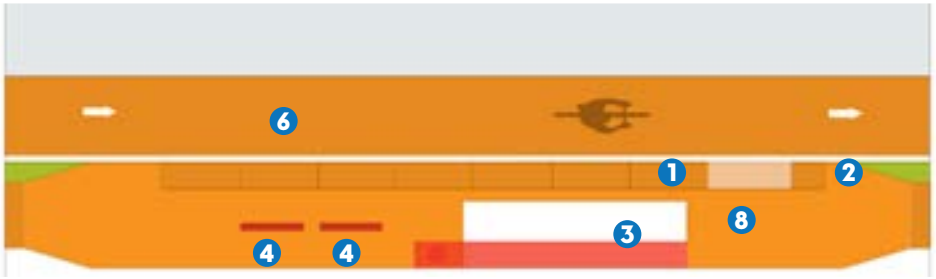
Bus Stop Island with Bikeway

Bikeways at roadway elevation can maneuver behind the bus stop, allowing access when the bus is loading. This detail involves a speed table within the bike lane for pedestrian crossings at grade.



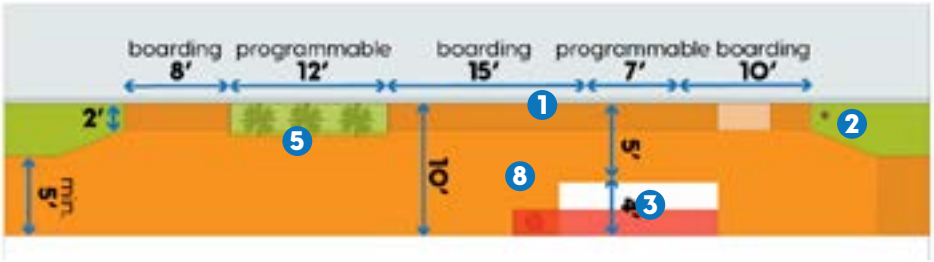
At-Grade Bikeway

Bus stops with sidewalk-grade bikeways can jog around shelters while providing a clear pedestrian crossing at the shelter. This is a modification of the Bus Stop Island detail that keeps bikes and pedestrians at the same elevation.



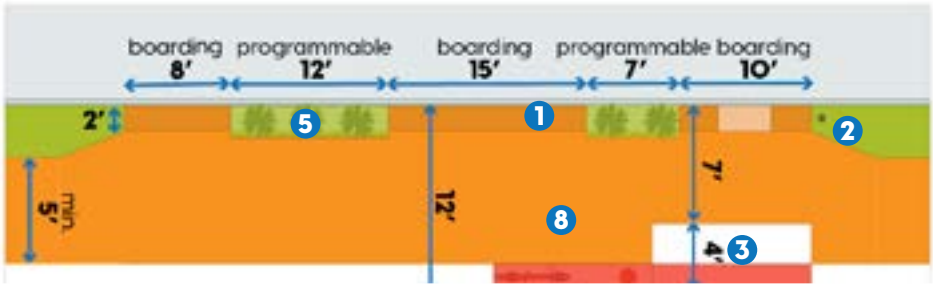
Standard Bikeway

The standard bikeway configuration follows the roadway and does not deviate behind the bus stop. Cyclists yield to buses when riders are boarding.



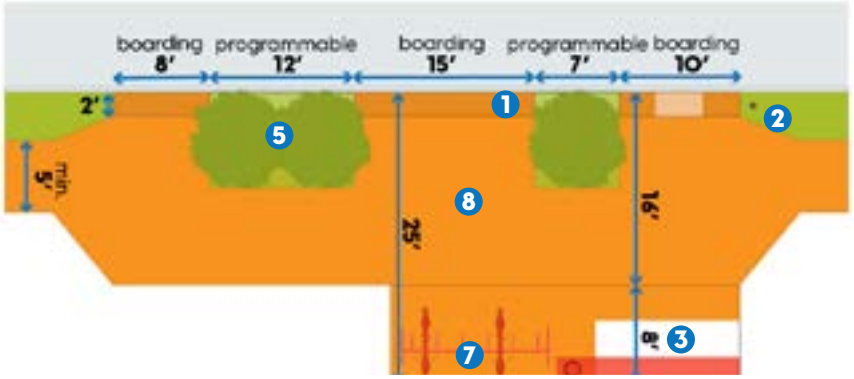
BOOST (10') Setback

In the BOOST standard configurations, the shelter is set back from the curb at 10' with optional programmable areas for planting.



BOOST (12') Setback

In the BOOST standard configurations, the shelter is set back from the curb at 12' with optional programmable areas for planting and minimal bike amenities.



BOOST (25') Setback

In the largest ROW condition, the BOOST Standard for a 25' setback from the curb includes planting areas, appropriate trees, and bike amenities.

Downtown Bus Stop

Bus Stop Case Study

Headline from the Future

"New Downtown Bus Stops Foster Resiliency and Provide Civic Services:

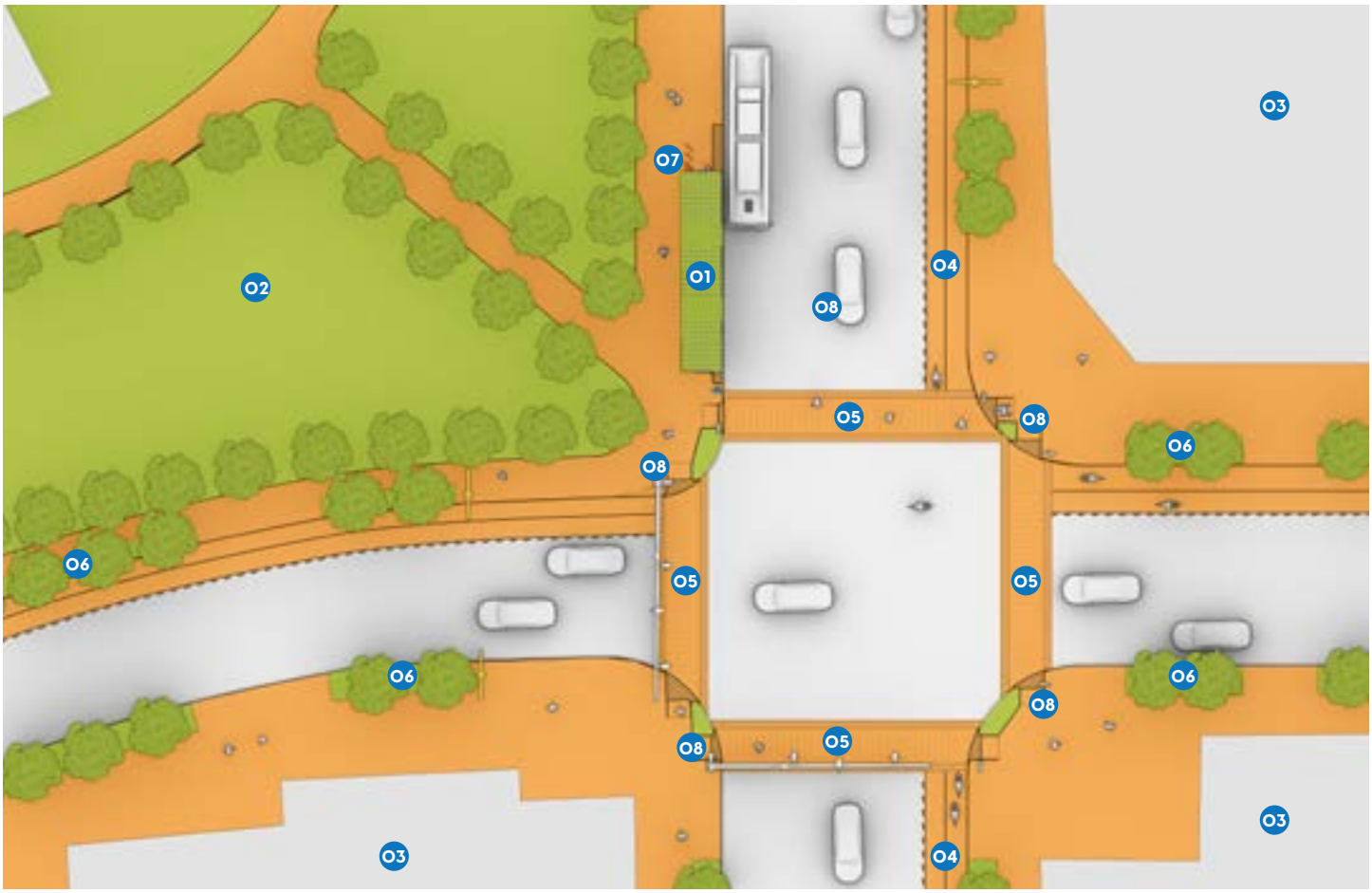
Houston METRO Partners with the Houston Public Library to Implement a Bookshare System at Bus Shelters"

Case Study Description

This case study demonstrates a downtown bus stop condition along a major collector and depicts a partnership to provide educational materials. The stop is also situated next to a historic park and represents opportunities for integration. The shelter provides accessible real-time arrival information, multiple seating options, shelter underlighting, and system routing information to enhance safety, comfort, and quality of life.

Plan Legend

- 01 METRO Bus Stop
- 02 Adjacent Historic Park
- 03 Adjacent Building
- 04 Dedicated Bike Lane
- 05 Crosswalk
- 06 Tree Planter
- 07 Bike Racks
- 08 Accessible Ramp



Facility Name: Conceptual Downtown Bus Stop Study

Facility Type
bus stop brt lrt park & ride transit center

Environmental Resilience

Ecoregional Zone
northwest southwest **central** southeast northeast

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) **moderate (0.25 - 0.50)** high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare **major collector** minor collector

Neighborhood Corridor Type
commercial/economic **cultural/historic** green/scenic/ceremonial neighborhood services high-speed access

Sustainable Development

Project Type
retrofit **redesign** new construction

Urban Context
downtown urban urban edge dense suburban developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** rideshare vehicle/tnc personal vehicle lrt brt

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) somewhat walkable (50-69) car-dependent (0-49)

Neighborhood Bikeability Score
biker's paradise (90-100) **very bikeable (70-89)** bikeable (50-69) somewhat bikeable (0-49)

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **redbud street / LOS D** **sage street / LOS C** **overcup oak street / LOS C**

Downtown Bus Stop

Bus Stop Case Study

Bus Stop Design

01 Comfortable multi-use leaning racks provide additional seating opportunities

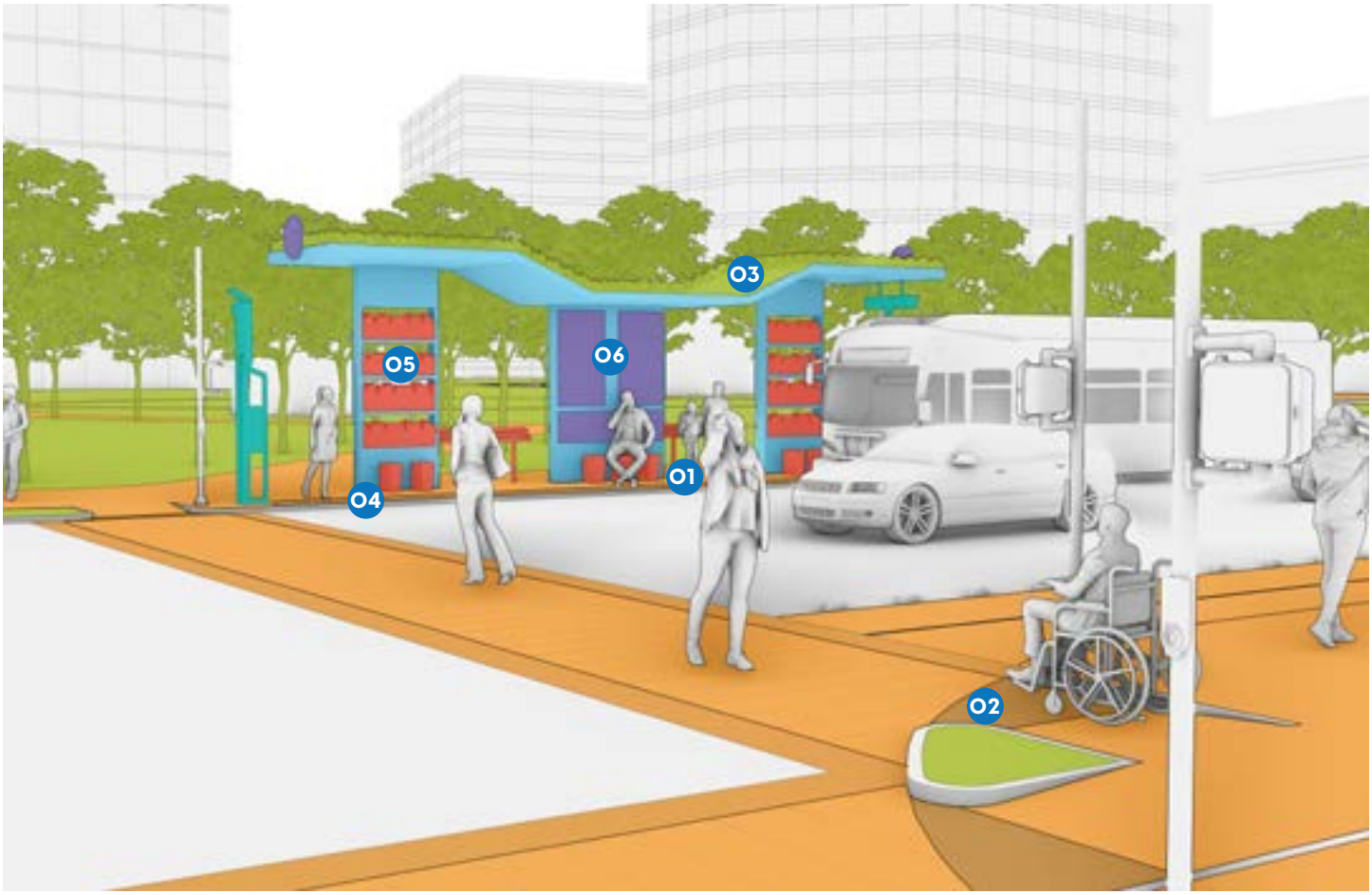
02 Directional crosswalks improve the safety of crosswalks

03 A native greenroof reduces heat island effect and demonstrates a reduction in stormwater runoff

04 Stop length accommodates two small buses or one articulated bus (4 buses per peak hour)

05 Partnership amenities such as reading nooks or other educational materials are displayed without blocking sightlines

06 Public art is displayed along translucent panels



Bus Stop Design

01 Bike racks offer accommodate micro-mobility storage

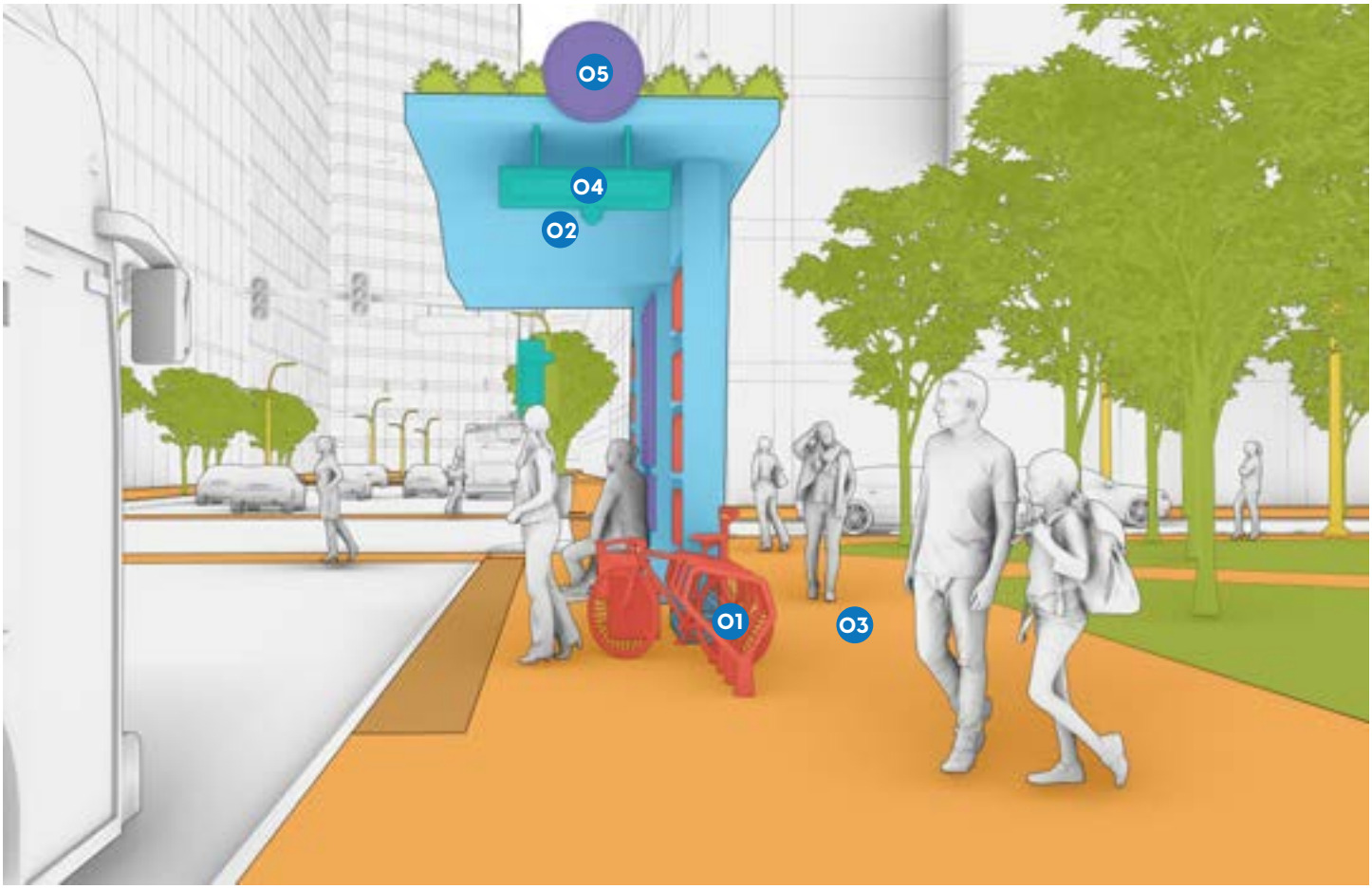
02 360 degree visibility is provided with clear sightlines to the facility station to provide natural surveillance and can accommodate shelter cameras

03 The pedestrian travelway is accessible in front of and behind the shelter

04 Relevant routing information is showcased on bus shelter

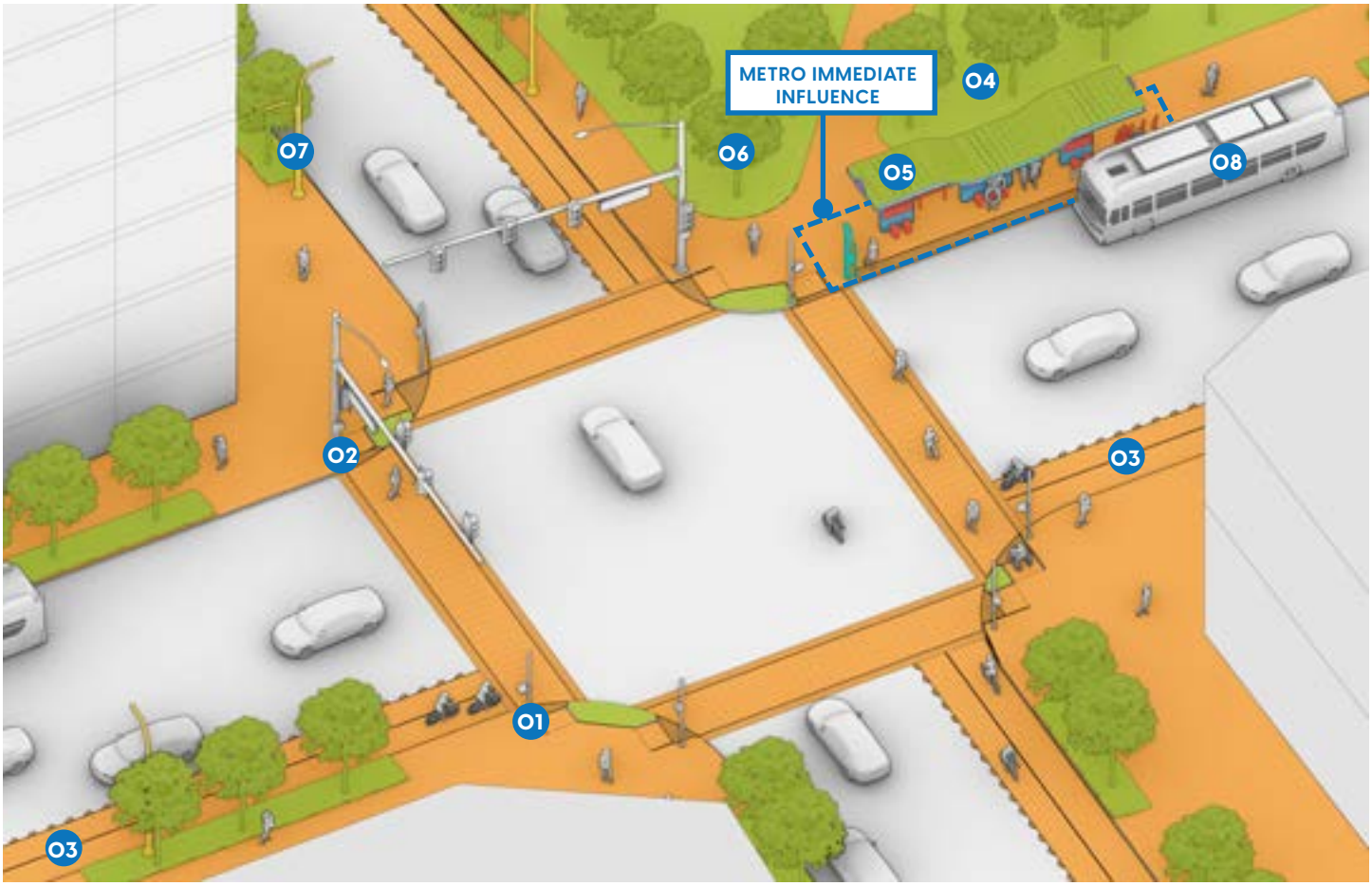
05 The METRO logo is visible within the design of the shelter

06 Detectable warning pavers delineate the edge of the bus stop



Downtown Bus Stop

Bus Stop Case Study



Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Crossings

Comfort

Tree Canopy / Shade
Wide Sidewalks
Streetscape Amenities

Quality of Life

Branded Elements
Planting
Park Access

Contextual Considerations

01 Signalized crossings create safe pedestrian access at intersections

02 Audio-enabled crossings create accessibility for the visually impaired

03 At-grade and on-street bike lanes are accessible to bus stop

04 Stations should be planned near important destinations such as parks, civic buildings, and event spaces while respecting important viewsheds

05 Clear sightlines are provided to transit facility

06 Historic tree canopy has been protected in streetscape renovation

07 Sustainable lighting fixtures supply lighting at adequate levels within walkable distances

Precedent Facilities

BUS STOP LIBRARY

LOCATION: SINGAPORE

AGENCY: GOVERNMENT + ARCHITECTURE FIRM

DESIGN ELEMENTS: This bus stop is designed with a small library of books, a swing, and a green roof.

BUS SHELTER MURAL PROGRAM

LOCATION: SEATTLE, WA

AGENCY: KING COUNTY METRO

One of the largest transit systems in the nation, King County maintains 1,799 bus shelters that are often painted by local artists. Artists pick up panels, paint, and return their murals after filling out an application.

SMART CULTURED BUS STOP

LOCATION: MEILEN, SWITZERLAND

AGENCY: GEMEINDEVERWALTUNG

DESIGN ELEMENTS: Solar powered site-specific bus shelter that incorporates cultural and historic background through perforated murals. In addition, supplemental lighting and important routing information are incorporated.

Urban Edge Bus Stop

Bus Stop Case Study

Headline from the Future

"New Bus Stops Promote Sustainable Development and Customer Experience:
Houston METRO Partners with Local TIRZ and Adjacent Developer to Create Walkable, Bikeable, and Transit-Focused Street"

Case Study Description

This case study demonstrates an urban condition along a major thoroughfare and depicts a partnership to enhance the bus shelter with a green roof. Due to early coordination with the adjacent streetscape redevelopment project, the bus shelter is coordinated with an at-grade bike lane and fosters a comfortable experience adjacent to a street-adjacent mixed-use development. Tree canopy plantings enhance pedestrian comfort approaching the transit facility and adjacent destinations. An alternative version of this stop features a "smart flagpole."

Plan Legend

- 01 METRO Bus Stop
- 02 Adjacent Residences
- 03 Mixed-Use Development
- 04 At-Grade Bike Lane
- 05 Crosswalk
- 06 Accessible Ramp
- 07 Tree Planter
- 08 Lean Rails
- 09 Grocery Store
- 10 Pedestrian Travelway

Facility Name: Conceptual Urban Edge Bus Stop Study

Facility Type
bus stop brt lrt park & ride transit center

Environmental Resilience

Ecoregional Zone
northwest southwest central southeast northeast

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) moderate (0.25 - 0.50) high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare **major thoroughfare** major collector minor collector

Neighborhood Corridor Type
commercial/economic **cultural/historic** green/scenic/ceremonial **neighborhood services** high-speed access

Sustainable Development

Project Type
retrofit **redesign** new construction

Urban Context
downtown urban **urban edge** dense suburban developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** rideshare vehicle/tnc personal vehicle lrt brt

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) **somewhat walkable (50-69)** car-dependent (0-49)

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) **bikeable (50-69)** somewhat bikeable (0-49)

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **walker street / LOS B** **victoria drive / LOS C** **cypress street / LOS D**

Urban Edge Bus Stop

Bus Stop Case Study

Bus Stop Design (Shelter)

01 Bus stop is integrated with adjacent bikelane to maximize pedestrian safety

02 The bus shelter includes an emergency call box to enhance perceived safety and increase access to emergency services

03 Integrated speakers and supplemental lighting assist visually impaired riders

04 Lean rails provide a temporary resting opportunity while serving as additional bike storage

05 Divided recycling and litter disposal are integrated into the design of the shelter to avoid conflicts in the travelway

Bus Stop Design (Flagpole)

01 Solar panels are integrative to the design of the flagpole to provide additional comfort amenities in the absence of a shelter

02 Trees are placed free and clear of solar panels

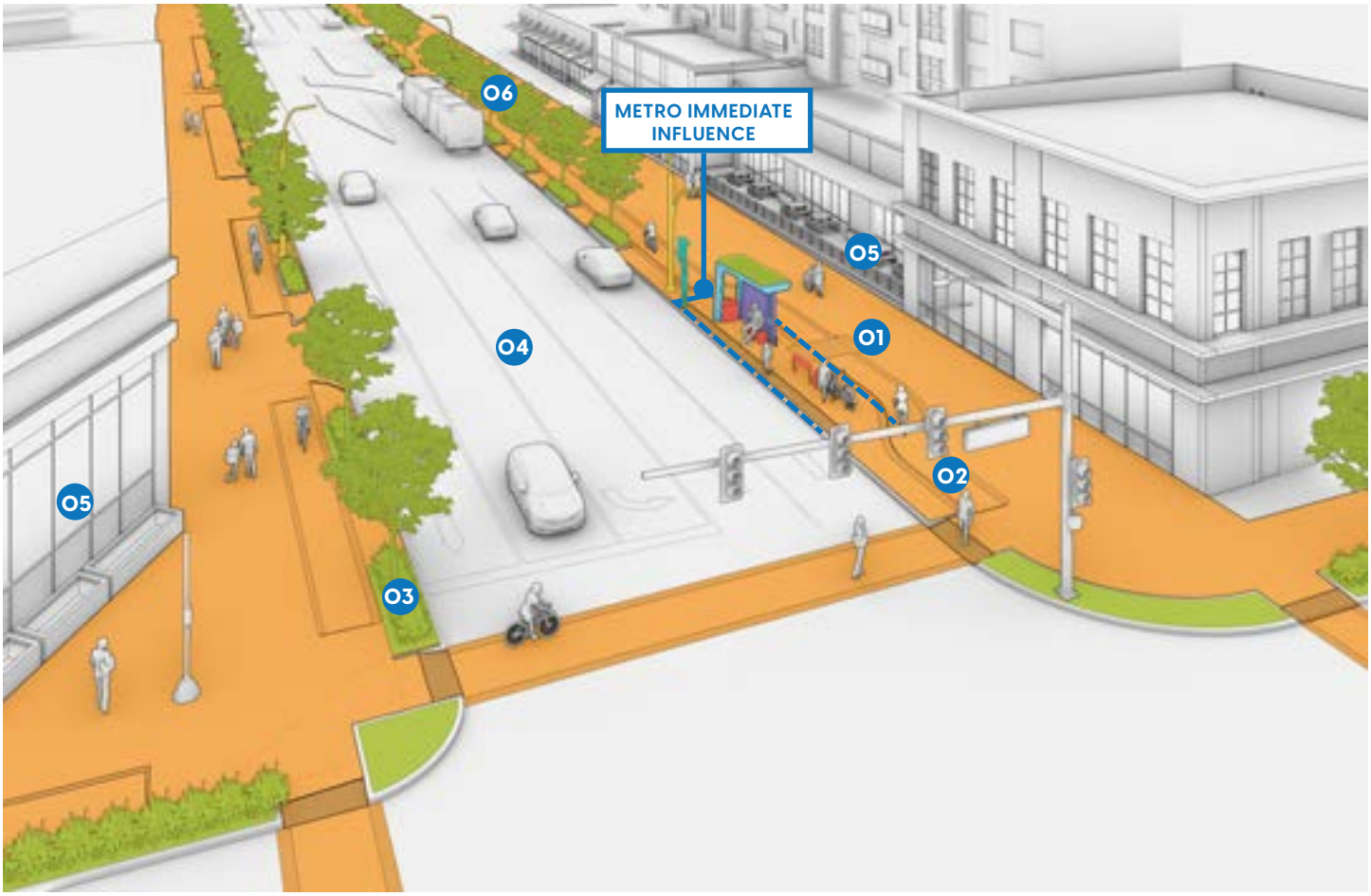
03 Short duration seating is provided at the base of the bus stop flag pole

04 Pedestrian access is punctuated through the bikeway with warnings to cyclists upon approaching the bus stop

05 The bikelane paving breaks to give pedestrians a safe crossing to the stop

Urban Edge Bus Stop

Bus Stop Case Study



Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Crossings
Bike Lane Integration

Comfort

Tree Canopy / Shade
Wide Sidewalks
Streetscape Amenities

Quality of Life

Branded Elements
Planting
Engagement with Adjacent Development
Greenroof

Contextual Considerations

O1 Safe separation of pedestrian and bike circulation is provided approaching the bus stop

O2 Bike lanes are clearly delineated, buffered, and branded distinctly from the pedestrian zone, as well as integrated to minimize conflict at bus shelters through the use of station islands or shifted bike lanes

O3 The tree basins are designed to filter and convey stormwater through the use of interconnected tree cells

O4 Underground culverts detain large scale stormwater runoff to reduce flood impacts within adjacent community

O5 Adjacent development engages the urban design environment through the minimization of driveways, rear parking orientation, and facade orientation along the streetscape to create a safe and vibrant urban design environment

O6 Trees are spaced to provide adequate shade for pedestrians approaching the bus stop

Precedent Facilities

GREENROOF ADOPT-A-STOP PROGRAM

LOCATION: UTRECHT, THE NETHERLANDS

AGENCY: CITY OF UTRECHT + CLEARCHANNEL

Clear Channel sponsored the installation of 316 bus shelter green roofs around the city. The shelter has LED lighting and solar panels, and is constructed of sustainable materials.

BUS SHELTER RECYCLING PROGRAM

LOCATION: BUDAPEST, HUNGARY

AGENCY: BKV + JCDecaux + IKEA

Local businesses integrated a green roof and recycling into bus shelters as both a marketing and educational opportunity for riders while serving as functional amenities.

SOLSTOP

LOCATION: LANSING, MICHIGAN

AGENCY: CAPITAL AREA TRANSIT AUTHORITY (CATA)

This solar powered flag pole stop is push button activated. It includes security lighting, a small integrated bench, bike rack, and pole mounted information displays.

Dense Suburban Bus Stop

Bus Stop Case Study

Headline from the Future

"Bus Stop Promotes Social Equity Through Neighborhood Connectivity:
Houston METRO Partners with Neighborhood Group and Private Developer to Enhance Safety Near a Busy Intersection"

Case Study Description

This dense suburban bus stop condition showcases a bus stop with solar panel integration in a vulnerable neighborhood. The solar panels power phone chargers and shelter lighting. Adjacent to the METRO stop, the local neighborhood group worked with the city to provide new sidewalks that were once disconnected and unkept. An adjacent developer provided a safe crossing to the fast food restaurant to provide safer access to their establishment.

Plan Legend

01 METRO Bus Stop
02 Adjacent Residences
03 Fast Food Restaurant
04 Pedestrian Walkway
05 Crosswalk
06 Accessible Ramp
07 Tree Median
08 Shaded Planting Area
09 Pedestrian Lighting

Facility Name: Conceptual Dense Suburban Bus Stop Study

Facility Type
bus stop brt lrt park & ride transit center

Environmental Resilience

Ecoregional Zone
northwest **southwest** central southeast northeast

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) moderate (0.25 - 0.50) high (0.50 - 0.75) **critical (0.75 - 1.0)**

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant **ethnically significant** **culturally significant** muti-ethnic

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare **major collector** minor collector

Neighborhood Corridor Type
commercial/economic cultural/historic green/scenic/ceremonial **neighborhood services** high-speed access

Sustainable Development

Project Type
retrofit **redesign** new construction

Urban Context
downtown urban urban edge **dense suburban** developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** rideshare vehicle/tnc personal vehicle LRT/BRT

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) **somewhat walkable (50-69)** car-dependent (0-49)

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) bikeable (50-69) **somewhat bikeable (0-49)**

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **outerland street / LOS C** **honeycomb street / LOS B** **rasa blvd / LOS A**

Dense Suburban Bus Stop

Bus Stop Case Study

Bus Stop Design (Shelter)

01 Shelter is well-lit under the structure to prevent dark shadows from adjacent development

02 Solar panels are unshaded by adjacent tree canopy

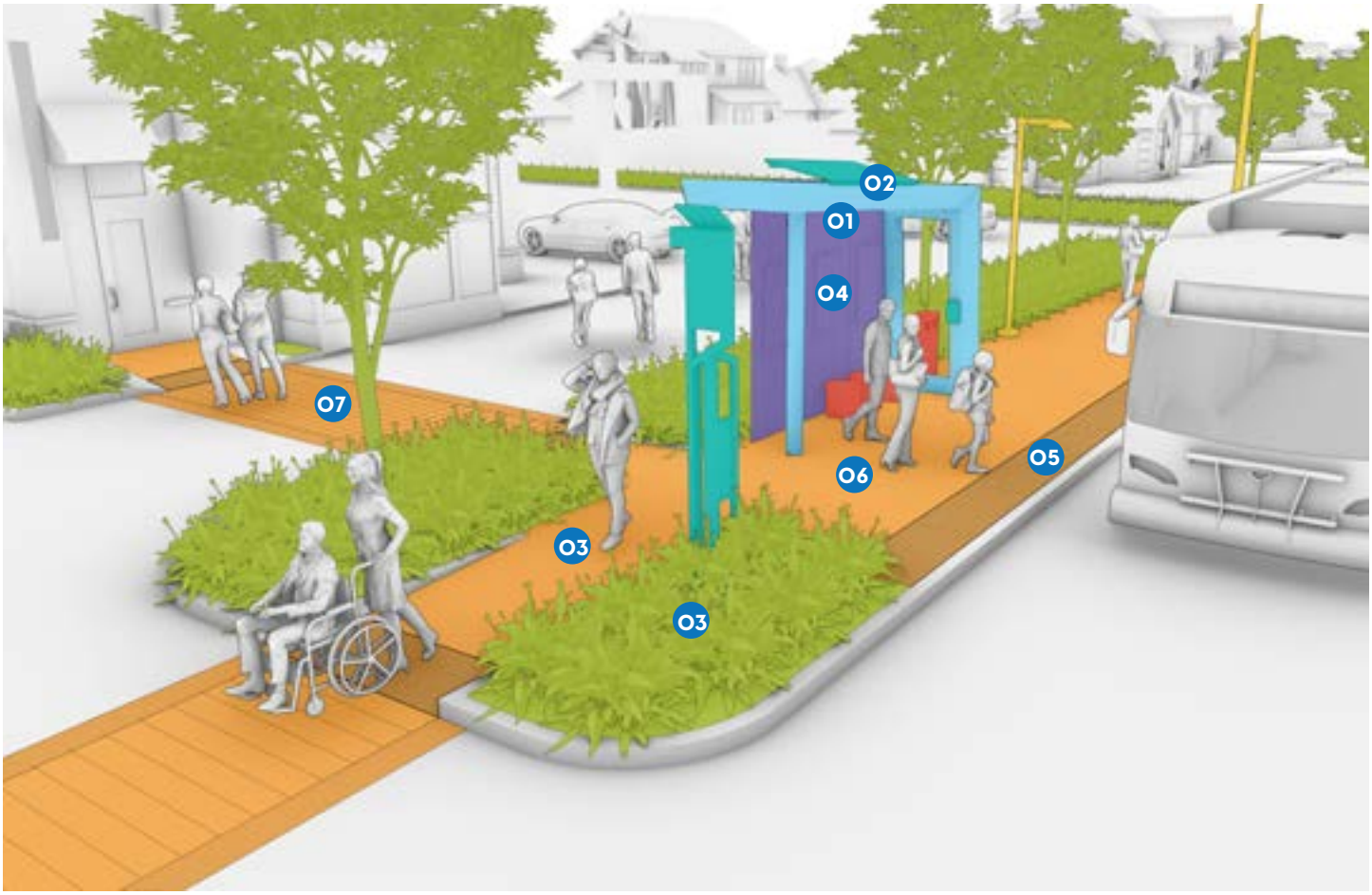
03 Low maintenance native planting is integrated into the edges of the bus stop to cool the bus stop environment

04 Art is integrated into the design of the bus shelter to reflect local community character

05 Detectable warning pavers line the edge of curb

06 The passing space within the pedestrian travelway exceeds the minimum ADA standard for comfort

07 Pedestrian access and safety is considered to the adjacent development



Bus Stop Design (Flagpole)

01 The solar flagpole stop is unshaded by adjacent tree canopy

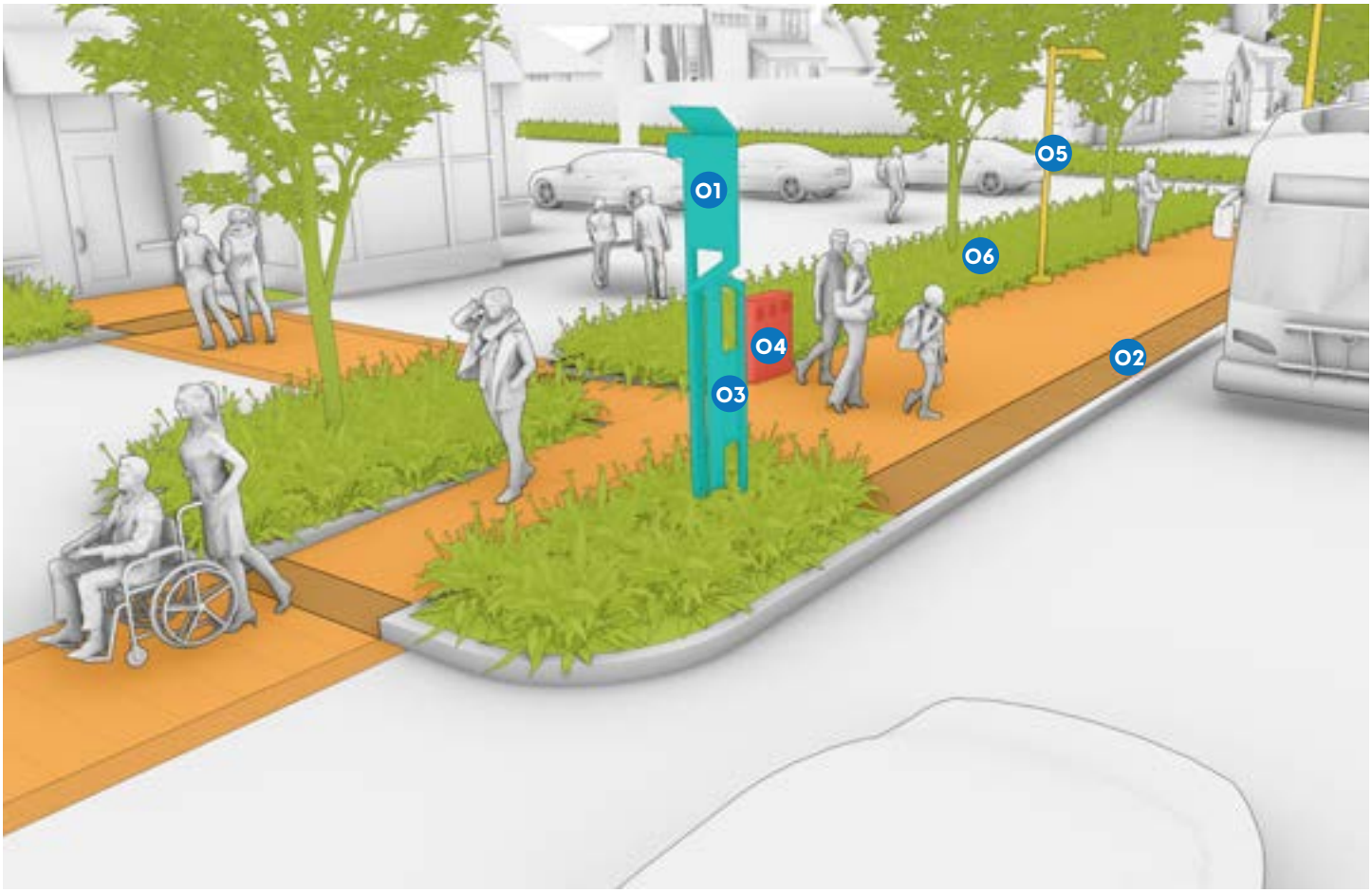
02 Detectable warning pavers line the boarding area along the edge of curb

03 Clear, multilingual signage is located on the flagpole

04 Adjacent streetscape furnishings are located along the outside edges of the pedestrian travelway

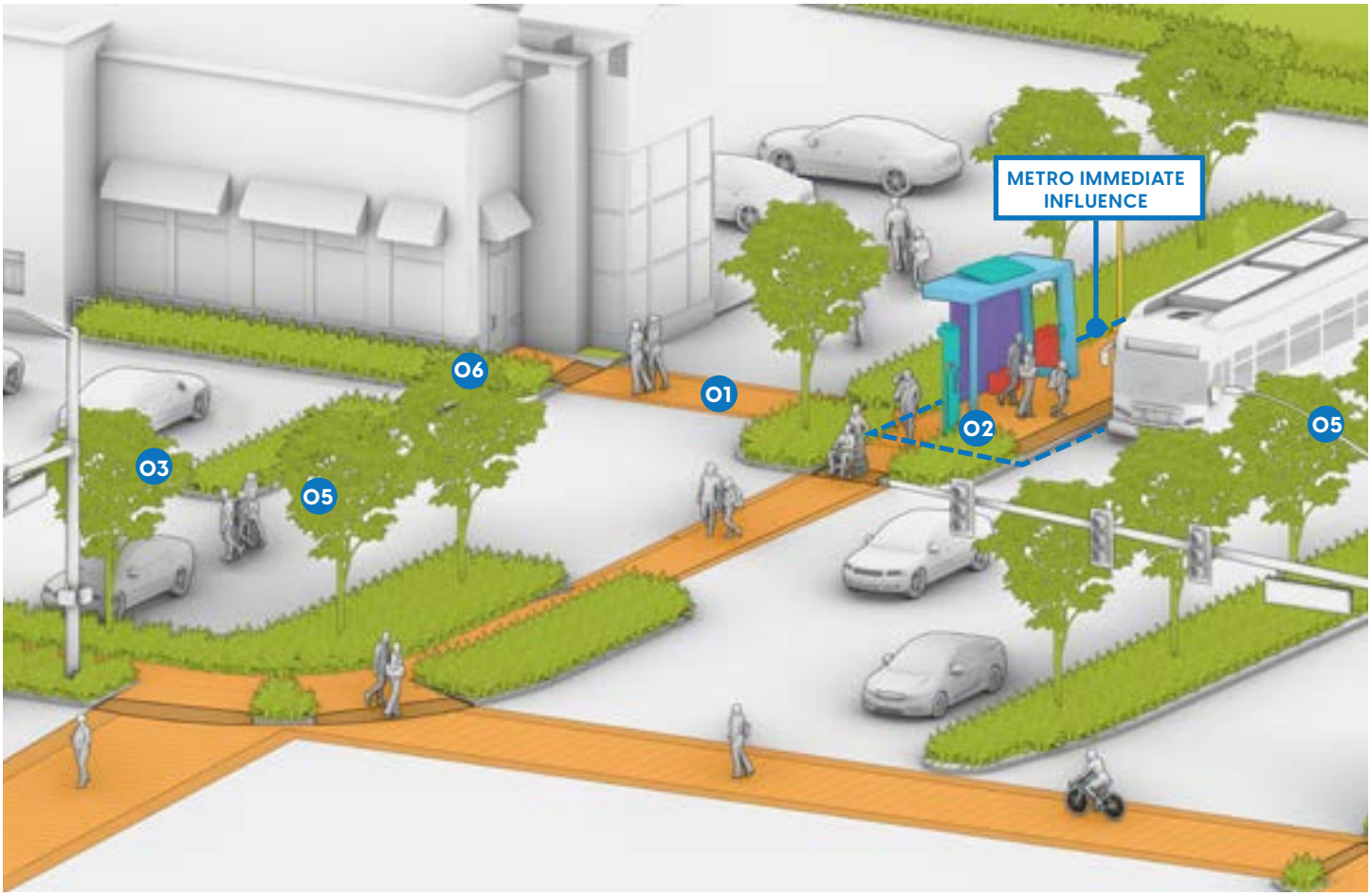
05 Pedestrian lighting provides high visibility approaching the bus stop and eliminates harsh shadows from the adjacent development

06 Adjacent development planting is selected to permit views into the bus stop area and prevent hiding areas



Dense Suburban Bus Stop

Bus Stop Case Study



Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Crossings
Shared ROW Bikeway

Comfort

Tree Canopy / Shade
Wide Sidewalks
Bus Stop Amenities

Quality of Life

Art Integration
Native Planting
Engagement with Adjacent Development
Solar Panels

Contextual Considerations

01 Pedestrian network is considered across jurisdictional boundaries to provide accessibility and connectivity throughout the urban design environment

02 Boulevard median contains curb cuts and is graded to incorporate stormwater bioretention to reduce flooding and cool paved areas

03 Wide pedestrian crossings at the corner intersection contain audio cues for the visually impaired

04 Street name signage is clearly legible from the pedestrian travelway and vehicular roadway

05 Vehicular sightlines are clear at corners to increase pedestrian safety

06 Pedestrian lighting improves visibility and perception of security

Precedent Facilities

CLEAN ENERGY BUS STOP

LOCATION: SAN FRANCISCO, CALIFORNIA

AGENCY: SAN FRANCISCO MUNICIPAL TRANSPORTATION AGENCY

San Francisco's shelters feature sustainable LED lighting, steel with 70% recycled content, and roof materials made out of 40% recycled content. The roof is embedded with silicon-based photovoltaic structures, and a Push-to-Talk feature provides auditory updates of the digital display for the visually impaired.

GARDEN STOPS

LOCATION: LEXINGTON, KENTUCKY

AGENCY: LEXTRAN + ART IN MOTION

Gardenstops incorporate living plants and native vines on backdrop and roof to divert storm water runoff and reduce urban heat island effect.

EDIBLE BUS STOPS

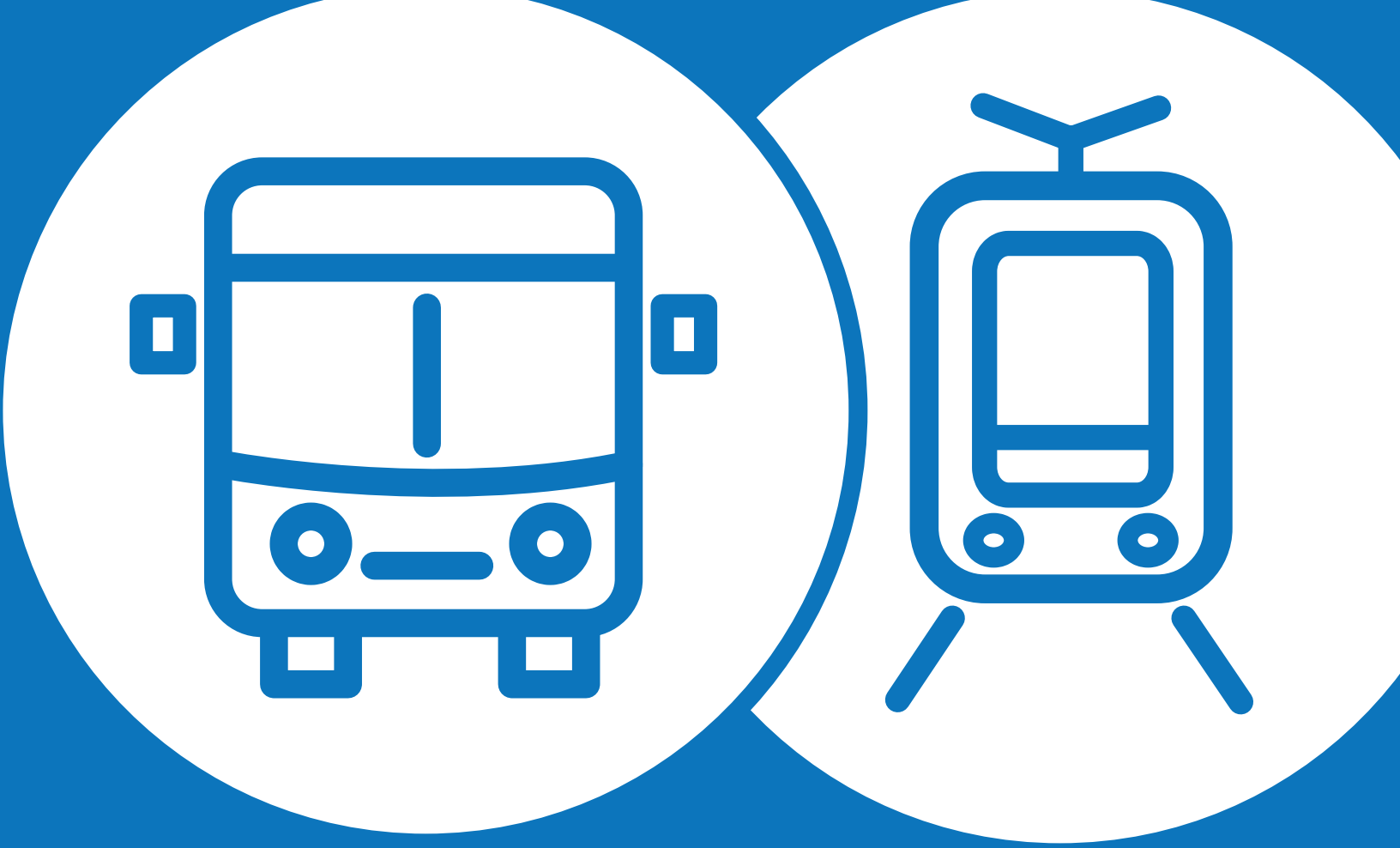
LOCATION: STOCKWELL, LONDON

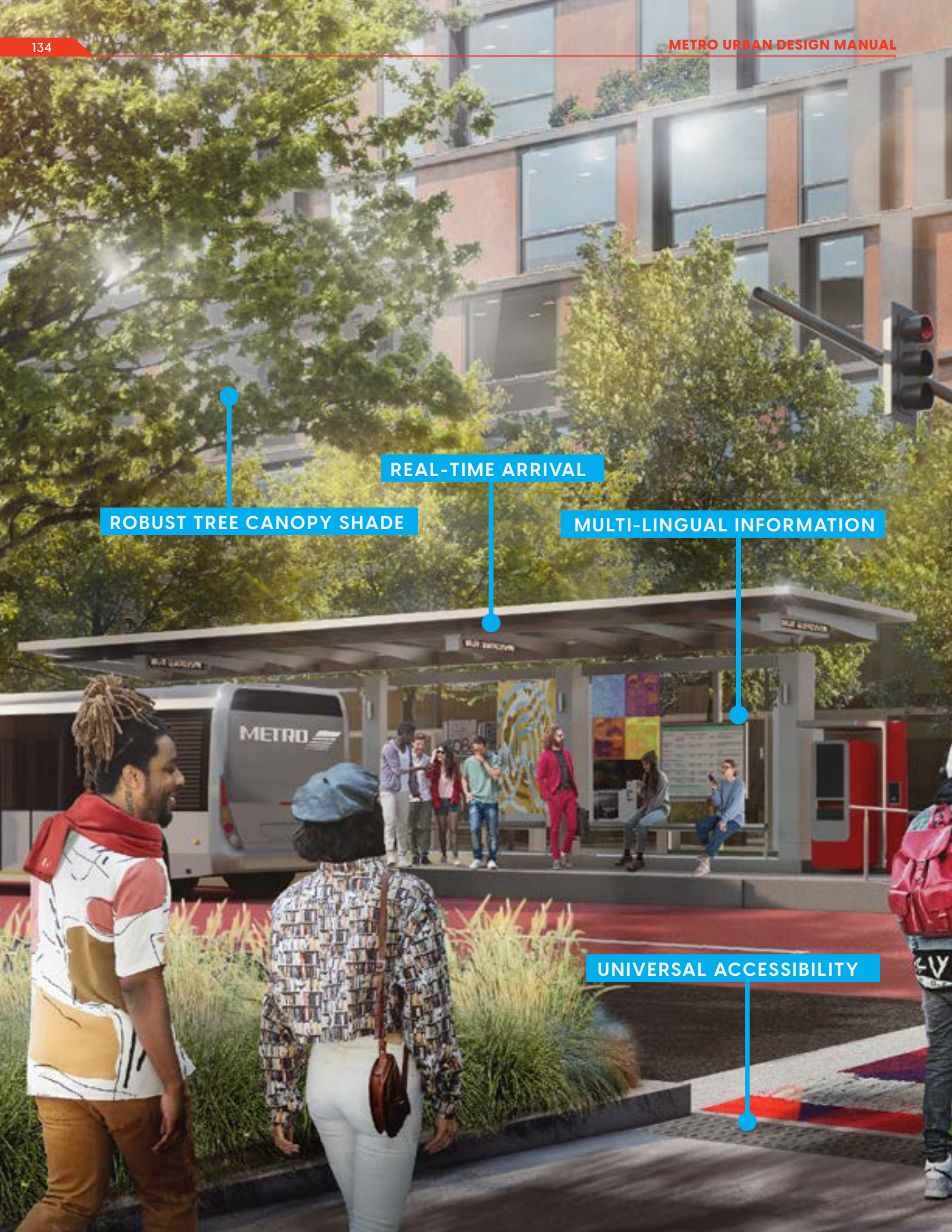
AGENCY: MAK GILCHRIST / EDIBLE BUS STOP

Developed as part of the Mayor of London's Pocket Park program in 2013, Edible Bus Stops animate the public realm through partnerships with developers and management companies. Edible Bus Stops brighten community engagement and lessen the impacts of food deserts.

BRT & LRT

BRT & LRT facilities can serve as the flagship corridors of stations within the METRO brand and have the ability to build connections between communities with differing identities, needs, and resources. LRT and BRT serve as a central spine network by connecting strategic nodes within the city and promoting access to cultural resources. The introduction of green infrastructure along BRT / LRT corridors will help mitigate heat island effect from large amounts of hardscape. Shade corridors should be planned with the redevelopment of streetscapes to accommodate transitways associated with BRT/LRT lines. These facilities promote TOD by creating a walkable environment and clearly defined transitways. The creation and enhancement of these facilities promote streetscape redevelopment efforts and can facilitate the implementation of "roadway diets" to increase pedestrian and bike safety.




ROBUST TREE CANOPY SHADE
REAL-TIME ARRIVAL
MULTI-LINGUAL INFORMATION
UNIVERSAL ACCESSIBILITY
METRO


COORDINATED UTILITIES
CIVIC ART
LEGIBLE SIGNAGE
WALKABLE STREETSCAPE
NEIGHBORHOOD CHARACTER
NATIVE PLANTING

BRT & LRT

3
EXISTING AND PROPOSED BRT LINES

18.4
MILLION RAIL TRIPS

3
EXISTING LRT LINES

$8B
IN DEVELOPMENT ALONG THE RED LINE









The LRT and BRT system strongly influences the urban design environment through the configuration of station elements and pedestrian safety integration.

Large utilities and kiosks create undesirable hiding places and should not be located perpendicular to the travelway. Art is typically integrated in a way that is difficult to maintain. The placement of trash cans greatly impacts the accessibility of these stations. Facility barriers should be durable and attractive.

Proper coordination of utilities and intuitive pedestrian access furthers the safety of LRT and BRT facilities. BRT stations can be enhanced through the addition of trees that serve as additional shade value for pedestrians boarding at the station platform.

Lean rails provide additional shaded resting areas for comfort out of the sun. Dedicated transitways provide a clear delineation for vehicles and pedestrians.

Partnership Opportunities

Transit Corridor Typologies

LRT	**Median Stop, Left-Side Boarding**
	Alternating Station
	Median Stop, Right-Side Boarding
BRT	**In-Street Boarding Island Stop (Limited ROW)**
	Medium Stop, Right-Side Boarding
	In-Street Boarding Island Stop (Extended ROW)
BRT / Specialty Line	**BRT/HOV Lane**
	Quickline
	Greenlink
	RapidLine

Partnership Opportunities

Management District

- Sidewalk
- Crosswalk
- Transit Environment Development
- Medium to high maintenance capacity
- TOD as development guidelines
- Funds for redevelopment and branded site elements

Redevelopment Authority (TIRZ)

- Streetscape redevelopments
- Funding source for pedestrian improvements
- No maintenance capacity
- Adopt-A-ROW; joint effort with developers

City of Houston

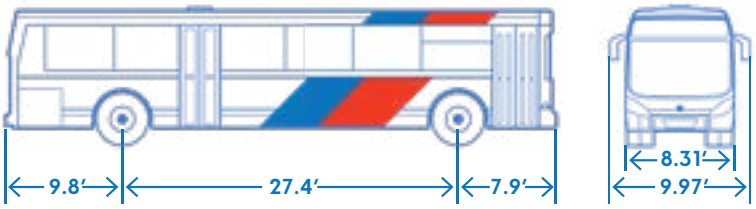
- Capital improvements
- Sidewalk and Safety improvements
- Transit Platform / Park Integration
- Planning Coordination
- Transit Oriented Development potential
- Resilient Houston / CAP Interface

Joint/Private Development

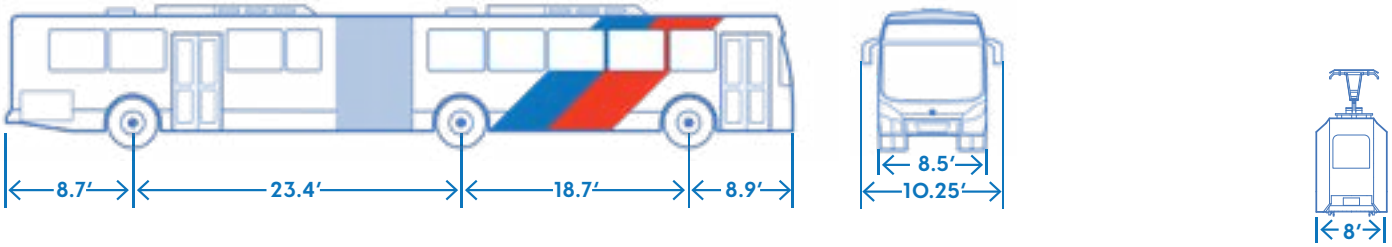
- Marketing Opportunities
- Green Roofs
- Solar Panels
- Non-Profit Funding
- Community-led initiatives

Vehicular Layout

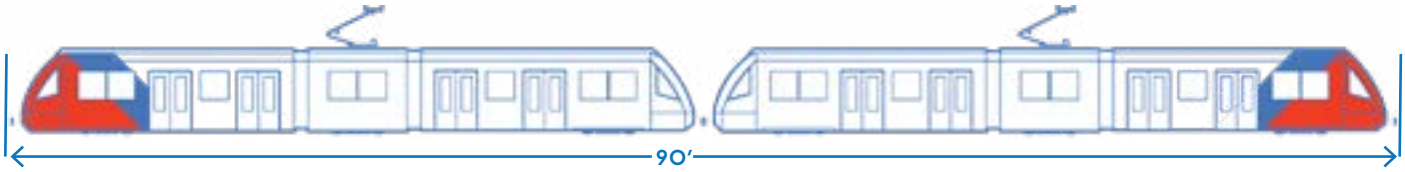
45' BUS



60' BUS



LIGHT RAIL



BRT Vehicles

- Articulated buses require a curb height of 9', while BRT platforms are level at 14'
- BRT vehicles can berth at shared shelters as standard articulated buses through the lowering of grade change at the platform
- Existing facilities can be retrofitted to meet new height requirements
- The flexibility of BRT vehicles allows for open transit systems, where dedicated transit ways can open up and transfer to other facilities

BRT Drivers of Site Design

- Long, limited corridors require the use of central transit lanes as opposed to curbside transit lanes
- Where high ridership is anticipated (neighboring popular destinations), larger shelter sizes are needed.
- Longer platforms enable a more gradual grade change but take up more space, while shorter platforms may require a handrail
- Clear landing areas should be provided at all doorways
- 24" detectable warning strips should be provided at the edge of the platform to prevent visually impaired riders from falling into the transitway
- Dedicated left turn lanes allow for an alternating arrangement if combined with pedestrian refuge islands for safety

LRT Vehicles

- Unlike BRT transitways which can be an open system. LRT is constrained to a dedicated transitway
- LRT vehicles are limited in their maneuvering abilities, but can navigate alongside vehicular traffic.
- LRT vehicles are much longer than buses and need long platforms / shelters.
- LRT vehicles can transport a large amount of passengers at once
- Several sets of doors must be accounted for on the transit platform

LRT Drivers of Site Design

- LRT lanes can either be central or curbside, which affects how pedestrian circulation interfaces with the platform
- Safety barriers adjacent to the LRT transitway can be weighed through aesthetic and spatial requirements
- Medians adjacent to LRT railways provide an opportunity for low impact development strategies or manicured landscaping
- Similar principles for BRT stations apply for transit platforms, but LRT stations differ in door height and must accommodate a cable system

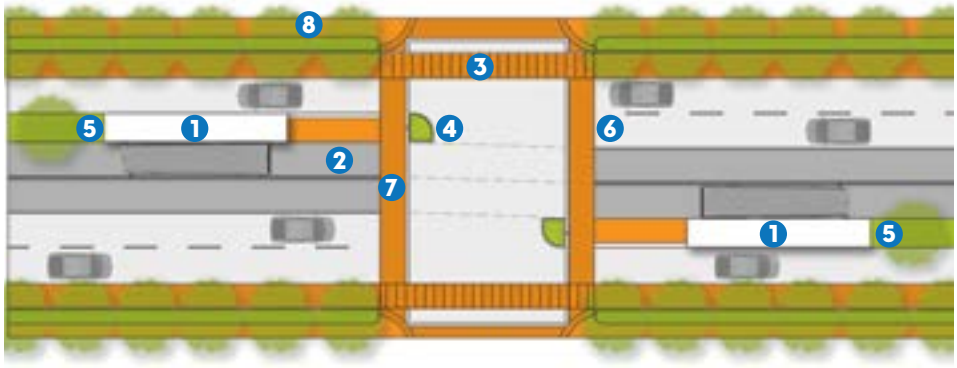
BRT Standard Configurations

1. BRT Station
2. Bus Only Lane
3. Bike Lane & Crossing
4. Pedestrian Refuge
5. Divider Median (Bioswale)
6. Dedicated Turn Lane
7. Pedestrian Crossing
8. Pedestrian ROW

*NUMBER OF VEHICULAR LANES VARY BASED ON ROW WIDTH

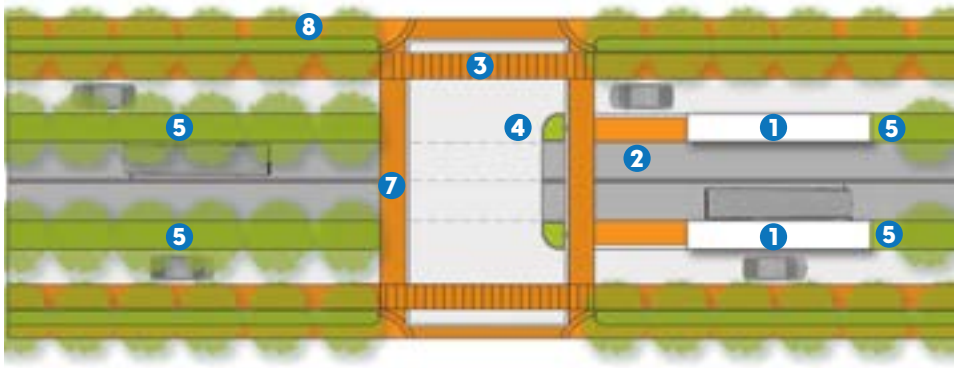
In-Street Boarding Island Stop (Limited ROW)

Within limited ROW conditions, split and alternating stations allow the flexibility to taper lanes. This arrangement is dependent on a left-turn only lane and utilizes a singular pedestrian refuge median at the posterior of the station platform.



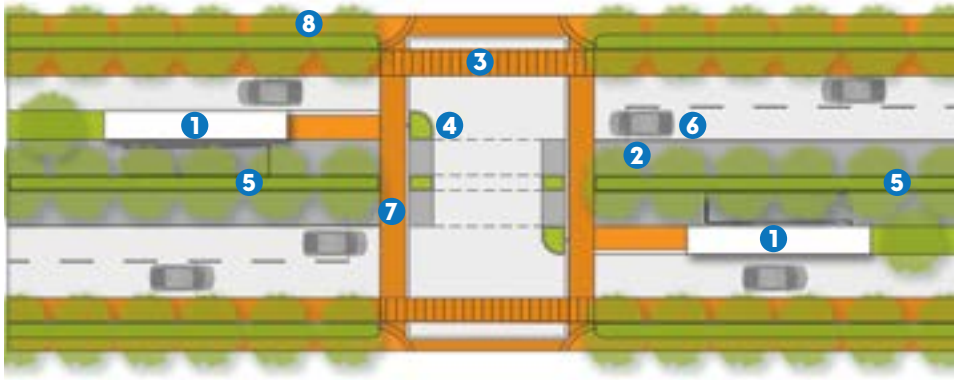
Median Stop, Right-Side Boarding

Dual stations require a larger amount of ROW, but allow the greatest ease-of-access to pedestrians / cyclists due to the proximity of stations and shared crossings. Dedicated BRT lanes are buffered by a green median or bioswale, separating bus / vehicular access.



In-Street Boarding Island Stop (Extended ROW)

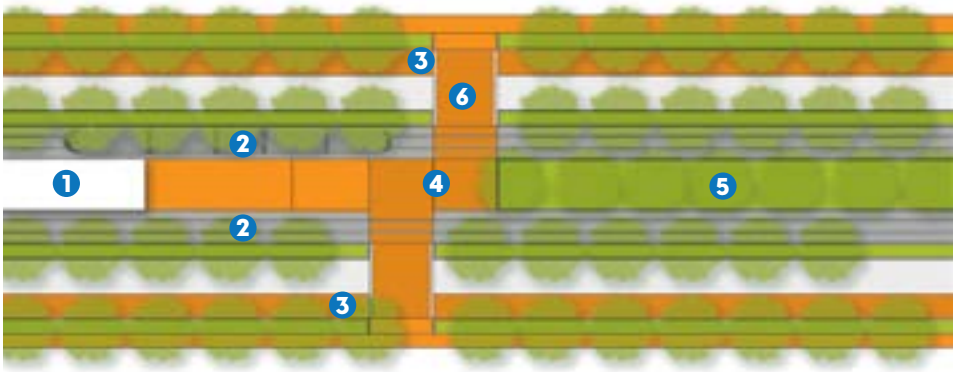
Within wide ROW conditions, split and alternating stations provide flexibility for a dividing median between BRT lanes. A lane taper can provide the flexibility to add additional medians. The Post Oak Blvd. Silver Line has this configuration.



LRT Standard Configurations

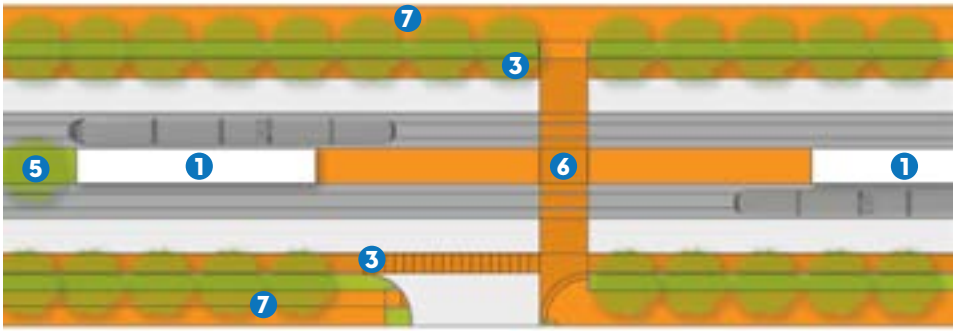
1. **LRT Station**
2. **LRT Only Lane**
3. **Bike Lane & Crossing**
4. **Pedestrian Refuge**
5. **Divider Median (Bioswale)**
6. **Pedestrian Crossing**
7. **Pedestrian ROW**

**NUMBER OF VEHICULAR LANES VARY BASED ON ROW WIDTH*



Midblock Crossing at Consolidated Station

This configuration allows for a shared station condition with a central median in-line with the station platform. The staggered crosswalk prevents pedestrians from cutting straight across the LRT track. Further control measures can be taken to ensure pedestrians cannot cross the tracks when the LRT vehicle is approaching.



Alternating Station at Intersection

Alternating stations configured around a central pedestrian crossing allows ease-of-access while preventing pedestrian / motorist conflicts. A signalized crossing or yield sign should be located on either side of the roadway.

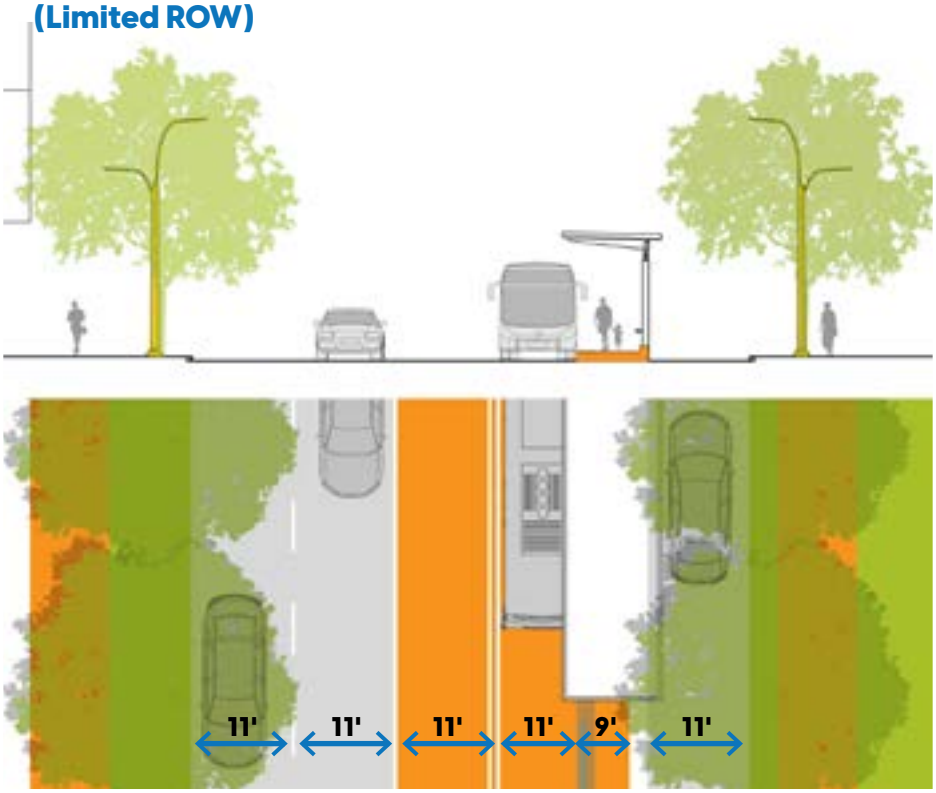
LRT at Intersections

Vehicular circulation should either transverse parallel or perpendicular to the LRT at controlled intersections. Anywhere an LRT must cross through a full intersection, lanes should be limited. The intersection should be designed for high visibility.

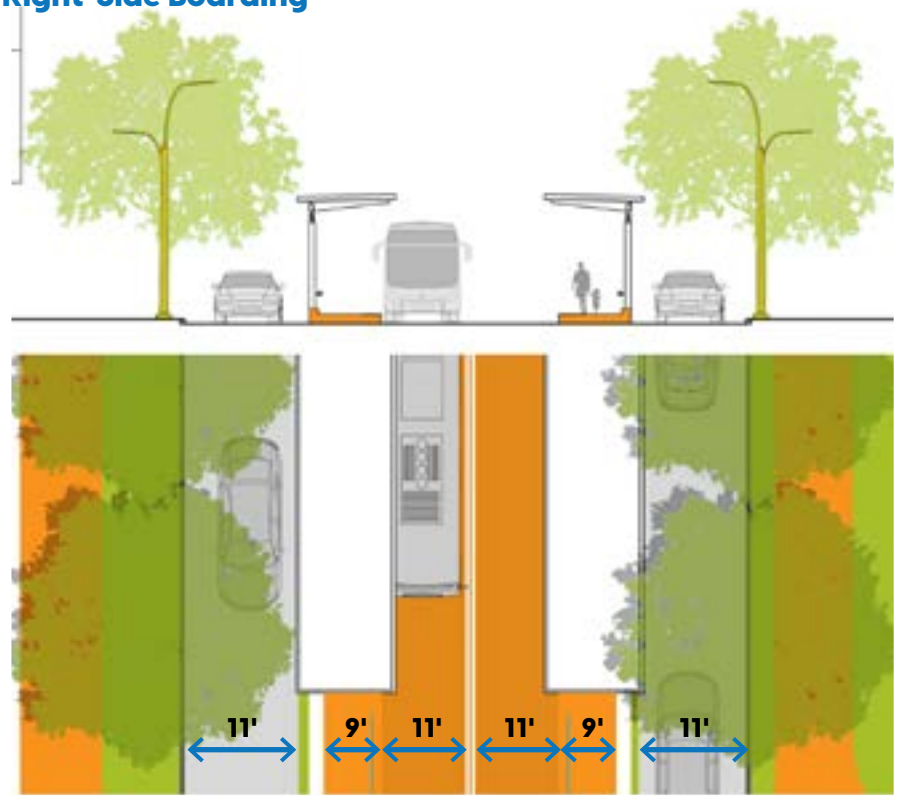
Pedestrian access should occur at protected and signalized midblock crossings and along the central axes of split stations.

BRT Study Configurations

In-Street Boarding Island Stop (Limited ROW)



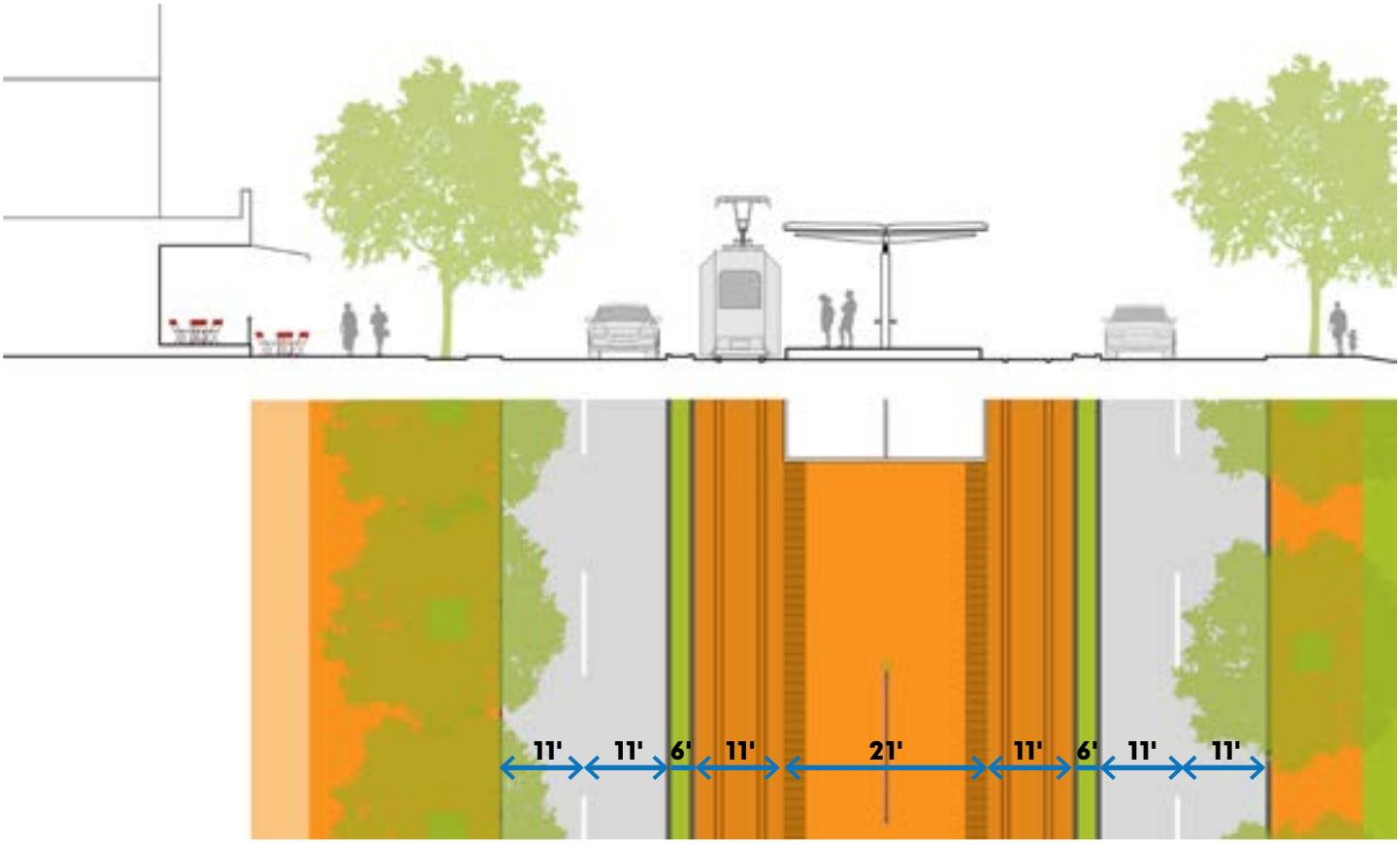
Median Stop, Right-Side Boarding



BRT Study Criteria

A street on the edge of the Core Quadrant was selected for a study for the retrofit of a new BRT station. This existing roadway is a key connector for retail, museum, and open space destinations. Two conditions were studied as potential models for new BRT facilities: an In-Street Boarding Island Stop and a Median Stop with Right Side Boarding. In the In-Street Boarding Island, alternating platforms within the limited ROW allowed for a dedicated left turn lane, but the limited ROW did not provide space for a separation median between the BRT dedicated lanes and adjacent vehicular lanes. Legibility and safety of the intersection at the left-turn lane is enhanced through the addition of a planting median at the posterior of the platform. In the Median Stop Condition, the distance between platforms was minimized through the consolidation of circulation along one intersection and median bioswales were added.

LRT Study Configurations



LRT Double Station

In this case study, a wide roadway within the Northeast Quadrant was selected for the extension of an existing LRT line. This location is adjacent to a bayou and a potential Transit Oriented Development opportunity. The central platform is accessible from crosswalks on either side of the development. Midblock crossing at the center of the platform was not advisable in this context due to the central platform. Connections to the bayou and development are enhanced through the redevelopment of the streetscape.

1. **Station / Platform**
2. **Dedicated Transit Lane**
3. **Bayou Trail Connection**
4. **Pedestrian Refuge**
5. **Divider Median / Bioswale**
6. **Dedicated Turn Lane**
7. **Pedestrian Crossing**
8. **Pedestrian ROW**
9. **Bike Amenities**
10. **Transit Oriented Development**
11. **Bike Amenities**
12. **Pedestrian Lighting (TYP.)**

LRT Station (TOD Integration)

LRT Case Study

Headline from the Future

"LRT Station Spurs Sustainable Development Along Green Commercial Corridor:
Houston METRO Connects Houstonians to Popular Shopping Destination and Bayou Trails"

Case Study Description

The LRT station in the depicted study illustrates a strong connection to a TOD retail and housing development adjacent to a bayou. This station enhances pedestrian safety measures with wide platforms, signalized crosswalks, planted safety barriers, and convenient connections to the adjacent bayou trail. The design of the station utilizes green tracks and permeable surface to reduce pervious cover adjacent to the bayou. The LRT platform is designed with energy efficient lighting, audio-visual wayfinding and real-time arrival information, comfortable lean rails, and enhanced security to encourage safety, comfort, and quality of life.

Plan Legend

01 METRO LRT Shelter
02 LRT Platform
03 Pervious Railway
04 Pedestrian Crossing
05 Shared Use Path
06 Adjacent TOD Development
07 Bioretention Median
08 Safety Hedge Planting
09 Adjacent Bayou

Facility Name: Conceptual LRT Station Study

Facility Type
bus stop brt **lrt** park & ride transit center

Environmental Resilience

Ecoregional Zone
northwest southwest central southeast **northeast**

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) **moderate (0.25 - 0.50)** high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare **major collector** minor collector

Neighborhood Corridor Type
commercial/economic cultural/historic **green/scenic/ceremonial** neighborhood services high-speed access

Sustainable Development

Project Type
retrofit redesign **new construction**

Urban Context
downtown urban **urban edge** dense suburban developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) **secondary TOD street (1/2 mi.)** none

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* 40' bus 45' bus 60' bus rideshare vehicle/tnc personal vehicle **lrt** brt

Neighborhood Walkability Score
walker's paradise (90-100) **very walkable (70-89)** somewhat walkable (50-69) car-dependent (0-49)

Neighborhood Bikeability Score
biker's paradise (90-100) **very bikeable (70-89)** bikeable (50-69) somewhat bikeable (0-49)

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **bayou way / LOS B** **warbler street / LOS C** **davy drive / LOS C**

LRT Station (TOD Integration)

LRT Case Study

LRT Station

01 Hedge buffer deters unsafe pedestrian movements across the transitway

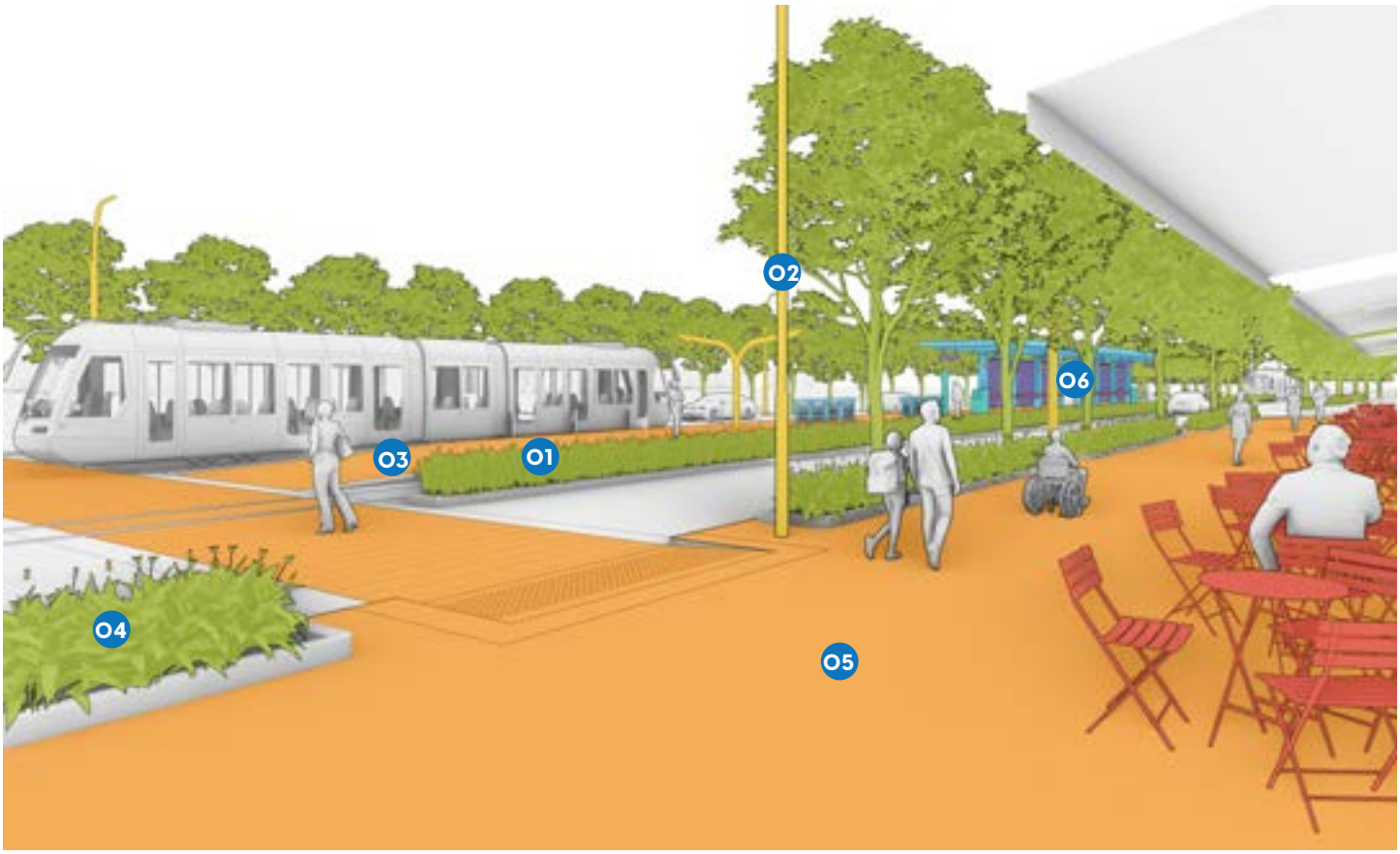
02 Transitway is well-lit for vehicular and pedestrian visibility

03 Permeable paving in light rail zone facilitates stormwater infiltration

04 Sightlines to station platform are clear of tall (greater than 3') vegetation or other structures

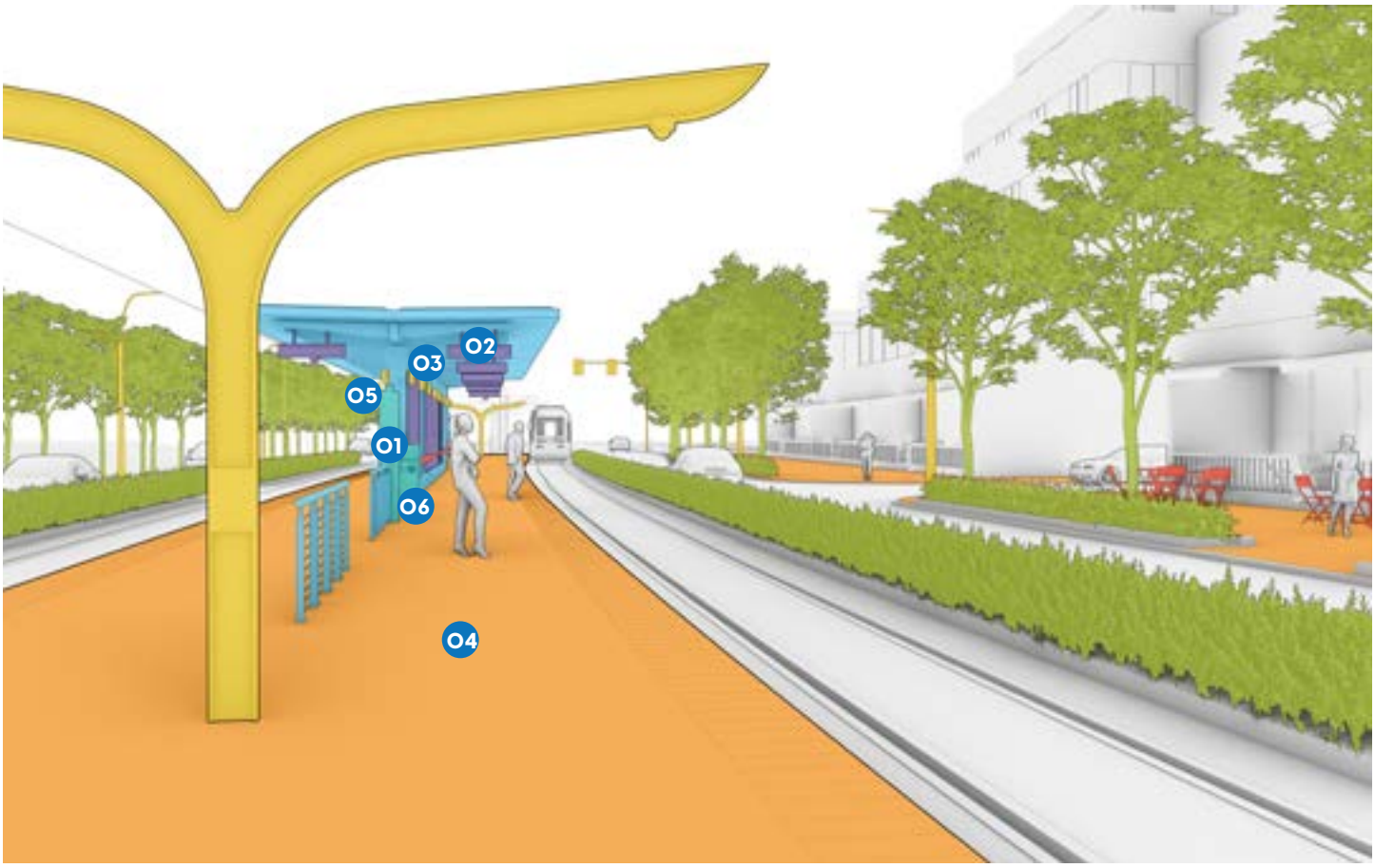
05 The pedestrian travelway is free of vertical obstructions

06 Shelter reflects aesthetic neighborhood character while portraying the METRO brand quality and signage



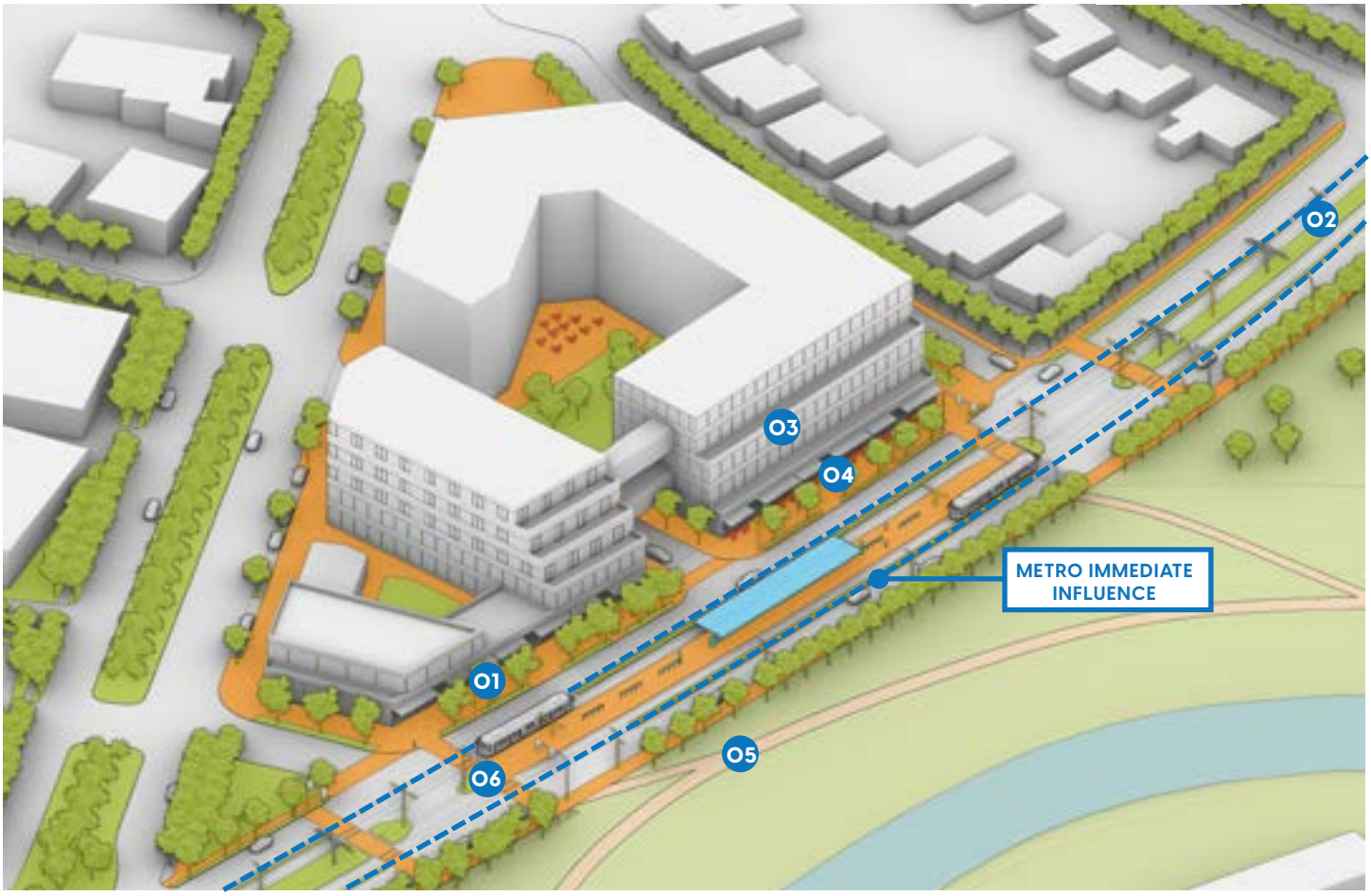
LRT Station

- **01** Emergency call signals are located in a visible location
- **02** Real-time arrival information is integrated into the shelter
- **03** The LRT shelter is adequately and sustainably lit while supplementary lighting safely illuminates the platform
- **04** Utilities are integrated outside of the travelway and are hidden from view
- **05** Supplemental lighting provides branding opportunities and increases ambient light
- **06** Amenities are located as to not impede the travelway and are oriented to prevent visual obstructions



LRT Station (TOD Integration)

LRT Case Study



Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Crossings
Multi-Use Hike & Bike Trail

Comfort

Tree Canopy / Shade
Wide Sidewalks
Platform Amenities

Quality of Life

Art Integration
Pervious Paving
Engagement with Adjacent Development & Bayou Trail

Contextual Considerations

01 Shade canopy is provided along LRT corridor to reduce heat island effect and create a comfortable walking environment

02 Roadway and pedestrian lighting provide ample and safe illumination along walkways leading to facility

03 Adjacent Transit Oriented Development is illuminated to provide safe land comfortable lighting conditions without spillover that creates harsh shadows in the transit environment

04 Adjacent Transit Oriented Development engages the streetscape through the minimization of driveways, activation of street edge (cafés, retail storefronts, etc.)

05 Wide pedestrian and bike trail provides access to adjacent Bayou amenity

06 Safe pedestrian and bike crossings are signalized with audio-visual cues for hearing and seeing impaired

Precedent Facilities

PORTLAND TRANSIT MALL

LOCATION: PORTLAND, OREGON

AGENCY: PBOT

This restricted Transit Mall prioritizes pedestrian circulation and provides safe and convenient access to retail /dining destinations. Paved crossings and tree canopy cover provide a comfortable pedestrian experience.

CBD AND SOUTH EAST LIGHT RAIL

LOCATION: SYDNEY, AUSTRAILIA

AGENCY: TRANSPORT FOR NSW

This LRT system contains transit malls at key shopping and business destinations. Pedestrian safety and circulation is seamlessly integrated within the transitway through the selection of paving materials and tree canopy.

ROTTERDAM GREEN TRAM

LOCATION: ROTTERDAM, THE NETHERLANDS

AGENCY: RET

The Rotterdam Green Tram line utilizes grass instead of pavements to cool the transit environment and provide stormwater infiltration.

BRT Station

BRT Case Study

Headline from the Future

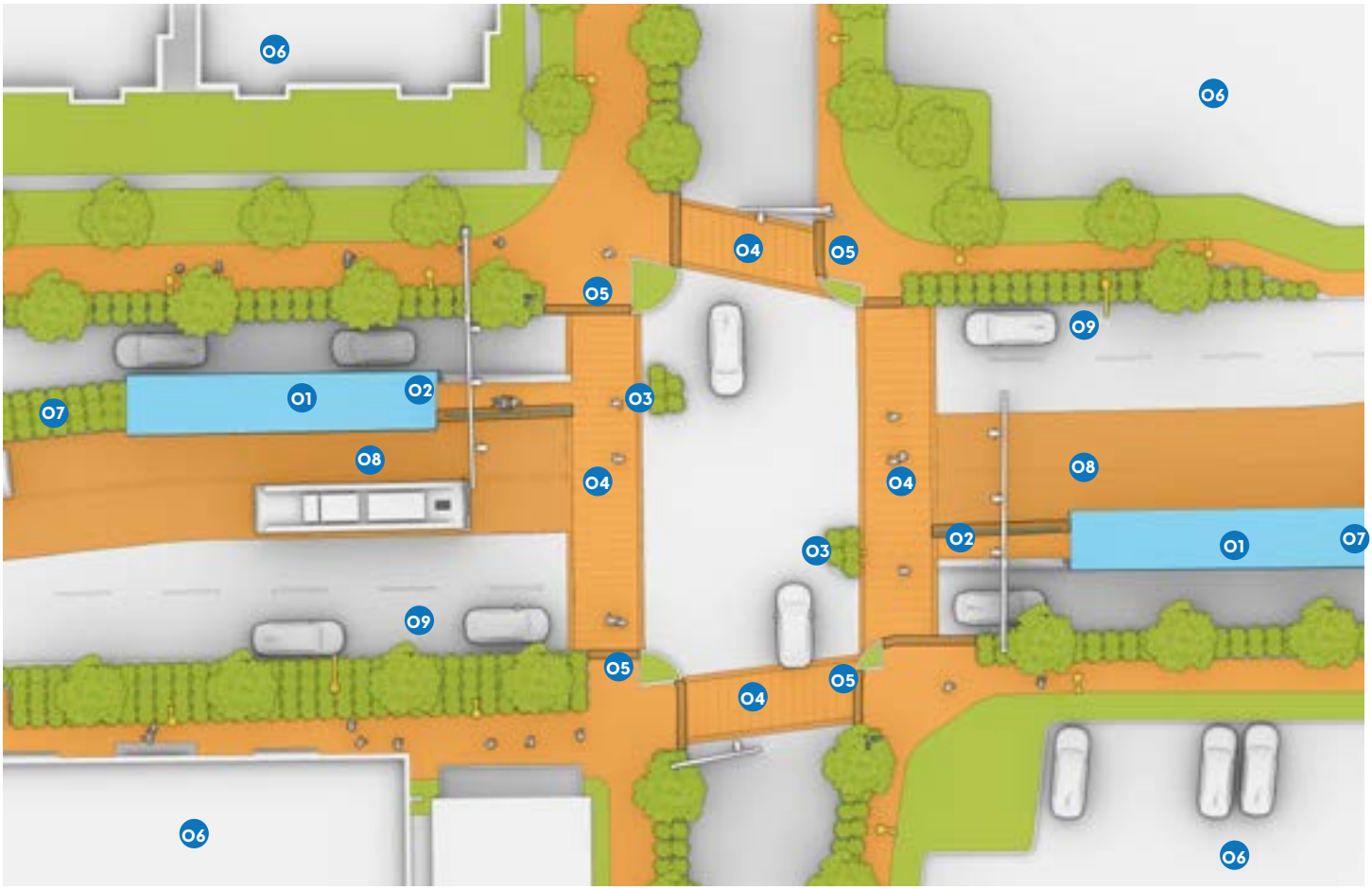
"BRT Facility Enhances Customer Experience Along Artful Mixed-Use District:
Houston METRO Partners with Management District to Infuse Personality and Sustainability Into Transit Corridor"

Case Study Description

This conceptual BRT facility creates a safe and walkable environment through the addition of signalized crosswalks, enhanced station lighting, and pedestrian refuges for customers to navigate the busy intersection. Partnering with the local management district, amenities for pedestrians and cyclists were coordinated to reflect the artful character of the community. Through the engagement of local artists, painted crossings, vibrant color schemes, and comfortable station and streetscape amenities enhance the transit experience.

Plan Legend

01 METRO BRT Shelter
02 BRT Platform
03 Pedestrian Island
04 Signalized Crosswalk
05 Accessible Ramps
06 Adjacent Retail / Residential
07 Bioretention Median
08 Dedicated Bus Lane
09 Vehicular Turn Lane



Facility Name: Conceptual BRT Station Study

Facility Type
bus stop **brt** lrt park & ride transit center

Environmental Resilience

Ecoregional Zone
northwest southwest **central** southeast northeast

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) **moderate (0.25 - 0.50)** high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare **major thoroughfare** major collector minor collector

Neighborhood Corridor Type
commercial/economic cultural/historic **green/scenic/ceremonial** **neighborhood services** high-speed access

Sustainable Development

Project Type
retrofit redesign **new construction**

Urban Context
downtown urban **urban edge** dense suburban developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) **secondary TOD street (1/2 mi.)** none

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* 40' bus 45' bus 60' bus rideshare vehicle/tnc personal vehicle lrt **brt**

Neighborhood Walkability Score
walker's paradise (90-100) **very walkable (70-89)** somewhat walkable (50-69) car-dependent (0-49)

Neighborhood Bikeability Score
biker's paradise (90-100) **very bikeable (70-89)** bikeable (50-69) somewhat bikeable (0-49)

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **live oak avenue/ LOS B** **moderno street / LOS C** **exhibit street / LOS C**

BRT Station

BRT Case Study

BRT Station

01 A small median serves as a pedestrian refuge and protects crosswalk users from turning vehicles

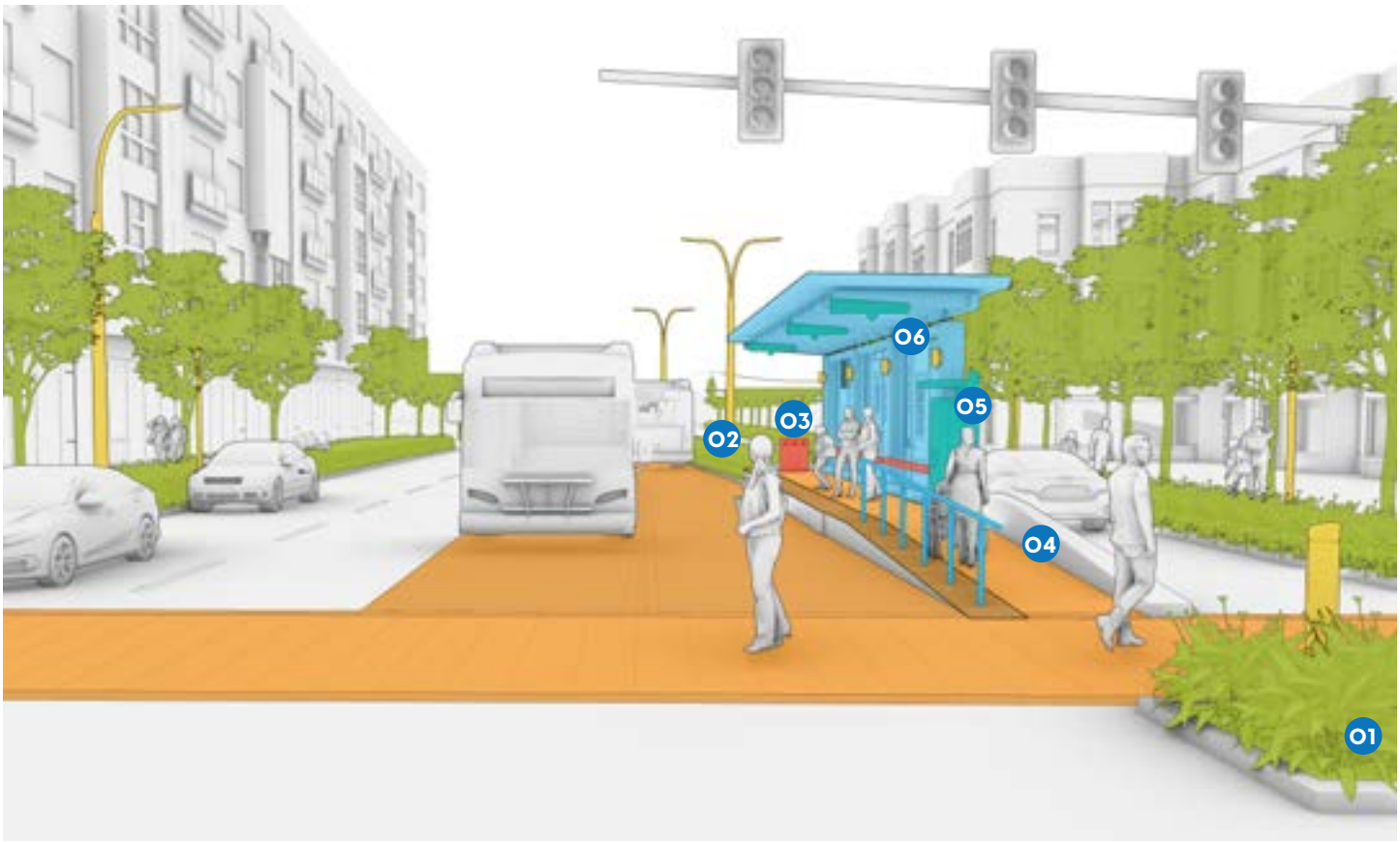
02 Bioswales can be implemented in place of traditional medians to filter stormwater and create a more resilient pedestrian / transit realm

03 Litter receptacles are placed adjacent to the boarding area and are located as to not obstruct the platform

04 A rail and barrier provide protection from the transitway and adjacent vehicular lane

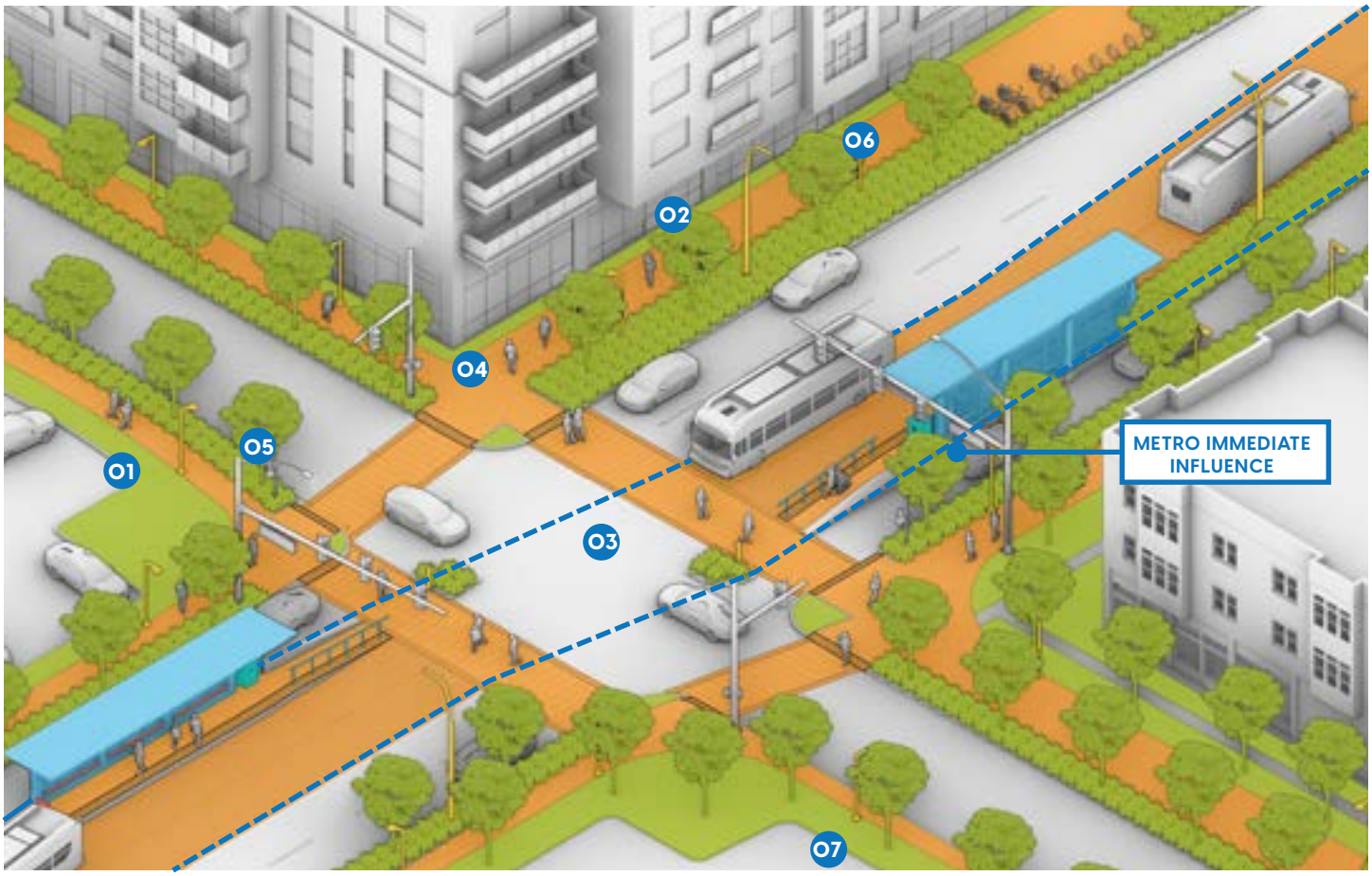
05 Ticket kiosks are located outside of the travelway and provide clear sightlines

06 Supplemental lighting provides ambient lighting while enhancing station character



BRT Station

BRT Case Study



Contextual Considerations

01 Shade canopy is provided along the BRT corridor to reduce heat island effect and create a comfortable walking environment

02 Roadway and pedestrian lighting provide ample and safe illumination along walkways leading to facility

03 Safe pedestrian and bike crossings are signalized with audio-visual cues for hearing and seeing impaired

04 Pedestrian crossings are clearly marked and incorporate art to reflect community character

05 Clear vehicular sightlines at corners are maintained for safety

06 Bike amenities are incorporated into the design of the streetscape

07 Wide pedestrian walkways create a comfortable and safe walking experience

Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Crossings
Pedestrian Refuge

Comfort

Tree Canopy / Shade
Wide Sidewalks
Platform Amenities

Quality of Life

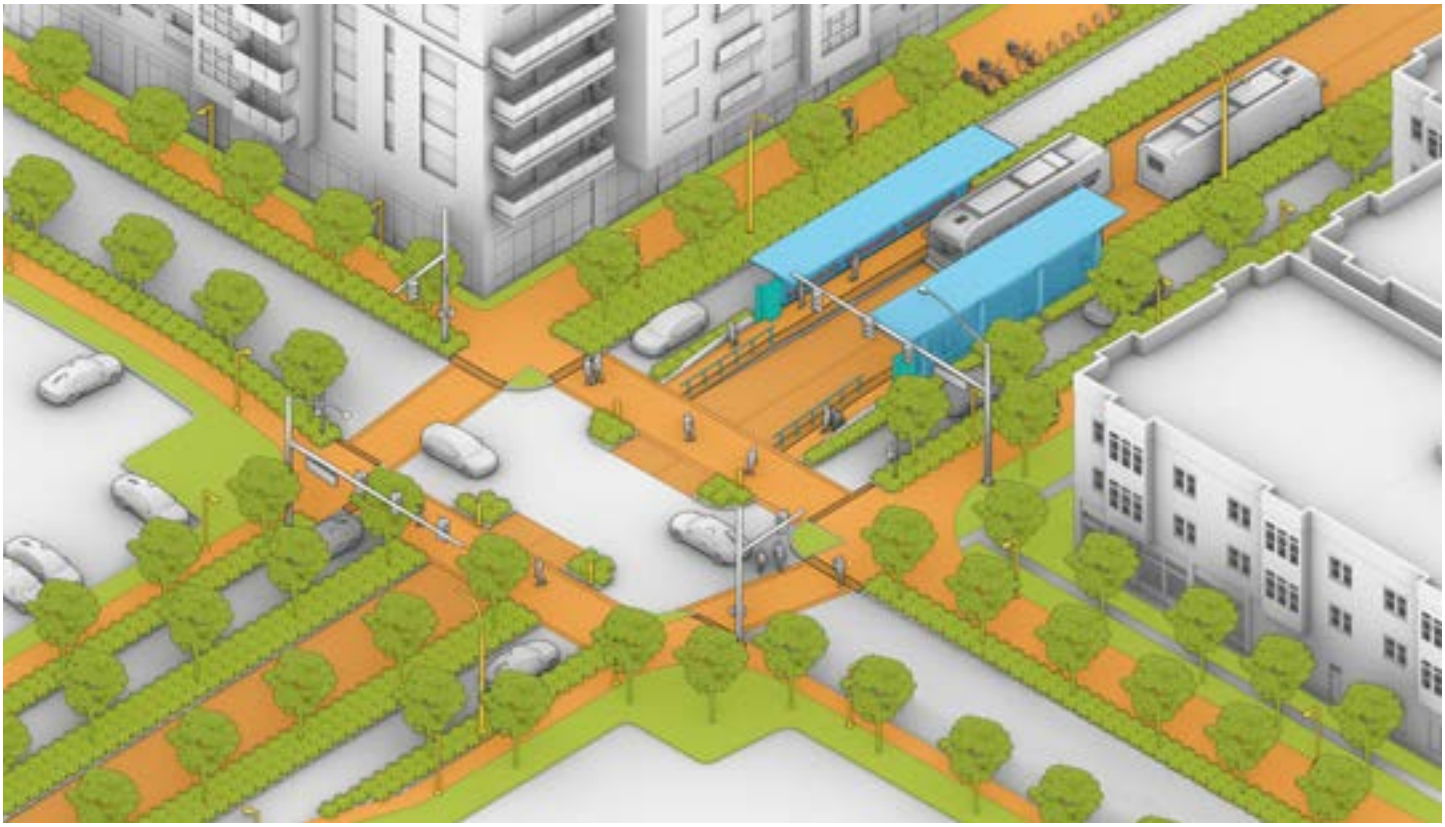
Art Integration
Bioswales
Bike Amenities

BRT Station

Alternative Configuration Study

Alternative Configuration

In this alternative configuration, the BRT stations have been located across from one another to create safe and efficient pedestrian circulation that is easily maneuverable between directional platforms. Both BRT lanes can be buffered by bioswale medians that capture stormwater from the METRO travelway. Pedestrian refuge islands on the ends of both platforms protect crosswalk users as they approach the BRT platform. The close proximity of the two shelters creates an opportunity for art and branding expression.



Precedent Facilities

HENNEPIN AVE. BRT

LOCATION: MINNEAPOLIS, MN

AGENCY: METRO TRANSIT

Dedicated BRT lanes replace traditional bus stops. Bike lanes are carefully integrated at sidewalk level and transition around the bus stop area.

HOBART UNDERGROUND BUS MALL

LOCATION: HOBART, AUSTRALIA

AGENCY: METRO TASMANIA

This conceptual study looks at creating a plaza edge and terraced amenity in lieu of a traditional BRT station. This in turn serves as a public amenity and social activator.

27TH & CRYSTAL STATION

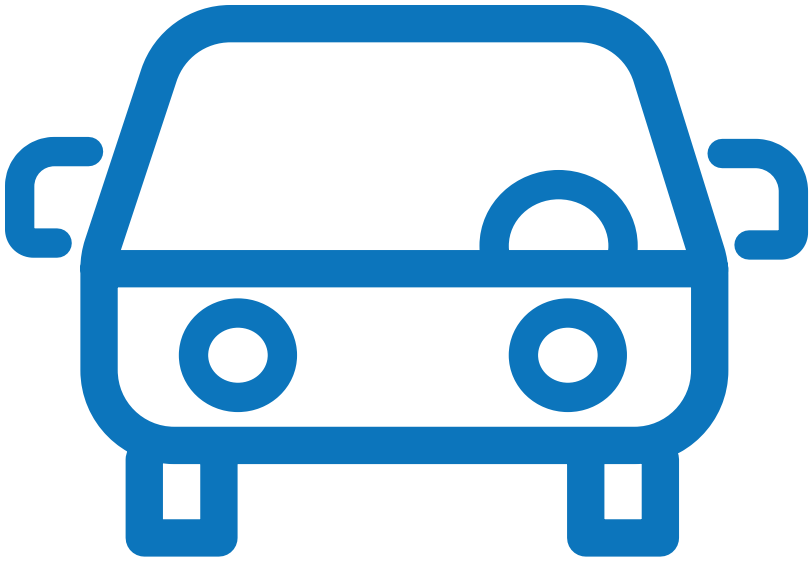
LOCATION: ARLINGTON, VA

AGENCY: ART

The dual BRT stations are integrated into a single structure and contain consolidated pedestrian crossings between blocks. Amenities are integrated within the structure.

Park & Ride

Park & Rides are the connective tissue from suburban areas to downtown. They are often located near busy freeways and connect to residential areas. Though most METRO customers drive to Park & Rides, safe and intuitive pedestrian and bike access from adjacent neighborhoods must be accommodated. As Park & Rides have concentrated activity during peak rush hours, clear pedestrian access throughout the parking lot to the shelter platform is imperative. Wayfinding should be integrated into a holistic system across the site while entry monuments should be visible from primary roadways. Sites with large surface lots offer great potential for green infrastructure integration to reduce stormwater flooding and reduce surface temperatures. The design of Park & Rides should anticipate a phased transition to future Transit Center uses as ridership increases.




EVAPORATIVE COOLING
NOISE BARRIER
ELECTRIC BUS CHARGING
STORMWATER INFILTRATION
METRO


SHADE CANOPY
ENERGY PRODUCTION
LEGIBLE CIRCULATION
BIKE CONNECTIVITY
NATIVE HABITAT
PHYTOREMEDIATION
METRO

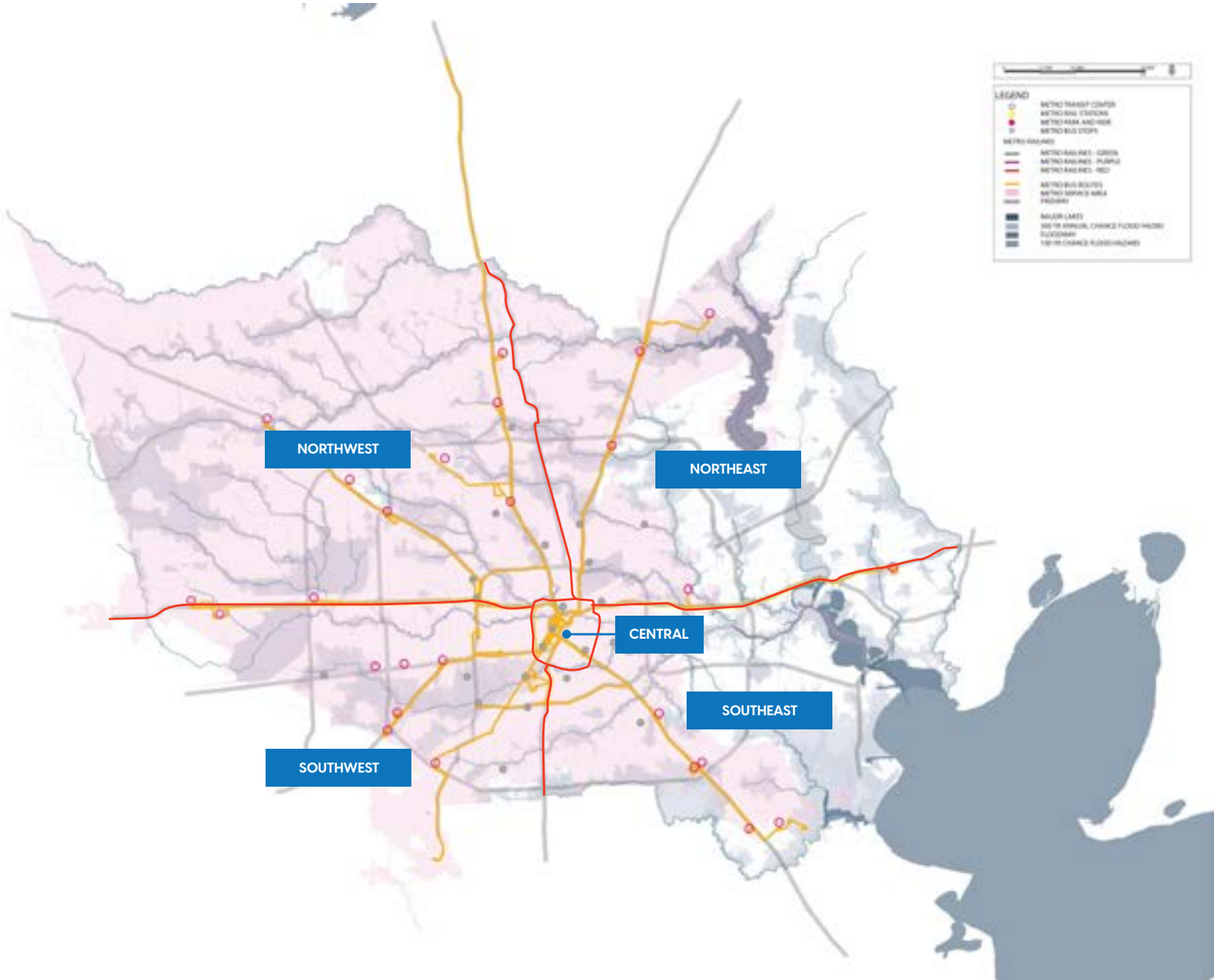
Park & Ride

7.7
MILLION RIDES

25.5
MILLION RIDERS USING HOV/HOT LANES

20,000
PERSONAL VEHICULAR TRIPS ELIMINATED

100
MILES OF METRO OPERATED HOV LANES











METRO Park & Rides typically consist of a shelter and boarding platform, "Kiss and Ride" zones that now serve as drop-off areas or rideshare pick-ups, operational structures, and surface parking lots. Some facilities contain restroom buildings, windscreens, benches, ticket machines, emergency call boxes, bike amenities, or other amenities for customer comfort.

Surface parking often attributes to the largest footprint in Park & Ride facilities. Older METRO facilities contain minimal -to-no tree canopy cover, creating an uncomfortable and unsustainable condition for METRO customers and the surrounding community, introducing ample tree canopy cover and green infrastructure can heavily influence the quality of these facilities.

In addition, clear pedestrian circulation and hierarchy to the station platform, a comprehensive wayfinding strategy, and clear accessible routes can vastly improve customer experience– particularly for those with disabilities.

As many METRO Park & Rides transition into Transit Centers, it is important to plan for future expansion.

Partnership Opportunities

Transit Corridor Typologies

Retrofit	**Integration of Additional Modes of Transportation**
	Modify to Include Sawtooth Boarding Platform
	Addition of LID and Sustainability Measures
Redevelopment	**Integration of TOD Measures**
	Optimize Circulation to Accommodate New Uses
	Respond to Changing Adjacent Transit Types
New Construction	**Clear Separation of Transit Types**
	Direct Access to Adjacent Transit Facilities
	Provide Opportunities to Respond to Future Transit Facilities and TOD

Partnership Opportunities

Management District

- Sidewalk
- Crosswalk
- Transit Environment Development
- Medium to high maintenance capacity
- TOD as development guidelines
- Funds for redevelopment and branded site elements

Redevelopment Authority (TIRZ)

- Streetscape redevelopments
- Funding source for pedestrian improvements
- No maintenance capacity
- Adopt-A-ROW; joint effort with developers

City of Houston

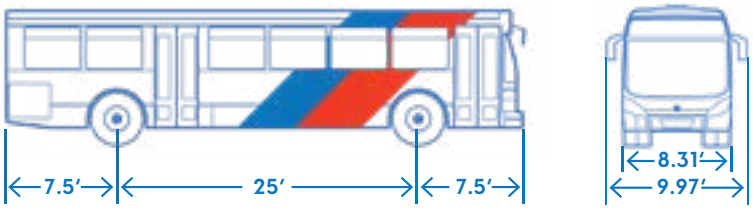
- Capital improvements
- Sidewalk and Safety improvements
- Transit Platform / Park Integration
- Planning Coordination
- Transit Oriented Development potential
- Resilient Houston / CAP Interface

Joint/Private Development

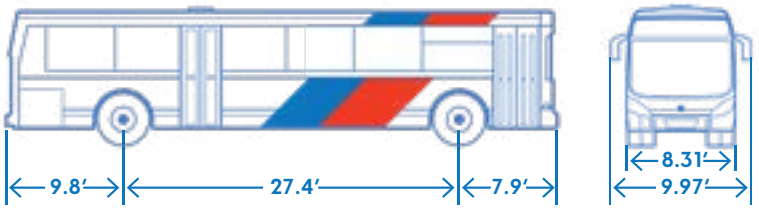
- Marketing Opportunities
- Green Roofs
- Solar Panels
- Non-Profit Funding
- Community-led initiatives

Vehicular Layout

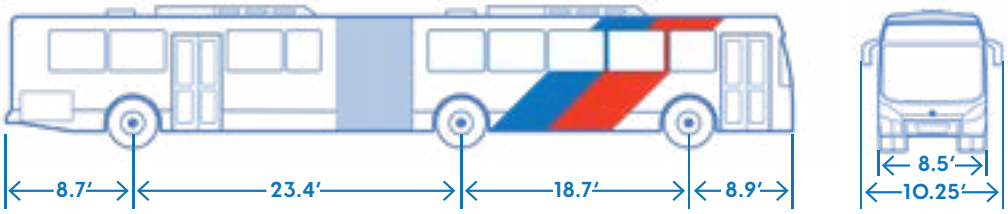
40' BUS



45' BUS



60' BUS



Accommodate Variety of Transportation Types

- Park & Ride facilities must accommodate the appropriate bus types by providing flexible berthing.
- Facilities should be designed to accommodate future transit modes such as integration of BRT.
- Curb height and berthing location are influenced by vehicular configuration.
- Sawtooth curb configuration will help guide buses into the correct berth.
- Prepare for an autonomous future by providing EV drop-off zones and charging stations to encourage use.
- Encourage green infrastructure by providing facilities for cyclists including parking, repair stations, and direct connections to bike lanes.

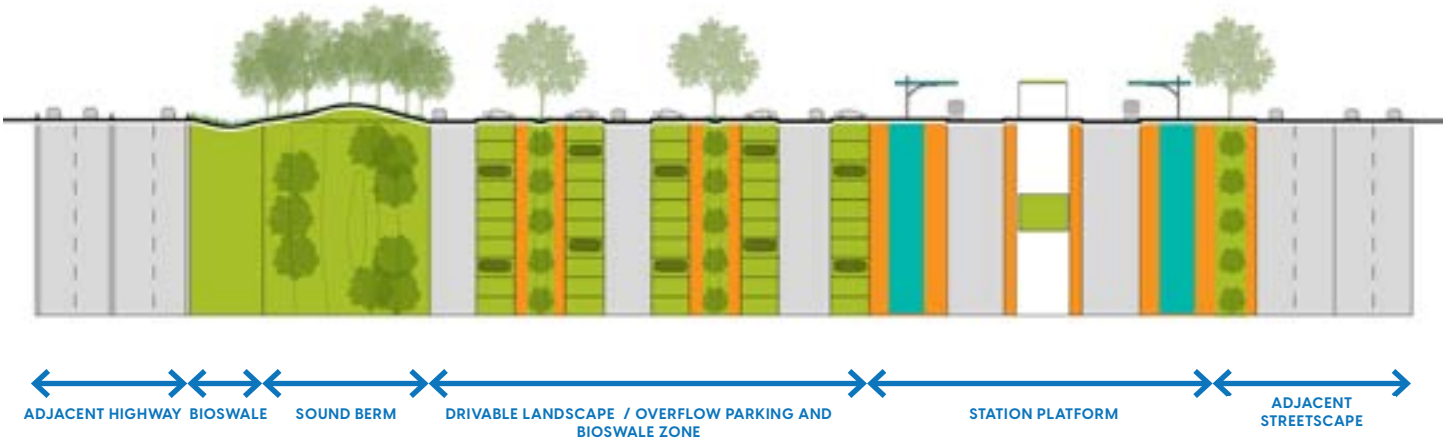
Special Conditions

- Due to the large footprint of a Park & Ride facility there is an opportunity to provide additional functionality to adjacent neighborhoods during non-operational hours. Temporary event spaces, farmers markets, and other special events will attract users to the site and promote ridership.
- Partnership opportunities are possible for improvements such as solar panelization of shade structures. These measures could power EV cars, METRO facilities, or even be sold back to the energy grid.

Park & Ride Drivers of Site Design

- There should be a clear and easily navigable organization to parking lot entry and circulation.
- Provide clear separation between METRO vehicles and other modes of transportation and where possible provide dedicated points of entry/egress.
- LID and sustainability measures should be integrated into and drive the design of the facility where possible. User interface with naturalistic features will improve the rider experience.
- Ensure the design is low-maintenance; native plantings may reduce irrigation requirements and are generally less maintenance-intensive.

Case Study Park & Ride Configurations



Bioswale Integration

Park & Rides can become cool, comfortable, and experiential environments through the connective integration of green infrastructure. Bioswales convey stormwater from parking areas into a central median filled with low maintenance and native planting. Water can then infiltrate into the soil–filtering stormwater of pollutants and conveying any remaining stormwater through an overflow to a detention wetland. The bioswale system reduces potential parking lot flooding, provides opportunities for additional tree canopy cover, and softens the appearance of paved areas. Bioswales with curb-cuts can allow water to flow into the planting area, replacing traditional parking medians that are mostly aesthetic in value. Proper drainage improves the longevity of the paved surface.

Sound and Vegetative Buffers

METRO facilities should be mindful of the surrounding residential areas. Noise from the transit facilities can be buffered through a combination of berms and tree canopy cover. Additionally, these sound buffers can reduce the sound adjacent to busy freeway areas or serve as a natural fence surrounding the site.

Pedestrian Parking Access

Pedestrian access should extend from the vehicular parking lot along a central bioswale median leading to the facility shelter. This reduces visibility issues as riders navigate the parking lot, and creates legible connections to the shelter.

SOLAR CARPORTS PARKING LOTS

LOCATION: DAVIS, CALIFORNIA

CAMPUS: UC DAVIS

Solar parking lots help generate energy as well as provide shade, lighting, and weather protection for customers. In addition to shade, the carports provide significant energy savings and reduce carbon footprint.

COOL PAVEMENT

LOCATION: LOS ANGELES, CALIFORNIA

AGENCY: BUREAU OF STREET SERVICES

Cool pavement is lighter in color than traditional asphalt, and reduces the amount of absorbed solar heat. Temperatures from paved surfaces are reduced, leading to cooler stormwater runoff and air rising off of the hardscape.

PARKING LOT SHADING

LOCATION: MONTGOMERY COUNTY, PENNSYLVANIA

AGENCY: PLANNING COMMISSIONER

The addition of shade trees provide microclimate conditions that reduce surface temperatures of adjacent hardscape. Across an entire site, shade trees can create a more comfortable environment while preventing erosion, intercept stormwater, and release moisture through evapotranspiration (further cooling the site).

GREEN ROOFS

LOCATION: AUSTIN, TX
LADYBIRD JOHNSON WILDFLOWER CENTER

Green roofs mitigate heat island effect by reducing the evaporative heat of structures and cool the adjacent site. Additionally, they can capture and purify stormwater, reducing the structure's impact as an impervious surface. On air conditioned buildings, green roofs can aid in energy efficiency.

PERMEABLE PAVEMENTS

LOCATION: CITY OF CITRUS HEIGHTS, CALIFORNIA
SYLVAN COMMUNITY CENTER

Permeable pavement can be durable enough to withstand vehicular traffic and allow for the infiltration of stormwater through an otherwise impermeable surface. Permeable pavements can connect to other stormwater infrastructure such as bioswales.

VEGETATED DETENTION / RETENTION BASIN

LOCATION: HOUSTON, TX
CROSS CREEK RANCH

Vegetated detention basins can hold large volumes of stormwater. Like their smaller bioretention counterparts, they can filter, convey, slow, purify, and infiltrate stormwater. Compared to traditional engineered detention basins, they greatly reduce site temperatures and mimic natural hydrological processes. Native grasses are often lower maintenance and perform better than mowed turf grass. Retention basins hold water permanently and can perform as a wetland and public amenity.

TREE BOX

LOCATION: HOUSTON, TX
COTTAGE GROVE GREEN STREET

Tree boxes located at stormwater inlets collect and treat stormwater runoff while capturing debris before it enters the stormwater system.

VEGETATED SWALE

LOCATION: HOUSTON, TX

MKT MIXED-USE DEVELOPMENT

Native grasses and wildflowers convey, clean, and slow stormwater prior to discharge. In lieu of traditional turf-grasses, the native grasses are lower maintenance and provide greater filtering ability while adding to visual interest.

BIORETENTION

LOCATION: HOUSTON, TX
MIDTOWN MANAGEMENT DISTRICT

Bioretention captures stormwater to convey, clean, slow, and infiltrate stormwater adjacent to hardscape surfaces. Bioswales can be interconnected to one another or connected to a larger vegetated detention basin to maximize impact. They can have reinforced edges in more urban settings or contain gentle slopes with filter strips.

Park & Ride (TOD Integration)

Park & Ride Case Study

Headline from the Future

"Park & Ride Becomes a Sustainable Model for Suburban Joint Development:

Houston METRO Facility Offers Community Services and Showcases an Integrated Network of Bioretention Facilities"

Case Study Description

This new development engages the streetscape to promote future neighboring sustainable development. The Park & Ride features a connective tissue of bioswales that captures stormwater from the parking lot and treats runoff as it enters a large vegetated detention facility. The station is further enhanced by the introduction of an extensive green roof, a branded entry, the innovative use of a sustainable solar canopy system, and permeable paving to reduce the facility's ecological footprint.

Plan Legend

01 Adjacent Freeway
02 TOD Development
03 Entry Gateway
04 Staff Restroom Facility
05 Security Center
06 Station Platform
07 Bioswales
08 Vegetated Detention
09 Amenity Trail
10 Pedestrian Crossings

Facility Name: Conceptual Park & Ride Facility (TOD)

Facility Type
bus stop brt lrt **park & ride** transit center

Environmental Resilience

Ecoregional Zone
northwest southwest central southeast northeast

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) moderate (0.25 - 0.50) high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare major collector minor collector

Neighborhood Corridor Type
commercial/economic cultural/historic **green/scenic/ceremonial** **neighborhood services** **high-speed access**

Sustainable Development

Project Type
retrofit redesign **new construction**

Urban Context
downtown urban urban edge dense suburban **developing suburban**

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** **rideshare vehicle/tnc** **personal vehicle** lrt brt

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) somewhat walkable (50-69) **car-dependent (0-49)**

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) bikeable (50-69) **somewhat bikeable (0-49)**

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **loblolly street / LOS A** **pine lane / LOS B** **berry drive / LOS B**

Park & Ride (TOD Integration)

Park & Ride Case Study

Entry Plaza

01 Wide crosswalks safely lead customers to the station platform

02 Bike lanes connect cyclists to the adjacent mixed-use development and improve the hierarchy of circulation

03 A level plaza invites customers to the station platform and is surrounded by protective light bollards

04 A large wayfinding column reinforces METRO brand identity while respecting neighborhood character

05 Station amenities in the entry plaza are free of the pedestrian travelway and are situated within the shade of the shelter awning

Parking Bioswale

01 Bioswale medians collect stormwater from adjacent hardscape and connect to larger vegetated detention facilities

02 Solar shade canopies capture renewable energy for facility use while shading pedestrian walkways

03 Tree canopy reduces surface temperatures across the site

04 Wide pedestrian walkways lead METRO customers to the facility platform and are clear of obstructions

05 Columns for architectural structures are located outside of the pedestrian travelway

06 Permeable paving at parking bays increases infiltration adjacent to bioretention facilities

Park & Ride (TOD Integration)

Park & Ride Case Study

Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Access

Comfort

Tree Canopy / Shade Canopies
Wide Sidewalks
Platform Amenities

Quality of Life

Wayfinding
Bioswales
Bike Amenities
Solar Panels & Green Roofs

Contextual Considerations

01 Dedicated entrances for vehicles and pedestrians through the center of the site minimize modal conflicts

02 Transit Oriented Development buildings are located along the roadway to promote sustainable community development

03 A gateway monument denotes the primary entry point while reflecting neighborhood character

04 Pedestrian access to the facility is considered in context of adjacent land use and development

05 The site's green infrastructure strategy, wayfinding experience, and pedestrian experience are considered in congruence throughout the facility and engage the external context

06 Parking for Transit Oriented Development is delineated from the Park & Ride designated parking areas

Precedent Facilities

DOLPHIN PARK & RIDE

LOCATION: MIAMI, FLORIDA

AGENCY: MIAMI-DADE COUNTY

Dolphin Park & Ride contains a driver's break lounge, a "Kiss & Ride" drop-off, 12 bus bays/10 bus layovers bays, and solar power walkways for pedestrians.

610 AND NOBLE PARK & RIDE

LOCATION: BROOKLYN PARK, MINNESOTA

AGENCY: METRO TRANSIT

The Park & Ride facility has vast prairie grass and a retention pond with high performance sustainable solar power covered facade.

STONE OAK PARK & RIDE

LOCATION: SAN ANTONIO, TEXAS

AGENCY: VIA

This Park & Ride matches the architectural character of the community while minimizing impact on the surrounding landscape. Branded elements, electric charging stations, and air conditioned waiting areas enhance experience.

Park & Ride (Flex Use)

Park & Ride Case Study

Headline from the Future

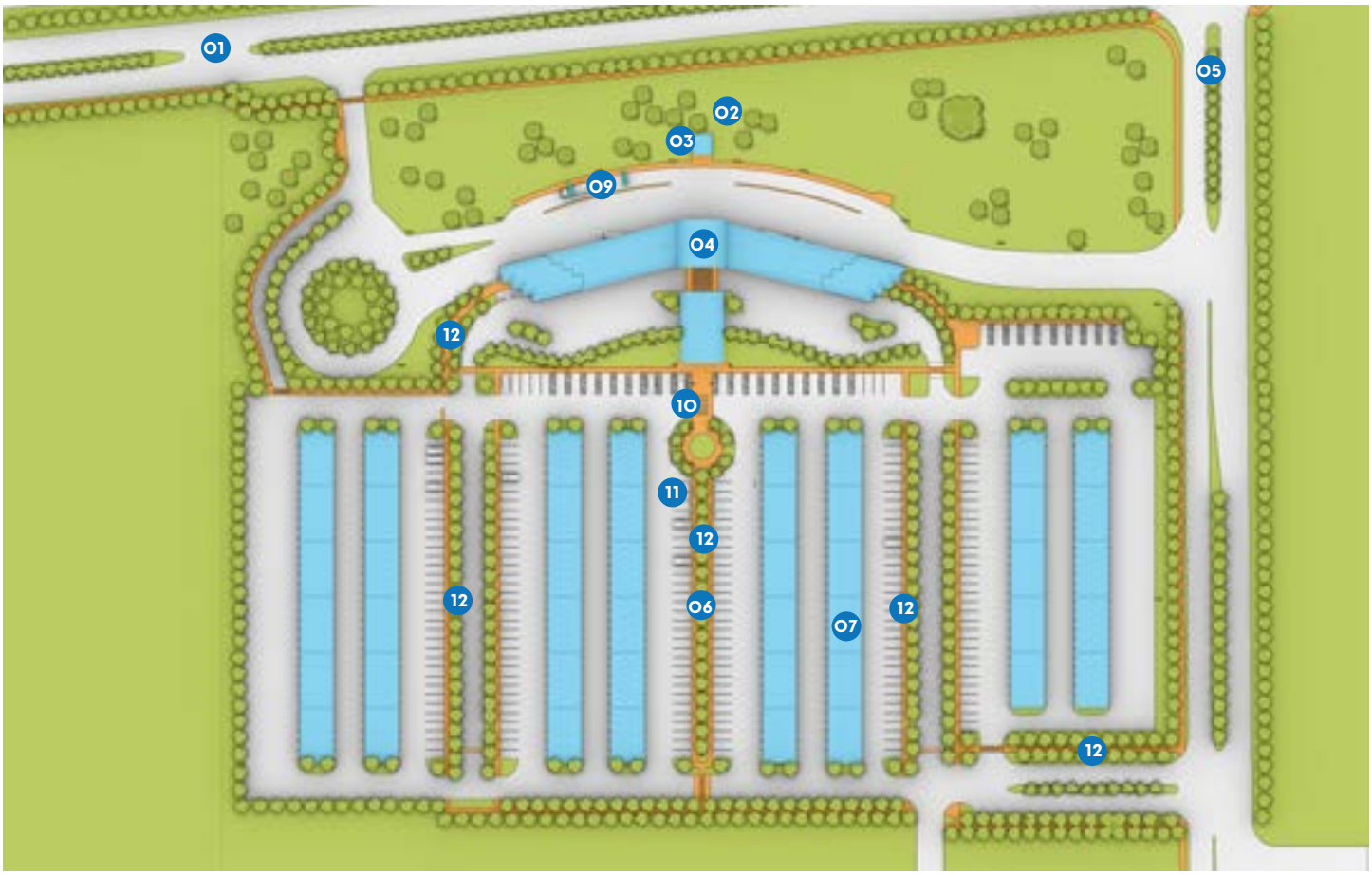
"Park & Ride Doubles as Community Market and Offers Community Services:
Houston METRO Facility Enhances Circulation and Amenities to Celebrate Community Diversity and Increase Resilience"

Case Study Description

This existing Park & Ride has been retrofitted to accommodate increased vehicular circulation and capacity, an improved pedestrian experience, and electric bus charging stations. In addition, portions of the site have been allocated to flexible use during "off-times" to provide community services to a vulnerable Houston neighborhood with a vibrant cultural character. Outlets have been provided to serve food trucks and medical stations. Vegetated detention collects and infiltrates stormwater following natural drainage patterns.

Plan Legend

01 Frontage Road
02 Vegetated Detention
03 Mechanical Building
04 Platform Shelter
05 Monument Entry
06 Central Pedestrian Spine
07 Solar Canopies
08 Pedestrian Walks
09 Bus EV Charging
10 Raised Pedestrian Crossing
11 Customer EV Charging
12 Enhanced Tree Canopy



Facility Name: Conceptual Park & Ride Facility (Flex Use)

Facility Type
bus stop brt lrt **park & ride** transit center

Environmental Resilience

Ecoregional Zone
northwest southwest central southeast **northeast**

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) moderate (0.25 - 0.50) high (0.50 - 0.75) **critical (0.75 - 1.0)**

Diverse Communities

Diversity Overlay
diverse abilities* cultural town **linguistically significant** **ethnically significant** culturally significant muti-ethnic

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare major collector minor collector

Neighborhood Corridor Type
commercial/economic **cultural/historic** green/scenic/ceremonial neighborhood services **high-speed access**

Sustainable Development

Project Type
retrofit redesign new construction

Urban Context
downtown urban urban edge **dense suburban** developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** **rideshare vehicle/tnc** **personal vehicle** lrt brt

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) somewhat walkable (50-69) **car-dependent (0-49)**

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) **bikeable (50-69)** somewhat bikeable (0-49)

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **highway a / LOS A** **metro way / LOS B** **garden road / LOS B**

Park & Ride (Flex Use)

Park & Ride Case Study

Station Platform

01 The station platform has a modular design to accommodate future bus berth expansion

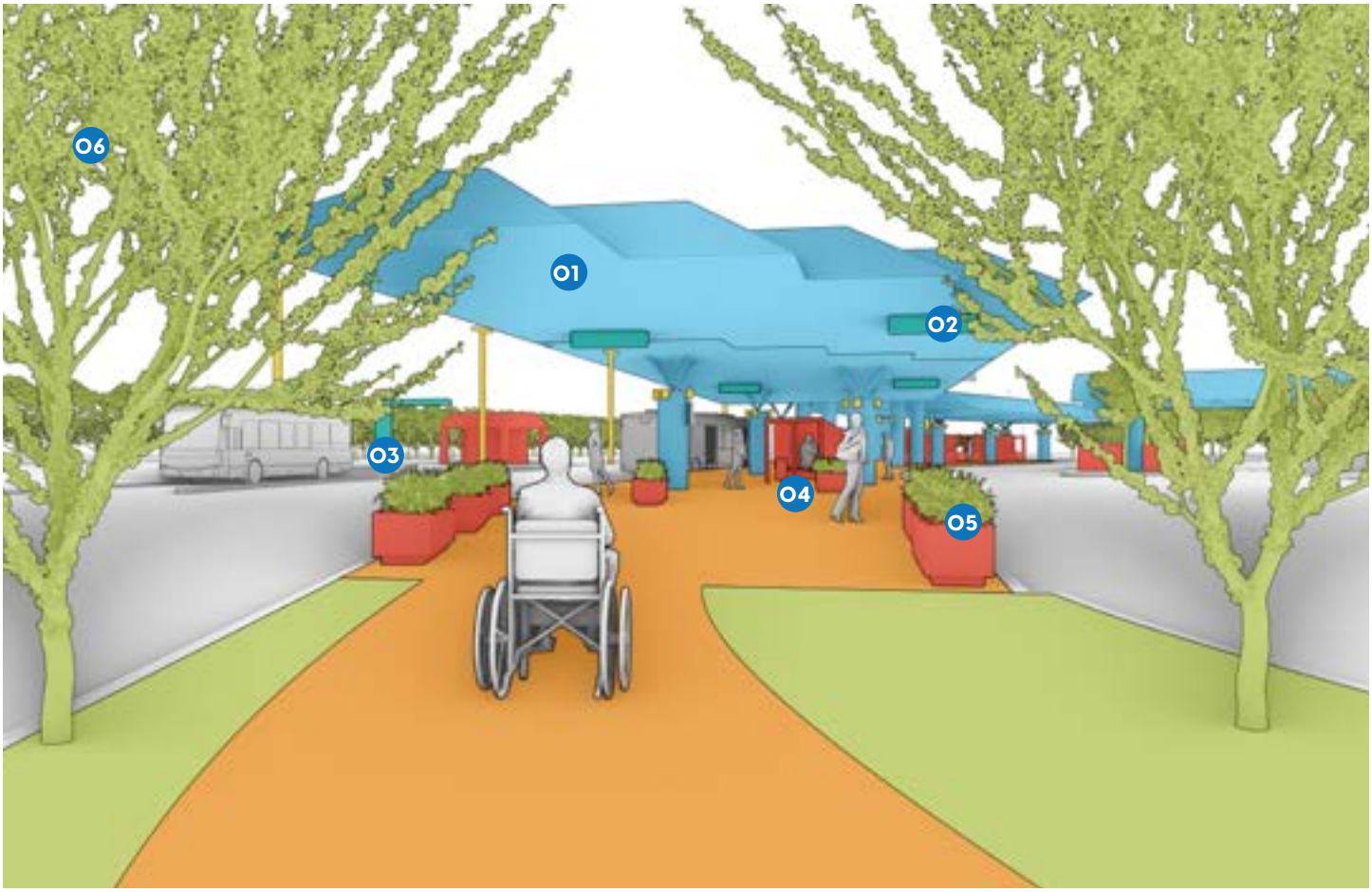
02 Audio-visual real time arrival information is visibly located at the platform

03 Bus EV charging is located away from pedestrian circulation route to avoid modal conflicts

04 Platform amenities are located clear of the pedestrian travelway and maximize sightlines

05 Native planting near boarding platform enhances ridership experience

06 Continuous tree canopy shades the pedestrian experience from the parking lot to the station platform



Pedestrian Spine

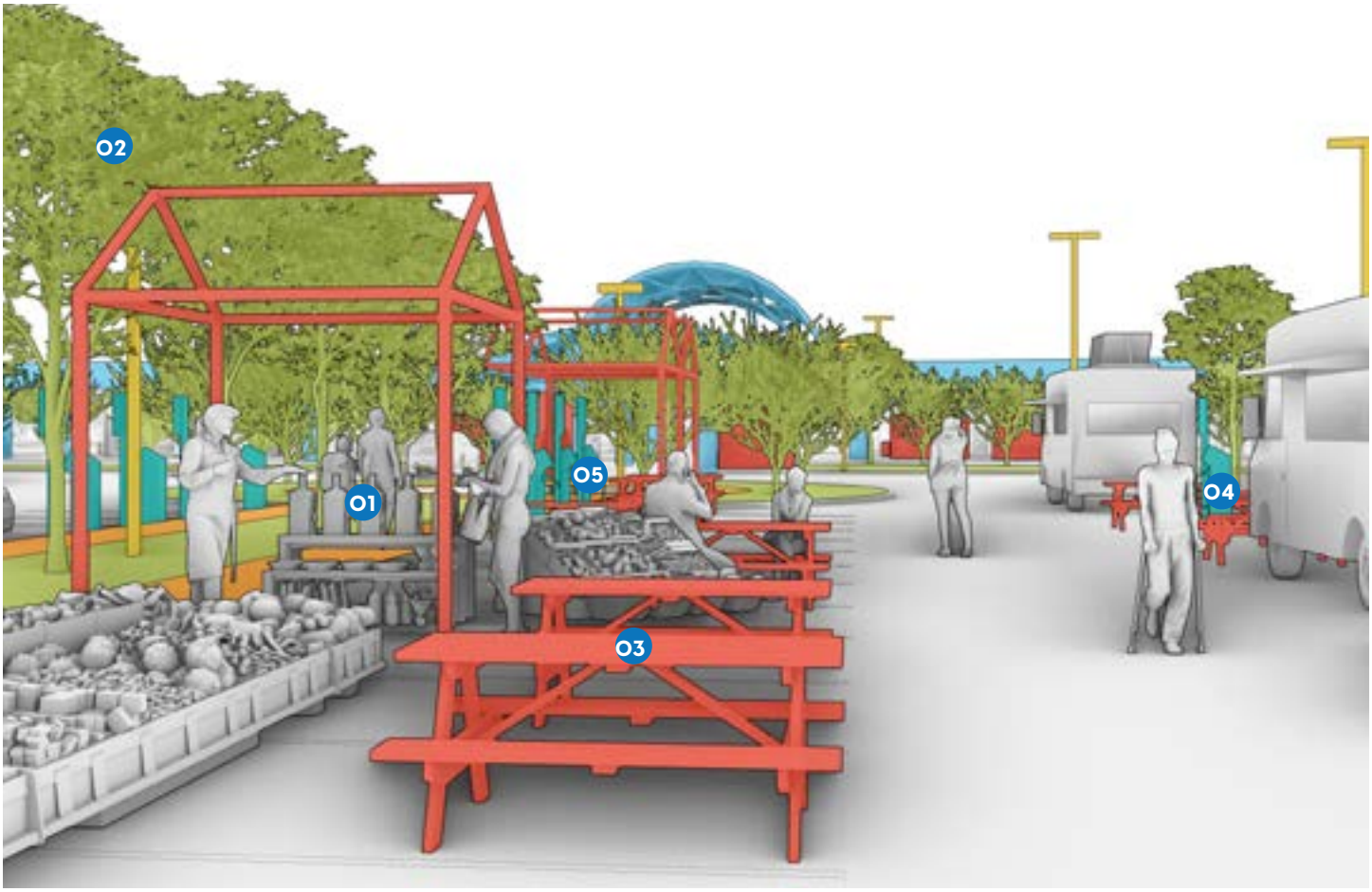
01 Pop-up market provides alternative use for parking lot on weekends to foster social resilience

02 Continuous tree canopy provides comfort for customers as they approach the station platform

03 Movable furnishings provide temporary seating spaces

04 Outdoor power is supplied for event use and is locked during operational hours

05 Personal vehicular EV chargers are located near the station platform



Park & Ride (Flex Use)

Park & Ride Case Study

Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Access

Comfort

Tree Canopy / Shade Canopies
Wide Sidewalks
Platform Amenities

Quality of Life

Wayfinding
Bioswales
Bike Amenities
Solar Panels

Contextual Considerations

01 Pedestrian and bike access from surrounding neighborhood is continuous and legible

02 Sidewalks leading to the Park & Ride facility are continuously shaded with tree canopy

03 A vegetated detention facility stores stormwater runoff from the adjacent parking lot

04 Adjacent neighborhood views are protected with rows of planted tree canopy

05 All site edges are buffered by performative planting and tree canopy to capture runoff, reduce surface temperatures, and reinforce site boundaries

Precedent Facilities

FRESH MARTA MARKET

LOCATION: ATLANTA, GEORGIA

AGENCY: MARTA & COMMUNITY FARMERS MARKETS

Fresh MARTA Market is a program that seeks to alleviate food deserts in communities through the partnership with local organizations to provide a farmers market outside of transit facilities. The program is currently a rotating pilot program that will be further integrated as an amenity within MARTA's facilities.

CENTENNIAL HILLS PARK AND RIDE

LOCATION: LAS VEGAS, NEVADA

AGENCY: REGIONAL TRANSPORTATION COMMISSION OF SOUTHERN NEVADA (RTC)

Centennial Hills Park and Ride provides native landscape to help reduce heat island effect.

STOURTON PARK AND RIDE

LOCATION: LEEDS, UNITED KINGDOM

AGENCY: STOURTON PARK & RIDE

Stourton Park and Ride includes smart traffic lights, zero emission electric buses, solar carports, and extensive landscape screens.

Park & Ride (Rapid Growth)

Park & Ride Case Study

Headline from the Future

"Park & Ride Retrofit Enhances Pedestrian Safety and Comfort

Houston METRO Facility Upgrades Transit Experience to Connect Customers to Previously Inaccessible Shopping Destination"

Case Study Description

A dated METRO Park & Ride facility has been retrofitted to enhance customer experience and comfort. Pedestrian access was coordinated with the City of Houston to reconnect the facility to the adjacent neighborhood shopping destination. Exterior pedestrian access ties into a legible hierarchy of pedestrian walkways. A central spine brings customers to a paved crosswalk before arriving at the station canopy. Solar panel canopies shade the parking lot and improve customer comfort. A bikeway is integrated into the existing site circulation.

Plan Legend

01 Service Road
02 Elevated Boulevard
03 Existing Creek
04 Solar Canopies
05 Pedestrian Spine
06 Bikeway
07 Creek Trail
08 Improved Entry Wayfinding
09 Bus EV Charging
10 Signalized Crossing

Facility Name: Conceptual Park & Ride Facility (Rapid Growth)

Facility Type
bus stop brt lrt **park & ride** transit center

Environmental Resilience

Ecoregional Zone
northwest southwest central southeast **northeast**

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) **moderate (0.25 - 0.50)** high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare major collector minor collector

Neighborhood Corridor Type
commercial/economic cultural/historic green/scenic/ceremonial **neighborhood services** **high-speed access**

Sustainable Development

Project Type
retrofit redevelopment new construction

Urban Context
downtown urban urban edge **dense suburban** developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** **rideshare vehicle/tnc** **personal vehicle** lrt brt

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) somewhat walkable (50-69) **car-dependent (0-49)**

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) bikeable (50-69) **somewhat bikeable (0-49)**

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **westex highway / LOS A** **townsend boulevard / LOS B** **rodger street / LOS B**

Park & Ride (Rapid Growth)

Park & Ride Case Study

Pedestrian Spine

01 The central spine connects to raised crosswalks at vehicular roadways to prioritize pedestrian safety

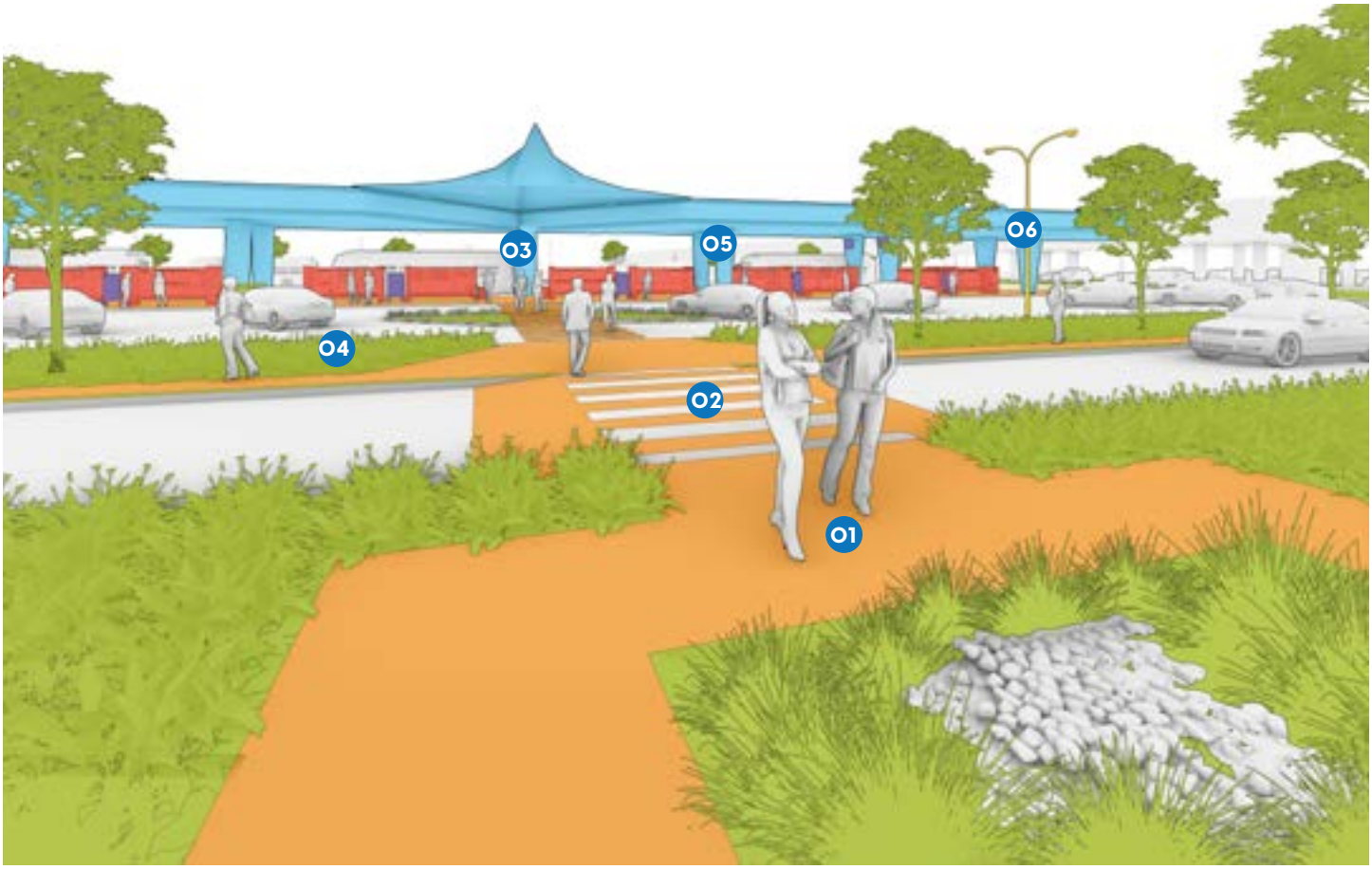
02 A raised pedestrian crossing slows vehicles and provides a safe walking experience

03 Sight-lines to the station canopy are uninterrupted along the pedestrian spine

04 Planting islands provide a pedestrian refuge between vehicular drives

05 Supplementary lighting increases light levels beneath the station canopy

06 Roadway lighting is located out of the pedestrian travelway



Central Bioswale

01 A central bioswale along the pedestrian spine collects stormwater from adjacent pavements

02 Native planting is designed to maintain sightlines and does not exceed 3' in height

03 A consistent tree canopy highlights primary pedestrian routes while providing shade approaching the station shelter

04 Pedestrian lighting poles are spaced to provide quality light coverage without creating undesirable shadows or glare

05 A bike lane connects the external facility edge to the primary pedestrian spine leading to the station platform

Park & Ride (Rapid Growth)

Park & Ride Case Study

Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Access

Comfort

Tree Canopy / Shade Canopies
Wide Sidewalks
Platform Amenities

Quality of Life

Wayfinding
Bioswales
Bike Amenities
Solar Panels

Contextual Considerations

01 Pedestrian and bike access from surrounding neighborhood is continuous and legible

02 The Park & Ride is connected to a creek trail and adjacent commercial development through a signalized pedestrian crossing

03 A pedestrian scale wayfinding monument directs pedestrian and cyclists to the station platform

04 External site circulation connects to a central pedestrian spine

05 All site edges are buffered by performative planting and tree canopy to capture runoff, reduce surface temperatures, and reinforce site boundaries

Precedent Facilities

WILLOWBROOK ROSA PARKS STATION

LOCATION: LOS ANGELES, CA

AGENCY: METRO

Transit hub connections to several bus lines and shuttles. Transfer mezzanine between lines, electronic signs with real time arrival, public plaza with customer center, offices for transit security, bike parking, parking lot with EV charging, community engagement and art integration, and pedestrian promenade.

MOUNTAIN VIEW STATION

LOCATION: MOUNTAIN VIEW, CA

AGENCY: CALTRANS

Intermodal station serving regional rail, light rail, local bus, and shuttle. Parking lot used for farmer's market on Sunday's, bicycle storage, recycling receptacles.

EAST VILLAGE TRANSIT CENTER

LOCATION: KANSAS CITY, MO

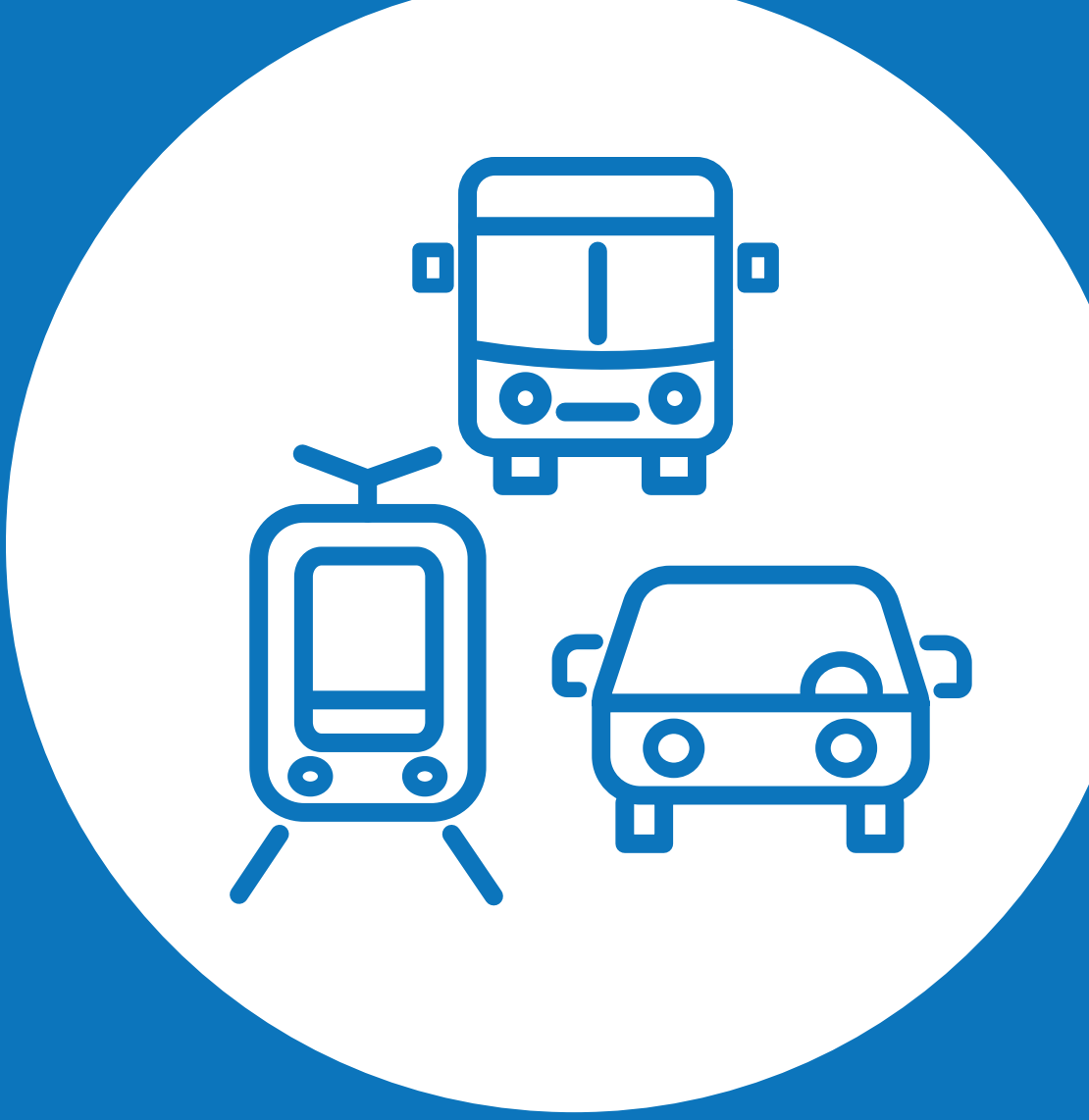
AGENCY: KCATA

BRT and local bus, bike racks, bike rentals, real-time information, free public Wi-Fi, customer service lobby.

Transit Center

Transit Centers act as central nodes within the transit system. Often located in more densely populated areas, Transit Centers meet a variety of needs and must balance transfers between multiple modes of transportation. Transit Centers can be relatively small in more urban areas or can be larger than a Park & Ride.

Careful consideration for pedestrian circulation between modal transfers must be articulated within the facility design. Legible site design and an intuitive wayfinding system can aid the performance and experience of these facilities. Green Infrastructure should be incorporated into larger sites. Transit Oriented Development may be considered within active neighborhood contexts. Entrances and METRO wayfinding should be highly visible.




WEATHER PROTECTION
WAYFINDING MONUMENT
FLEXIBLE
COMMUNITY SPACE


COHESIVE WAYFINDING
BIKE AMENITIES
CLEAR TRAVELWAY
DIGITAL APP NAVIGATION
METRO
metrobus

Transit Center

7.7
MILLION RIDES

25.5
MILLION PEOPLE USING HOV/HOT LANES

20,000
PERSONAL VEHICULAR TRIPS ELIMINATED

100
MILES OF METRO OPERATED HOV LANES









METRO Transit Centers contain various combinations of Bus Stops, LRT, BRT, or Park & Ride facilities. Many METRO Transit Centers were once Park & Ride facilities that were retrofitted to include BRT service over time. Others without surface lots often contain a form of bus service adjacent to a LRT station, or even a series of bus stops. The mixture of multi-modal use often determines facility scale, station amenities, and pedestrian circulation patterns.

In addition to improvements highlighted in previously mentioned facilities, clear pedestrian prioritization and access between modalities are the most impactful improvements to existing and future Transit Center facilities. Connections between transportation types should be close in proximity, comfortable, accessible, and intuitive.

Future Transit Centers will contain more split-level transitions as BRT connections become more integrated. Some examples between stacked facilities can be found on page 194.

Partnership Opportunities

Transit Corridor Typologies

Retrofit	**Integration of Additional Modes of Transportation**
	Modify to Include Sawtooth Boarding Platform
	Addition of LID and Sustainability Measures
Redevelopment	**Integration of TOD Measures**
	Optimize Circulation to Accommodate New Uses
	Respond to Changing Adjacent Transit Types
New Construction	**Clear Separation of Transit Types**
	Direct Access to Adjacent Transit Facilities
	Provide Opportunities to Respond to Future Transit Facilities and TOD

Partnership Opportunities

Management District

- Sidewalk
- Crosswalk
- Transit Environment Development
- Medium to high maintenance capacity
- TOD as development guidelines
- Funds for redevelopment and branded site elements

Redevelopment Authority (TIRZ)

- Streetscape redevelopments
- Funding source for pedestrian improvements
- No maintenance capacity
- Adopt-A-ROW; joint effort with developers

City of Houston

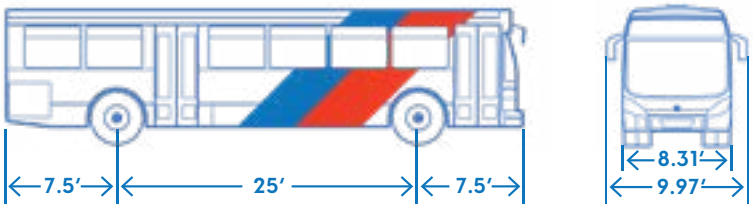
- Capital improvements
- Sidewalk and Safety improvements
- Transit Platform / Park Integration
- Planning Coordination
- Transit Oriented Development potential
- Resilient Houston / CAP Interface

Joint/Private Development

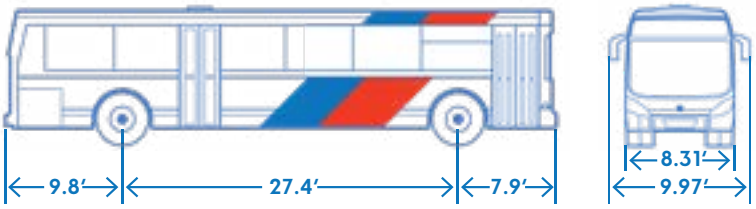
- Marketing Opportunities
- Green Roofs
- Solar Panels
- Non-Profit Funding
- Community-led initiatives

Vehicular Layout

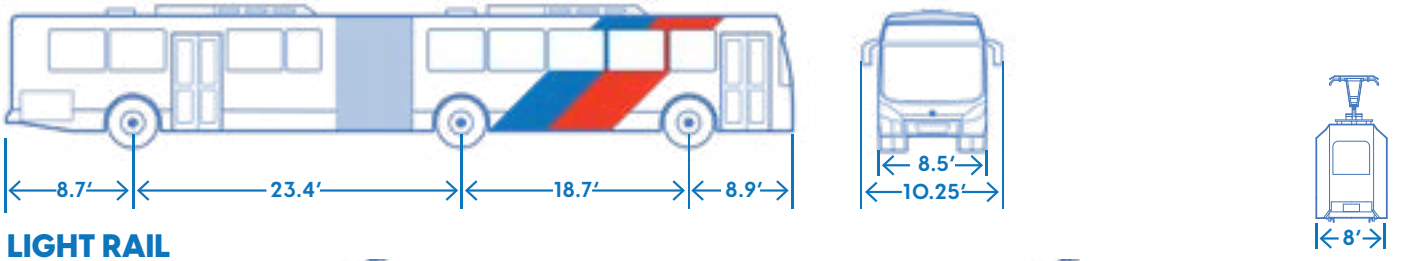
40' BUS



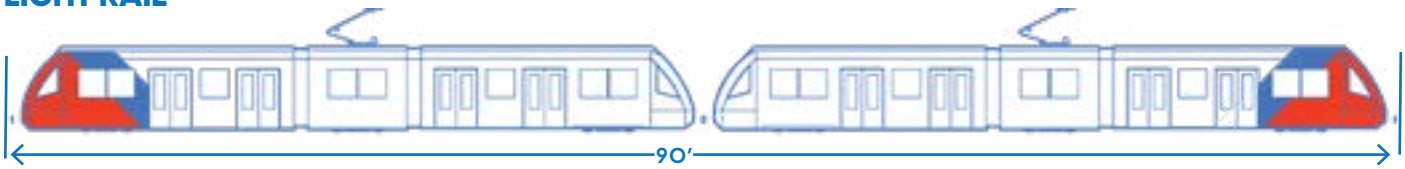
45' BUS



60' BUS



LIGHT RAIL



Accommodate Variety of Transportation Types

- Transit Center facilities must accommodate the appropriate bus types by providing flexible berthing.
- Facilities should be designed to accommodate future transit modes such as integration of BRT.
- Curb height and berthing location are influenced by vehicular configuration.
- Sawtooth curb configuration will help guide buses into the correct berth.
- Prepare for an autonomous future by providing AV drop-off zones and charging stations to encourage use.
- Encourage green infrastructure by providing facilities for cyclists including parking, repair stations, and direct connections to bike lanes.

Special Conditions

- Transit Centers with large surface lots offer an opportunity to provide additional functionality to adjacent neighborhoods during non-operational hours. Temporary event spaces, farmers markets, etc., will attract users to the site and promote ridership.
- Partnership opportunities are possible for improvements such as solar panelization of shade structures. These measures could power EV cars, METRO facilities, or even be sold back to the grid.

Transit Center Drivers of Site Design

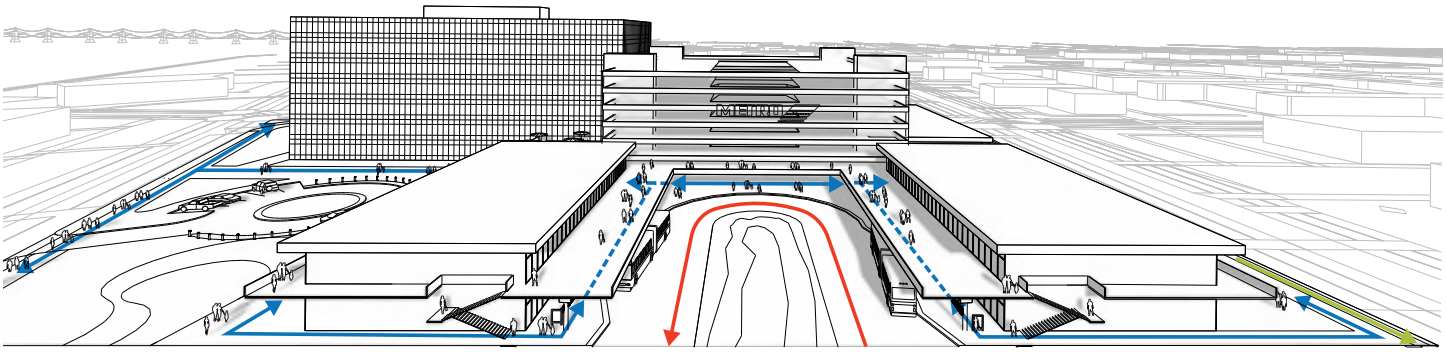
- Transit Centers should be clearly designed by intuitive and safe pedestrian circulation patterns.
- Provide clear separation between METRO vehicles and other modes of transportation and where possible provide dedicated points of entry / egress.
- LID and sustainability measures should be integrated into and drive the design of the facility where possible.

Split Level Integration

Coordinating Multi-Modal Transfers

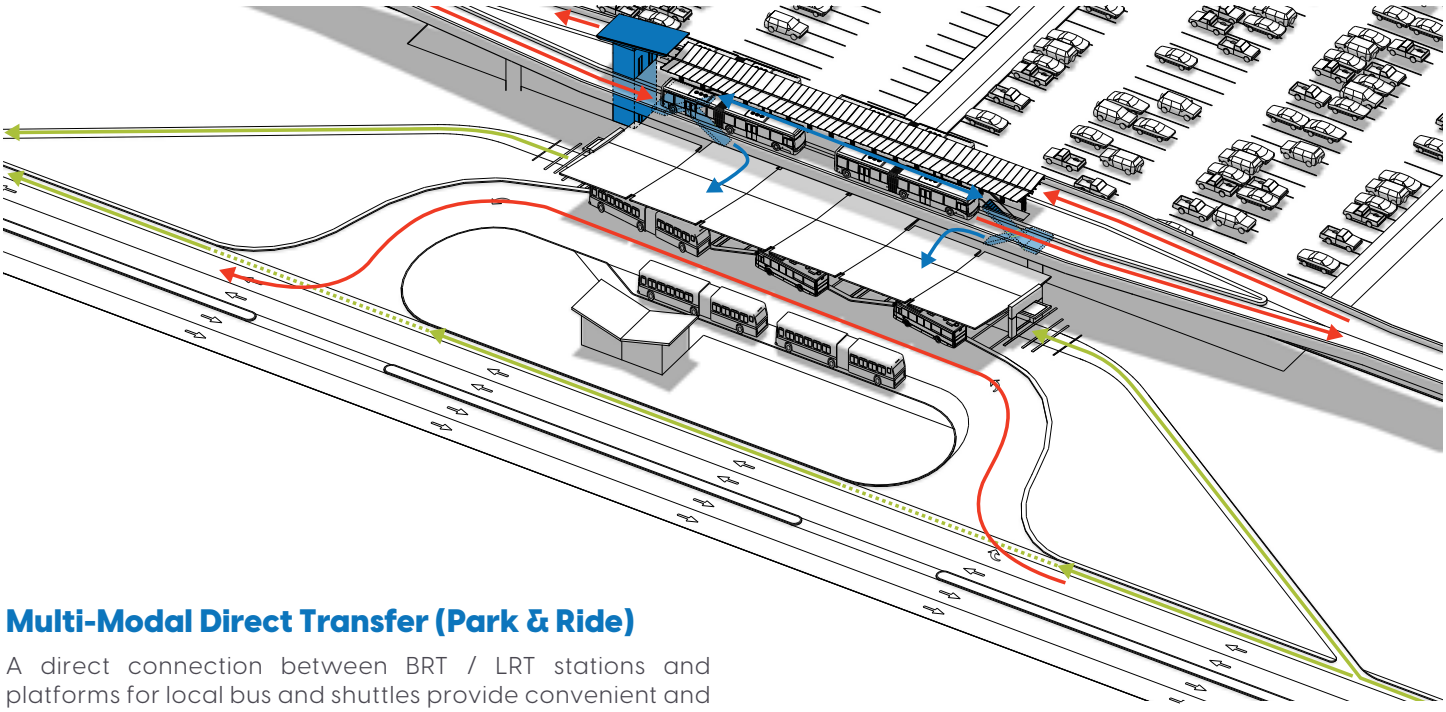
In conditions where one mode of transportation is elevated over another, optimal configurations to provide safe and convenient connections for passengers–while maintaining dedicated and convenient routing for vehicles–are essential to reduce dwell time.

At vertical stacked connections, overlapping platforms to provide a direct transfer between modes is optimal for pedestrians. In some conditions, a bridge connection or ground level crossing may be necessary. Transit oriented developments or Transit Centers with high capacity ridership may have the demand for a parking garage. Configurations which provide direct access to the platform from vertical circulation provide a greater degree of comfort for customers.



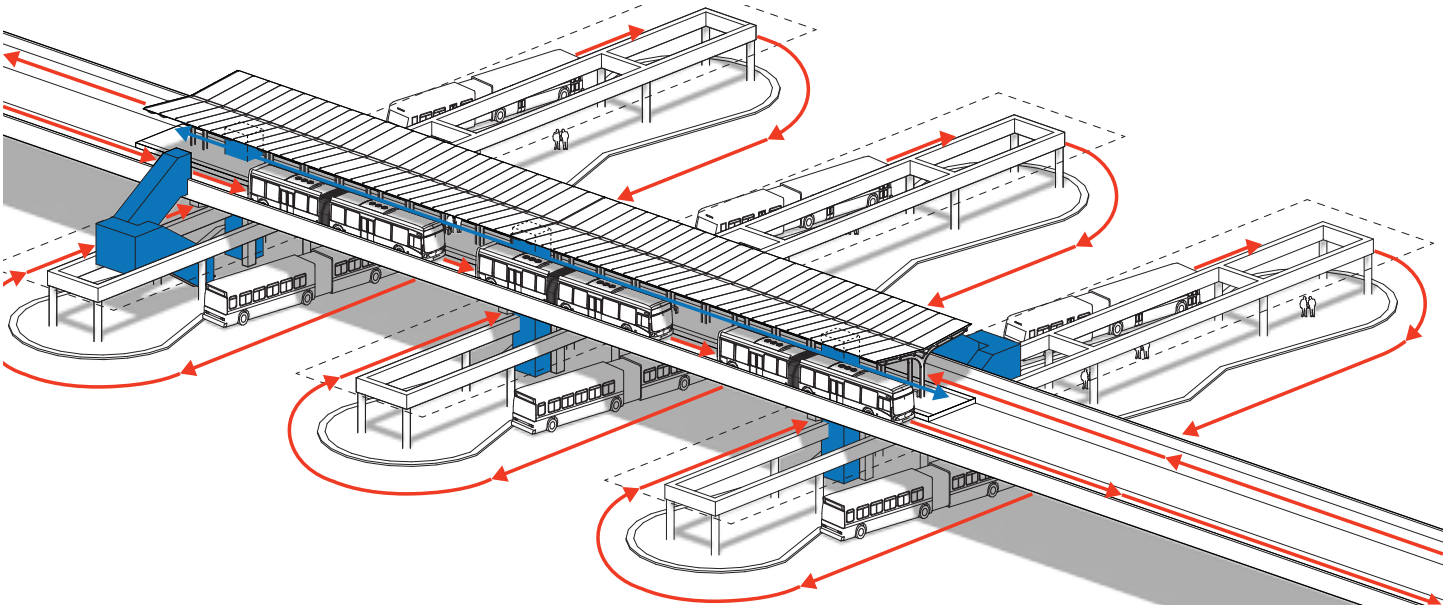
TOD Transit Hub

Single sided bus boarding configurations within TOD facilities enable the opportunity for dedicated bus lanes. Additionally, they minimize crossings and promote opportunities for direct access from parking garages, ride share, and mixed-use developments.



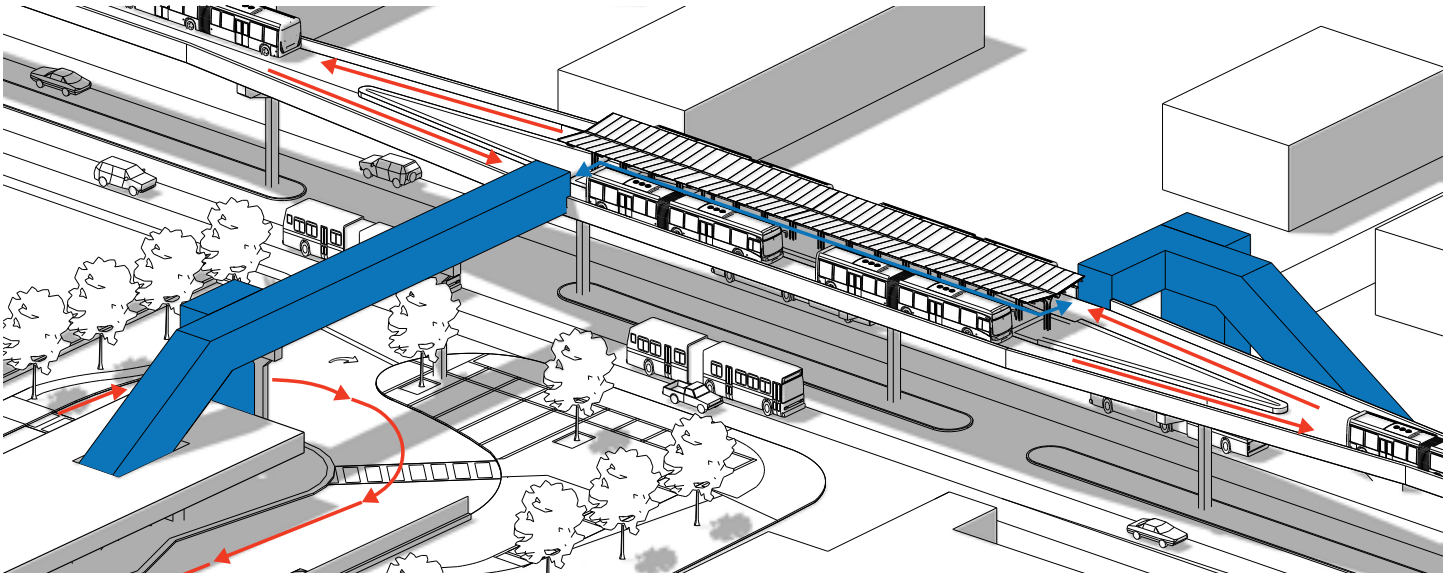
Multi-Modal Direct Transfer (Park & Ride)

A direct connection between BRT / LRT stations and platforms for local bus and shuttles provide convenient and safe transfers for pedestrians. These transfers are adaptable for single loaded and double loaded configurations.



Multi-Modal Direct Transfer

A direct connection between BRT / LRT stations and platforms for local bus and shuttles provide convenient and safe transfer for pedestrians.



Multi-Modal Bridge

Pedestrian bridge connections between elevated stations and transportation centers provide safe and dedicated crossings for pedestrians.

Transit Center (Park & Ride, BRT)

Transit Center Case Study

Headline from the Future

"Transit Center Becomes Public Amenity and Enhances Neighborhood Trail System:
Houston METRO Facility Showcases Wetland Detention through the Integration of BRT Facilities"

Case Study Description

An existing Park & Ride facility has been converted into a neighborhood park amenity and efficient BRT-integrated Transit Center. Serving as a sustainable solution to combat an increase in surface parking, the transit agency converted a concrete detention facility into a wetland pond that manages and purifies stormwater. Integrating a trail system that is connected to a neighborhood green network, the detention facility complements community character while attenuating the impact of flooding. A large sound berm reduces adjacent highway noise into the facility.

Plan Legend

01 Tollway
02 Vegetated Detention
03 Existing Bayou Trails
04 Platform Shelter
05 "Kiss & Ride" Drop-off
06 BRT Shelter
07 Solar Canopies
08 Pedestrian Spines
09 Bus EV Charging
10 HOV-Access Ramp
11 Customer EV Charging
12 Sound Buffer Berm

Facility Name: Conceptual Transit Center Facility (Park & Ride & BRT)

Facility Type
bus stop brt lrt park & ride **transit center**

Environmental Resilience

Ecoregional Zone
northwest southwest central southeast **northeast**

CDC Social Vulnerability Index (SVI)
low (0.0 - 0.25) moderate (0.25 - 0.50) **high (0.50 - 0.75)** critical (0.75 - 1.0)

Diverse Communities

Diversity Overlay
diverse abilities* cultural town linguistically significant ethnically significant culturally significant **muti-ethnic**

Regional Corridor Type
freeway / tollway principal thoroughfare major thoroughfare major collector minor collector

Neighborhood Corridor Type
commercial/economic cultural/historic green/scenic/ceremonial neighborhood services **high-speed access**

Sustainable Development

Project Type
retrofit **redevelopment** new construction

Urban Context
downtown **urban** urban edge dense suburban developing suburban

City of Houston Special Street Designation
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)
pedestrian/cyclist* **40' bus** **45' bus** **60' bus** **rideshare vehicle/tnc** **personal vehicle** lrt **brt**

Neighborhood Walkability Score
walker's paradise (90-100) very walkable (70-89) somewhat walkable (50-69) **car-dependent (0-49)**

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) bikeable (50-69) **somewhat bikeable (0-49)**

Existing Street Conditions and Level of Service (Immediate Adjacency)
Street Names / LOS (A-F): **easton tollway / LOS A** **harley drive / LOS B** **rodger street / LOS C**

Transit Center (Park & Ride, BRT)

Transit Center Case Study

Vegetated Detention & Bioswale

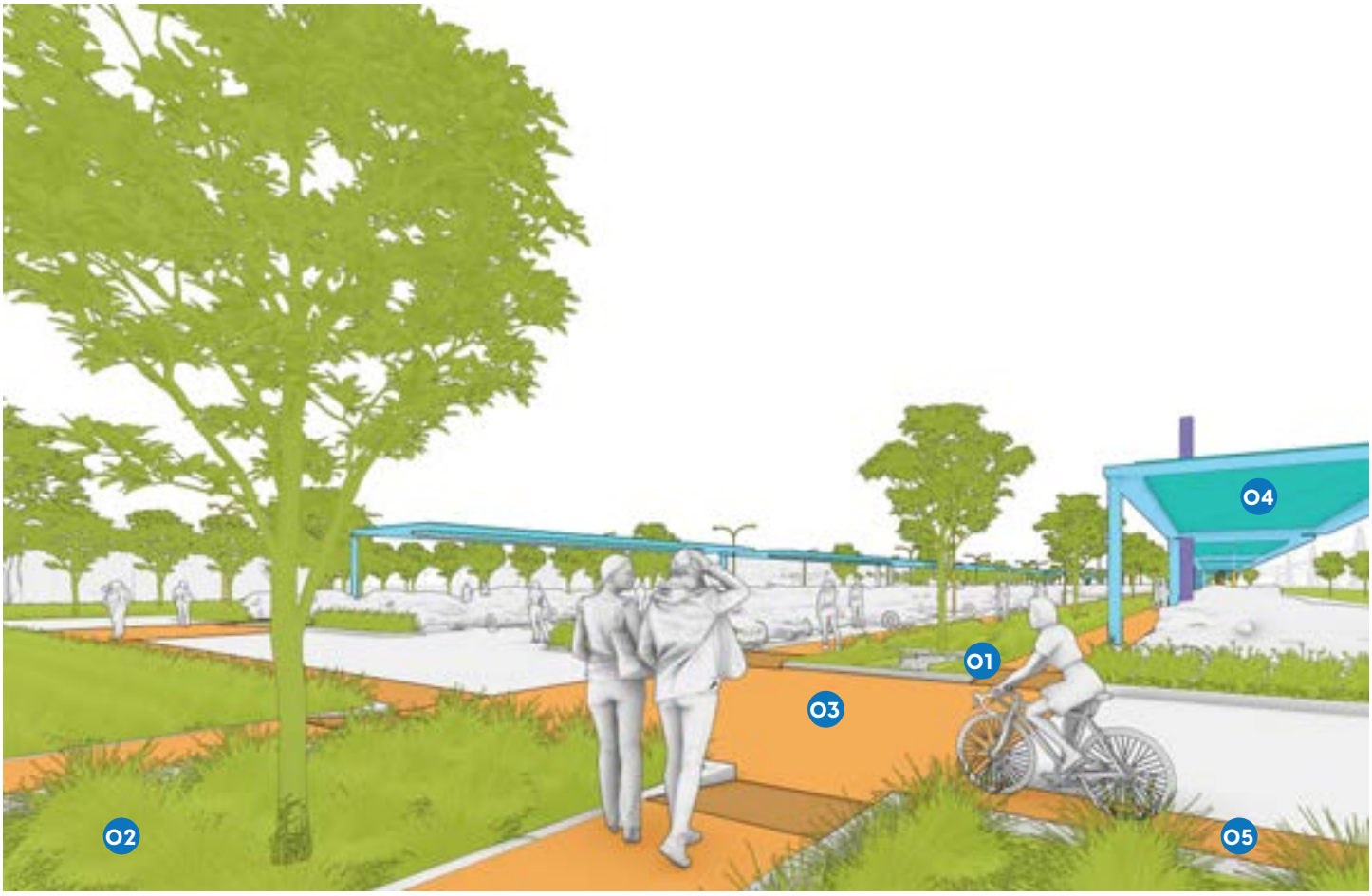
01 A central vegetated swale collects stormwater runoff from the center of the site, filters first flush pollutants, and flows under the roadway via an underground culvert to a vegetated detention pond

02 Stormwater from a vegetated swale infiltrates into the vegetated detention facility–reducing site temperatures and runoff volume

03 A paved crosswalk indicates pedestrian priority at the vehicular roadway

04 Solar shade canopies cover pedestrian walkway and generate energy to offset facility consumption

05 Bikeway circulation is considered throughout the site and is emphasized secondary to pedestrian crossing



BRT Connection

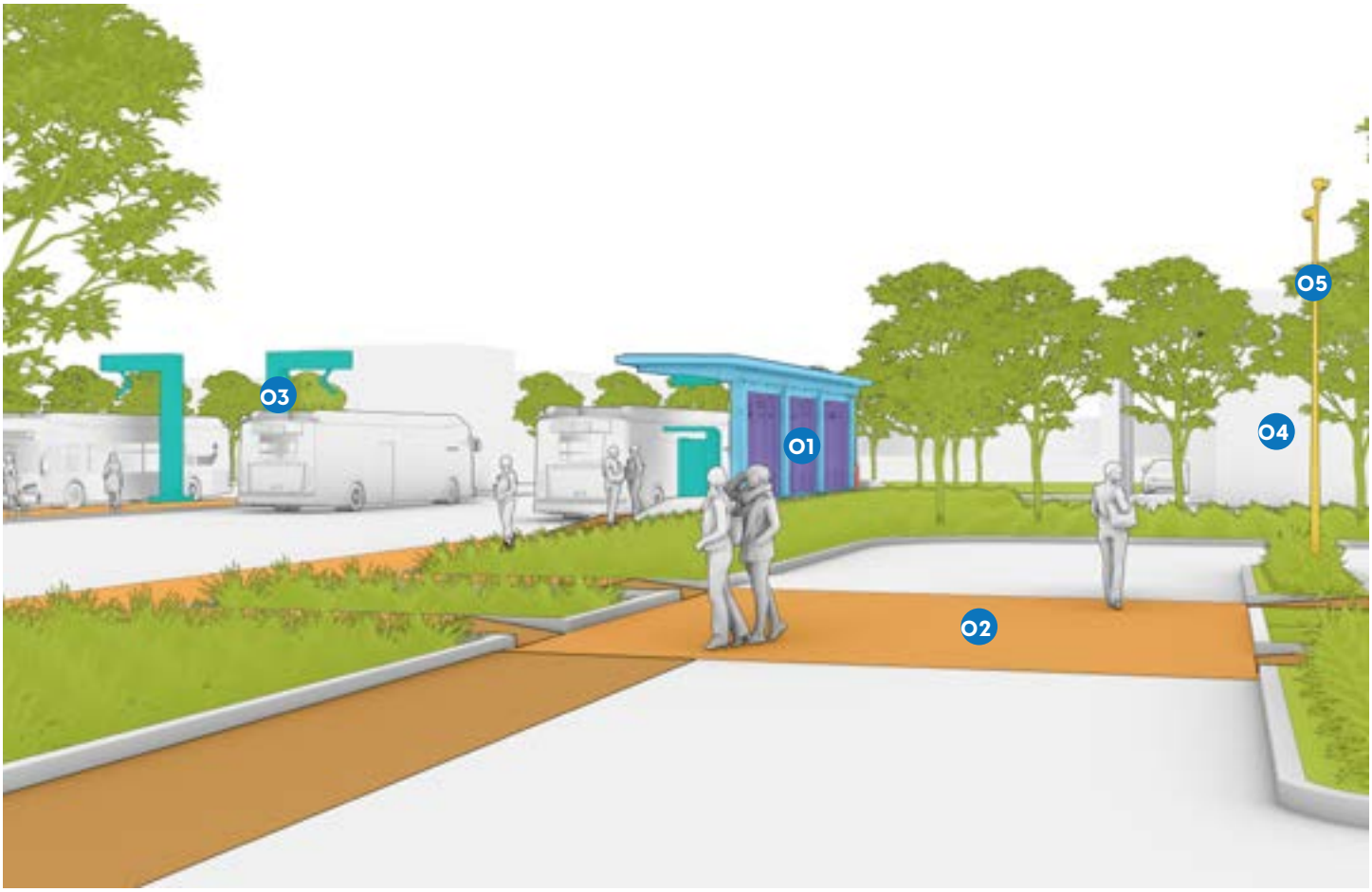
01 BRT buses are located in a specified and legible area separate from standard routes

02 A large, paved pedestrian walkway safely connects customers to modal transfers between commuter bus and BRT operations

03 A dedicated area is provided for bus EV charging away from pedestrian circulation routes

04 Separate and private facilities for METRO staff, MPD, and drivers provide rest areas, vending, and secure office space

05 Solar light poles reduce energy consumption throughout the facility



Transit Center (Park & Ride, BRT)

Transit Center Case Study

Safety

Utility Coordination
Lighting
Sightlines
Pedestrian & Bike Access
Paved Crossings

Comfort

Tree Canopy / Shade Canopies
Wide Sidewalks
Platform Amenities
Native Plantings

Quality of Life

Wayfinding
Green Infrastructure
Bike Amenities
Solar Panels
EV Charging

Contextual Considerations

01 Community open space mitigates stormwater runoff impacts through the design of a vegetated detention park amenity adjacent to a neighboring bayou and ties into an existing trail system

02 Pedestrian circulation surrounds the exterior of the site responds to differing modes of transportation within the Transit Center

03 Walkways throughout parking lot safely connect pedestrians to the external circulation network, platform locations, and on-site amenities

04 Sound berms located alongside the roadway buffer the noise of traffic as well as undesirable access off of Freeway systems

05 Access off of the Freeway / HOV lanes is designed to maximize efficiency of circulation while providing safe crossings to the platform for pedestrians

TEMPE TRANSPORTATION CENTER

LOCATION: TEMPE, ARIZONA

AGENCY: VALLEY METRO REGIONAL PUBLIC TRANSPORTATION AUTHORITY (RPTA) / CITY OF TEMPE

One of the first LEED Platinum transportation buildings, this site showcased green infrastructure strategies including a native desert green roof, greywater collection, stormwater retention, efficient emergency power generation, sustainable building design, ongoing sustainable practices, and use of renewable resources that reduced the energy footprint by 52% and construction waste by 94%.

ARTIC TRANSIT CENTER

LOCATION: ANAHEIM, CALIFORNIA

AGENCY: CITY OF ANAHEIM

The landscape design establishes a unique image for the ARTIC Mixed-Use District by complementing the site's iconic architecture with a strong streetscape identity. A large central plaza integrates passenger drop-off areas, a central pedestrian zone, and a forecourt for the terminal building. Artwork is also incorporated into the overall plaza design.

RICHARD E. MOYA EASTSIDE BUS PLAZA

LOCATION: AUSTIN, TEXAS

AGENCY: CAPMETRO + CARTS

A barren road median within a bus plaza was transformed into a vibrant, ecologically robust refuge for wildlife. Utilizing the native Blackland Prairie planting palette, the plaza employs a series of connected passive stormwater features to retain and attenuate stormwater. The site retains all stormwater from a 100-year storm event and is SITES Silver certified.

Transit Center (TOD Overlay)

Transit Center Case Study

Headline from the Future

"New Transit Center Integrates Vibrant Mixed-use Center:
Houston METRO Facility Combines Garage Parking, BRT Access, and Joint Development"

Case Study Description

This Transit Center thoughtfully integrates both standard bus service and BRT service into a compact facility. Leveraging opportunities with a joint developer, the station also offers retail, dining, and office space. A central bioretention basin collects stormwater runoff while underground detention tackles large system flooding. The site is designed to promotes safe and comfortable pedestrian access. The station platforms are integrated into the design of the architecture and upgraded station amenities increase the safety, comfort, and quality of life of METRO customers and retail visitors.

Plan Legend

01 Existing Freeway
02 Drop-Off Plaza
03 Shelter Canopy
04 Office / Retail
05 Parking Garage
06 Central Bioretention
07 Rideshare Parking
08 Native Planting
09 Tree Cells
10 Permeable Paving
11 Shaded Dining Terraces
12 Art Plaza

Facility Name: Conceptual Transit Center Facility (TOD Overlay)

Facility Type

bus stop brt lrt park & ride **transit center**

Environmental Resilience

Ecoregional Zone

northwest **southwest** central southeast northeast

CDC Social Vulnerability Index (SVI)

low (0.0 - 0.25) moderate (0.25 - 0.50) high (0.50 - 0.75) **critical (0.75 - 1.0)**

Diverse Communities

Diversity Overlay

diverse abilities* **cultural town** **linguistically significant** **ethnically significant** culturally significant muti-ethnic

Regional Corridor Type

freeway / tollway principal thoroughfare major thoroughfare major collector minor collector

Neighborhood Corridor Type

commercial/economic cultural/historic green/scenic/ceremonial **neighborhood services** **high-speed access**

Sustainable Development

Project Type

retrofit redevelopment **new construction**

Urban Context

downtown urban urban edge **dense suburban** developing suburban

City of Houston Special Street Designation

walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) **none**

Customer Service

Transit Modes (Proposed and Future)

pedestrian/cyclist* **40' bus** **45' bus** **60' bus** **rideshare vehicle/tnc** **personal vehicle** lrt **brt**

Neighborhood Walkability Score

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Neighborhood Bikeability Score

biker's paradise (90-100) very bikeable (70-89) **bikeable (50-69)** somewhat bikeable (0-49)

Existing Street Conditions and Level of Service (Immediate Adjacency)

Street Names / LOS (A-F): **south freeway / LOS A** **bark road / LOS C** **belton street / LOS C**

Transit Center (TOD Overlay)

Transit Center Case Study

Arrival Plaza

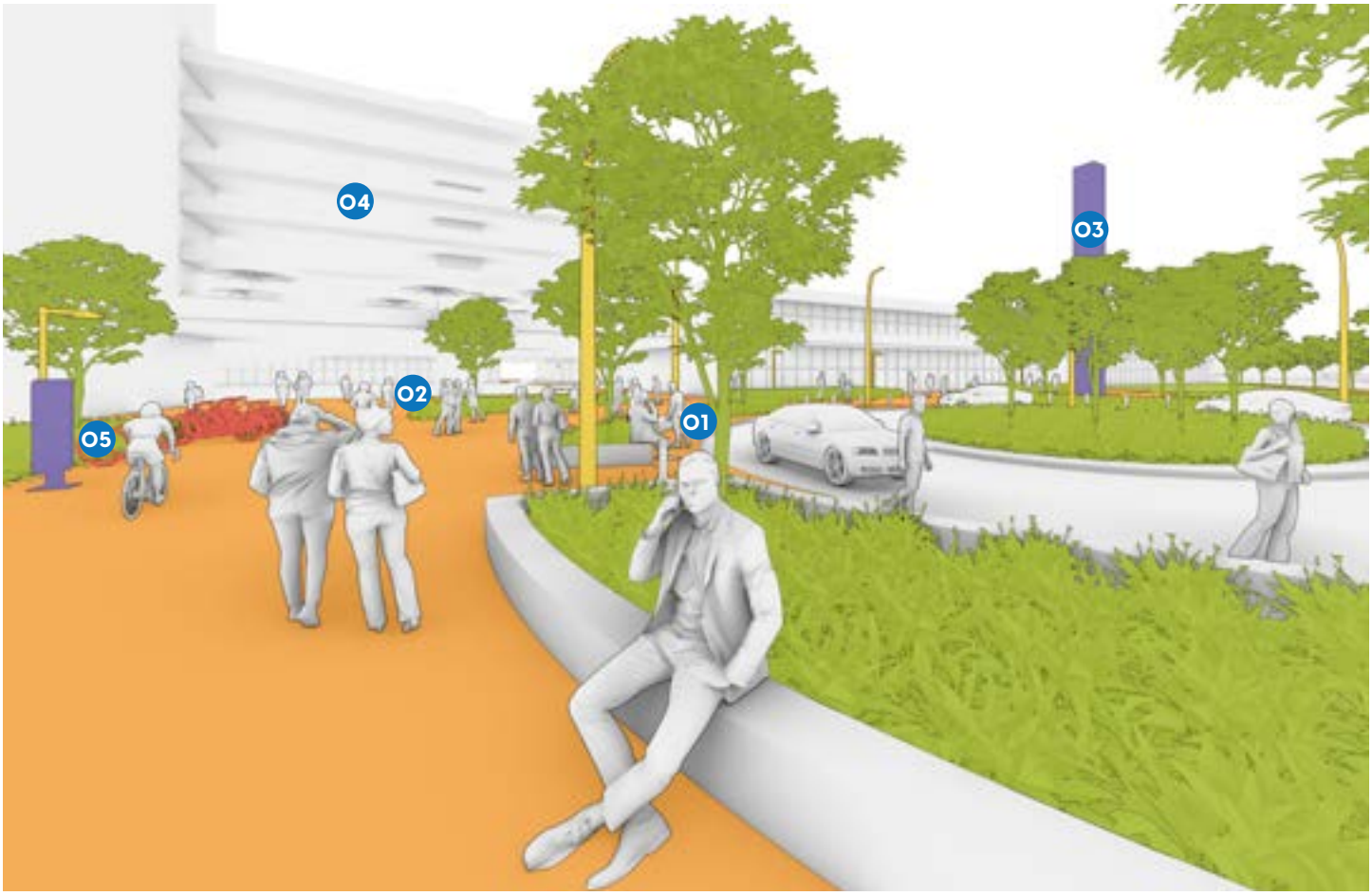
01 A contemporary "Kiss & Ride" serves vehicular drop-off functions for rideshare programs and includes short-term parking spaces

02 Pedestrian access to the transit platform is planned to eliminate the need to cross vehicular traffic routes within the site

03 A large wayfinding monument orients vehicles and pedestrians to the boarding platform

04 A shared use parking garage serves METRO and retail / dining customers in lieu of a traditional surface lot

05 Bike amenities and a digital kiosk offer customer comfort amenities under shade trees



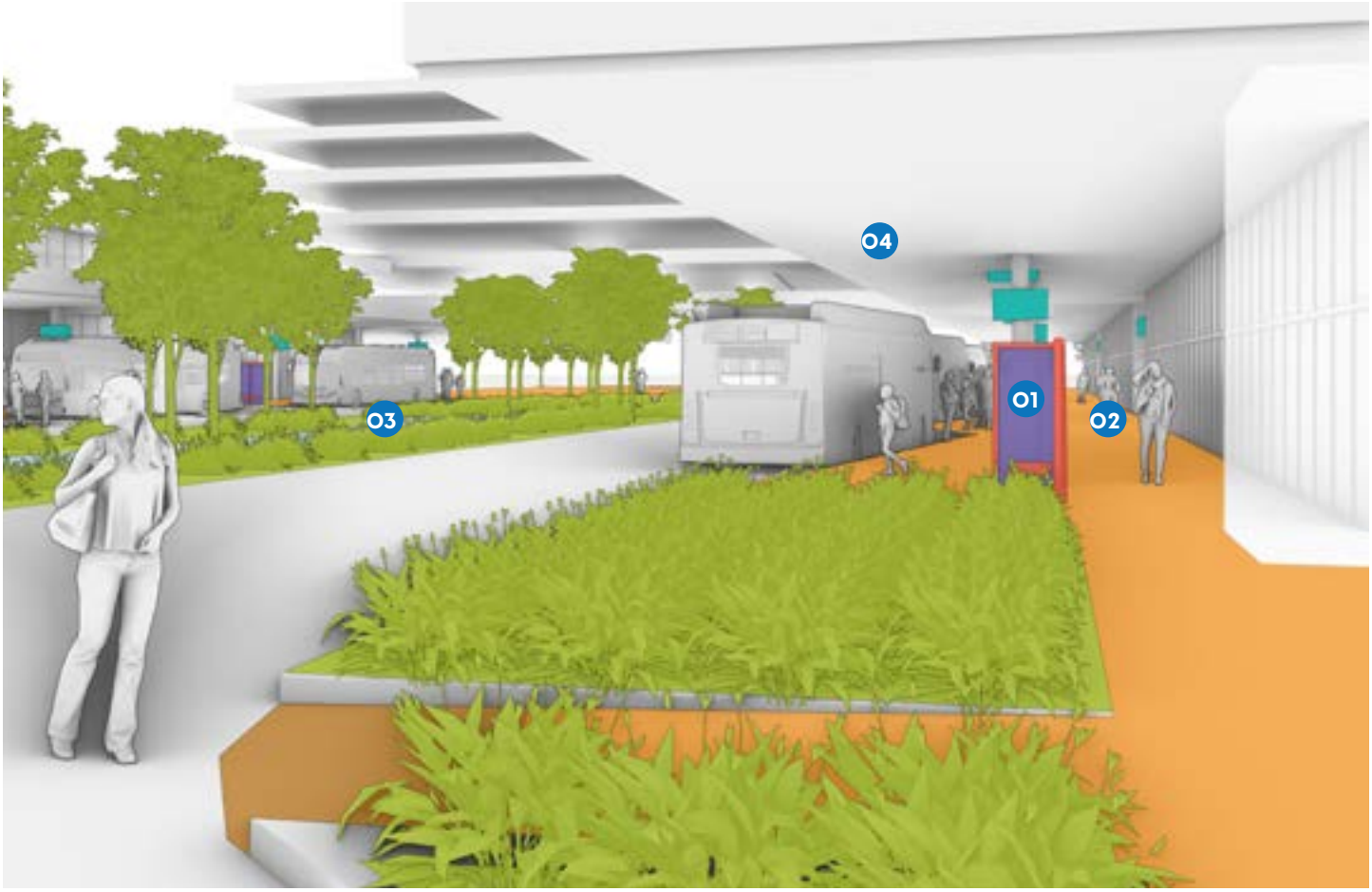
Platform Relationships

01 Wind and weather protection for the bus loading and waiting areas is provided by a structure integrated into the adjacent retail structures; perforated screens provide a surface for art

02 Shared retail and transit circulation enhance pedestrian experience and safety for customers

03 A central bioretention structure captures and filters stormwater runoff before draining into an underground detention facility under the dedicated bus lanes

04 The shelter platform accommodates both large articulated buses and end-of-line BRT vehicles with parallel berthing configuration positioned clear of the adjacent saw-toothed local bus route berths and alternating curb heights with vertical transitions



Transit Center (TOD Overlay)

Transit Center Case Study

Safety

Utility Coordination
Lighting
Sightlines
Integrated Pedestrian Circulation

Comfort

Tree Canopy / Shade Canopies
Wide Sidewalks
Platform Amenities
Native Plantings

Quality of Life

Wayfinding
Green Infrastructure
Bike Amenities
Engaging Retail Development

Contextual Considerations

01 Vehicular and pedestrian lighting are integrated into a cohesive lighting scheme throughout the site

02 Elimination of street level parking in front of the retail creates opportunities for a vibrant streetscape of shops and cafes

03 Pedestrian crossings of bus drives are eliminated within the facility by design, reinforced by vegetation that precludes pedestrian shortcuts between loading areas

04 Large pedestrian walkways connect the site to the adjacent community to encourage sustainable redevelopment in the surrounding area

05 Native grasses and vegetation are utilized in lieu of mowed lawn to improve sustainable function, reduce maintenance, and enhance site character

FEDERAL WAY TRANSIT CENTER

LOCATION: FEDERAL WAY, WA

AGENCY: SOUND TRANSIT

This facility contains 12 bus platforms, 1,190 space garage, bicycle storage, and public art integration. Retail, restaurants, senior living apartments, and a city park are all within walkable distances.

CLARENDON METRO STATION

LOCATION: ARLINGTON, VA

AGENCY: WMATA

This station is surrounded by mixed-use development. A plaza at the entry to the station accommodates bicycle amenities and community events such as farmers markets and music events.

FRUITVALE VILLAGE

LOCATION: OAKLAND, CA

AGENCY: BART

A livable community of mixed-use development was planned at Fruitvale Village BART station. The development is accessible by train and bus from retail, office and housing. Pedestrian plazas provide space for farmers markets and other events.

Design Systems Resources

Scale
site

Learning Objective
Utilize the toolbox of amenities to address safety, comfort, and quality of life at individual facilities

Summary
Design resources and selection criteria for transit facility design elements are presented, including: amenities & furnishings, pedestrian pavements, lighting, landscape, technology, architecture, and wayfinding & art.


METRO
5
6
7
8

Design Systems

RESOURCES AND APPLICATION

Regulatory Requirements & Best Practices

National and local regulations, best management practices (BMPs), research, and user experience resources (found on the following page) form the framework of the Design System Resource Guide. Although not an exhaustive list, these resources direct planners, engineers, designers, and consultants to contextually design, coordinate, and implement design systems to a quality that meets and exceeds minimum design standards. These resources provide valuable insight to the emerging standard of design elements within the urban design environment at the site scale.

While METRO's internal facility standards heavily influenced the Design Systems Toolbox, these resources will help inform future standards at METRO. Emphasis on resilience, sustainable development, diverse communities, and transit experience should be considered in the creation of future facility standards that draw upon these selected resources and others to come.

The Design Systems Toolkit

The Design Systems Toolkit is comprised of site scale elements that help inform the design of METRO Facilities. They serve as guidelines for the selection, placement, requirements, best practice design decisions, and considerations for important elements within each design system. These design elements should primarily be selected and placed to further the safety, comfort, and quality of life within METRO facilities.

Internal workshops for the METRO Urban Design Manual revealed the desire for further coordination within departments for the selection and implementation of design system elements, as well as a method for "evidence-based learning" of what METRO riders need and value through the use of post-occupancy and marketing surveys to help influence the design of future facilities.

Additionally, the Design Systems Toolkit not only seeks to influence future METRO standard features, but to inform custom facilities within the METRO system. Custom elements created by management districts and other entities should follow the same guidelines in regard to regulatory requirements, best management practices, and considerations.

Material Selection Criteria

Materials for each applicable design system were explored to evaluate factors related to resilience, comfort, character, and cost. Both commonly utilized materials within METRO facilities and emerging materials on the market were evaluated to compare benefits and drawbacks to product quality.

These Material Selection Criteria help inform decisions for the selection of furnishings, pavement types and markings, lighting finishes, architectural finishes, and wayfinding mediums. In addition, they serve as a decision making tool when comparing initial cost to lifecycle cost. Products should not be chosen solely on initial upfront cost—as maintenance, replacement, and rider dissatisfaction often exceed savings in the value engineering process. Sustainable, durable, attractive, comfortable, and charactered design elements cannot only provide a return on investment, but a perceived return on ridership perception as well.

Resources

National Regulatory Requirements

- Americans with Disabilities Act (ADA)
- Manual on Uniform Traffic Control Devices (MUTCD) - FHWA
- American Association of State Highway and Transportation Officials (AASHTO)
- National Highway Administration (FHWA / DOT)
- International Building Code

National Agency Guidelines / BMPs

- Crime Prevention Through Environmental Design (CPTED)
- National Association of City Transportation Officials (NACTO)
- American Public Transportation Association (APTA)
- LEED / ENVISION / Sustainable SITES
- Dark-Sky Compliance (IDA)
- Society for Experiential Graphic Designs (SEGD)
- Institute of Transportation Engineers (ITE)
- ASHRAE
- EPA's Energy Star
- U.S. Department of Energy (USDOE)

Local Regulatory Requirements

- COH Development Ordinance
- COH Infrastructure Design Manual
- COH Bike Plan
- TXDOT
- TDLR
- Harris County Geometric Roadway Design Guidelines
- COH Tree and Shrub Ordinance / Approved Tree List
- COH MTFP

Local Guidelines / BMPs

- Scenic Houston Streetscape Resource Guide
- COH Users' Guide for Walkable Places and TOD
- Complete Streets Design Manual
- Community Master Plans
- METRO Plans & Standards
- Resilient Houston
- Complete Streets and Transportation Report
- Houston Vision Zero

Research / Studies

- HGAC Livable Centers
- American Medical Association (AMA)
- Textbook BMPs (*Sustainable SITES Handbook, Time Savers Standards for Landscape Architects / Architects, Landscape Architecture Graphic Standards, Urban Design and The Bottom Line*)
- Transportation Research Board / The National Academies

User Experience

- Field Errors
- Licensure / Standard of Care
- Universal Accessibility
- Site Legibility
- Utility Integration
- Ridership Surveys

Design Systems Toolkit

Amenities & Furnishings	Pedestrian Pavements	Lighting	Landscape	Technology	Architecture	Wayfinding & Art

Urban Design Toolkit

DESIGN SYSTEMS AT A SITE SCALE

At the site scale, amenities related to safety, comfort and civic pride shape the urban design environment. The qualitative properties of these elements enhance the perception of public transit and ensure an enjoyable experience.

	Amenities & Furnishings	Pedestrian Pavements	Lighting
Safety		Detectable Strips ADA Ramps Bike Access Bus Loading / Unloading Transit Network Drop-off Parking Access Path Crosswalks / Crossings Islands / Bulbouts / Refuge	Pedestrian Lighting Bollards Parking Lighting Platform Lighting
Comfort	Shelter Seating Bike Storage / Repair Litter	Platform Bays Waiting Areas Permeable Pavements	LED Lighting Luminaries Smart Lighting
Quality of Life	Planters Event / Flexible Use Space Recycling	Branded Finishes Cohesive Materials Programmed Plaza Space	Supplemental Lighting (Color, Accents, etc.) Branded Luminaries Selection Style

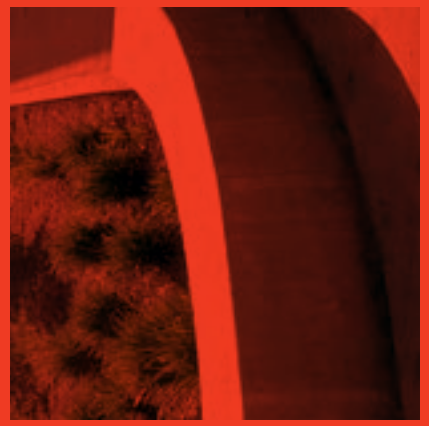
Landscape	Technology	Architecture	Wayfinding & Art
Landscape Buffers	Security Cameras	Fences / Walls	Vehicular Wayfinding
Stormwater Detention	Centralized Control	Security Booth	Traffic Control Signage
Utility Integration	Smart Infrastructure	Railing	Regulatory Signage
	Crossing Signals / HAWK	Utility Building	
	Emergency Assistance	Utility Integration	
		Employee Break Rooms	
		Employee Offices	
		Employee Rest Areas	
		Police Office	
Bioretention	Ticket Machines	Shade Canopy	Trip Planning Kiosk
Rain Gardens	Solar Panels / Canopies	Materiality	Flagpoles
Tree Canopy	ICM (Integrated Corridor Management)	Wind / Rain Screens	Pedestrian Wayfinding
	Real Time Arrival Signs	End of Trip Facilities for Employees and Patrons (Card Access)	Branded Entry Signs
	EV Charging		Info Systems
	Electronic Info Systems		Vending
Entry Garden	Mobile Charging Stations	Branded Material Composition (Structural System, Metals, etc.)	Public Art
Urban Ecology	Conduit for Future Capacity	Architectural Expression	Advertisement Kiosk
Green Roofs		Style	Visual Articulation of Entrances
Reclaimed Irrigation			
Habitat Planting			

Amenities & Furnishings

Furnishings within the Transit Environment should be selected for function, comfort, durability, and character added to the site. These elements can either greatly enhance or detrimentally detract from the ridership experience and METRO brand. Furnishings should exceed minimal functionality and integrate seamlessly into the surrounding site design.

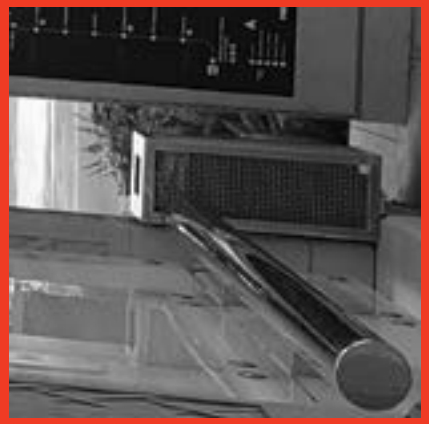
Universal accessibility, horizontal & vertical clearances, and coordination of adjacent elements should be considered in the selection and placement of amenities & furnishings. In accordance with the Metro Climate Action Plan, recycled materials should be used when possible.

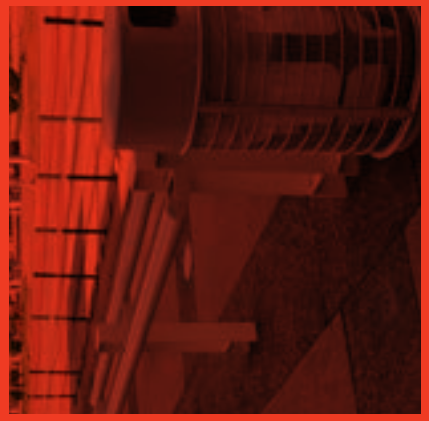
SEATING



BIKE AMENITIES

LITTER RECEPTACLES





WIND SCREENS

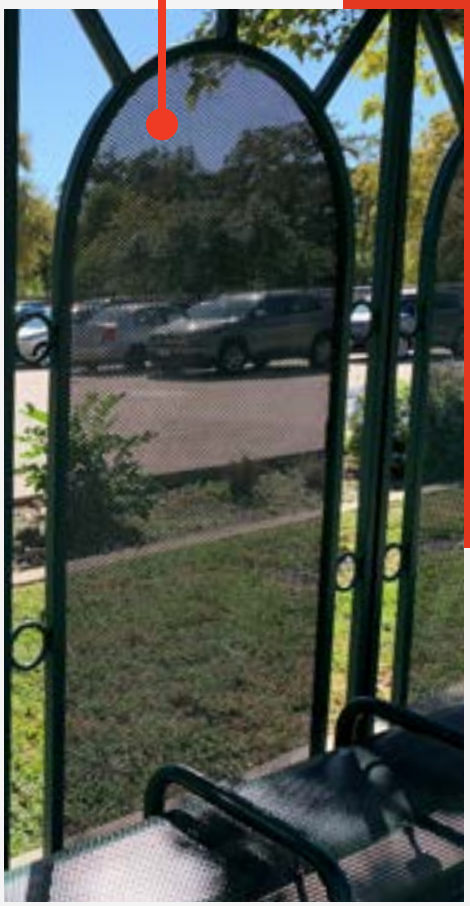
Amenities & Furnishings

ACCESSIBLE BENCHES

DIVIDED RECYCLING

New amenities can be standardized across METRO facilities while allowing flexibility for customizable accents to adapt to community character. The standard of quality in longevity, aesthetic, and function is a direct reflection of the "METRO brand" and the perception of transit within the city. Furnishings should be surface-mounted rather than embedded when possible to ease maintenance burden in the event that a furnishing is damaged. Amenities and furnishings should be cohesive in appearance throughout the site. Site features must be coordinated to ensure that amenities and furnishings do not conflict with site utilities and minimum travelway offsets.

PERFORATED WIND SCREEN



CUSTOMIZABLE ACCENTS

Amenities & Furnishings

Glass
Tempered

Glass is beneficial to use as a solid and transparent barrier for bus shelters and windscreens but is easily vandalized.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

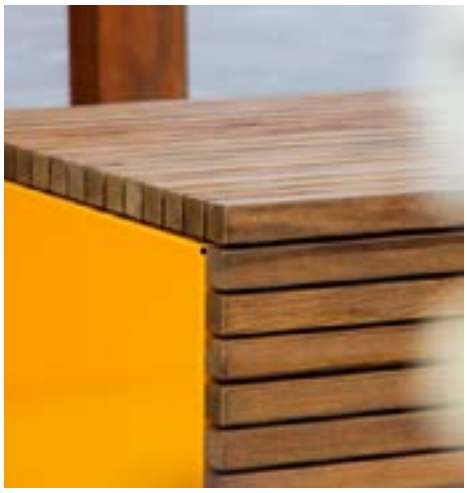
- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost



Tropical Hardwood
FSC Certification Only

Tropical hardwoods (various species) are durable but must be FSC certified for all furnishings to ensure they are sourced ethically.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Accoya
Hardwood Alternative

Accoya is a fast-growing and more sustainable alternative to tropical hardwoods. It is just as durable as tropical hardwoods and has low embodied carbon.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Thermo-Wood
Thermally Modified

Ash, oak, pine, or other species are thermally treated for pest resistance and decay without the use of harsh chemicals. Kebony is similar and slightly more durable.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Resysta
Wood Alternative

Resysta is a sustainable wood alternative made from rice husks. It is salt, moisture, pest, and decay resistant and can be stained like wood. It can be recycled at the end of its life.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

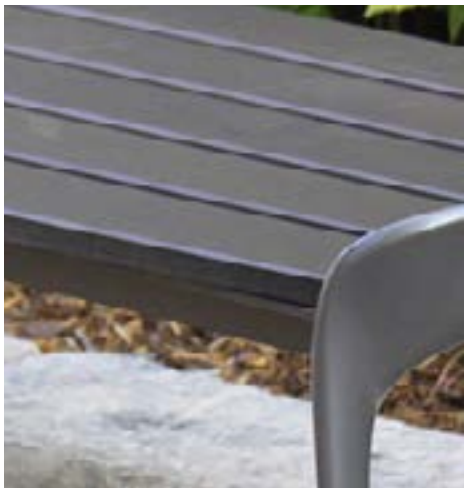
- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost



Composite
High Density Paper (HDPC)

High density paper composites are made from recycled paper and can be harder than wood. It comes in limited options but is insect and rot resistant. It is prone to vandalism and scratches.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Amenities & Furnishings

Aluminum
Die-Cast / Recycled

Aluminum is lighter than steel and comes in a variety of elegant forms. Die cast aluminum, when recycled, is more sustainable than stainless steel but can oxidize.

Resilience

●●●○○ Durability
●●●○○ Corrosion Resistance
●●●●○ Vandal Resistance
●●●●○ Sustainability
●●●●● UV Resistance

Comfort

●●●○○ Heat Dissipation
●●○○○ Low Reflectivity
●●●●● Freeze Resistance

Character

●●○○○ Color Branding
○○○○○ Art Integration

Cost

●●●●○ Low Life-cycle Cost
●●○○○ Low Initial Cost
●●●●● Low Maintenance Cost

Aluminum
Powdercoated

Aluminum can be powdercoated to add character and coloring opportunities while reducing reflectivity. Like powdercoated steel, it can be easily vandalized.

Resilience

●●●○○ Durability
●●●●○ Corrosion Resistance
●●●○○ Vandal Resistance
●●●○○ Sustainability
●●●●● UV Resistance

Comfort

●●●●○ Heat Dissipation
●●●●● Low Reflectivity
●●●●● Freeze Resistance

Character

●●●●● Color Branding
●●●●○ Art Integration

Cost

●●●○○ Low Life-cycle Cost
●○○○○ Low Initial Cost
●●●○○ Low Maintenance Cost

Aluminum
Anodized

Anodized aluminum promotes corrosion resistance and allows for color branding opportunities. It is naturally oxidized.

.

Resilience

●●●●○ Durability
●●●●● Corrosion Resistance
●●●●○ Vandal Resistance
●●●○○ Sustainability
●●●●● UV Resistance

Comfort

●●●●○ Heat Dissipation
●●●○○ Low Reflectivity
●●●●● Freeze Resistance

Character

●●●●● Color Branding
●●●●○ Art Integration

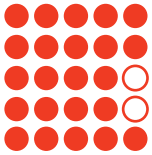
Cost

●●●●○ Low Life-cycle Cost
●○○○○ Low Initial Cost
●●●●● Low Maintenance Cost

Steel
Stainless

Stainless steel has anti-microbial properties, is corrosion resistant, and is resistant to warping in the sun. It is low maintenance but can get very hot in the sun.

Resilience



Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

Cost

Low Life-cycle Cost
Low Initial Cost
Low Maintenance Cost

Steel
Powdercoated

Powdercoated steel can add a lot of character to a site and reinforce neighborhood or brand identity, but is susceptible to scratching / vandalism.

Resilience

Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

Cost

Low Life-cycle Cost
Low Initial Cost
Low Maintenance Cost

Steel
Weathering

Weathering steel can enhance site character. It weathers naturally and changes color over time while minimizing glare and enhancing natural site textures.

Resilience

Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

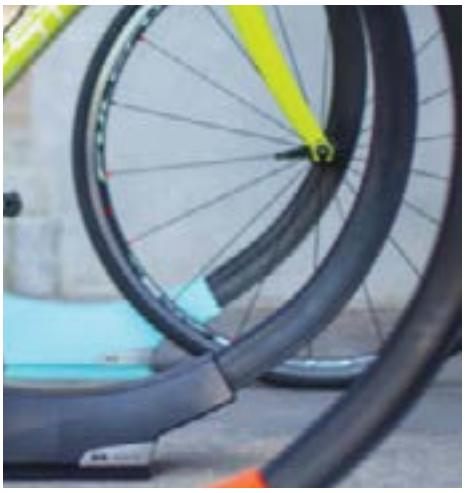
Character

Color Branding
Art Integration

Cost

Low Life-cycle Cost
Low Initial Cost
Low Maintenance Cost

Amenities & Furnishings



Recycled Rubber
EPDM

EPDM rubber can be a durable solution for bike racks and prevent scratches to bikes but may be less heat resistant in the sun.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

High Density Polyethylene
HDPE

HDPE is a thermoplastic that can either be new or recycled. It is resistant to temperature, moisture, and has anti-microbial properties.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Plastic
Recycled (PP & PE)

High quality recycled plastic furnishings are becoming more durable and resistant to vandalism and environmental degradation. It can be recycled again.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Concrete
Site Cast

Simple concrete forms can be designed specific to a site's needs. Concrete is reliable, durable, simple, and comfortable relative to temperature changes. It is susceptible to chipping.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Cast Stone
Cast Stone / Pre-Cast

Pre-cast concrete is formed using a reusable mold, reinforced with a metal structure, and is heavily controlled for a consistent quality. The molds and internal structure allow for more organic shapes.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

GFRC
Glass Reinforced Concrete

GFRC is similar to pre-cast in its flexibility and versatility, but includes glass fibers in the mixture to allow further spans with less supports. GFR is suitable for long, organic shapes.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Seating Elements

Individual Bench

Bus Stops / Park & Rides / Transit Centers

Selection

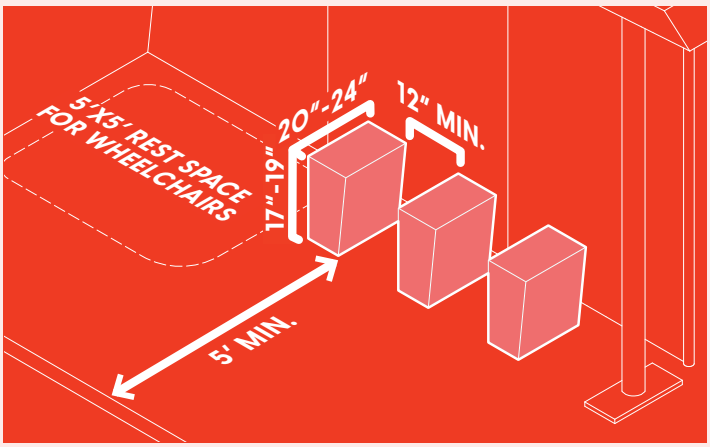
- Avoid sharp corners on seat edges
- Select bench material and style that respects and responds to adjacent context or community character

Requirements & Guidelines

- Place individual seats 12" apart minimum
- Provide 5' minimum between the edge of the bench and edge of pedestrian travelway (3' min., *ADAAG §403*)
- Benches should be 17"-19" high, at least 43" long, and 20"-24" in seat depth (*NACTO, ADAAG §903*)
- Provide a 5'x5' minimum resting space nearby for wheelchair users

Considerations

- If benches are located in an area where shade is not consistent throughout the day, metal benches should be avoided to reduce the chance of burns
- Segmented seating should be located adjacent to a handrail or an alternative bench with arms for riders with mobility impairments should be located nearby
- Individual benches should be placed together to create a group of seating elements



Multi-Seat Bench

BRT / LRT / Park & Rides / Transit Centers

Selection

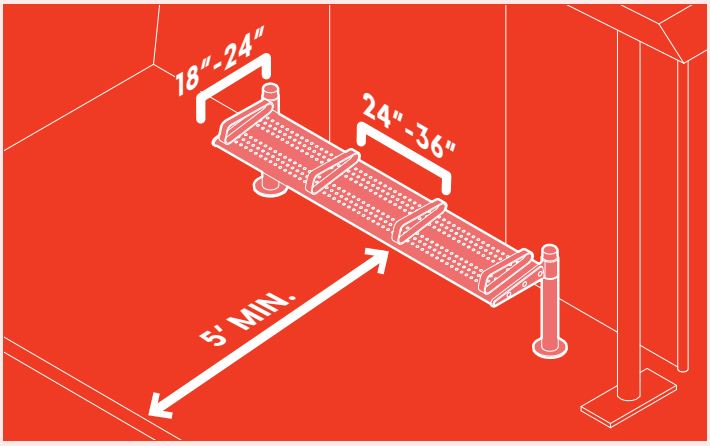
- Select a multi-seat bench with functional arms for mobility impairments
- Avoid bench dividers that feel hostile or uninviting

Requirements & Guidelines

- Benches should have 24"-36" seating space between arm rests or seat dividers
- Provide 5' minimum between the edge of the bench and edge of pedestrian travelway (3' min., *ADAAG §403*)
- Benches should be 17"-19" high, at least 43" long, and 20"-24" in seat depth (*NACTO, ADAAG §903*)
- Provide a 5'x5' minimum resting space nearby for wheelchair users

Considerations

- Provide several seating type options at Transit Centers and Park & Rides
- Consider bench designs that separate seats with simple, smooth dividers rather than sharp deterrents in designs that do not have arm rests



Standing Rail

Bus Stops / BRT / LRT

Selection

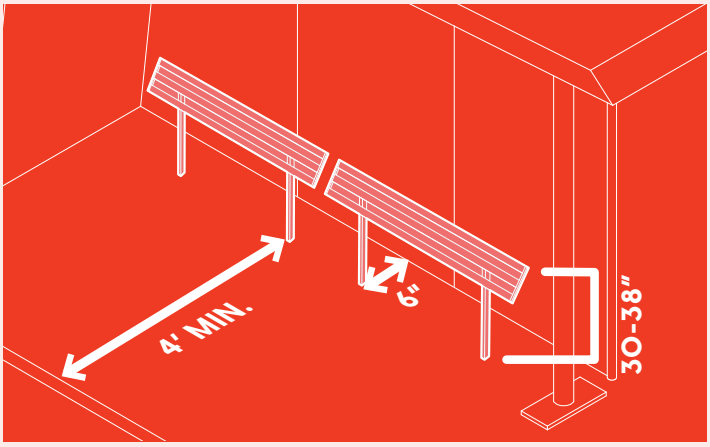
- Choose cooler materials for lean rails that are placed in the sun or part shade
- Select a style that matches the character and materiality of adjacent furnishings

Requirements & Guidelines

- Provide a minimum of 4' between the front edge of the lean rail and edge of the pedestrian travelway
- The standing rail should be 30"-38" high (*NACTO Transit Street Guide*)
- Standing rails must be offset 6" from the non-boarding edge of boarding islands and 1' from the edge of bike channels (*NACTO Transit Street Guide*) to ensure safety

Considerations

- Consider placing the standing rail near the exterior of transit area to encourage riders to wait further back
- Choose standing rails made of materials that do not retain heat
- Consider designs that have a flat and angled rail for leaning comfort



Litter Disposal

Trash Only (Freestanding)

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

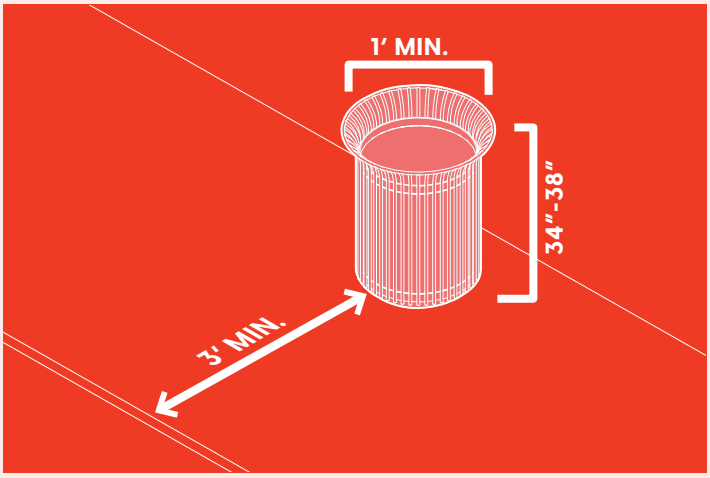
- Avoid dome lids to prevent trash heaping
- Select trash can that responds to site character
- Select volume based on anticipated ridership

Requirements & Guidelines

- Place trash cans at a minimum 60' apart at Park & Rides and Transit Centers, and BRT / LRT Stations
- Situate trash can a minimum 3' clear of the pedestrian travelway
- Select trash can with side openings for easier bag removal
- Openings should be wide enough to provide visibility to contents inside to avoid opportunities for illicit storage of dangerous materials

Considerations

- If the trash can is not under a shelter, consider a design with a rain screen in lieu of a dome lid
- Consider designs with side openings for easier access for ADA users and children
- Consider segmented or higher capacity cans for bus stops with higher ridership rather than placing multiple trash cans



Divided Recycling

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

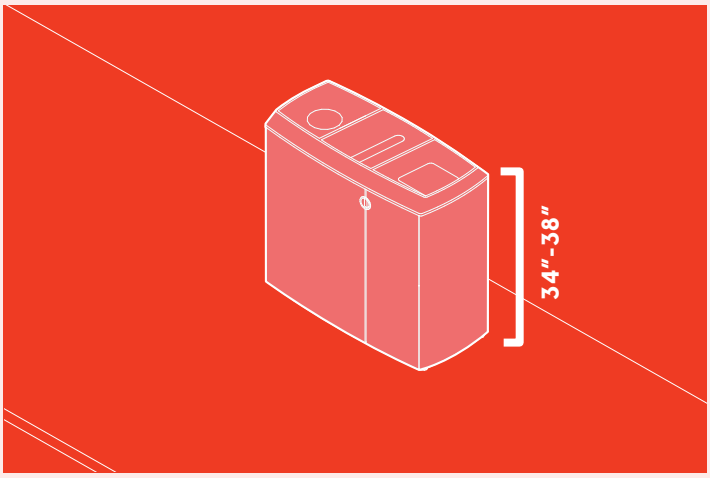
- Select volume based on anticipated ridership and maintenance capacity
- Select divided recycling that encourages separation through limited open sizes

Requirements & Guidelines

- Place trash cans at a minimum 60' apart at Park & Rides and Transit Centers, and BRT / LRT Stations
- Situate trash can a minimum 3' clear of the pedestrian travelway
- Include specific signage or labels on each divided can for clarity about what can be recycled
- Openings should be wide enough to provide visibility to contents inside to avoid opportunities for illicit storage of dangerous materials

Considerations

- Consider using divided recycling in lieu of regular trash cans in areas that have less traffic
- Pair with larger trash cans or solar compactors in areas with higher ridership volumes



Solar Compactors / Smart Cans

LRT / Park & Rides / Transit Centers

Selection

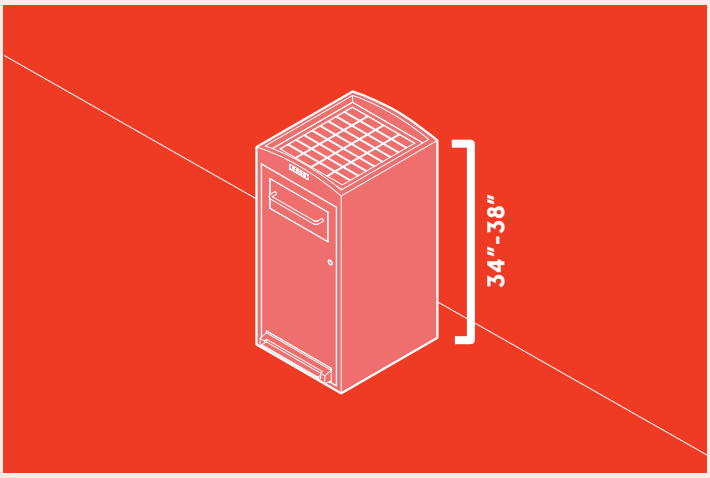
- Consider solar trash compactors in areas with high ridership
- Select a trash compactor for performance reliability

Requirements & Guidelines

- Situate trash can a minimum 3' clear of the pedestrian travelway
- Place compactors in visible locations to prevent creating hiding places and blind corners
- Select compactors with safety sensors
- Solar compactors should have an opening to provide visibility to contents inside to avoid opportunities for illicit storage of dangerous materials

Considerations

- Consider solar compactors with smart technology integration to notify maintenance staff when the can is full, reducing the need for unnecessary servicing
- Consider models that integrate art wraps to provide opportunities for METRO marketing, community art, or station branding



Bicycle Amenities

Bike Racks

Bus Stops / Park & Rides / Transit Centers

Selection

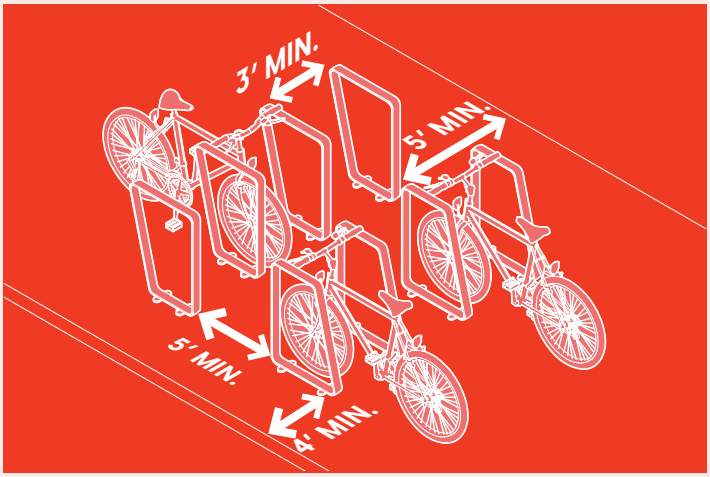
- Select bike racks that reflect the character of the site
- Select models with individual racks so they can be easily replaced

Requirements & Guidelines

- Provide a minimum 5' passing space between the bike rack and edge of pedestrian travelway
- Place center of rack a minimum 4" from curbs when placed on the roadway or parking lot side
- Bike racks should be 10' (parallel) and 3' (perpendicular) away from the edge of buildings, walls, and parallel obstructions
- When angled at 45°, bike racks should be spaced at 4' on center
- Place bike racks in shaded areas

Considerations

- Select models with individual racks so they can be easily replaced
- Consider art integration or integration into other site furnishings



Bike Storage Canopy

Park & Rides / Transit Centers

Selection

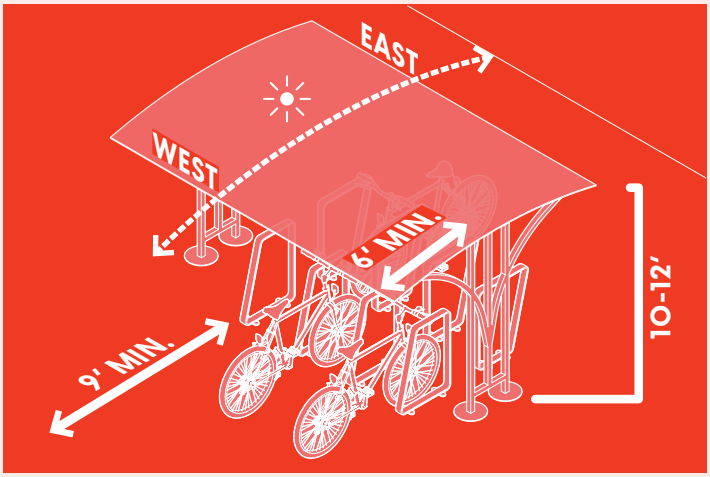
- Select or design canopies to complement the style of other architecture on site

Requirements & Guidelines

- Extend canopy roof at least a minimum 6' past the center of the bike racks (up to 8' preferred) on all sides to ensure the canopy covers the entire bike area
- Ensure canopy is properly oriented to reduce afternoon sun exposure
- Ensure that storage canopy does not contain visual obstructions

Considerations

- For enclosed bike storage, consider models that can be accessed via mobile app or a kiosk-based smart system
- Consider supplying further shade around the sides of the shelter through the use of perforated panels or transparent shade elements
- Consider modular enclosed bike parking as a marketing opportunity that furthers the METRO brand and site specific character



Bike Repair Station

Bus Stops / Park & Rides / Transit Centers

Selection

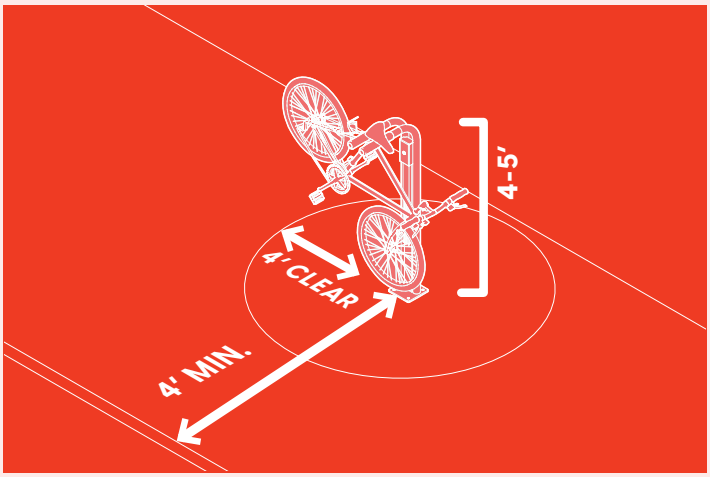
- Select models that have a tire pump and basic repair tools
- Select models that are surface mounted to ease maintenance repairs

Requirements & Guidelines

- Bike repair stations should be placed within a maximum of 20' of a bike parking area
- Place bike repair station 5' clear of the edge of pedestrian travelway
- Repair station should be 8' clear on center from obstructions such as walls, seating, or other vertical elements

Considerations

- Consider selecting models with rubber on the bike supports to more securely hold bikes in place as well as prevent damage to bikes
- Consider designing a special area for the bike repair station within paving that is out of the way of the pedestrian travelway



Weather Screens

Single Sided

Bus Stops / Park & Rides / Transit Centers

Selection

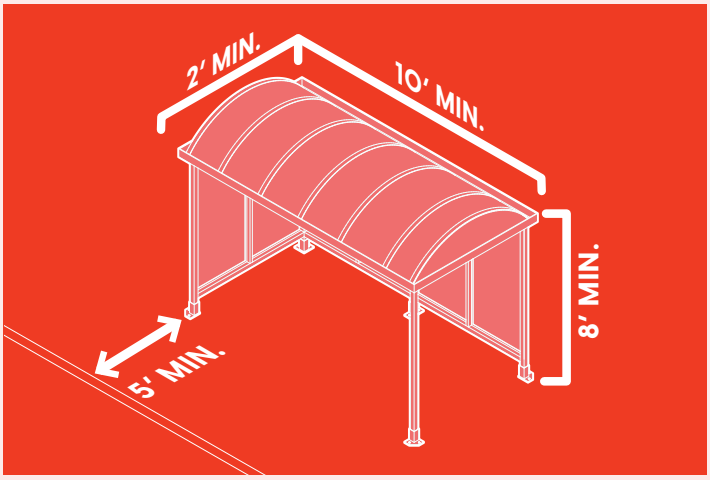
- Weather screens with a single side enable passengers to choose their comfort level
- Weather screens can slow the wind on cold days, but most days are warm and require adequate wind flow

Requirements & Guidelines

- Single sided weather screens should be made of glass, high performance acrylic, or other transparent to semi-transparent materials
- Weather screens should be 5' clear from the edge of the pedestrian travelway
- The back side of the weather screen should be at least 10' long and 8' high, while the side panel should be at least 2' long and 8' high
- Any adjacent support columns (bus stop) should not block visual access into seating area

Considerations

- If panels are desired on both sides of the weather screen, consider designing an adjustable screen that is able to open or close depending on weather conditions



Perforated

Bus Stops / Park & Rides / Transit Centers

Selection

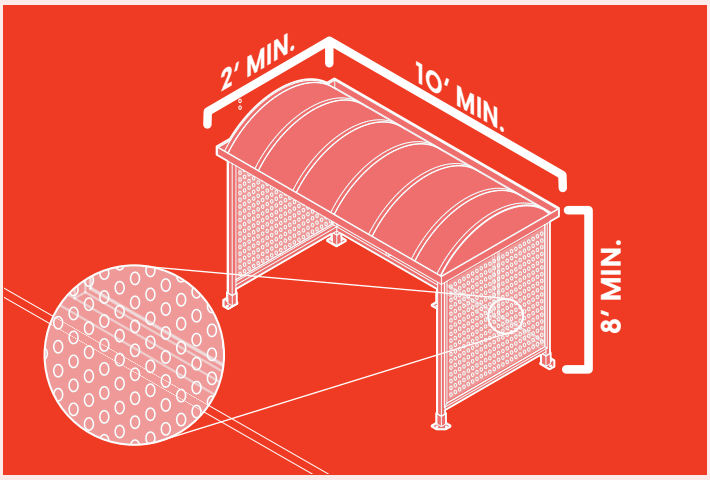
- Weather screens that are made of perforated material allow for filtered flow of wind without completely blocking wind flow
- Perforated metal and other durable materials can be less vandal resistant than typical glass panels

Requirements & Guidelines

- Perforations should be frequent enough to be transparent for visibility and safety
- Perforations should be a maximum of 1" in diameter
- Weather screens should be 5' clear from the edge of the pedestrian travelway
- The back side of the weather screen should be at least 10' long and 8' high, while the side panel should be at least 2' long and 8' high

Considerations

- Consider perforations that enhance character with a special design or motif
- Ensure that the space between perforations is large enough to prevent breaking



Pedestrian Pavements

Pavements heavily influence the Transit Environment. Too much paving without shade or planting can lead to uncomfortable temperatures and can increase stormwater runoff. Cracks in the pavement present a tripping hazard. Clearly delineated ADA ramps and crosswalks ensure pedestrian safety and improve efficiency. Differing yet coordinating paving schemes can create a cohesive and legible ridership experience.

SIDEWALKS

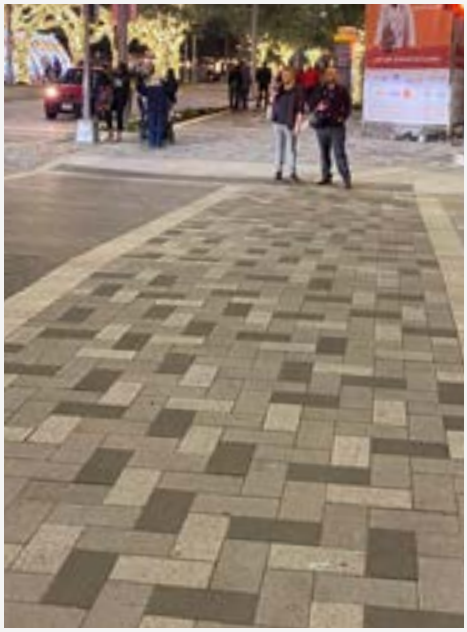
ADA RAMPS

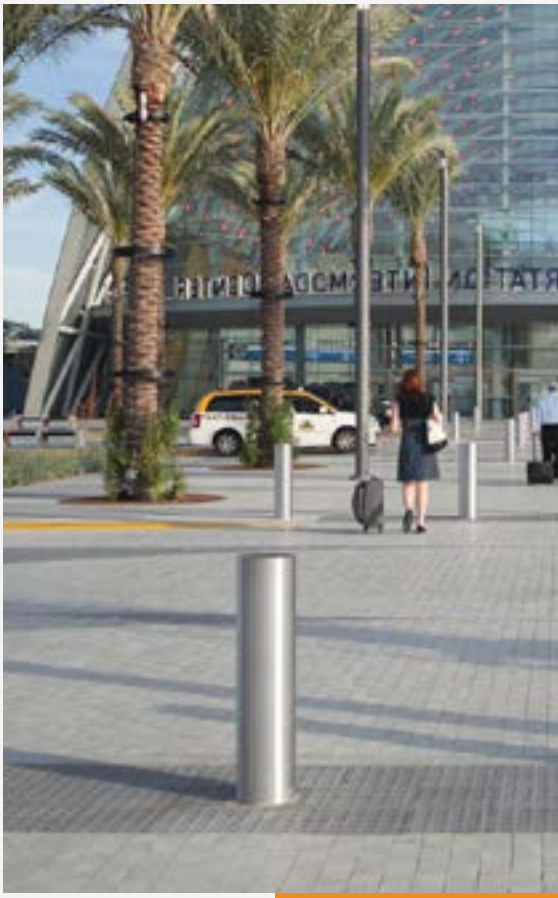
CROSSWALKS

PLAZAS

Pedestrian Pavements

ART CROSSINGS



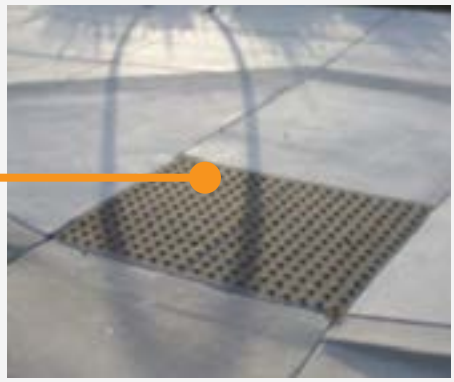


DISTINCTIVE BIKEWAY & MARKINGS

Pedestrian paving materiality should be chosen based on durability, neighborhood character, sustainability goals, and legibility. Adequate planning for accessible space within the pedestrian travelway is imperative for a successful METRO facility, regardless of scale. Coordination of utility integration and stormwater management is imperative for a safe, secure, and positive experience within the urban design realm. Hardscape areas should be designed with pedestrian safety as the paramount priority, focusing on opportunities to employ traffic calming measures in all areas of potential vehicular conflict. Expansion joints and control joints must be considered in relation to other site amenities in order to ensure the longevity of the facility.

RAISED CROSSINGS

CONTRASTING WARNING PAVERS



PAVED ARRIVAL PLAZAS

Pedestrian Paving

Concrete
Natural

Concrete paving is a cost effective solution that provides opportunity for decorative finishes and surface retardants, but can be less durable if installed improperly.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

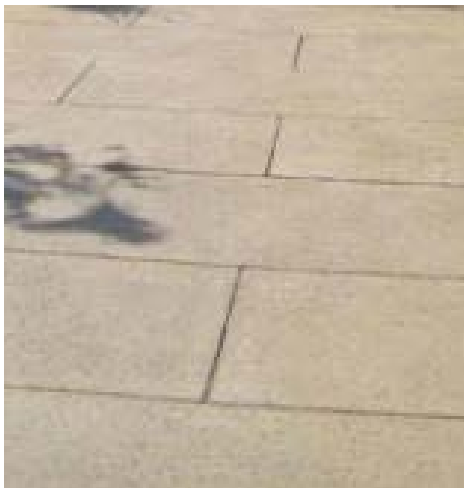
- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost



Integral Color
Concrete Additive

Integral color improves aesthetic qualities of natural concrete and can delineate clear areas and improve legibility. Integral color is preferred to stained concrete due to its UV resistance.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Surface Retarder
Concrete Top-Surface

Top-surface retarders come in a variety of etch depths based on application time and offer color and texture variations.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Concrete Paver
Concrete Unit Pavers

Concrete pavers come in a wide range of color options, are less expensive than clay pavers, and are easy to install. They are prone to color fading and tend to chip or wear easily.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Clay Paver
Clay Brick

Clay pavers come in limited colors but are more resistant to UV fading than concrete. They can be recycled for a more sustainable footprint, but tend to crack over time; particularly on expansive soils.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Stone Paver
Granite / Slate / Quartz

Stone pavers are the most durable pavers in high traffic areas. They come in a wide range of shapes and colors but often have a high initial cost. They are less prone to weathering and chipping.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Pedestrian Paving

Paint
Epoxy-Based

Epoxy-based paint is best used for accent markings near crosswalks and pavement markings. It can be mixed with additives to enhance reflective properties. It wears off easily and needs to be replaced.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Application

- Temporary Use
- Ease-of-Appliance
- Even Consistency

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Biorenewable Paint
Soy / Alkyd Latex

Biorenewable paint is a durable and low-VOC water-based paint with high gloss. It is UV-resistant, and comes in a variety of colors.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Application

- Temporary Use
- Ease-of-Appliance
- Even Consistency

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

DLPM
Durable Liquid Pavement Markings

DLPM includes epoxy and methyl methacrylate. It is recommended for both concrete and asphalt., but is a two part system that has an initially long application period.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Application

- Temporary Use
- Ease-of-Appliance
- Even Consistency

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Thermoplastics
Surface-Applied

Thermoplastics are best suited for asphalt and are highly durable and have a low-lifecycle cost. They provide an opportunity for branding as they can be applied in different colors / patterns.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Application

- Temporary Use
- Ease-of-Appliance
- Even Consistency

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Colored Asphalt
Integral Color

Color pigment is mixed into asphalt to produce an integral color. It is popular in Europe but difficult to install properly. It is the most durable option but difficult to patch.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Application

- Temporary Use
- Ease-of-Appliance
- Even Consistency

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Cool Pavement
Reflective Additives

Asphalt sealcoats can be formulated with lighter colors that are reflective and reduce heat. They are highly durable and reduce heat-island effect.

Resilience

- Durability
- Stain Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Application

- Temporary Use
- Ease-of-Appliance
- Even Consistency

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Sidewalks & Bikeways

Pedestrian Sidewalk

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

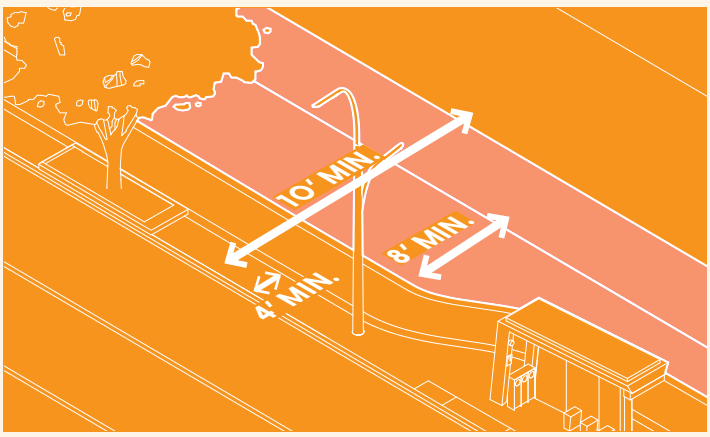
- Select paving materials based on durability, low life-cycle costs, sustainability goals, and community character

Requirements & Guidelines

- For sidewalks within or adjacent to the ROW, refer to the City of Houston *Walkable Places Program and Transit Oriented Development Ordinance*, *Resilient Houston*, *Complete Communities*, community-specific master plans, *Scenic Houston Street Resource Guide*, and HGAC Livable Centers Study (when applicable) for guidelines and regulations
- Primary TOD streets within the ROW must have a minimum sidewalk width of 8', while secondary TOD streets require a 6' sidewalk. Along urban corridors and high activity areas, the pedestrian walkway should be a minimum of 10', while 15'-20' is recommended when allowed. The minimum safety buffer width is 4' (*City of Houston Transit-Oriented Development Standards*)
- All sidewalks must be a minimum of 6' unobstructed (*City of Houston Transit-Oriented Development Standards*) and should be clear of any above-ground utilities in the walkway

Considerations

- Consider embedded wayfinding as a placemaking strategy and include trees spaced 20'-30' apart



Bikeway (Sidepath / Elevated)

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

- Sidewalk-grade bike lanes are preferred for short trips, along retail areas, and are safer for less experienced cyclists within areas adjacent to METRO facilities

Requirements & Guidelines

- For all bikeways, refer to the *City of Houston Bike plan and the Complete Streets Executive Order*, The *City of Houston Infrastructure Design Manual* and The MTFP for guidelines, strategies, and regulations
- Two-way bidirectional side paths should be a minimum of 10', while one-way paths should be a minimum of 6'
- Elevated bikeways should be at a consistent height with the pedestrian ROW and should be delineated with a different paving material or bikeway paint
- Signage, lane markings, and driveway configurations should adhere to the *Infrastructure Design Manual*
- Slopes and cross slopes must adhere to ADA requirement and meet drainage standards
- A minimum 3' buffer must exist between the edge of bikeway and back of curb (Infrastructure Design Manual)

Considerations

- Consider integrating tactile warning strips where the pedestrian travelway must cross the bikeway

Bikeway (Buffered / Roadway)

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

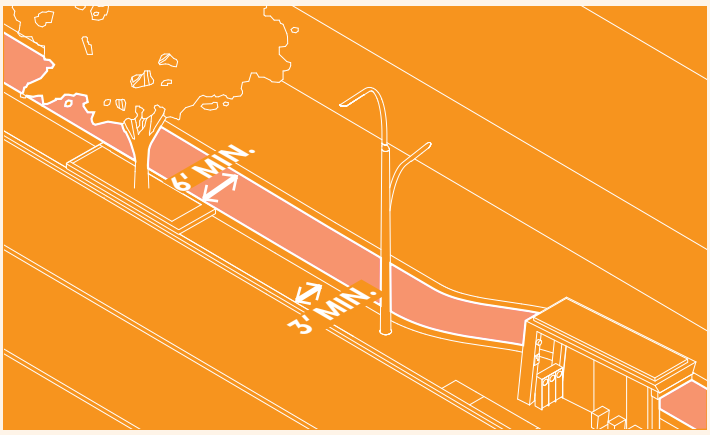
- Buffered bike lanes are comfortable for longer commutes along stretches of roadway due to even grade change
- Buffered bike lanes are a safer option than standard bikeways, especially in the transit environment or when the speed limit exceeds 30 mph

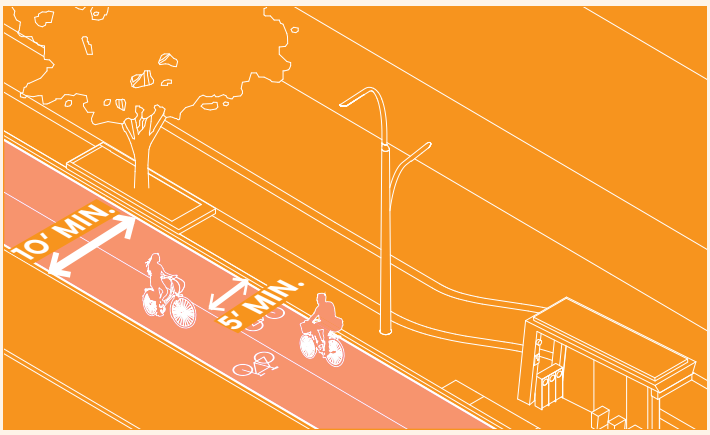
Requirements & Guidelines

- For all bikeways, refer to the *City of Houston Bike plan* and the *Complete Streets Executive Order*, The *City of Houston Infrastructure Design Manual* and The MTFP for guidelines, strategies, and regulations
- Two-way bidirectional lanes should be a minimum of 10', while one-way lanes should be a minimum of 5'
- Raised delineators are required on buffered bike lanes when there is less than 2' between vehicles and the bikeway (*Infrastructure Design Manual*)
- Signage, lane markings, and driveway configurations should adhere to the *Infrastructure Design Manual*

Considerations

- Consider branded bikeway coloring, embedded signage, and / or cool paving to define the bikeway as part of the METRO urban design environment





ADA Ramps

Flare Ramp

Bus Stops / Park & Rides / Transit Centers

Selection

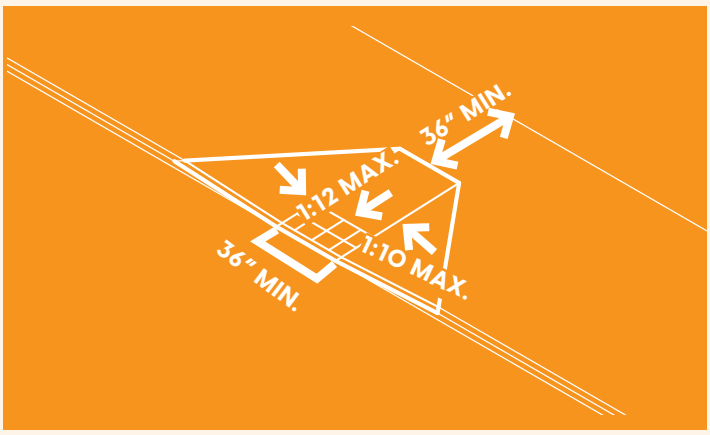
- Flare ramps can be used in most applications where there is a sufficient landing area

Requirements & Guidelines

- Ramp slopes should adhere to ADA required slopes and landings (ADA *§406)*
- Ramp should be free of obstructions such as light poles, utility boxes, traffic lights, overhead electric poles, fire hydrants, or other objects
- Grading must be coordinated to deter the pooling of water at the base of the flare ramp
- There must be a smooth and flush grade transition at the top and base of the flare ramp
- Curb gutters make ADA ramps inaccessible, and are not permitted in the urban design environment
- The flare ramp cannot project into vehicular travel lanes, parking spaces, or access aisles (ADA *§406)*
- A 2' wide tactile warning strip must be located along the entire base of the flare ramp

Considerations

- Consider integrating contrasting tactile pavers in lieu of plastic truncated domes



Curb Return / Directional Ramp

Bus Stops / Park & Rides / Transit Centers

Selection

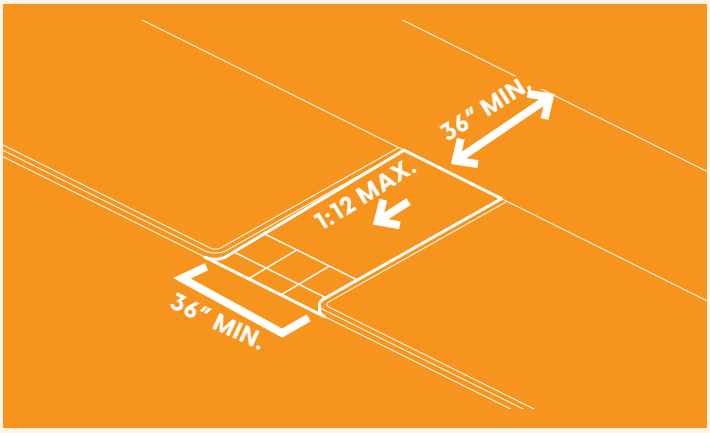
- Directional ramps can orient pedestrians / cyclists in the direction of travel and prevents unsafe circulation

Requirements & Guidelines

- Ramp slopes should adhere to ADA required slopes
- Ramp should be free of obstructions such as light poles, utility boxes, traffic lights, overhead electric poles, fire hydrants, or other objects.
- Drainage should be kept behind curb ramps or on street level to prevent pooling at ramp entrance; curb gutters cannot be located at the base of ramps
- A raised median should be added between bidirectional ramps to improve pedestrian safety
- Provide flat staging areas for pedestrian and wheelchair access (*Scenic Houston*, 35)
- A 2' wide tactile warning strip must be located along the entire base of the ramp

Considerations

- Consider a contrasting integral color to delineate the ramp slope from the walkway



Parallel Curb Ramp

Bus Stops / Park & Rides / Transit Centers

Selection

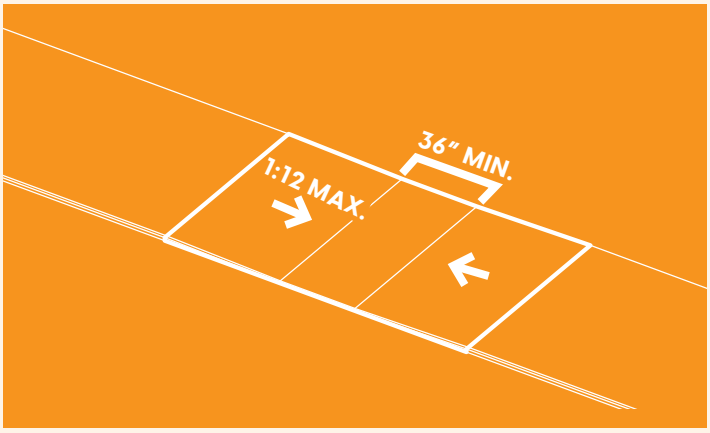
- Parallel curb ramps should only be used when a top landing is not feasible, or when used adjacent to parallel parking areas in limited ROW conditions

Requirements & Guidelines

- The landing must be level to the roadway and should be a minimum of 48", though 60" is preferred (ADA *§406)*
- The slope must be no greater that 1:12
- The sloping surface should have a 2' wide contrasting detectable warning strip across the lower levels of the sloping ramp
- Drainage should be kept behind curb ramps or on street level to prevent pooling at ramp entrance; curb gutters cannot be located at the base of ramps
- Ramp should be free of obstructions such as light poles, utility boxes, traffic lights, overhead electric poles, fire hydrants or other objects

Considerations

- Consider providing a wayfinding element at the landing for either community branding or directional wayfinding



Crosswalks

Striped + Art Crossing

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

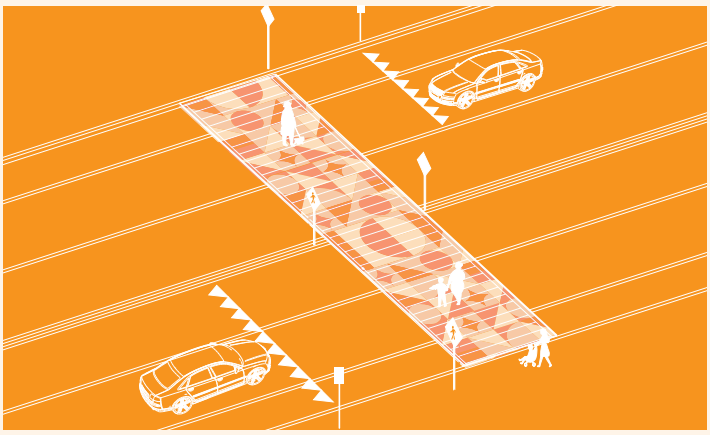
- Select striping / paint material based on slip resistance, desired longevity, and maximum slope

Requirements & Guidelines

- Crosswalks should be located at every location where a primary pedestrian / bike path crosses vehicular circulation within Transit Centers, Park & Rides, and every intersection adjacent to a transit facility regardless of traffic volumes; roadway markings must comply with the City of Houston requirements
- External to all facilities, crosswalks should be paired with safety signalization based on vehicular volumes and surrounding context such as beacons, raised crossings, medians; refer to MUTCD and FHWA guides
- All signalized intersections near a transit facility should have an audio countdown to assist the visually impaired and reduce unsafe pedestrian crossings
- For crossings within Park & Rides and Transit Centers, crossings should have a pedestrian crossing sign
- Place crosswalks at safest and most direct pedestrian areas, or every 120'-200' (*NACTO Urban Street Guide*)

Considerations

- Consider painting temporary or permanent art at crossings to enhance site character



Raised Crossing (Speed Table)

Park & Rides / Transit Centers

Selection

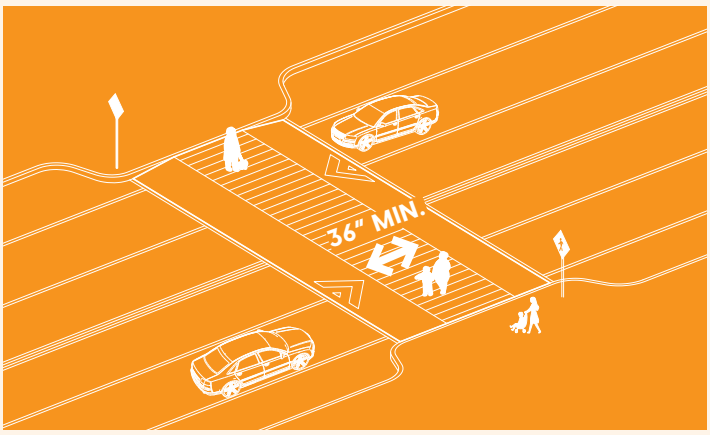
- Raised crossings cause vehicular traffic to slow down and yield to pedestrians
- They are recommended for midblock crossings and crossings between parking lots and primary pedestrian circulation; on City of Houston streets, approval is required and is necessitated based on traffic volume, vehicular speeds, and geometry

Requirements & Guidelines

- Do not utilize raised crossings in areas that cross Park & Ride or Transit Center bus circulation
- Only design for areas with less than 45 MPH
- Raised crossings / speed tables must have a warning sign (MUTCD W17-1)
- Slopes should not exceed 1:10 or be less steep than 1:25., and tapers should be no greater than 1:6 (NACTO Urban Street Design Guide)
- Provide a minimum of 36" width at grade within the speed table, but 60" to 72" is recommended.

Considerations

- Consider paving the top of the speed table with pavers for emphasis and legibility



Pedestrian Safety Islands

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

- A pedestrian safety island, also known as a pedestrian refuge, should be used when there are three or more lanes of traffic (*NACTO Urban Street Design Guide*) and should be especially used adjacent to BRT and LRT facilities

Requirements & Guidelines

- Islands should be at least 6' wide, but 8'-10' width is recommended (*NACTO Urban Street Design Guide*)
- The cut through at the median should be the same width as the crosswalk (*NACTO Urban Street Design Guide*)
- Medians must have curbs to protect pedestrians
- Medians should have a rounded edge facing vehicular traffic to slow drivers at intersections
- Crosswalks should be paired with crosswalk striping or an art crossing
- Crossings should be signalized or denoted with pedestrian crossing signs

Considerations

- Pedestrian safety islands should be planted with low planting when space allows

Plazas

Arrival Plaza

Park & Rides / Transit Centers

Selection

- Select distinct paving materials based on size of plaza, community character, and create a distinct space for platform arrival and vehicular drop-off ("Kiss and Ride")

Requirements & Guidelines

- The design of arrival plazas should align with primary pedestrian circulation from the parking lot or streetscape to the main transit waiting area
- When space allows, the front face of the arrival plaza should be planted with street trees (refer to the "Landscape" section of Chapter 06 of this manual)
- Paving should be vehicular rated to accommodate maintenance vehicles
- Large expanses of paving (more than 50') should be punctuated with landscape planters or trees to reduce the amount of hardscape
- Align control joints and expansion joints to the edge of other design elements such as planters, structure columns, adjacent walkways, and embedded furnishings

Considerations

- Create wide curbless arrival plazas with bollards to enhance character and pedestrian safety

Station Plaza

BRT / LRT / Park & Rides / Transit Centers

Selection

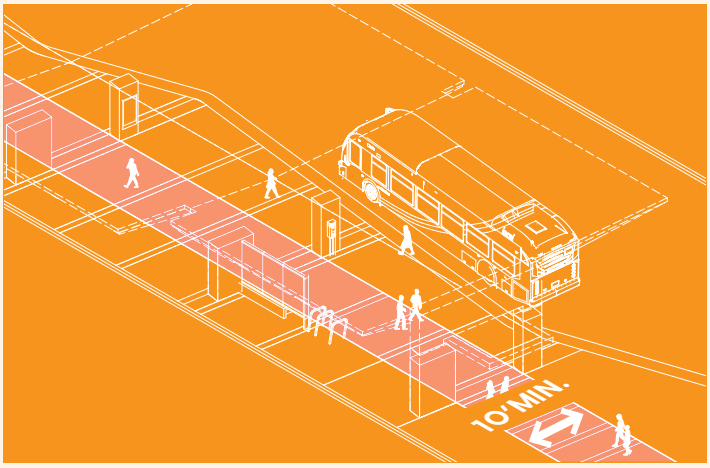
- Select paving material that delineates both waiting and boarding areas and complements the character of the architectural canopy

Requirements & Guidelines

- The design of the station plaza should include a clear walking space between waiting and boarding areas (10'-12' central walkway through Park & Ride and transit facilities, and 6'-8' clear of the boarding side for LRT / BRT platforms)
- 2' wide detectable warnings should be provided at the edge of all boarding areas
- Align control joints and expansion joints to the edge of other design elements such as planters, structure columns, adjacent walkways, and embedded furnishings
- Paving should be vehicular rated to accommodate maintenance vehicles

Considerations

- Consider incorporating embedded wayfinding or art as an additional way to direct riders to the correct bus platform or incorporate community / facility identity



Programmed Plaza

Park & Rides / Transit Centers

Selection

- Programmed plazas can be included interior to station platforms, wide crossing areas, and parking lots to serve accommodate temporary function for community engagement / seasonal events
- Programmed spaces can be used to pilot new programmatic uses that can be incorporated into future facility design (refer to the METRO Programming Catalog)

Requirements & Guidelines

- Hardscape areas designated for programmed spaces should foremost accommodate the space's intended function
- Temporary features such as market tents, parklets, painted sports courts, play amenities, food trucks, and other programmatic elements should be placed within a planned designated area that respects site vehicular and pedestrian circulation

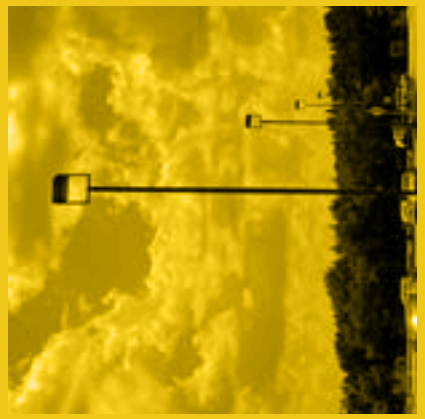
Considerations

- Consider adding PDOC outlets for food trucks and other event programming that requires power
- Consider movable park furnishings that can be relocated to other areas of the site after event use

Lighting

Appropriate lighting levels improve safety, deter crime, and add to station character while minimizing light pollution and energy consumption. Careful attention to lighting output, color temperature, lighting direction, the scale of fixtures is important for pedestrian and vehicular visibility. Accent lighting can enhance the character of the surrounding community and increase site legibility. Smart features and solar panel integration can monitor and reduce energy consumption.

PARKING LIGHTING



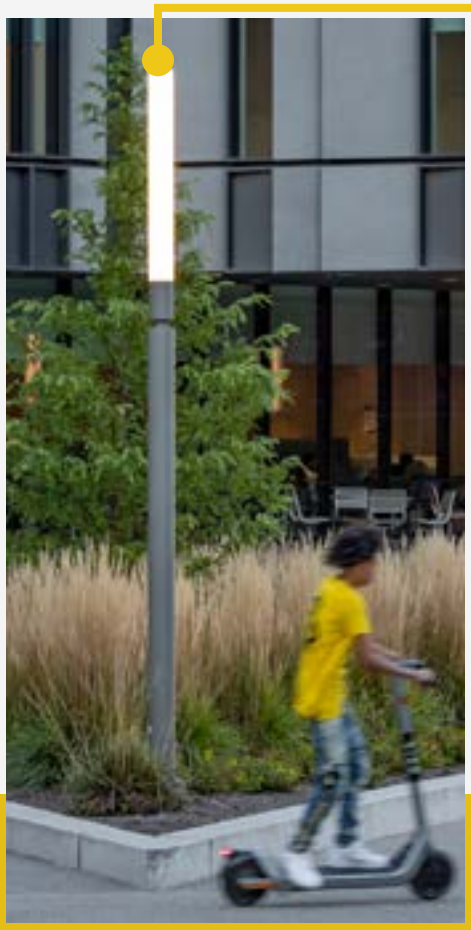
PEDESTRIAN LIGHITNG

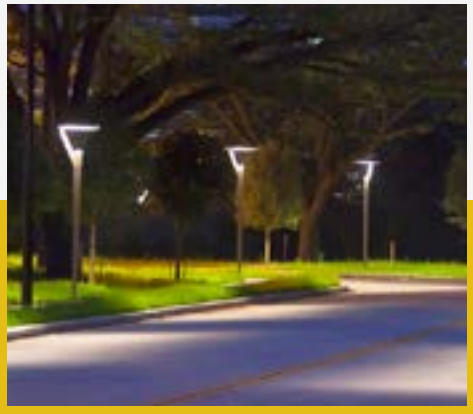
PLATFORM LIGHTING

BOLLARDS

Lighting

PEDESTRIAN WAYFINDING





FULL CUTOFF FIXTURES

When selecting lighting for METRO facilities, it is imperative to consider lifecycle and energy reduction costs as part of the overall project budget. Lighting that is inexpensive initially can potentially cost more long term due to inefficiencies, poor craftsmanship, and inefficient energy use. Pedestrian and vehicular safety should be emphasized in the design of all METRO facilities including bus stops.

Lighting should be chosen to LEED standards through the selection of low BUG (Backlight, Uplight, and Glare) ratings in accordance with the surrounding lighting zone designation. Lighting should be controlled with a centralized smart system that reduces lighting to minimal levels for safety after hours, or activates additional lighting when movement is detected. This will minimize wasted energy, reduce community light pollution, and improve safety.

SHIELDED LIGHT SOURCE

SUPPLEMENTAL LIGHTING

Lighting

Concrete

Concrete poles are suitable for the Southeast quadrant of the city that is more susceptible to flooding and responds to a more humid and corrosive environment.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Aluminum
Powdercoated

Aluminum can be powdercoated to add character and coloring opportunities while reducing reflectivity. Like powdercoated steel, it can be easily vandalized.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

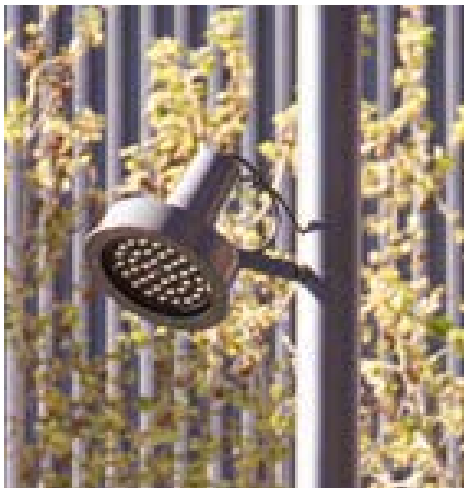
- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost



Aluminum
Anodized

Anodized aluminum promotes corrosion resistance and allows for color branding opportunities. It is naturally oxidized.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel
Stainless

Stainless steel has anti-microbial properties, is corrosion resistant, and is resistant to warping in the sun. It is low maintenance but is very expensive.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel
Powdercoated

Powdercoated steel can add a lot of character to a site and reinforce neighborhood or brand identity, but is susceptible to scratching / vandalism.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel
Weathering

Weathering steel can enhance site character. It weathers naturally and changes color over time while minimizing glare and enhancing natural site textures.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

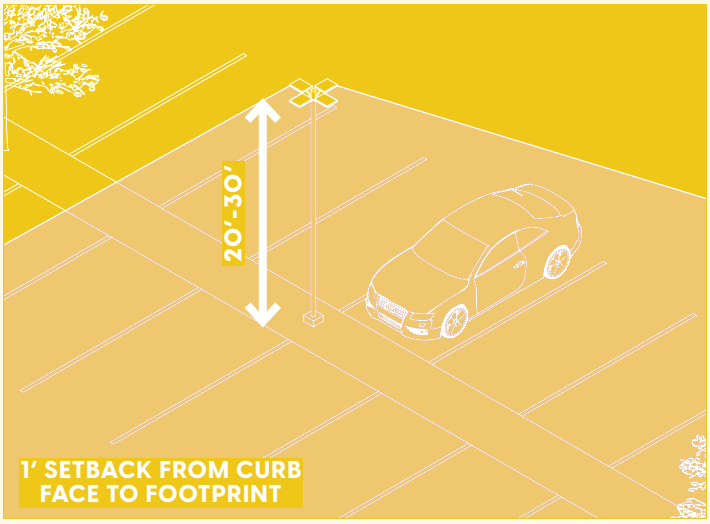
Parking Lighting

Parking Overhead Lights

Park & Rides / Transit Centers

Selection

- If site has high levels of sun exposure, consider solar lighting
- Light fixtures should match the character of the architecture and amenities for the shelter
- Fixtures should be Dark-Sky compliant
- Wet and damp location UL ratings are preferred
- Select parking lot lighting with the lowest BUG (backlight, uplight, and glare) rating possible without exceeding the appropriate MLO lighting zone to adhere to LEED accreditation standards
- Minimize amount of lighting that crosses property lines onto adjacent land
- Utilize full cutoff or shielded fixtures to ensure excess or "lost" light is limited

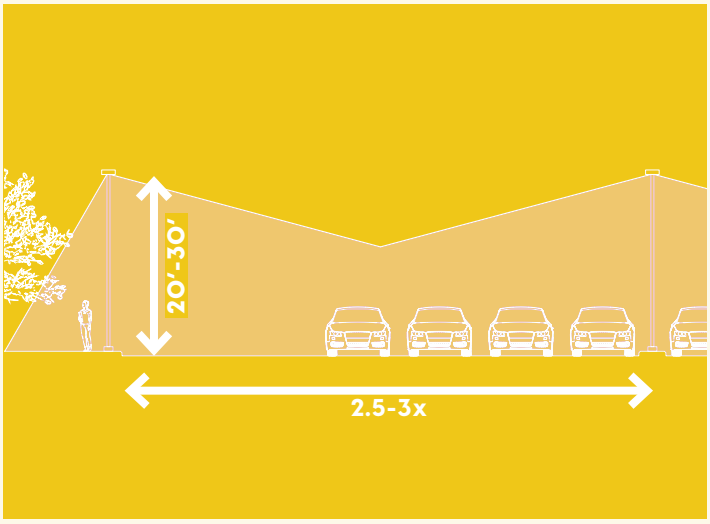


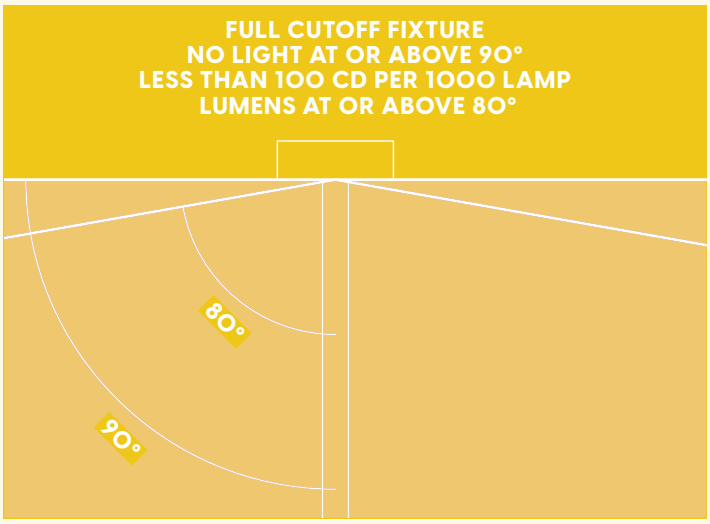
Requirements & Guidelines

- Light source should be 20-30' above parking lot surface
- Light poles should be spaced 2.5-3x the height of the light sources
- Lighting temperature should optimally be 3000K or warmer dependent on immediately surrounding light levels (*International Dark-Sky Association*)
- In Park & Rides and Transit Centers, 1.5-2.0 footcandles must be provided in parking areas, 3.0-4.0 footcandles must be provided in the drop off zone, 3.0-4.0 must be provided at handicap parking, entrances and exits must be 3.0-4.0 footcandles, and bus access areas must be 1.0-1.5 footcandles
- At least 95% of lighting should be directed towards ground to minimize light pollution
- Trees should not obstruct parking lighting
- Locate fixtures no closer to the property line than 4x the mounting height of the fixture, and not exceeding the height of adjacent structures (exceptions may be made for larger parking areas or commercial zones adjacent to highways)

Considerations

- If smart technology is not within budget of original implementation, install hardware for future phase connections
- Consider safe and affordable maintenance / repair of fixtures when making selection
- Minimize the use of cooler / high intensity LED fixtures in parking areas to reduce harmful health effects of the prolonged exposure of blue light (temperature above 3000k) to METRO staff and community (*Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, American Medical Association*)
- Consider placing parking light poles in planted medians at a minimum of 3' from the back of curb to prevent damage to poles without the use of a large concrete footing





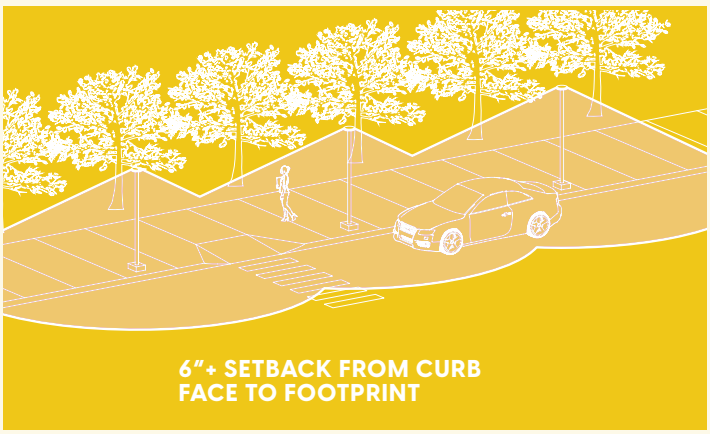
Pedestrian Lighting

Pedestrian Light Fixtures

LRT / BRT / Park & Rides / Transit Centers

Selection

- Pedestrian light fixtures should be located at regular intervals along primary pedestrian circulation routes in areas that do not meet facility footcandle requirements
- Pedestrian lighting should additionally light plaza spaces and illuminate crosswalks and station entrances
- Light fixtures should match the character of the architecture and amenities for the shelter
- Fixtures should be Dark-Sky compliant
- Wet and damp location UL ratings are preferred
- Select parking lot lighting with the lowest BUG (backlight, uplight, and glare) rating possible without exceeding the appropriate MLO lighting zone to adhere to LEED accreditation standards

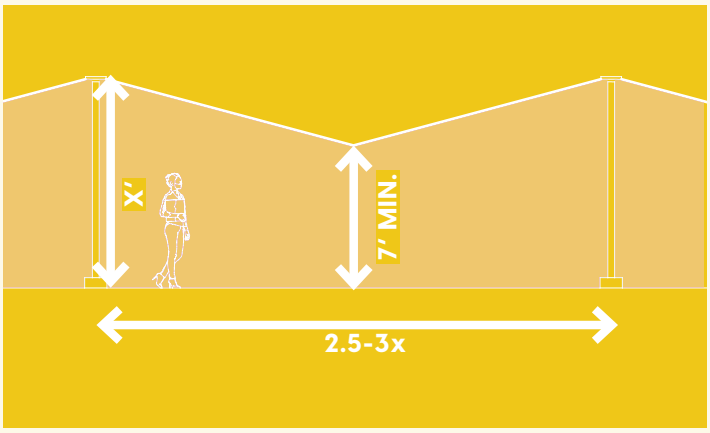


Requirements & Guidelines

- Light poles should be spaced 2.5-3x the height of the light sources
- Utilize 3000K or warmer for pedestrian lighting
- Provide a minimum of 6" from the edge of pavement to the edge of concrete footing
- When the sidewalk is 10' wide or greater, pedestrian poles may be placed adjacent to the curb at 24" minimum on center
- In sidewalk conditions less than 10', poles should be placed on the opposite side of the walkway, especially in ROW areas
- Light source should not be directly visible at eye level; use shielded or cutoff fixtures to prevent glare
- At least 95% of site lighting should be directed towards ground to minimize light pollution
- Locate fixtures no closer to the property line than 4x the mounting height of the fixture, and not exceeding the height of adjacent structures
- Footcandles should be consistent for entire pedestrian walkway

Considerations

- If smart technology is not within budget of original implementation, install hardware for future phase connection
- Consider safe and affordable maintenance / repair of fixtures when making selection
- Minimize the use of cooler / high intensity LED fixtures in parking areas to reduce harmful health effects of the prolonged exposure of blue light (temperature above 3000k) to METRO staff and community (*Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, American Medical Association*)
- Minimize dark potential hiding spots on periphery or behind opaque structures or plantings (*CPTED*)
- If possible, use automatic shutoff fixtures that turn off after 30 minutes of inactivity



Supplementary Lighting

Light Bollards

BRT / LRT / Park & Rides / Transit Centers

Selection

- Light bollards serve as both physical and visual safety measures
- Light bollards should be used at flush plaza conditions, walkways wider than 10', vehicular drop off zones, and pedestrian refuge medians

Requirements & Guidelines

- Bollards should be vehicular rated to the speed of the adjacent roadway (K12 for 50mph, K8 for 40, and K4 for 30mph)
- Bollards should be placed between 3'-5' apart to accommodate wheelchair accessibility while restricting vehicular access
- Light bollards should contain LED lights that match the color temperature of pedestrian and station lighting
- Bollards should have a cover or visor to reduce glare and focus the light source more efficiently
- Bollards should be removable to facilitate maintenance activities

Considerations

- Provide light bollards as a path lighting option

Accent Lighting

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

- Accent lighting can enhance the ridership experience while enhancing the perceptions of safety
- Fixtures that supply ambient luminescence, focal glow, atmospheric lighting, and internal illumination can add character to METRO facilities or embrace community character

Requirements & Guidelines

- Accent lighting can match the color temperature of other site lighting or can wash architectural elements with bright colors
- Accent lighting should respond to surrounding lighting levels and should minimize light pollution
- Factor in accent lighting in footcandle calculations to ensure it does not exceed maximum site requirements
- Light sources should be shielded to prevent glare and should follow Dark-Sky principles
- Accent lighting should be timed with other smart lighting at Park & Rides to shut off an hour after closure

Considerations

- Illuminate all monument and wayfinding signage

Canopy Lighting

Park & Rides / Transit Centers

Selection

- Platform lighting should be provided under every architectural canopy and bus shelter in locations with low levels of ambient light from the surrounding context

Requirements & Guidelines

- Lighting levels under the platform shelter must be 10 to 12 footcandles
- Platform lighting should use LED lights in lieu of traditional metal halide lights to reduce exposure to harmful blue light levels, reduce lifecycle costs, and prevent rider stress levels
- If the ambient light surrounding bus stops does not meet a minimum of 1.5 footcandles, canopy lighting must be provided within the shelter
- Employee and utility buildings should be considered within the architectural lighting scheme
- Lighting should evenly light the entire platform and should prevent unwanted shadows

Considerations

- Consider solar powered lighting at bus stops where electrical connections cannot be provided

Landscape
& Green Infrastructure

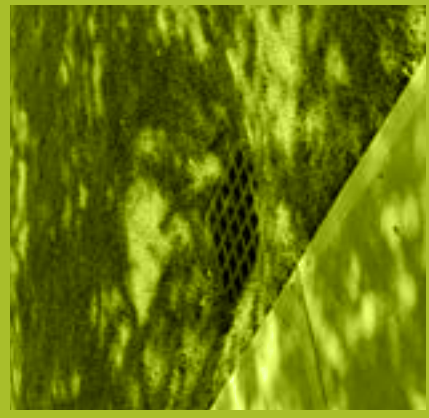
Landscape infrastructure cools the Transit Environment through the provision of quality shade, reduction of site paving, and environmental performance of native plants undergoing evapotranspiration. Landscape buffers can deter unsafe pedestrian circulation without the use of harsh barriers. Tree canopy should shade both the parking lot and pavements leading to the transit facility. Stormwater can be managed through green detention, wetland ponds, bioswales, and other green infrastructure strategies. Careful attention to species selection can decrease maintenance concerns and create a higher performing landscape.

BRANDED LANDSCAPE

BUFFERS

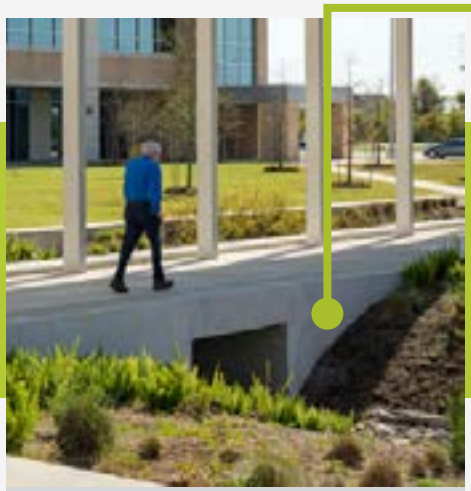
SHADE CANOPY

GREEN INFRASTRUCTURE



Landscape & Green Infrastructure

INTEGRATED STORMWATER MANAGEMENT

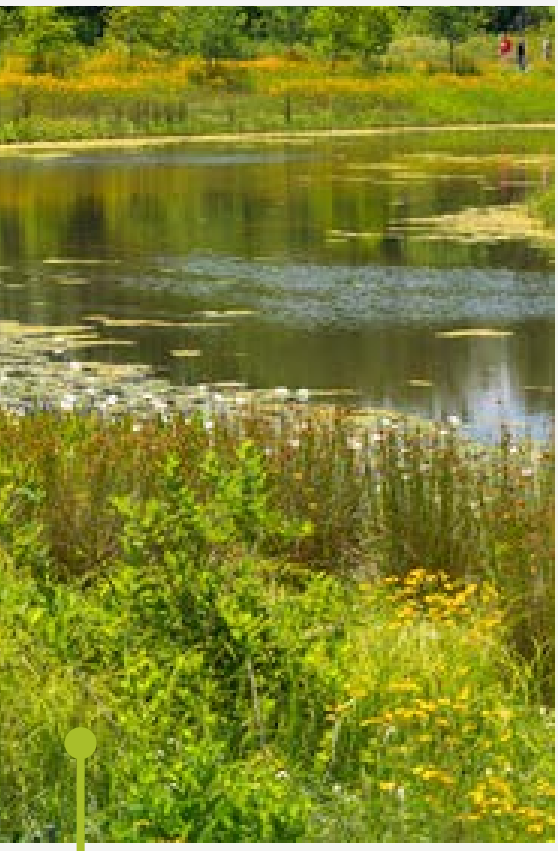


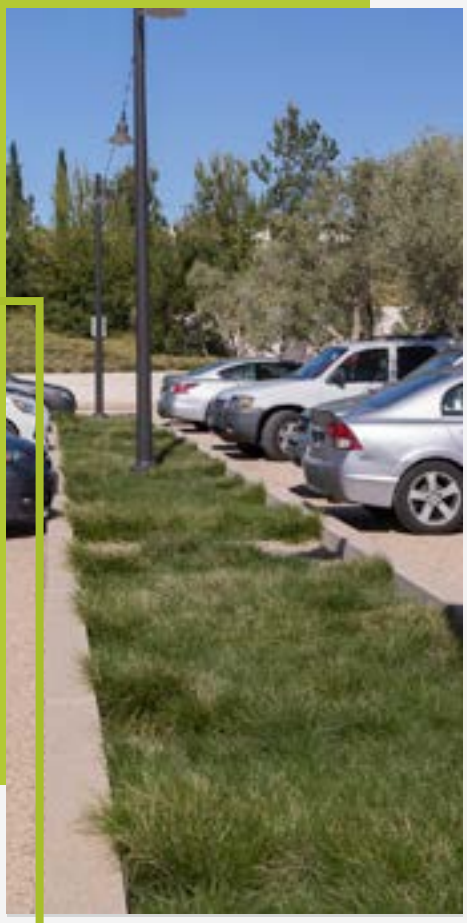
SOFT DETENTION

New amenities can be standardized across METRO facilities while allowing flexibility for customizable accents to adapt to community character. Furnishings should be surface mounted rather than embedded when possible to ease maintenance burden in the event that a furnishing is damaged. Amenities and furnishings should be cohesive in appearance throughout the site.

NATIVE GREEN ROOFS

PARKING INFILTRATION





Ornamental / Branded Landscape

Gateway Planting

Park & Rides / Transit Centers

Selection

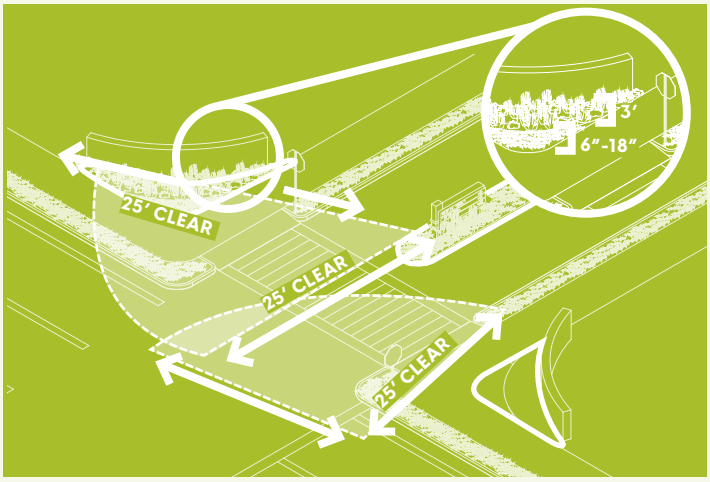
- Entry plant species should be selected based on desired effect, seasonality, maintenance capabilities, and regional character

Requirements & Guidelines

- Planting height (and associated wayfinding elements) should not exceed 2-1/2' within the sight visibility triangle
- Sight visibility triangles should be considered within 25' from the back of the stop sign to 25' from the back of curb perpendicular to the driveway. Refer to *Submittal of Harris County Geometric Design Guidelines* (2019) for future design speed visibility requirements.
- Trees should line the front of the facility, but no trees shall be located within the sight visibility triangle
- Gateway planting should be located at each driveway entry

Considerations

- Consider planting taller plants along entry walls (2-3')
- Provide a balance of seasonal color to evergreen plants for both interest and coverage
- Provide appropriate irrigation and maintenance plan



Corridor Planting

Bus Stops / BRT / LRT

Selection

- Corridor plant species should reflect the character of the community, streetscape, and region

Requirements & Guidelines

- Within 50' of the edge of all medians, plants should not exceed a maximum height of 3' (including trees)
- Median and streetscape planters should provide shade along the roadway where possible
- Edges of medians should contain low planting or an unplanted buffer within 2' of the back of curb
- Trees should contain 2"-4" of mulch to improve tree health, but no more to reduce the growth of fungus

Considerations

- Plant selection should be selected on maintenance needs and irrigation requirements
- Corridor should be combined with green infrastructure strategies and planting when possible to enhance performance measures
- Use native grass and wildflower mix in lieu of a traditional mowed grass median for ecological value and lower water use / maintenance

Planters / Planter Boxes

Bus Stops / Park & Rides / Transit Centers

Selection

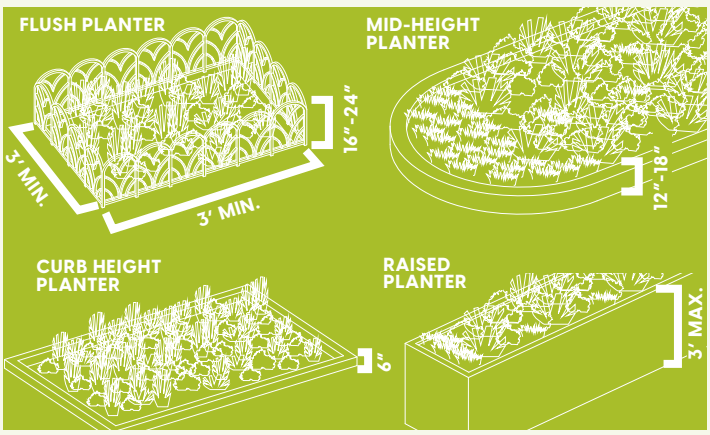
- Flush planters, raised planters, curb planters, and mid-height planters should be designed based on intended stormwater function, ecological impact, and plant selection

Requirements & Guidelines

- All planting should adhere to the City of Houston *Tree and Shrub Ordinance*, CPTED Guidelines, and ADA requirements
- Flush planters should have edge protection fencing in locations prone to trampling, such as those between paving or small planter areas
- All planters should be a minimum of 3' wide to accommodate planting
- Design raised planters in areas where they will not vertical clearances of other site elements such as bike repair stations
- Planter boxes must be elevated and connected to downspouts; an underdrain is needed at the bottom
- Depressed planter boxes should be designed with curb cuts to function as a small bioretention facility

Considerations

- Consider using ornamental plants near station platforms



Buffers

Hedge Buffer

BRT / LRT / Park & Rides / Transit Centers

Selection

- Hedge buffers can be used in lieu of rail chains to deter unsafe pedestrian movement across the transitway
- Hedge buffer plants should be evergreen species selected based on hardiness, durability, maintenance capabilities, and regional character

Requirements & Guidelines

- Hedge planting should be kept at approximately 3' high to deter pedestrian crossings while providing full visibility
- Raised planters can be provided in areas with ample buffer space between the roadway, but must be no greater than 3' high including plant height
- Hedge planting should terminate within the sight visibility triangle of intersections when vehicles must turn adjacent to transitways; in this instance, barriers should comply with Neighborhood and Site Scale guidelines within the METRO Urban Design Guidelines Manual

Considerations

- Consider disguising bollards within planting hedge to further create a more defensible space in areas where adjacent vehicular traffic poses safety concerns

Tree Buffer

Park & Rides / Transit Centers

Selection

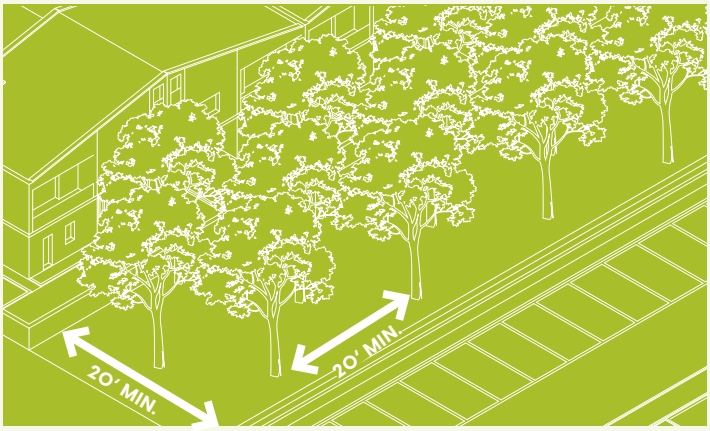
- Tree buffers should be provided adjacent to residential areas, historic communities, or other important viewsheds from the transit facility to respectfully screen views to private property as well as reduce light and noise pollution
- Trees species should be fast growing and should be selected based on hardiness, regional character, and screening considerations

Requirements & Guidelines

- Tree buffers should be a minimum of 20' wide to accommodate enough trees for screening
- Trees must not overhang the property edge
- At least one row of trees must be planted 20' apart for the length of the adjacency
- When buffering residential areas, the tree buffer must also comply with the city ordinance (*Code of Ordinances City of Houston, Texas* § 33-128)

Considerations

- Consider a reforestation mix for fast growth and ecological value



Sound Berm

Park & Rides / Transit Centers

Selection

- Sound berms should be used adjacent to busy freeways to create a more comfortable experience for riders
- Sound berms can be used in lieu of high fencing

Requirements & Guidelines

- Sound berms must be graded at least 6' high
- The berm should not exceed 3:1 in slope
- The berm should extend the length of the adjacent freeway edge
- Two to three rows of evergreen trees should be planted to reduce noise levels along the entire length of the berm
- The sound berm can contain native turf grasses, low shrub plantings, groundcovers, or native seed mixes
- Any shrubs planted on slopes should not exceed 3' in height to ensure visibility

Considerations

- Consider placing a solid wall fence along the outside edge of the berm for further noise deflection, security, and a wayfinding opportunity
- Consider planting with high ecological value for habitat

Shade Canopy

Parking Shading

Park & Rides / Transit Centers

Selection

- Parking shading be provided as either a canopy structure or tree shading
- Tree species should be located in parking lot islands, planted parking medians, and adjacent to pedestrian walkways as well as be suitable for site soil conditions

Requirements & Guidelines

- Parking islands shall be located approximately every 10 vehicular parking spaces and should include a tree (*Code of Ordinances City of Houston, Texas* § 33-127)
- Trees in central parking medians and along pedestrian walkways should be spaced at 20'-30' apart
- Trees should line all primary walkways in surface lots to aid in pedestrian wayfinding and shade access to the facility

Considerations

- Consider both linear and organic planting schemes
- Avoid placing trees in areas that shade solar charging
- When combining planted medians with bioswales or flow through planters, ensure that tree species are tolerant to periodic inundations of stormwater

Streetscape Shading

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

- Street trees should be planted in or adjacent to the public ROW to enhance a shaded and comfortable experience approaching the transit facility

Requirements & Guidelines

- Street trees must comply to the City of Houston *Approved Tree List* and *Code of Ordinances City of Houston, Texas*
- Along TxDOT roadways, street trees should comply with regulatory offsets
- Trees should be selected based on desired shading ability, growth habit, and durability
- Street trees should be planted between 20'-30' apart along the streetscape
- A minimum of 3" caliper trees must be planted along Transit Corridor Streets designated as major thoroughfares and a minimum of 2" caliper per all other TOD street types per the City of Houston *User's Guide for Walkable Places and Transit Oriented Development*

Considerations

- Consider the use of tree cells / tree boxes to ensure a healthy canopy growth, improved stormwater quality / interception

Shaded Seating Area

Park & Rides / Transit Centers

Selection

- Shaded seating areas should be provided near METRO employee break areas adjacent to staff-only facilities
- Shade trees should be selected based on site soil types, site character, and mature canopy size

Requirements & Guidelines

- Trees should be planted 5' away from the edge of the seatwall, bench, or other seating element to adequately shade the seating area at maturity
- Shaded seating areas should contain vegetation to further cool the seating environment
- Shaded seating areas can enhance large plaza areas

Considerations

- Consider native, low maintenance planting that has a mixture of evergreen and seasonal interest
- Consider opportunities to capture stormwater from adjacent paving areas through flow through planters or rain gardens
- Consider providing secluded shaded areas designated for smoking to deter smoking near primary waiting areas

Green Infrastructure

Green Roof

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

- Extensive green roofs are lightweight compared to intensive green roofs and can be designed or retrofitted to help mitigate the urban heat island effect and to reduce the amount of rainwater runoff from METRO canopies of any size

Requirements & Guidelines

- Green roofs should be designed, maintained, and inspected per the City of Houston *Infrastructure Design Manual*
- Extensive greenroof construction should not exceed 8" deep and should accommodate 1.5" to 5" of growing medium
- Green roof should have a root barrier, durable and waterproof membrane layer, underdrain system designed for optimal soil moisture, and lightweight growing medium (*Infrastructure Design Manual)*
- Succulents, bulbs / corms, native grasses, wildflowers, and / or wetland species should be chosen based on sun requirements, soil depths, drought tolerance, and hardiness

Considerations

- Modular systems ease maintenance but dark containers should be avoided to prevent heat absorption

Bioretention / Bioswales

Bus Stops / Park & Rides / Transit Centers

Selection

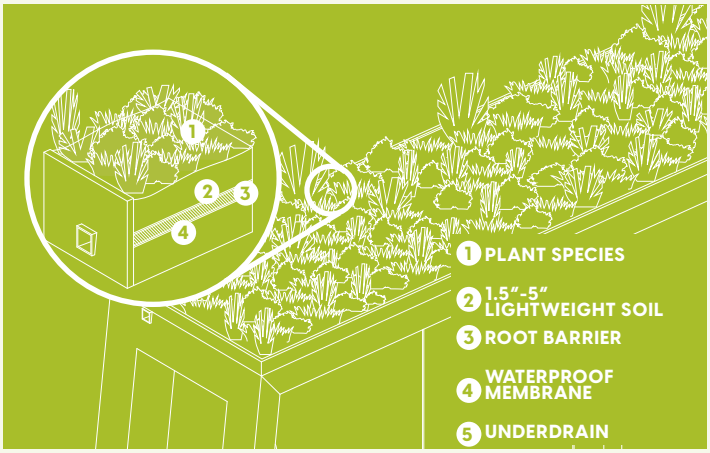
- Bioretention lowers the heat island effect, mitigates the stormwater runoff, provides environmental benefits, and improves rider experience
- Select native plant species that can tolerate periodic inundation without requiring irrigation as well as thermal runoff from hardscape areas

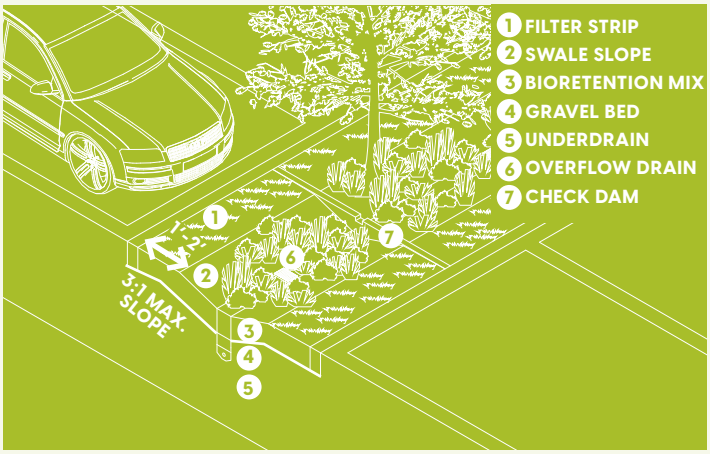
Requirements & Guidelines

- Slopes of bioretention and linear bioswales should not be steeper than 3:1
- Provide a 1'-2' minimum filter strip in areas requiring pre-treatment to sheetflow into bioretention areas
- Provide an overflow inlet or raised area drain at ponding depth
- Ponding water should be designed to empty within 48 hours; Infiltration rates less than 0.5 inches per hour will require a subsurface drainage system.
- Provide 18"-24" of bioretention soil mix within the entire bioswale or bioretention area to aid drainage
- Provide a perforated pipe at the bottom with an overflow that connects to the storm drain

Considerations

- Consider using a series of check dams to encourage infiltration and slow system flow





Vegetated Detention Basin

Park & Rides / Transit Centers

Selection

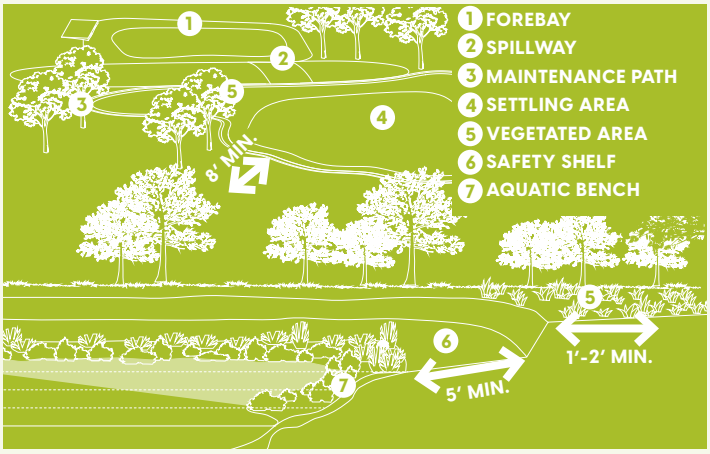
- Vegetated Detention is recommended in lieu of a traditional mowed detention basin and should be designed to capture beyond City of Houston detention requirements when feasible

Requirements & Guidelines

- When wetland detention is possible, include a sediment trapping forebay that overflows into the deepwater settling area (not required for dry basins)
- Provide a 1'-2' minimum filter strip to sheetflow into detention areas
- Provide an 8' mowed maintenance path (with drivable landscape when possible) surrounding the detention facility
- Design the safety bench and detention slopes per the City of Houston Infrastructure Design Manual

Considerations

- Consider wetland detention as a recreational amenity and community resource
- Consider designing wider safety shelves to reduce the need for a chain link fence around the facility



Vegetated Swales

Park & Rides / Transit Centers

Selection

- Use vegetated swales in lieu of concrete lined channels to convey stormwater while filtering pollutants and debris

Requirements & Guidelines

- Infiltration rate should be 0.27 to 0.5 inches/hour with a 48 hour maximum ponding time
- Cover the entire swale with vegetative cover
- Design swale to accommodate the volume of runoff to be conveyed
- Bottom width shall be 2 feet wide minimum or 6 feet wide max.
- Longitudinal slope shall range from 1% to 6%.
- Sheetflow at 2%-5% slope
- Slopes should not exceed 3:1 without a geotechnical report

Considerations

- Consider check dams to slow the velocity of water
- Consider native grasses and vegetation in lieu of turf grasses when possible

Green Infrastructure

Tree Boxes

Park & Rides / Transit Centers

Selection

- Tree boxes can be retrofit into existing curb inlets to serve as miniature bioretention areas that improve stormwater quality and can contain trees or shrubs

Requirements & Guidelines

- Tree boxes must include a pre-cast concrete container, mulch layer, planting media, observation and clean-out pipes, over-drain pipes, a tree or shrub, and a grate cover
- Tree boxes should utilize specialty soil media for fast infiltration abilities and curb inlet applications, tree boxes must be connected to the storm sewer system
- Tree boxes should be easily accessible by maintenance vehicles
- In roadway applications, shrubs should be used in lieu of trees when regulatory TxDOT offsets cannot be met
- Tree box filters should be designed per the bioretention system design criteria and engineered media testing requirements (*Harris County, 2011*)

Considerations

- Tree boxes have limited soil volume and may not promote adequate growth of larger trees; consider small species trees that can tolerate inundation

Tree Cells / Structural Soil

Bus Stops / Park & Rides / Transit Centers

Selection

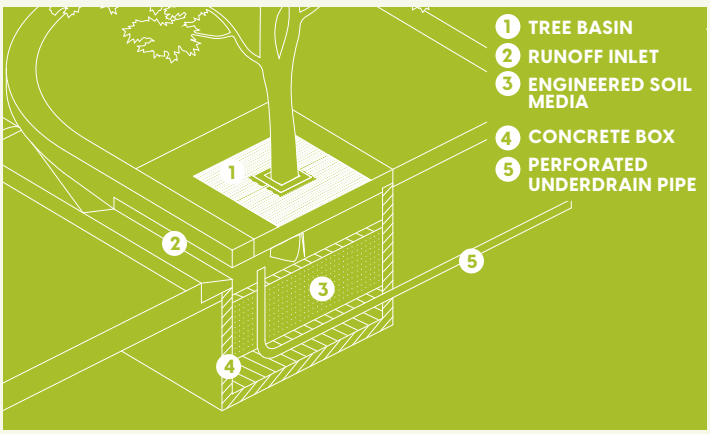
- Tree cells and structural soil can be used in paving areas to increase tree canopy size, improve stormwater quality, and convey excess water to an approved location to reduce runoff and heat island effect

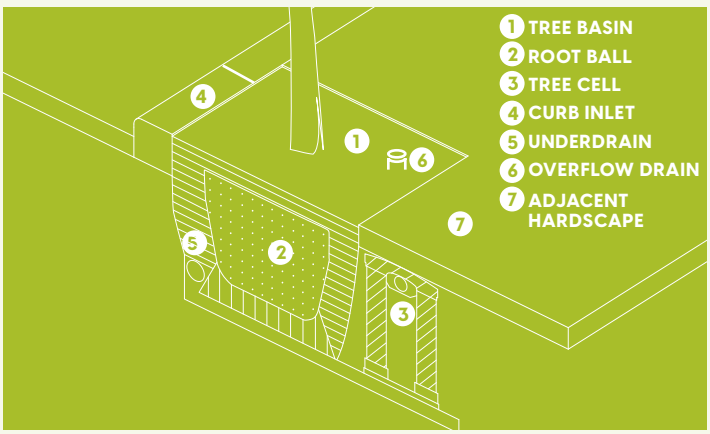
Requirements & Guidelines

- Size according to the tree size and preferred soil volume for infiltration and detention goals
- Utilize tree cell systems and structural soil for new facilities and install tree boxes as a retrofit solution
- Provide a ponding space for tree cells according to the manufacturer; tree boxes should have a max. ponding depth of 24" and should drain within 24 hours (underdrain)
- Connect systems together underground for maximum conveyance of water and overall tree growth results
- Provide overflow drain at maximum ponding depth for tree cells

Considerations

- In streetscape and roadway environments, consider a system that collects stormwater into an inlet that feeds into the tree cells, tree boxes, or structural soil basins





Permeable Paving

Park & Rides / Transit Centers

Selection

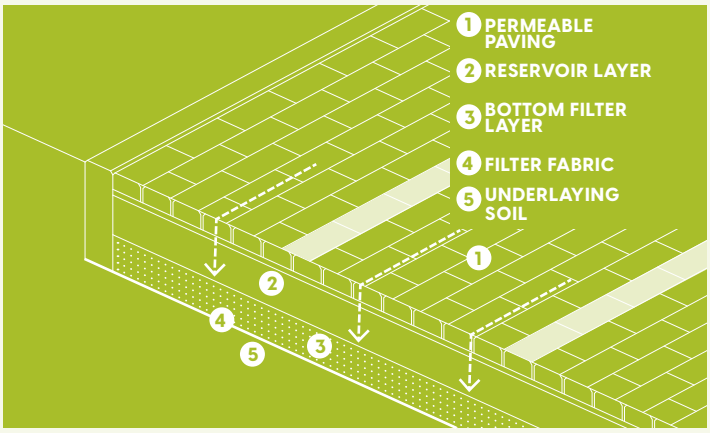
- Permeable pavements are sustainable alternatives to traditional parking lot surfaces
- Permeable concrete, permeable pavers, and porous asphalt are all hardscape surfaces that allow the infiltration of stormwater runoff

Requirements & Guidelines

- In-situ subsoil shall have a minimum infiltration rate of O.5 inches per hour; subsurface drainage systems are required if in-situ subsoil rate is less than O.5 inches per hour
- Subsurface drainage systems are required to be drained in 48 hours
- Permeable pavers should have an underdrain in Type C&D soil conditions
- Permeable paving must have interlocking ridges and should be infilled with gravel aggregate in the openings as opposed to polymeric sand due to Houston's soil composition and climactic considerations

Considerations

- Consider integrating permeable paving into lower elevation areas of the parking lot if the project budget does not permit permeable paving the entire lot



Drivable Landscape

Park & Rides / Transit Centers

Selection

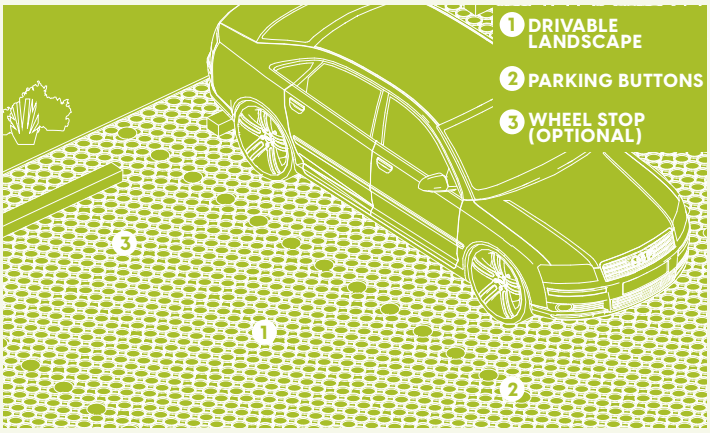
- Drivable landscape consists of interlocking plastic grids that support the weight of vehicles when planted with turf or gravel to provide a soft and pervious parking solution
- Drivable landscape provides the flexibility to designate temporary overflow parking to increase parking capacity while reducing hardscape

Requirements & Guidelines

- Provide ample depth of aggregate subbase to meet stormwater detention and infiltration goals
- In Type C & Type D soils, provide an underdrain
- Ensure detail and application of drivable landscape meets ADA requirements
- Ensure parking areas with drivable are delineated with either signage or parking space "buttons" to indicate designated parking areas

Considerations

- Consider drivable landscape in overflow parking areas or within programmable greenspace near station platforms



Underground Detention

Stormwater Cubes

Park & Rides / Transit Centers

Selection

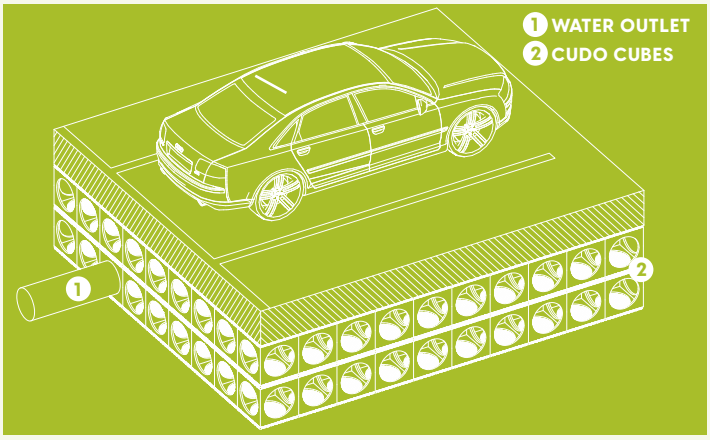
- Stormwater cubes are a growing solution for underground detention that can be used for storage, infiltration, treatment, and water re-use.
- Stormwater cubes have high water storage capacity and are easily maintainable, as well as integrate well into bioretention systems and drivable landscape

Requirements & Guidelines

- Stormwater cubes should be designed to meet or exceed detention requirements per the City of Houston Infrastructure Design Manual
- A geotechnical report should be performed prior to the design of stormwater cube layout
- Stormwater cubes should connect to civil drainage, bioretention facilities, drivable landscape, permeable paving, or other green infrastructure elements for maximum impact
- Stormwater cubes must have an inlet and outlet

Considerations

- Consider products that allow harvesting to reclaim stormwater for irrigation on site



Pre-Cast Structures

Park & Rides / Transit Centers

Selection

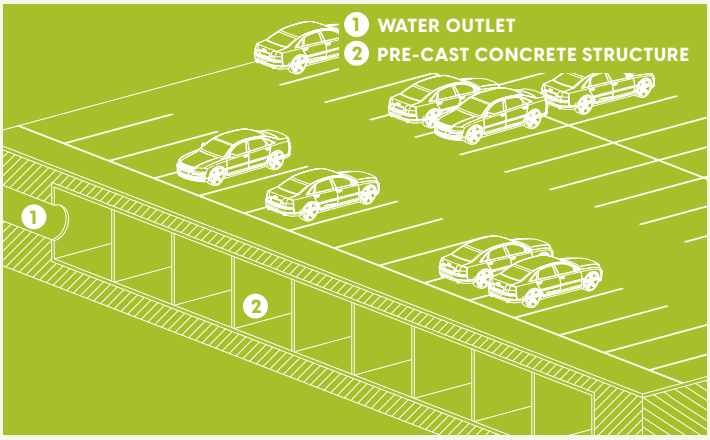
- Pre-cast detention structures contain a large volume of stormwater and is preferable under building applications due to load strength, lifespan, and ease of installation
- Pre-cast detention does not mitigate heat island effect to the degree of landscape-focused strategies, and should only be used when the volume of stormwater exceeds the capacity of vegetated detention/ bioretention abilities on-site

Requirements & Guidelines

- Pre-cast detention structures should be designed to meet or exceed detention requirements per the City of Houston Infrastructure Design Manual
- Pre-cast detention structures must be selected from certified plants ensuring quality
- Structures must contain an inlet and outlet to the City Storm-drain
- A geotechnical report should be performed prior to the design of pre-cast detention system

Considerations

- In sites with space constraints, pair pre-cast detention structures with small scale bioretention interventions



Oversized Pipes

Park & Rides / Transit Centers

Selection

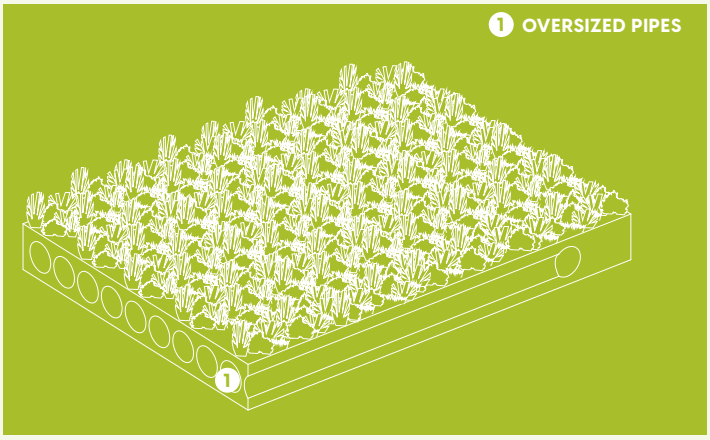
- Oversized pipes can be used to add capacity to vegetated detention facilities
- Oversized pipes are not recommended for parking lot applications due to load constraints

Requirements & Guidelines

- Oversized pipes (when used in tandem with vegetated detention facilities or standalone) should be designed to meet or exceed detention requirements per the City of Houston Infrastructure Design Manual
- Underground pipes must contain an inlet and outlet to the City Stormdrain
- A geotechnical report should be performed prior to the design of pre-cast detention system

Considerations

- Combine with rainwater harvesting techniques to provide reclaimed site irrigation



Technology

Technology can enhance the Transit Environment by providing energy savings, access to emergency services, aiding in accessibility through real-time arrival information, and enhancing facility security. Solar power can be integrated into many existing systems, and provide amenities to bus stops that would not otherwise receive electricity. Smart systems can aid in the operation and maintaining of all electrical systems across the METRO transit network.

KIOSKS & DIGITAL SIGNS

EMERGENCY SYSTEMS

SECURITY

INFORMATION SYSTEMS

Technology

INTEGRATED PHONE CHARGING STATION

BUS CHARGING STATION

Smart integrated technology is becoming increasingly available and standard within transit systems. As reliance of electric and plug-in hybrid vehicles becomes increasingly more popular, new facilities will need to consider the rapid change of technology in the initial design and planning phases. METRO has an opportunity to enhance its role in emergency response situations through the integration of real-time information. Digital kiosks and speaker systems offer new accessibility opportunities for the visually impaired as well as provides flexibility for multi-lingual integration. Charging stations offer convenience to METRO riders, who may access their transit information and ticketing via their mobile device. Proper security camera location helps improve the perception of public safety.

SMART KIOSKS

REAL TIME INFORMATION

Ticket Kiosks

Large Kiosk (Cash Accepting)

LRT / BRT

Selection

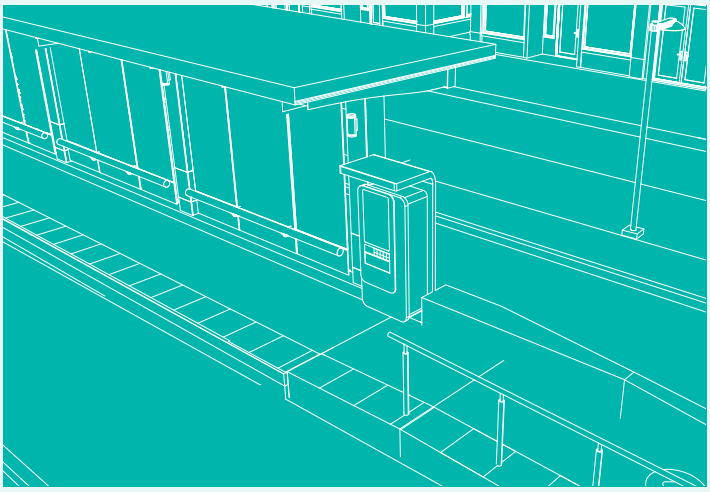
- Cash-accepting kiosks are located at LRT and BRT stations where cash cannot be accepted on the vehicle typical to normal bus routes

Requirements & Guidelines

- Large kiosks create visibility and safety issues when located improperly
- Kiosks should be located parallel to the pedestrian travelway / boarding area flush against a divider or against a wall
- When possible, the kiosk should be located at the far boarding end of the platform adjacent to a low planted area to help riders feel safe while they are paying
- Security cameras should have a complete view to all kiosks
- Kiosks should follow ADA accessibility requirements for wheelchair leg space and reach lengths

Considerations

- Consider branding the kiosk decal to match furnishings, art, or community character



Small Kiosk (Card-Only)

Park & Rides / Transit Centers

Selection

- Small kiosks are located at Park & Rides and Transit Centers, but may be replaced by a mobile app system

Requirements & Guidelines

- Where small kiosks are needed, orient kiosks parallel to the pedestrian travelway
- Place the kiosk in a centrally located area against a wall or divider panel
- Kiosks should be accompanied by wayfinding indicating its location within the facility
- Security cameras should have a complete view to all kiosks
- Kiosks should follow ADA accessibility requirements for wheelchair leg space and reach lengths

Considerations

- Consider locating the kiosk near system maps and trip planning information

Digitally Integrated Kiosk

Bus Stops / Park & Rides / Transit Centers

Selection

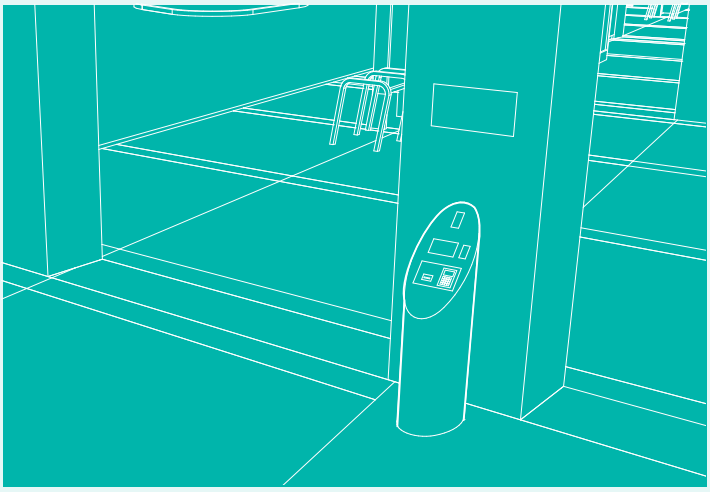
- Digitally integrated (touch screen) kiosks provide the opportunity to combine features such as payment, trip planning information, real time information, health and safety guidelines

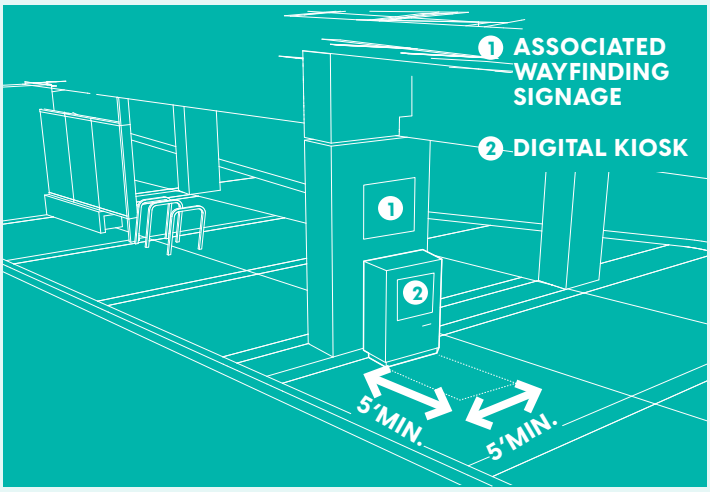
Requirements & Guidelines

- Place digital kiosk in a highly visible area against a wall, structure column, or divider parallel to the pedestrian travelway
- Provide a minimum of 5' walking space behind the kiosk
- Kiosks should be accompanied by wayfinding indicating its location within the facility
- Security cameras should have a complete view to all kiosks
- Kiosks should follow ADA accessibility requirements for wheelchair leg space and reach lengths

Considerations

- Consider kiosks that have audio narration and language selection to accommodate a variety of users with visual, language, or other accessibility needs





Security Systems

Emergency Call Post

LRT/ BRT / Park & Rides / Transit Centers

Selection

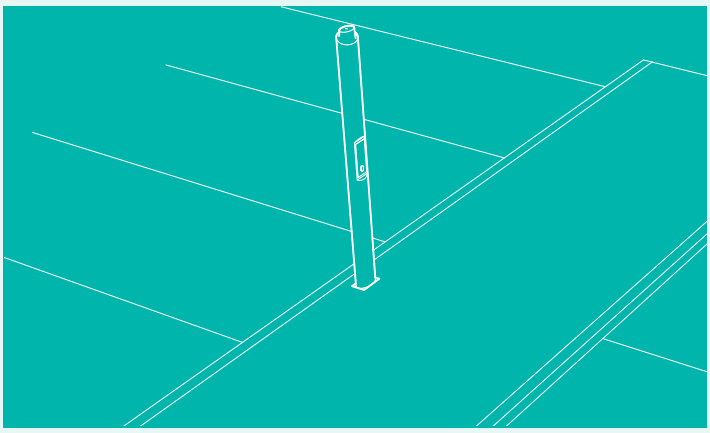
- Emergency call posts are necessary to ensure the safety of the facility

Requirements & Guidelines

- Emergency call posts should be located in parking lots along primary pedestrian routes
- Call posts should be located 6" from the edge of paving and should be at least 3' clear of the edge of the pedestrian travelway
- Do not locate call posts in planting areas
- Ensure that the call post is oriented parallel to the pedestrian travelway
- Ensure emergency call posts are located in the rear, center, and front portions of parking areas
- Emergency call posts should be lit with an emergency light, and should be well-lit with pedestrian scale lighting at all times
- Nearby planting should be a maximum of 3' in accordance with CPTED guidelines

Considerations

- Consider models with integrated cameras and other smart security features



Call Box

Bus Stops / LRT/ BRT / Park & Rides / Transit Centers

Selection

- Integrated call boxes are emergency call systems mounted to a column or structure to save space

Requirements & Guidelines

- Place emergency call boxes in highly visible and well-lit areas
- Mounted call boxes should be located at reach lengths according to ADA requirements
- Nearby planting should be a maximum of 3' in accordance with CPTED guidelines
- Integrated call boxes should be marked with overhead wayfinding to signal their location
- Ensure call boxes are located adjacent to the pedestrian travelway
- Coordinate the location of integrated post utilities with the location of the call box
- Locate surveillance cameras within direct view of the call box

Considerations

- Consider solar powered call boxes at bus shelters or integrated into the design of "flagpole" bus stops

Cameras

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

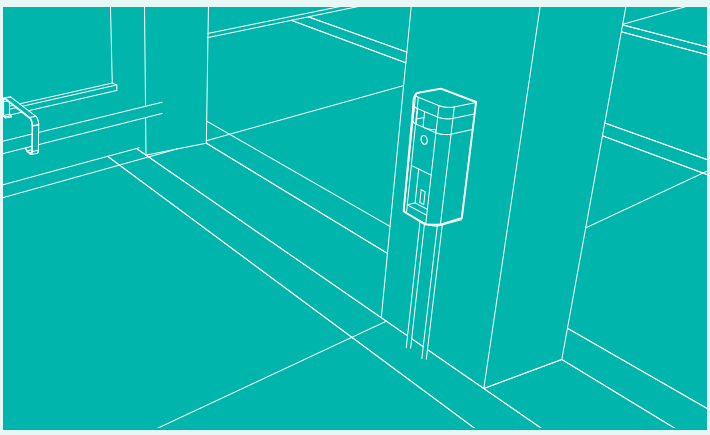
- Cameras should be selected for desired distance visibility, video and audio quality, central control integration, and future-proofing abilities

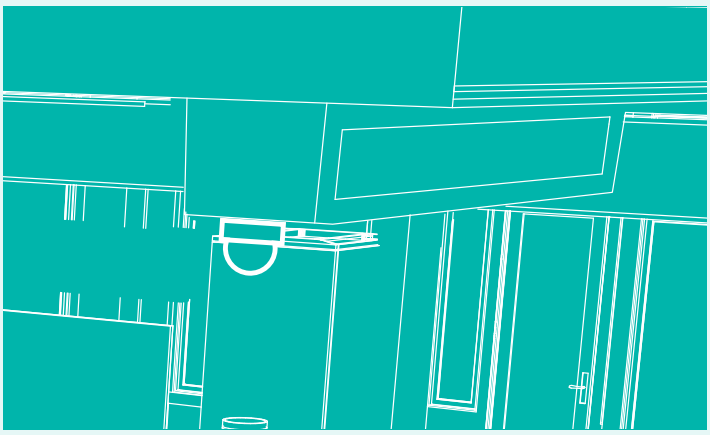
Requirements & Guidelines

- Cameras should provide 360° visibility and should be located for a full view of the entire transit facility
- Cameras should be located free from obstructions
- Cameras should be integrated into the design of the canopy and should be centered within canopy panels, etc.
- Cameras should provide both real-time viewing and recording capacity

Considerations

- Consider locating cameras in parking lots to deter vehicular related crimes





Information Systems

Real-Time Arrival Signs

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

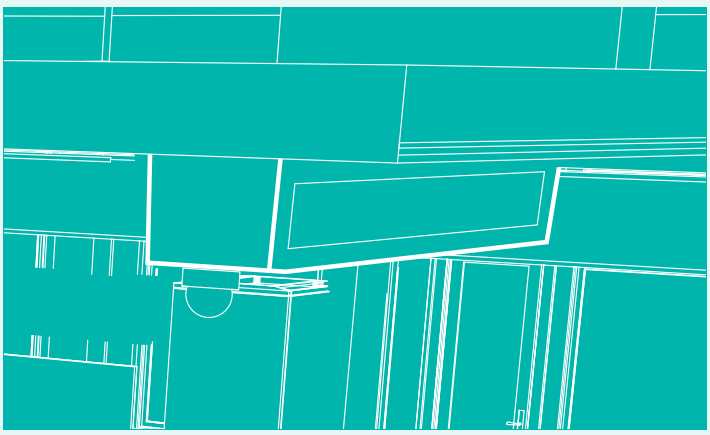
- Real time arrival signage keeps passengers informed of route information, vehicular delays, or emergency announcements
- Real-time arrival signage should be integrated into the design of bus shelters, canopies, and trip planning signage

Requirements & Guidelines

- Canopy-mounted arrival signs should be located above vehicular clearance and designed as an integral part of the canopy system
- Park & Rides and Transit Centers that do not have the immediate budget for real-time arrival signage should integrate the necessary infrastructure for when the option becomes available
- Arrival information should be free of visual obstructions
- Arrival signage should have a contrast of 70% for colorblindness and partial visual impairments
- Lettering should be a minimum of 2" for overhead signage *(ARCP Report 52)*

Considerations

- Provide special announcements in multiple languages



Real-Time Arrival Speakers

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

- Real time arrival signage keeps passengers informed of route information, vehicular delays, or emergency announcements
- Real-time arrival speakers provide audio announcements for the visually impaired

Requirements & Guidelines

- Real time arrival speakers should be located near or integrated with real-time arrival signage
- Place multiple speakers throughout the facility set at a low volume rather than a few loud speakers that could disrupt the community
- Integrate real time arrival speakers into the architectural canopy, bus shelter, or column structure

Considerations

- Consider integrating audio speakers into other site elements such as signage, kiosks, and emergency call boxes
- Translate important emergency announcements in multiple languages

Trip-Planning Kiosk

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

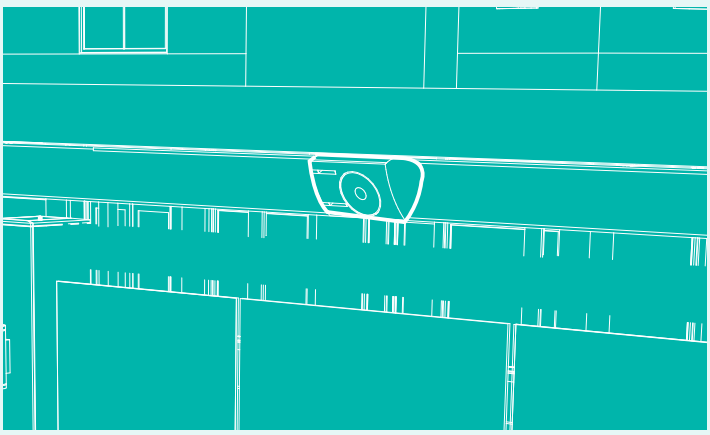
- Trip planning kiosks provide an interactive display that can provide multi-transfer routing information, facility information, METRO program information, and directional wayfinding

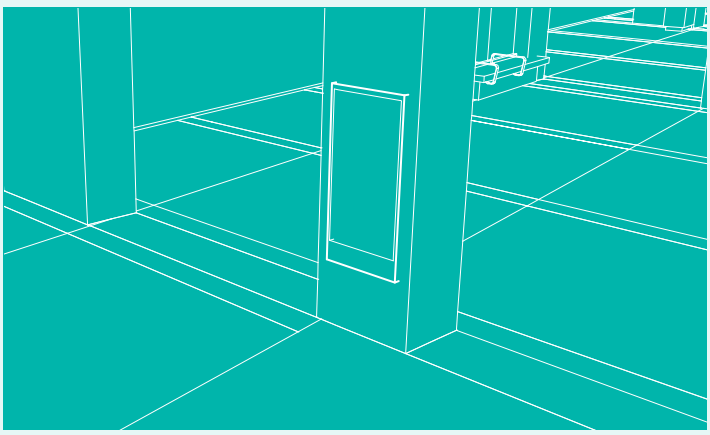
Requirements & Guidelines

- Digital kiosks should be located parallel to the pedestrian travelway / boarding area flush against a divider or against a wall
- Trip-planning kiosks should accommodate ADA reach heights
- When possible, trip planning kiosks should include an audio accessibility option
- Wayfinding signage should be displayed above the kiosk indicating that it is an information source
- Text should be a minimum of 5/8" for legibility *(ARCP Report 52)*

Considerations

- Trip planning kiosks can be a branding opportunity for METRO and community; consider matching interface to art features and wayfinding elements





Charging Systems

Phone Charging

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

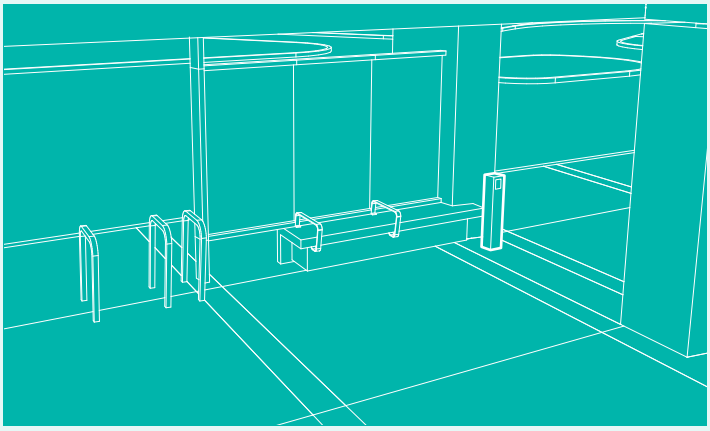
- Phone chargers can be embedded into seating elements, standalone charging stations, or canopy structures

Requirements & Guidelines

- Charging outlets must be outdoor rated
- Charging outlets integrated into structures should have a cover
- Locate charging stations near the center of Park & Rides and Transit Centers to congregate charging ability within the most visible area
- Place standalone chargers outside of pedestrian travelway
- Charging outlets integrated into structures should have a cover
- Magnetic chargers at standing stations are preferred to avoid "camping" near charging stations

Considerations

- Phone chargers should be chosen without Wi-Fi capability to protect rider data



Outdoor Circuits

Park & Rides / Transit Centers

Selection

- Outdoor circuit outlets can be programmed into the design of the site to supply power for temporary uses (such as food trucks, festival equipment, medical stations, etc.), maintenance, and emergency use

Requirements & Guidelines

- Outdoor power circuits must be UL listed, and should have a cover when not in use
- Power supply should be a minimum of 50 amps for event use
- 6" high pedestals should not be located within 6" of the pedestrian travelway or plaza space to avoid tripping hazards
- Pedestals taller than 6" should be concealed in planting
- Select circuit pedestals with a locking cover to keep circuits tamper-free; all access should be controlled internally by METRO staff
- Circuits should be provided in places designated for its intended use

Considerations

- Consider selecting a color that minimizes the appearance of the structure

EV Chargers (Bus & Vehicle)

BRT / Park & Rides / Transit Centers

Selection

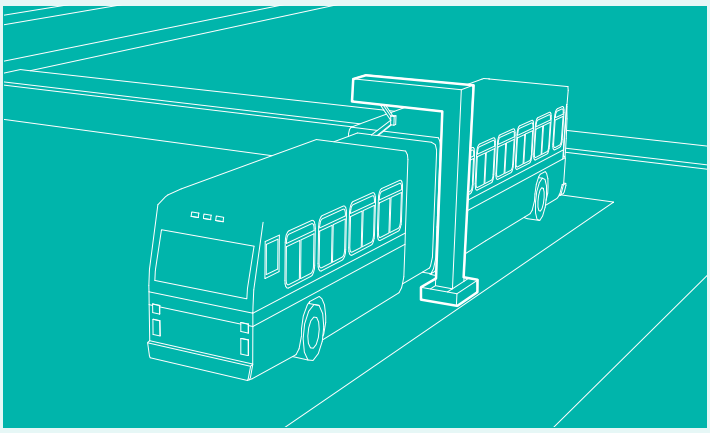
- EV chargers are imperative to meet the growing fleet of electric METRO vehicles and emergence of electric personal vehicles

Requirements & Guidelines

- Level 1 chargers can be used for personal vehicles in Park & Rides and Transit Centers
- Personal vehicle chargers should be located in designated parking spaces in a centralized area near the station platform and should be embedded in a concrete footing within a planting median
- Bus charging stations should be located in dedicated charging lots away from standard bus circulation routes
- Bus charging areas should be located free from primary pedestrian circulation routes

Considerations

- Consider smart charging stations that monitor charging levels and shut off when charging is complete to conserve site energy as well as protect battery life



Solar Power

Solar Canopy / Roof

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

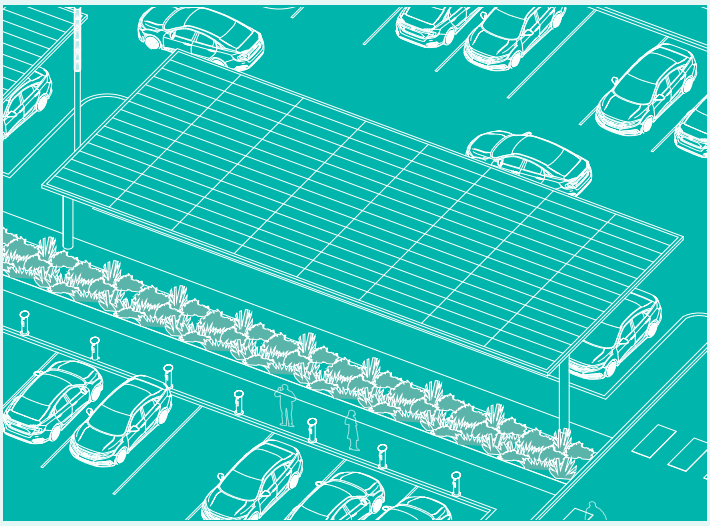
- Solar canopies / roofs can mitigate site energy consumption
- Solar canopies should be treated as a secondary method of shading to healthy tree canopy across the site

Requirements & Guidelines

- Ensure solar canopy / roof is unshaded by adjacent buildings to maintain solar collector exposure
- Orient static shade structures according to sun direction
- For existing structures, ensure roof is structurally sound prior to retrofitting
- Plan maintenance access space for panels and batteries
- Provide adequate space for energy storage equipment
- Place energy storage equipment in a secluded area to prevent tampering and visual obstructions

Considerations

- Consider designing solar capacity for net-zero site energy consumption



Solar Light pole

Park & Rides / Transit Centers

Selection

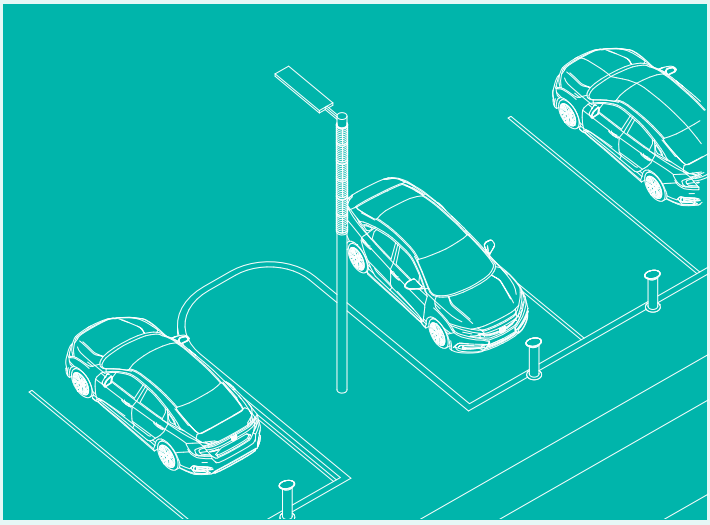
- Solar light poles can be self-sustaining and greatly reduce site energy consumption
- Some solar light poles can be digitally connected to smart monitoring systems

Requirements & Guidelines

- Choose solar light poles with minimal panel footprints to reduce visual impact on the facility and adjacent neighborhood
- Ensure solar light pole is unshaded by adjacent buildings, trees, or other structures
- Select models with LED fixtures

Considerations

- Consider models with lithium batteries to extend reliability in exposure to hot weather
- Pair solar lighting into a larger system of site solar panels for maximum impact
- Choose modular systems that integrate a variety of other safety, lighting, digital, or smart amenities



Solar Flagpole

Bus Stops

Selection

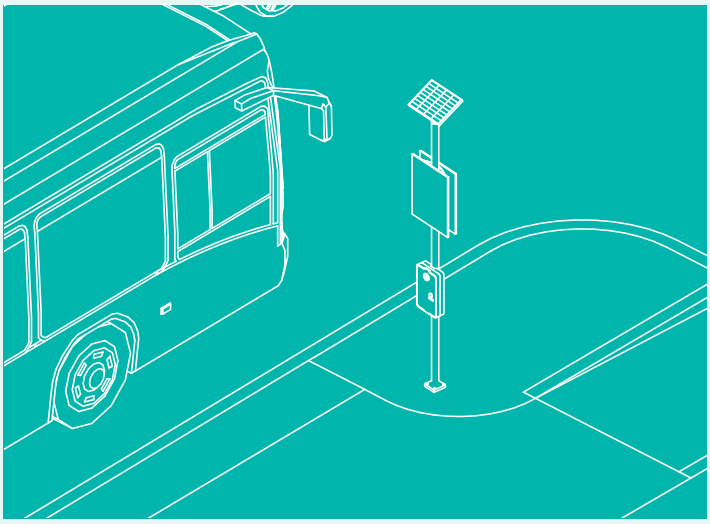
- Solar flagpoles can provide power for amenities in instances where electricity cannot be supplied via an underground connection
- Panels located on solar flagpoles can provide power for real-time arrival information, speaker systems, emergency call boxes, or lighting

Requirements & Guidelines

- Protect the solar panel(s) from rain and debris by orienting panel(s) to a 45 degree angle
- Ensure solar flagpole is unshaded by adjacent buildings, trees, or other structures
- Choose or design solar flagpoles with consideration for the energy requirements of desired amenities
- Locate solar flagpoles outside of the pedestrian travelway

Considerations

- Consider partnerships for the inclusion of educational signage



Architecture

Architectural elements, transit platform canopies and transit support structures are highly visible from roadways and communities and should reflect both the character of the surrounding neighborhood and quality of the METRO brand. Shelter structures should be open and inviting while protecting patrons from the elements. Utilities, systems, and transit amenities should be integrated into structures in a manner that protects the systems from vandalism while still allowing for technological upgrades throughout the life of the structure.

Transit support functions should be grouped into functional, multi-purpose buildings sited to be visible to the public but sufficiently separated to limit interruption of METRO personnel from their designated duties. Designs should seek to eliminate the need for railings and fencing but where they are functionally required, they should be thoughtful in design, performing their primary function without seeming imposing.

SHADE CANOPY

SUPPORTING STRUCTURES

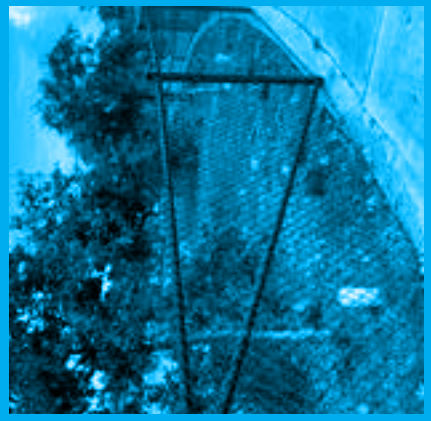
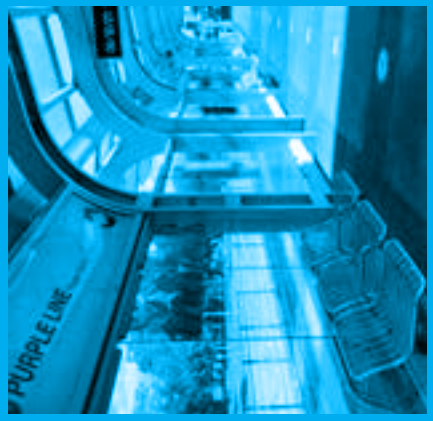
RAILINGS & BARRIERS

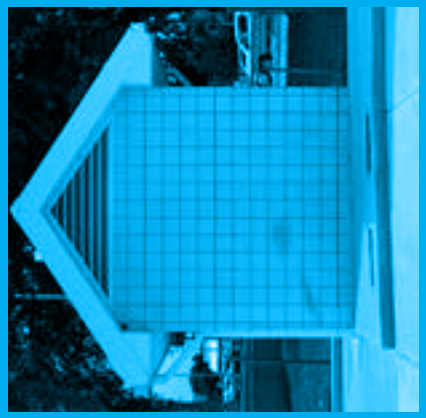
SHELTER CANOPIES







Architecture

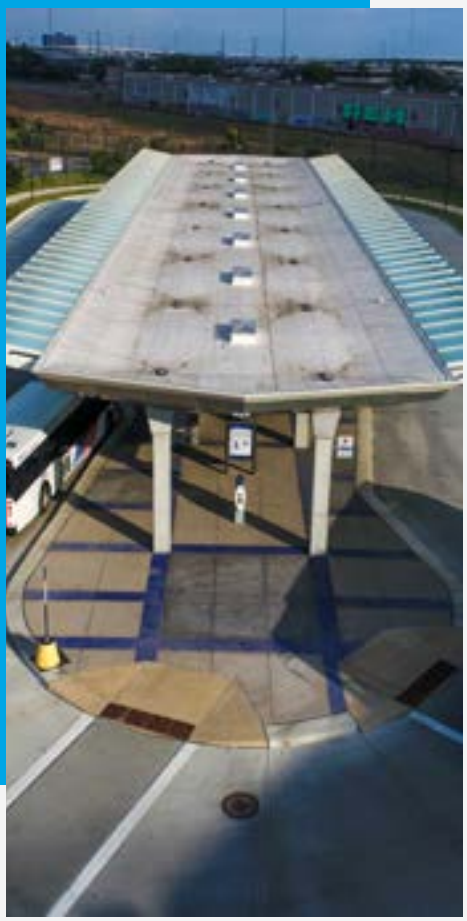
TENSILE FABRIC

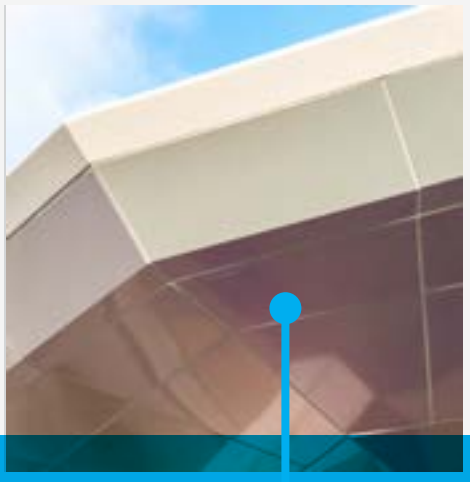
INTEGRATED SKYWALK

Architectural materials should be durable, easily maintainable, provide comfort, and reflect the METRO brand. Across a single site, materials and color selections should reflect a cohesive design. Across METRO facilities, materials can be standardized for particular facility types while allowing flexibility for customizable accents to adapt to community character.

CONCRETE STRUCTURE

SCREENED GLAZING





COMPOSITE METAL PANELS

Architecture

Glass
Laminated / Tempered

Glass is beneficial to use as a solid and transparent barrier for bus shelters and windscreens but can be easily vandalized. Use custom designs sparingly as replacement can require long lead times.

Resilience

●●●○○
●●●●●
●●○○○
●●●○○
●●●●●

Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

●●●○○
●●●●○
●●○○○

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

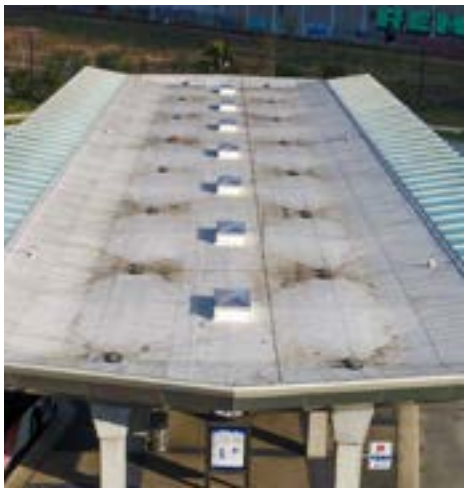
●●○○○
●●●●○

Color Branding
Art Integration

Cost

●●○○○
●●●○○
●●○○○

Low Lifecycle Cost
Low Initial Cost
Low Maintenance Cost



Membrane Roof
KEE PVC Membrane

Durable membrane with fully welded seams naturally reflects heat reducing heat island effects. Use fully adhered application to maximize wind resistance. Higher KEE to PVC ratios increase durability.

Resilience

●●●●●
●●●●●
●●●●○
●●●●○
●●●●●

Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

●●●●●
●○○○○
●●●●●

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

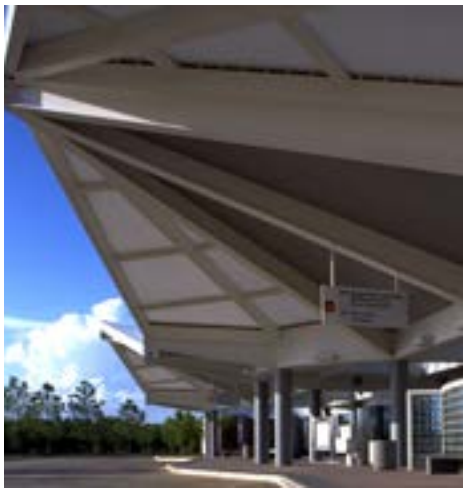
●○○○○
●○○○○

Color Branding
Art Integration

Cost

●●●●○
●●●○○
●●●●●

Low Lifecycle Cost
Low Initial Cost
Low Maintenance Cost



Tensile Fabric Roof
PTFE (TEFLON) Fabric

Tensile fabric is a durable self-cleaning material. It can be an economical choice when covering large areas. It also diffuses sunlight and can reflect up-lights to glow at night.

Resilience

●●●●○
●●●●●
●●○○○
●●●○○
●●●●●

Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

●●●●○
●●●●●
●●●○○

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

●●○○○
●●●●○

Color Branding
Art Integration

Cost

●●●●○
●●●●○
●●●●○

Low Lifecycle Cost
Low Initial Cost
Low Maintenance Cost

Metal Composite Panels

Stainless / Powdercoated

Thin metal skins are integrally bonded to a plastic core with anodized, painted or another metal finish and can be formed into 3-D forms.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Lifecycle Cost
- Low Initial Cost
- Low Maintenance Cost

Aluminum

Powdercoated / Anodized

Aluminum is a strong, durable, and lightweight, material resistant to corrosion when properly isolated. High recycle content.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Lifecycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel

Stainless / Powdercoated Perforated / Corten

High strength material with high recycle content, requires coatings for corrosion protection. Corrosion resistive steels are more costly; Corte steels shed oxides that stain.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Lifecycle Cost
- Low Initial Cost
- Low Maintenance Cost

Architecture

Glass
Laminated / Tempered

Glass is beneficial to use as a solid and transparent barrier for bus shelters and windscreens but is easily vandalized.

Resilience

●●●○○ Durability
●●●●● Corrosion Resistance
●●○○○ Vandal Resistance
●●●○○ Sustainability
●●●●● UV Resistance

Comfort

●●●●○ Heat Dissipation
●●●●● Low Reflectivity
●●●○○ Freeze Resistance

Character

●●○○○ Color Branding
●●●●● Art Integration

Cost

●●○○○ Low Lifecycle Cost
●●●○○ Low Initial Cost
●●○○○ Low Maintenance Cost

Metal Mesh
Conveyor Belt Metal Mesh

Characterized by a round or flat spiral wire with looped edges and is flexible and rollable. The strong mesh provides possible designs for higher stresses (i.e.: fixed or movable curtains and elements outdoors).

Resilience

●●●○○ Durability
●●●○○ Corrosion Resistance
●●○○○ Vandal Resistance
●●●○○ Sustainability
●●●●● UV Resistance

Comfort

●●●●○ Heat Dissipation
●●●●○ Low Reflectivity
●●●○○ Freeze Resistance

Character

●●○○○ Color Branding
●●●○○ Art Integration

Cost

●●●○○ Low Lifecycle Cost
●○○○○ Low Initial Cost
●●●○○ Low Maintenance Cost

Fabric Mesh
Recycled / PTFE Fabric

Fabric mesh is an economical alternative to metal mesh, perforated metal, and glass. Facade screening can be up to 50% less expensive, and is available in many art options & colors.

Resilience

●●●●● Durability
●●●●● Corrosion Resistance
●●○○○ Vandal Resistance
●●●○○ Sustainability
●●●●● UV Resistance

Comfort

●●●●○ Heat Dissipation
●●●●● Low Reflectivity
●●●○○ Freeze Resistance

Character

●●●●● Color Branding
●●●●● Art Integration

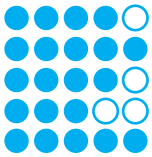
Cost

●●●○○ Low Lifecycle Cost
●●●●○ Low Initial Cost
●●●●○ Low Maintenance Cost

Concrete
Site Cast / Precast / Aggregate

Easily formed, strong durable material resistant to vandalism. Can contain integral coloration or colored aggregates. Strive to design for repetition and reuse of form work to reduce costs.

Resilience



Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

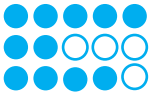
Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

Cost

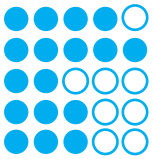


Low Lifecycle Cost
Low Initial Cost
Low Maintenance Cost

Plastic
Polycarbonate / Acrylic

Polycarbonate / acrylic is a durable material that provides a transparent surface at bus shelters. It is less easily damaged than glass.

Resilience



Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

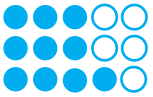
Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

Cost

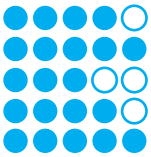


Low Lifecycle Cost
Low Initial Cost
Low Maintenance Cost

Masonry
CMU / Brick

Masonry is a porous material that will need to be glazed or sealed to provide a durable and maintainable surface.

Resilience



Durability
Corrosion Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

Cost

Low Lifecycle Cost
Low Initial Cost
Low Maintenance Cost

Double Loaded Canopy

Double Loaded Platforms

Park & Rides / Transit Centers

Selection

Consider for use at locations where four or more bus routes converge for sheltered transfer between routes.

Requirements & Guidelines

Canopy and platform configuration requires clockwise bus circulation for standard right-side boarding of vehicles

Bus circulation requirements dictate use in an island platform configuration where last-mile patrons must cross the bus circulation drives, a safety concern at high use facilities

For operational flexibility provide bus berthing positions sized for articulated vehicles to allow capacity increases without requiring additional bus operators

Canopies should be designed to provide weather protection to transit users to include coverage over loading area of the mode of transportation; preferably 10' over the loading doors' vehicles

Height of canopy must account for the operational clearance of buses and vehicles - 13'-0" minimum from top of curb to lowest member of the canopy

Material and color selection of canopies should consider maintenance requirements and aesthetics to support longevity and the METRO brand

Considerations

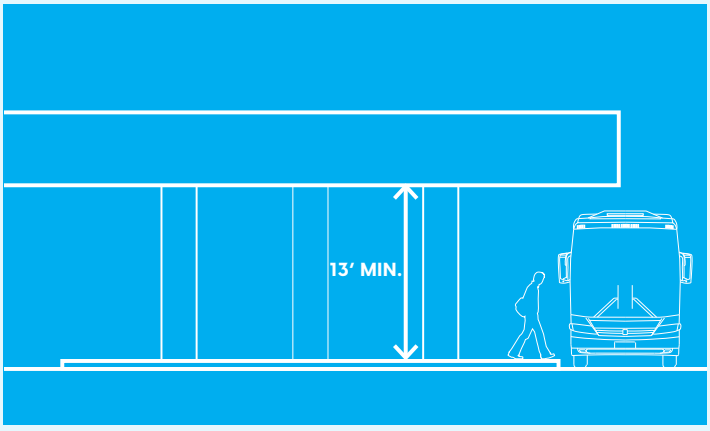
Design structures to minimize the creation of bird roosting areas which increases required maintenance and impacts passenger experience

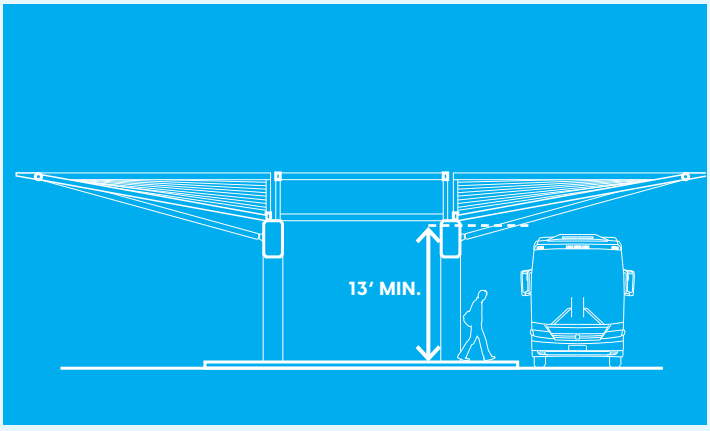
Roof material can be tensile fabric, standing seam metal, or membrane roofing designed to resist high wind events without damage

Materials within reach of patrons should be durable and vandal resistant. Fascia and soffit should be enclosed and composed of metal interlocking panels or concrete

Column materials can include concrete or painted structural steel. Smooth surfaces are most easily maintained. Field painting of structural steel should be avoided wherever possible as coating failure at field welded connections is common

Consider use of ceiling fans to provide air circulation for comfort at platform waiting area





Double Loaded Platforms

BRT / LRT Stations

Selection

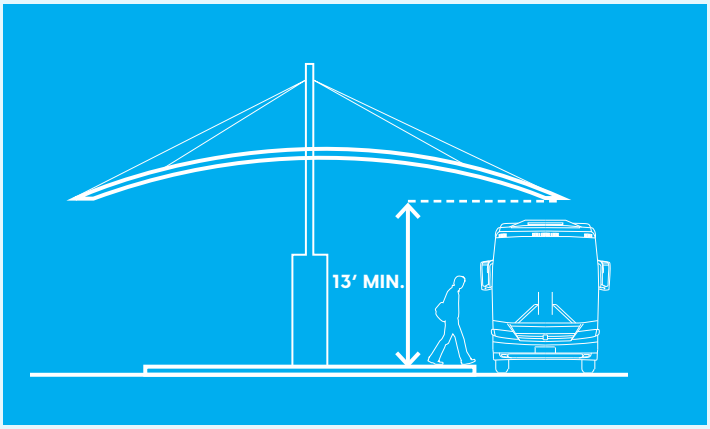
- Consider for use at center platform locations on bi-directional BRT or LRT routes
- Platform configuration requires left-side vehicle / boarding

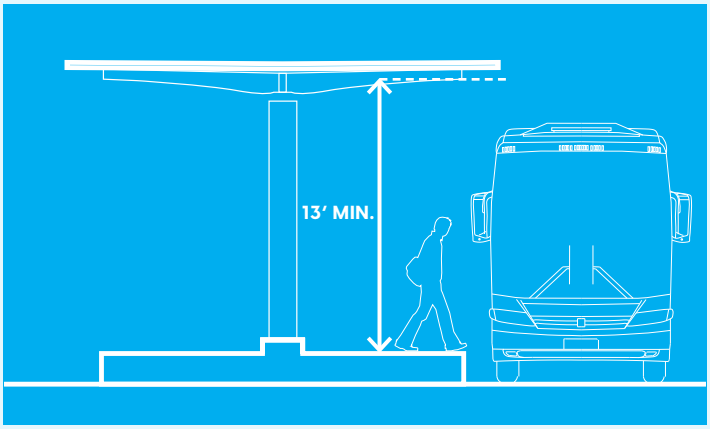
Requirements & Guidelines

- Canopies should be designed to provide weather protection to transit users
- Where adjacent to an exclusive METRO transit way, include protected coverage over loading areas
- Where transit way is not exclusive, hold back edge of canopy from platform edge
- Height of canopy must account for the operational clearance of vehicles.

Considerations

- Material and color selection of canopies should consider maintenance requirements and aesthetics to support longevity and the METRO brand
- Coordination with community districts for potential of art integration
- Refer to Double Loaded Canopy description for additional considerations





Single Loaded Canopy

Single Loaded Platform

Park & Rides / Transit Centers

Selection

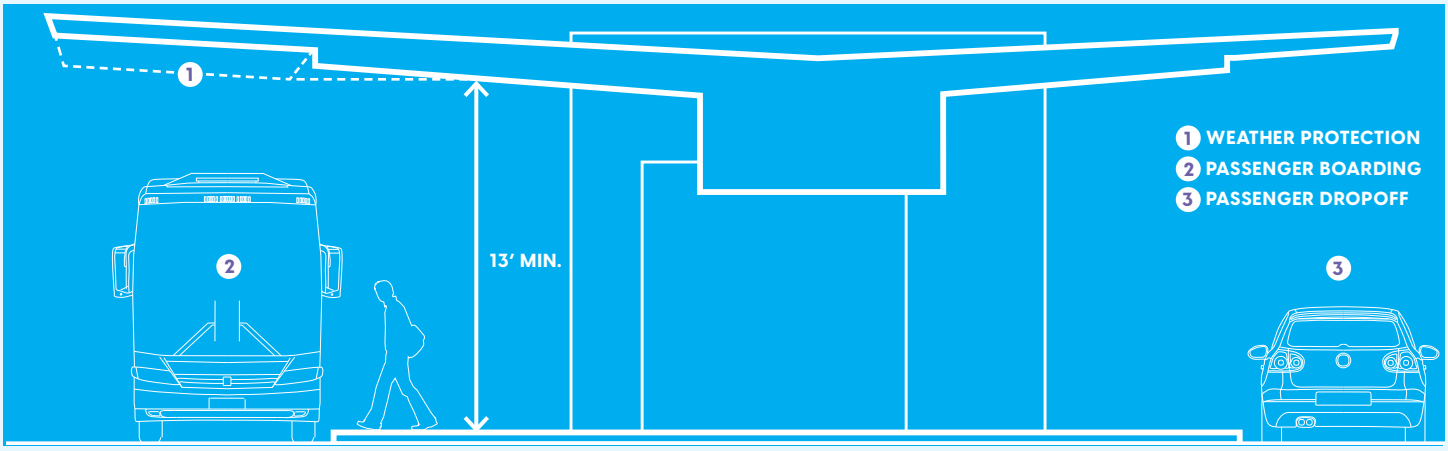
- Consider for use at locations where four or less bus routes converge for sheltered transfer between routes
- Canopies designed for single sided bus boarding are primarily found at Park & Rides served by limited routes; the canopy can be configured to accommodate coverage for ride-share if this function is planned to share the loading platform (Townsen and El Dorado P&R are examples)
- Canopy and platform configuration requires counter-clockwise bus circulation for standard right-side boarding of vehicles, though bus circulation requirements generally do not force patrons to cross bus drives to access boarding platforms
- For operational flexibility provide bus berthing positions sized for articulated vehicles to allow capacity increases without requiring additional bus operators

Requirements & Guidelines

- Canopies should be designed to provide weather protection to transit users to include coverage over loading area of the mode of transportation; preferably 10' over the loading doors' vehicles
- Height of canopy must account for the operational clearance of buses and vehicles - 13'-0" minimum from top of curb to lowest member of the canopy

Considerations

- Material and color selection of canopies should consider maintenance requirements and aesthetics to support longevity and the METRO brand
- Design structures to minimize the creation of bird roosting areas which increases required maintenance and impacts passenger experience
- Roof material can be tensile fabric, standing seam metal, or membrane roofing designed to resist high wind events without damage
- Materials within reach of patrons should be durable and vandal resistant. Fascia and soffit should be enclosed and composed of metal interlocking panels or concrete
- Column materials can include concrete or painted structural steel. Smooth surfaces are most easily maintained. Field painting of structural steel should be avoided wherever possible as coating failure at field welded connections is common



Single Loaded Platform

BRT / LRT

Selection

- Consider for use at split station platform locations on bi-directional BRT or LRT routes; in this configuration the boarding platform serves only one direction of travel
- Canopy and platform configuration can accommodate either right-side or left-side boarding of vehicles depending upon its placement relative to the guideway

Requirements & Guidelines

- Canopies should be designed to provide weather protection to transit user
- Where adjacent to an exclusive METRO transit way, include protected coverage over loading areas
- Where transit way is not exclusive, hold back edge of canopy from platform edge
- Height of canopy must account for the operational clearance of vehicles
- Material selections should consider ease of maintenance and resistance to vandalism, particularly for those elements within reach of customers

Considerations

- See Considerations listed under double loaded BRT / LRT Canopy Structures.

U-Shaped Platform

Park & Rides / Transit Centers

Selection

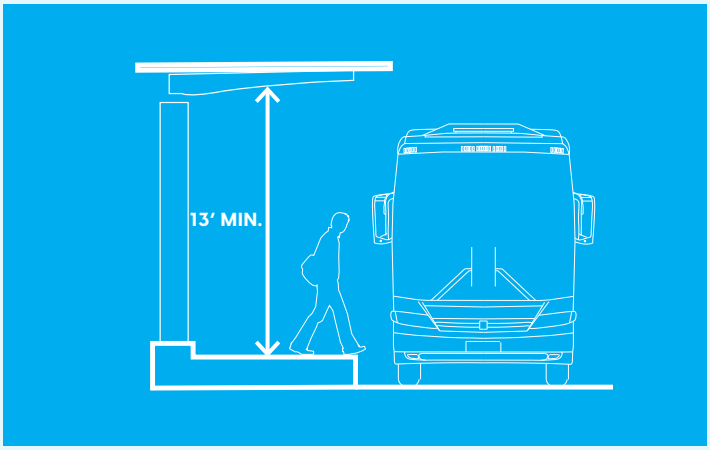
- U-shaped platform configurations are not currently found among current METRO facilities but they offer advantages to patrons by minimizing conflicts with vehicular traffic to access the boarding platform
- This configuration may be advantageous for Park & Ride facilities where parking is outboard from the bus circulation, and for Transit Oriented Developments allowing direct access to the platform from other perimeter uses without interference to bus operations
- At larger facilities this configuration would increase transfer walking distances between bus berths and create situations where patrons might attempt to take shortcuts across bus circulation paths
- For operational flexibility provide bus berthing positions sized for articulated vehicles to allow capacity increases without requiring additional bus operators

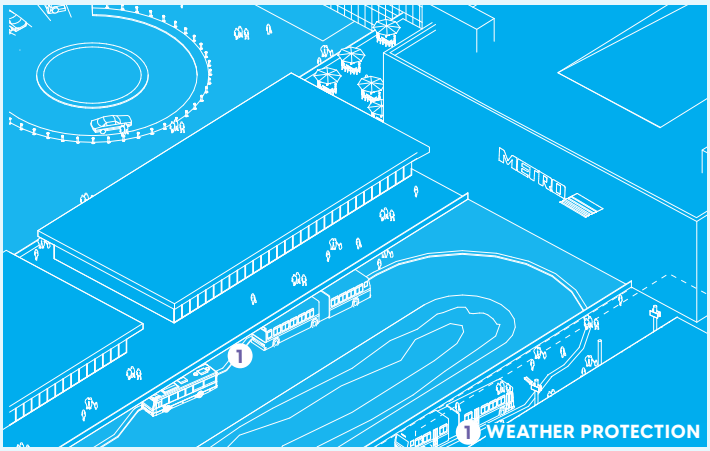
Requirements & Guidelines

- See Park & Ride / Transit Center Canopies for requirements

Considerations

- See Park & Ride / Transit Center Canopies for requirements





Support Structures

Utility Building

Park & Rides / Transit Centers

Selection

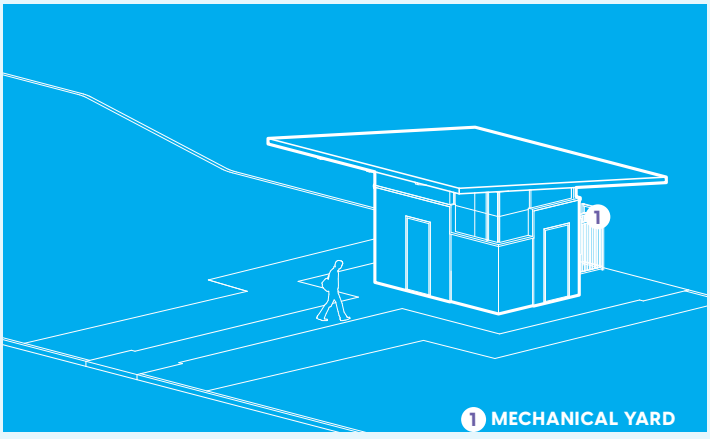
- Material selection to provide low maintenance requirements, resistance to graffiti, and longevity
- Facade materials to include metal composite panel, masonry, or porcelain enamel panels; masonry to consist of glazed concrete units or epoxy painted decorative concrete units
- Roofing material to be standing seam metal
- Doors and frames of color-tinted fiberglass or stainless steel flush hollow metal (limited use)

Requirements & Guidelines

- Location on site to prevent visual obstruction of the public paths to the bus loading area; the building entrance shall face the bus platform be located on the side of the building that is visible at all times
- Divert storm water from the roof away from public walkways or entrances
- Provide HVAC system and intrusion detection
- Conform to International Building Code Standards

Considerations

- Locate to screen mechanical equipment
- Provide a shaded pathway to the building entrance
- Locate in an area convenient to parking area for maintenance personnel



Utility & Driver's Rest Facility

Park & Rides / Transit Centers

Selection

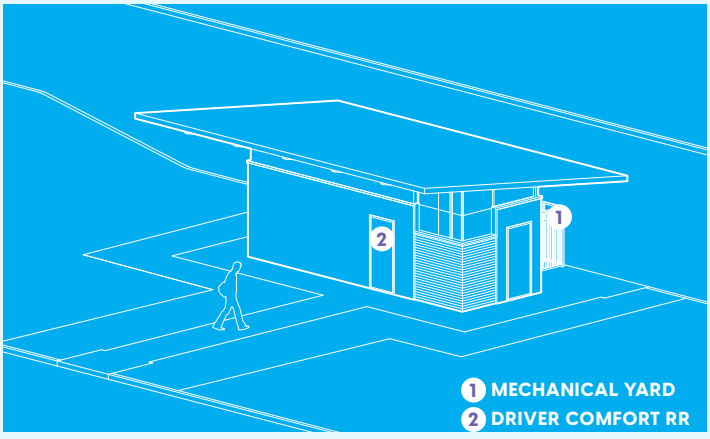
- Includes a vestibule that provides a driver's seating area, ADA compliant restrooms, and utility rooms
- Material selection to provide low maintenance requirements, resistance to graffiti, and longevity
- Facade materials to include metal composite panel, masonry, or porcelain enamel panels; masonry to consist of glazed concrete units or epoxy painted decorative concrete units
- Roofing material to be standing seam metal
- Glazing at driver's seating area
- Doors and frames of color-tinted fiberglass or stainless steel flush hollow metal (limited use)

Requirements & Guidelines

- Provide HVAC system and intrusion detection.
- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards
- Refer to Utility Building for additional Requirements & Guidelines

Considerations

- Location and screening of mechanical equipment
- Shaded pathway to the building entrance
- The location of the facility should be convenient for bus drivers to access such as adjacent to the bus queuing area.



Utility & MPD Office

Park & Rides / Transit Centers

Selection

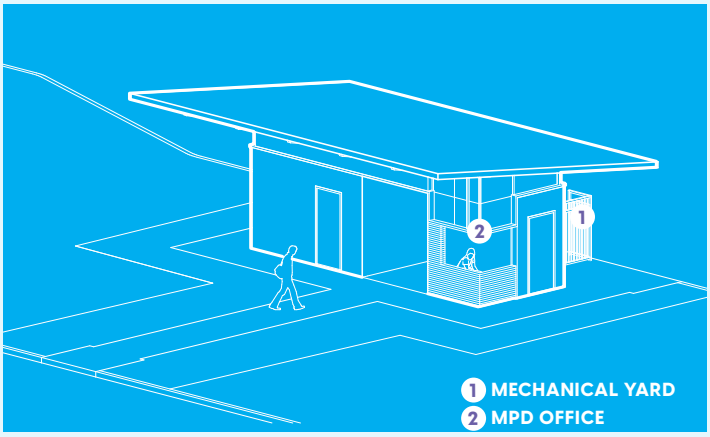
- Includes METRO Police Department office, ADA compliant restrooms, and utility rooms
- Material selection to provide low maintenance requirements, resistance to graffiti, and longevity
- Facade materials to include metal composite panel, masonry, or porcelain enamel panels. Masonry to consist of glazed concrete units or epoxy painted decorative concrete units
- Standing seam metal roofing
- Glazing at the MPD Office to provide visibility to the site.
- Doors and frames of color-tinted fiberglass or stainless steel flush hollow metal (limited use)

Requirements & Guidelines

- Divert storm water from the roof away from public walkways or entrances
- Provide HVAC system and intrusion detection
- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards

Considerations

- Locate MPD office in an area visible throughout the site
- Locate near parking areas for maintenance access and convenience



Patron Restrooms

Park & Rides / Transit Centers

Selection

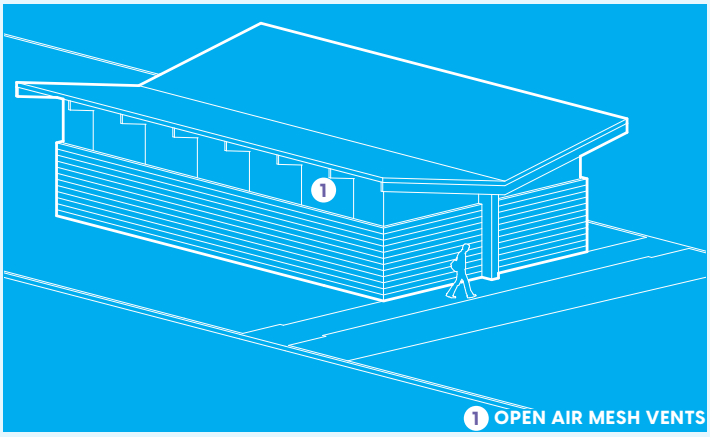
- Includes ADA compliant open-air restrooms for use by patrons
- Material selection to provide low maintenance requirements, resistance to graffiti, and longevity
- Facade materials to include metal composite panel, masonry, or porcelain enamel panels; masonry to consist of glazed concrete units or epoxy painted decorative concrete units
- Roofing material to be standing seam metal
- Doors and frames of color-tinted fiberglass or stainless steel flush hollow metal (limited use)

Requirements & Guidelines

- Location on site to provide visibility to entrances
- Exterior enclosure wall heights sufficient for privacy and installation of doors
- Open-air with mesh vent screens above for patron safety
- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards
- Divert storm water from the roof away from public walkways or entrances

Considerations

- Provide shaded pathway to the building entrances



Railing & Fencing

Perimeter Fencing

Park & Rides / Transit Centers

Selection

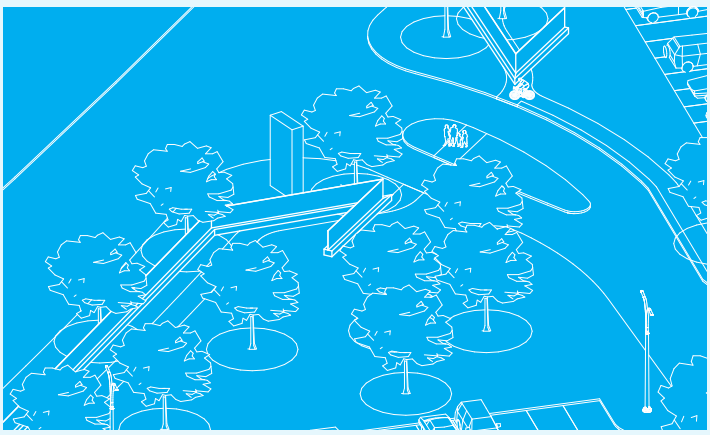
- Perimeter fencing shall be provided to control vehicle and pedestrian access to the site

Requirements & Guidelines

- Fencing shall be black polyvinyl coated chain link per METRO design standards
- Alternate fencing materials may be considered in special instances where appropriate for neighborhood integration
- Provide cantilever sliding gates at vehicle access points and swing gates at pedestrian access points. Entrances to be clearly defined
- Points of access to have unobstructed cross-visibility between height of 2'-6" and 7'-0" above the centerline of the street and 15' back from the curb with a 45 degree lateral visibility or AASHTO sight distance standards
- Maintain 24" between landscaping and pedestrian gates for ease of use
- Landscaped buffers of 10' shall be provided between fences and parking lots

Considerations

- Coordinate with right-of-way elements such as sidewalks, trees, and landscaping
- Where appropriate omit fencing at Transit Centers to promote neighborhood connections and last mile access



Detention Pond Fencing

Park & Rides / Transit Centers

Selection

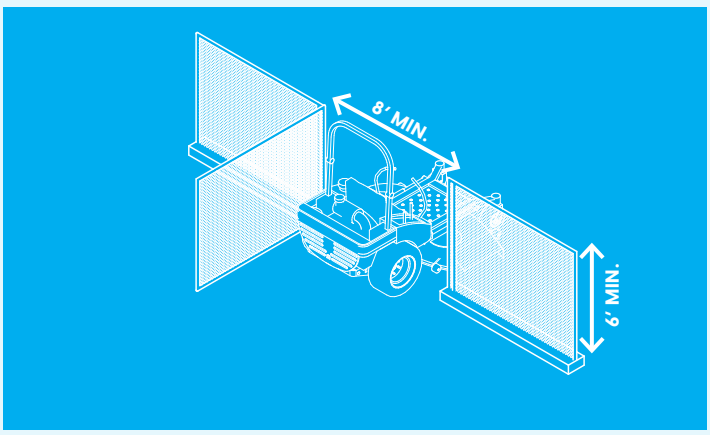
- Fenced, poorly maintained detention facilities detract from the METRO brand and should be avoided
- Strive to design detention facilities to not require fencing and better integrate with facility landscape elements and the surrounding environment
- METRO should consider modifying detention fencing requirements to address both detained water depths and duration of detention

Requirements & Guidelines

- Follow jurisdictional requirements and METRO standards for detention pond fencing
- Detention ponds greater than 3' deep shall be enclosed with fencing. Fencing material to be composed of black polyvinyl coating chain link
- Fencing to be 6' high, 1" mesh with an 8' wide gate for maintenance equipment access. The fence to be mounted on a one foot wide mow strip

Considerations

- Coordinate with landscaping to create a softer edge and more easily maintained facility



Pedestrian Barriers

Park & Rides / Transit Centers

Selection

- Consider for use as a barrier between parking areas and the bus platforms to channel crossings of vehicle lanes to defined locations.

Requirements & Guidelines

- Use low height fencing of 3' maximum where fencing is used solely as a pedestrian barrier.
- Provide guardrails of stainless steel or prefinished coated steel where required for protection at changes in level or to serve as a method controlling of pedestrian routing at high traffic locations.
- Guardrail height should be 42" tall

Considerations

- Consider use of chain rails and landscaping as an alternate barrier for controlling pedestrian crossings. Refer to sections on bollards and landscape buffers for additional information.

Vehicular Barriers

Park & Rides / Transit Centers

Selection

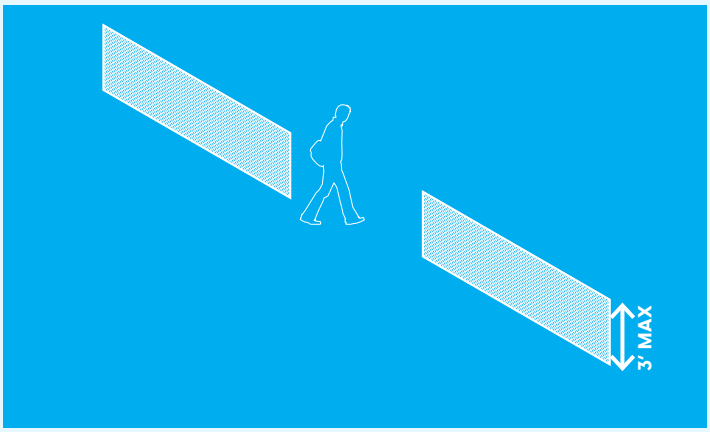
- Vehicular barriers on site consist of landscaping or bollards
- Bollards should be provided at pedestrian loading areas of passenger vehicles where there is no curb, such as ADA loading areas

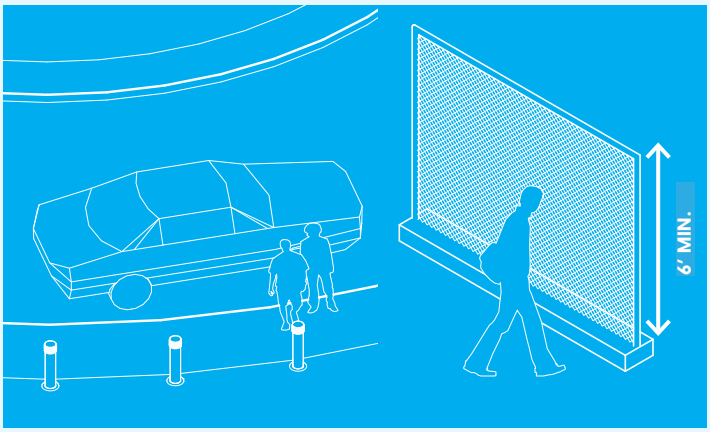
Requirements & Guidelines

- Landscape - Refer to Landscape section
- Bollards - Refer to Bollards section

Considerations

- Landscape - Refer to Landscape section
- Bollards - Refer to Bollards section





Shelter

Bus Shelter

Bus Stops

Selection

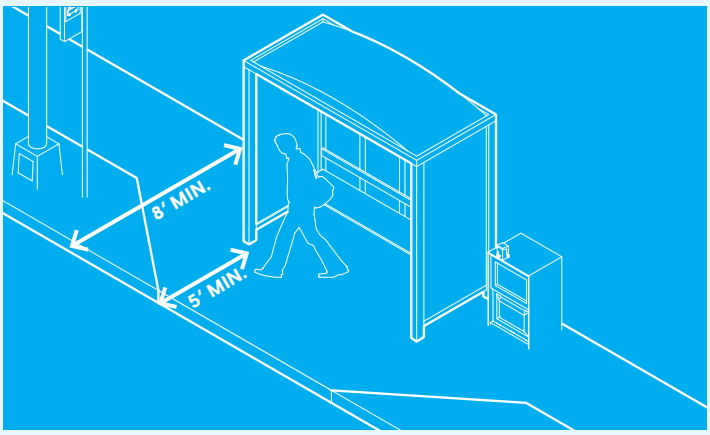
- Bus shelters are typically prefabricated and material can consist of clear polycarbonate, tempered / laminated safety glazing, or acrylic within an aluminum or stainless steel frame
- Roofing material may also consist of insulated metal panels
- Shelter design to route storm water away from entrances and public circulation
- Coordinate shelter design with community districts that may influence the character or color of the shelter and integration of unique elements, such as custom pavement graphics, wayfinding, custom amenities, landscaping, and art
- Bus shelter amenities can include seating, litter disposal, art, wayfinding, digital signage, and lighting
- Refer to Amenities, Lighting, and Identity & Wayfinding sections for additional information
- Coordinate integration of infrastructure for lighting and digital displays if they are provided

Requirements & Guidelines

- Enclosure material to provide visibility to bus shelter users for security
- Setback from the street to allow safe and ADA accessible queuing and boarding

Considerations

- Bus shelters that include a consistency in material can provide ease of maintenance
- Coordinate with right-of-way conditions, such as bike lanes, street parking, and utilities
- Availability of the right of way may impact the shelter size and selection
- Location of shelter to nearby businesses and street lighting for additional security and safety



Cantilevered Shelter

Bus Stops

Selection

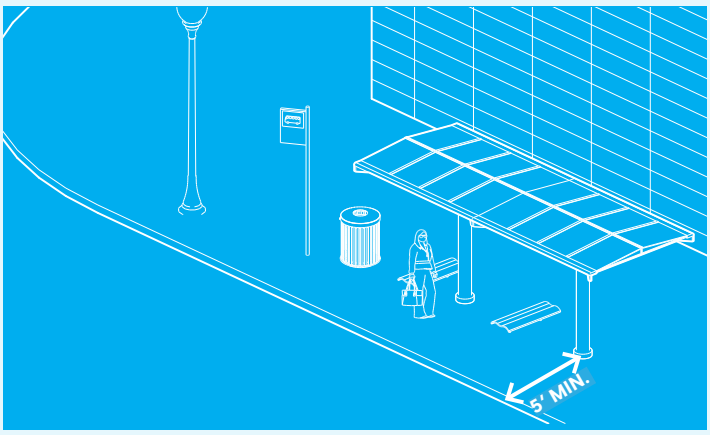
- Cantilevered shelters provide shade and rain protection, however have open sides and therefor do not protect from wind exposure
- They can be advantageous for use at dense urban areas where larger demand of pedestrian queuing space along with high traffic at sidewalks would benefit from an unobstructed waiting area

Requirements & Guidelines

- Minimize columns to maximize visibility
- Place cantilevered shelter with an appropriate setback from street to provide clearances for all vehicles
- Place cantilevered shelter with an appropriate setback for safe and accessible queuing and boarding

Considerations

- Refer to Bus Shelter section for additional considerations



Solar Power Shelter

Bus Stops

Selection

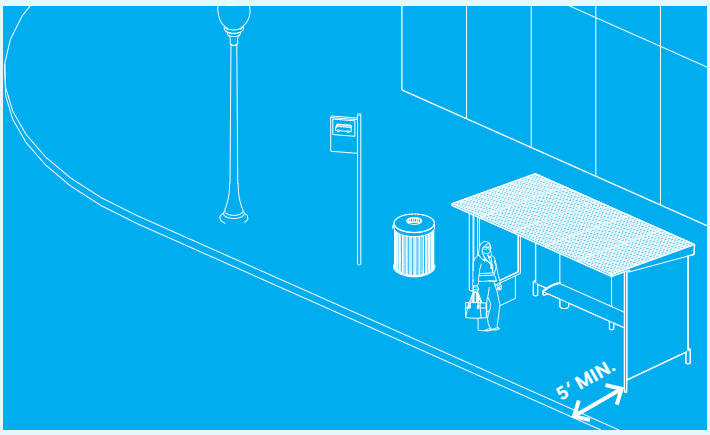
- Solar collectors can be integrated into the shelter to provide power for lighting and other digital technology provided
- Shelter orientation and relationship to adjacent buildings will need to be accounted for to ensure sun exposure to solar collectors.

Requirements & Guidelines

- Enclosure material to provide visibility to bus shelter users for security
- Set solar power shelter away from the street to allow safe and ADA accessible queuing / boarding

Considerations

- Coordinate battery location and integration within the shelter design
- Refer to Bus Shelter section for additional considerations



Vertical Circulation

Ramp

Park & Rides / Transit Centers / BRT / LRT

Selection

- Provide for Universally Accessible access to boarding platforms

Requirements & Guidelines

- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards
- Maintain slopes on surfaces so that they are considered sloped walks (< 1:20) rather than ramps so that handrail requirements are eliminated
- Where slopes exceed 5%, provide handrails with ADA required extensions

Considerations

- Consider maximum slopes of 4% when designing to account for constructed field conditions; avoid slopes over 5% when possible
- Stainless steel or anodized aluminum handrail materials are preferred
- Surface materials should have a slip resistant texture
- Provide weather protection over ramp and landings where appropriate

Stairs

Park & Rides / Transit Centers / BRT / LRT

Selection

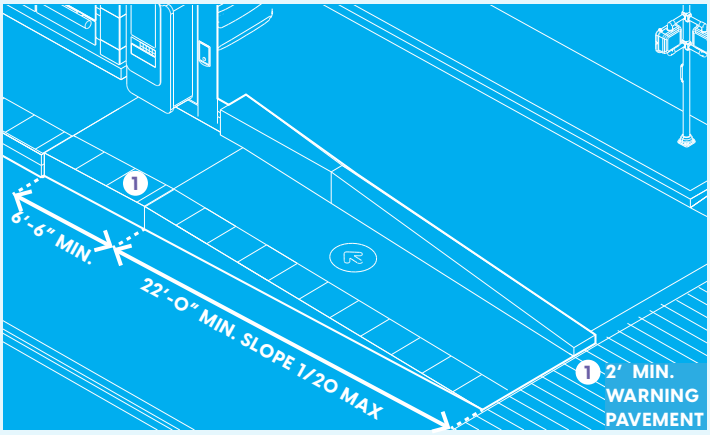
- Provide stairs where vertical elevation change preclude the use of ramps
- Prioritize the use of elevators and escalators in lieu of stairs wherever possible to accommodate a wider range of accessibility

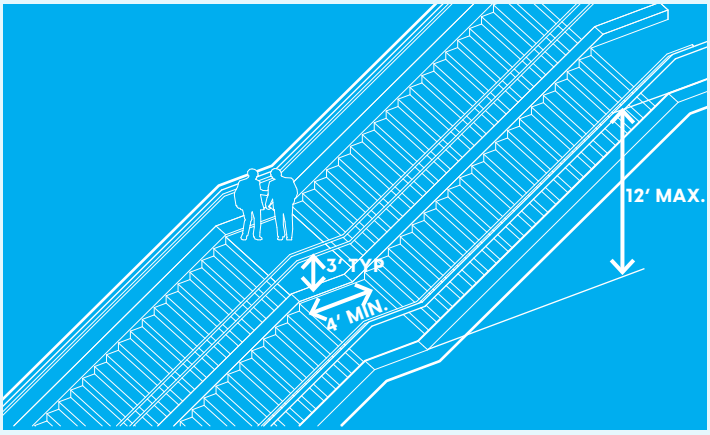
Requirements & Guidelines

- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards
- Where code provisions allow, stairs shall be open to provide visible lines of sight for CPTED compliance
- Stairs should be concrete with slip resistant and sloped treads to avoid the collection of water
- Handrails must be provided with ADA compliant extensions

Considerations

- Stainless steel or anodized aluminum handrail materials are preferred to minimize maintenance
- Provide weather protection over stairs and landings where appropriate





Elevator

Elevated Transit Centers or BRT / LRT Stations

Selection

- Limit elevator use to locations where vertical separation exists between transit modes that cannot be accommodated through the use of ramps
- Elevators are the preferred vertical circulation type for providing universal accessibility, however they have high cost and maintenance requirements and should be avoided where possible

Requirements & Guidelines

- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards
- Size elevator cabs to accommodate stretchers
- Two elevator cars minimum should be provided to ensure a redundancy while providing for equipment being out of service during maintenance
- Elevators should incorporate vision glass to provide visible lines of sight for CPTED compliance

Considerations

- Provide weather protection at entrances
- Provide clear line of sight to entrances and convenience of access
- Consider required ongoing maintenance costs in acquisition

Escalator

Elevated Transit Centers or BRT / LRT Stations

Selection

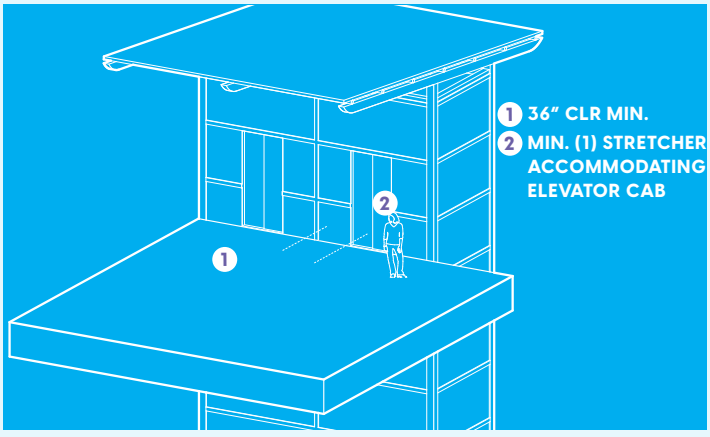
- Limit escalator use to locations where the vertical separation between transit modes and passenger loads would overwhelm the ability of elevators and stairs to provide the necessary capacity for passenger transfer between levels
- Due to the high initial costs and ongoing maintenance requirements for escalators, the decision to provide escalators should be determined for use only in limited special situations and at enclosed facilities only

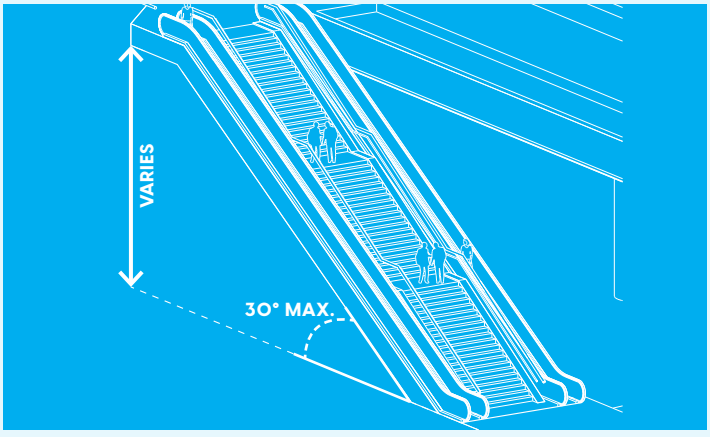
Requirements & Guidelines

- Conform to ADA Accessibility Guidelines (ADAAG) and International Building Code Standards
- Provide additional clearance width for customer passing on the elevator

Considerations

- Provide enclosed weather protection at escalators
- Provide a clear line of sight to entrances
- Consider required ongoing maintenance costs in acquisition





Integrated Stacked Facility

Garage / Platform Stack

Park & Rides / Transit Centers

Selection

- Where land use densities are appropriate, build multi-level developments with integrated parking structures

Requirements & Guidelines

- Wherever possible, restrict transit operations to grade level to minimize structural requirements and construction costs
- Be mindful of vertical clearance requirements for bus operations including tow vehicles
- Provide universally accessible vertical circulation between mixed-uses and transit platform; land vertical transport onto platform where possible

Considerations

- Consider ventilation requirements when enclosing bus operating areas; provide supplemental ventilation and exhaust where necessary
- Enclosed structures amplify sounds of operating buses and equipment; consider sound absorptive materials to mitigate sound pollution
- Design structures to minimize the creation of bird roosting areas which increase required maintenance and impact passenger experience
- Materials within reach of patrons should be durable and vandal resistant; fascia and soffit should be enclosed and composed of metal interlocking panels or concrete
- Consider utilizing concrete or painted structural steel within the design of column structures
- Smooth surfaces are most easily maintained; field painting of structural steel should be avoided to prevent coating failure at field welded connections
- Integrate utilities and support systems into the design of structures to improve aesthetics and minimize vandalism potential
- Consider integrating drainage, speakers, cameras, lighting, mounted signage, and other canopy mounted elements within the design of columns, roofs, and structures

Transit Oriented Development

Transit Centers

Selection

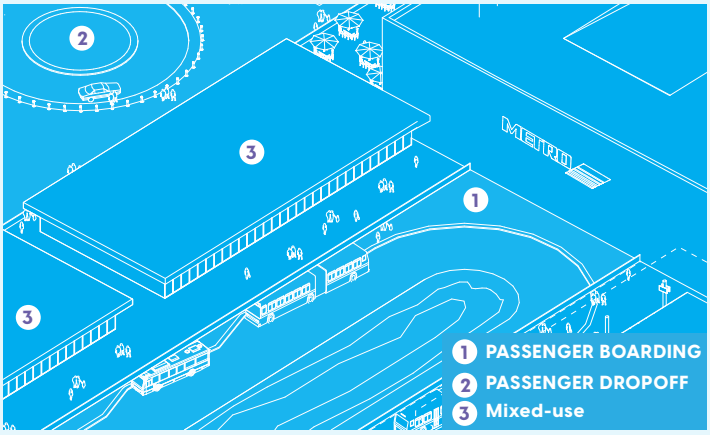
- Consider where land use densities or location suggest appropriate Transit Oriented development integrated with transit facilities.

Requirements & Guidelines

- Generally, restrict transit operations to grade level to minimize structural requirements and construction costs.
- Be mindful of vertical clearance requirements for overhead structures required for bus operations including tow vehicles.
- Provide universally accessible vertical circulation between mixed-uses and transit platform at multi-level facilities land vertical transport onto platform where possible

Considerations

- Refer to pages 194 and 195 of the UDM for more information on integrated stacking
- Refer to Stacked Garage Transit Platform for other considerations



Skybridge

Transit Centers

Selection

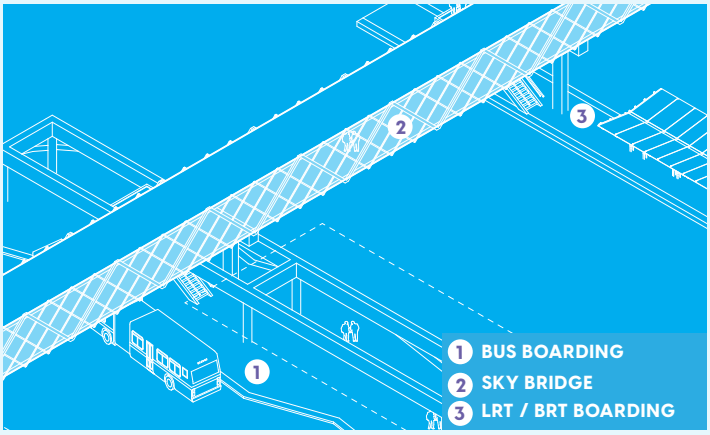
- Where safe at-grade crossings are not feasible, provide safe customer passage over freeways or high traffic roads to access Transit Centers or transfer between transit modes

Requirements & Guidelines

- Provide necessary vertical circulation at each end
- Provide overhead cover and screened wall enclosure for weather protection

Considerations

- Provide visibility through wall enclosures through the use of transparent materials such as perforated metal or mesh
- Design structures to minimize the creation of bird roosting areas which increases required maintenance and impacts passenger experience.
- Materials within reach of customers should be durable and vandal resistant; fascia and soffit should be enclosed and composed of metal interlocking panels or similar materials



Wayfinding & Art

Wayfinding and Art elements are often overlooked in the transit environment, but they play a vital role in pedestrian and vehicular safety. Entry monuments guide visitors from the roadway and attract attention to the facility. Vehicular circulation guides vehicles into facility entrances and guides traffic throughout the site. Pedestrian wayfinding, in tandem with crosswalks and traffic calming techniques, signal primary routes for pedestrians to walk while clarifying access to clear facility destinations. The possibilities to integrate art into facilities is endless, offering opportunities to engage community participation and infuse neighborhood character. Further guidelines can be found in the METRO Arts in Transit Program Vision Plan.

ENTRY MONUMENT

DIRECTIONAL

REGULATORY

ART

Wayfinding & Art

EMBEDDED WAYFINDING

SCULPTURE AMENITIES

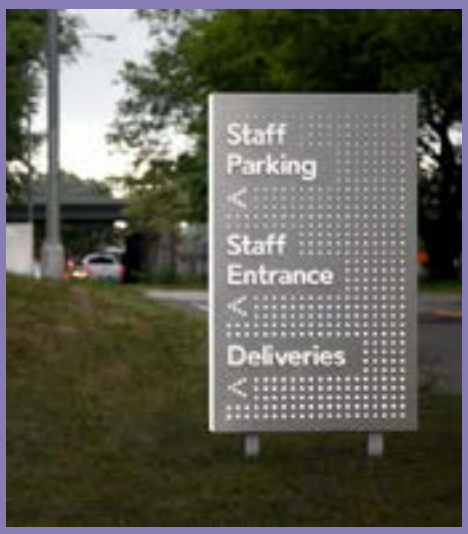
Wayfinding and art enhance facility character, further the METRO brand, strengthen community identity, and guide riders through their transit experience. Entry monuments welcome riders to Transit Centers and Park & Rides. Directional wayfinding communicates pertinent information related to site circulation in ways that are easy to understand. Regulatory signage communicates facility regulations and requirements. Art can be implemented through a variety of functional uses such as embedded paving elements, architectural branding, furnishings, lighting, and other site features.

LEED Section 6.7 should be considered for materials selection. Colors should contrast for colorblindness.

INTEGRATED SIGNAGE

STRUCTURE EMBEDDED ART

PERMANENT ART FEATURES



Wayfinding & Art

Acrylic

Acrylic is a durable material that can come in many different colors. It is less flexible than architectural resin but can be easily backlit. It is lightweight and versatile.

Resilience

●●●○○	Durability
●●●●●	Corrosion Resistance
●●○○○	Vandal Resistance
●●●○○	Sustainability
●●●●○	UV Resistance

Comfort

●●●●○	Heat Dissipation
●●●●●	Low Reflectivity
●●●●●	Freeze Resistance

Character

●●●●●	Color Branding
●●●○○	Art Integration

Cost

●●●○○	Low Life-cycle Cost
●●●○○	Low Initial Cost
●●●○○	Low Maintenance Cost

Architectural Resin

Polycarbonate resin transparent panels are highly durable and come in a range of colors and patterns that can be customized into flexible forms with lighting.

Resilience

●●●●○	Durability
●●●●●	Corrosion Resistance
●●●●○	Vandal Resistance
●●●○○	Sustainability
●●●●○	UV Resistance

Comfort

●●●●○	Heat Dissipation
●●●●●	Low Reflectivity
●●●●●	Freeze Resistance

Character

●●●●●	Color Branding
●●●●●	Art Integration

Cost

●●●●○	Low Life-cycle Cost
●●○○○	Low Initial Cost
●●●●○	Low Maintenance Cost

Laminated Graphics

Laminated graphic signage is fully customizable and can come with protective UV Coatings. It has a lower initial cost than other materials but is less durable.

Resilience

●●○○○	Durability
●●●●●	Corrosion Resistance
●●●○○	Vandal Resistance
●●●○○	Sustainability
●●●○○	UV Resistance

Comfort

●●●●○	Heat Dissipation
●●●●●	Low Reflectivity
●●●●●	Freeze Resistance

Character

●●●●●	Color Branding
●●●●●	Art Integration

Cost

●●○○○	Low Life-cycle Cost
●●●●○	Low Initial Cost
●●●○○	Low Maintenance Cost

Concrete

Concrete paving is a cost effective monument and art material that can be finished in many different textures and stains. Lettering can be embedded, mounted, or embossed .

Resilience

Durability
Stain Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

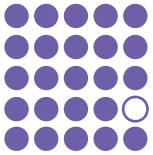
Cost

Low Life-cycle Cost
Low Initial Cost
Low Maintenance Cost

Granite

Granite is a durable and timeless accent material that can be used for embedded wayfinding or other special uses. Granite comes in a variety of finishes and can be etched or embossed.

Resilience



Durability
Stain Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

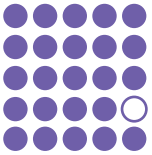
Cost

Low Life-cycle Cost
Low Initial Cost
Low Maintenance Cost

Native Stone

Stone is a durable wayfinding monument material. Stone may be more appropriate for more suburban or nature-centric Park & Rides, but often has a high initial cost.

Resilience



Durability
Stain Resistance
Vandal Resistance
Sustainability
UV Resistance

Comfort

Heat Dissipation
Low Reflectivity
Freeze Resistance

Character

Color Branding
Art Integration

Cost

Low Life-cycle Cost
Low Initial Cost
Low Maintenance Cost

Wayfinding & Art

Aluminum
Die-Cast / Recycled

Aluminum is lighter than steel and comes in a variety of elegant forms. Die cast aluminum, when recycled, is more sustainable than stainless steel but can oxidize.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

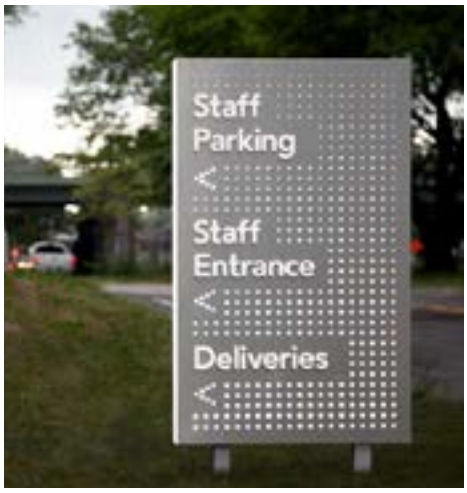
- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost



Aluminum
Powdercoated

Aluminum can be powdercoated to add character and coloring opportunities while reducing reflectivity. Like powdercoated steel, it can be easily vandalized.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel
Stainless

Stainless steel has anti-microbial properties, is corrosion resistant, and is resistant to warping in the sun. It is low maintenance but can cause burns if touched when located in direct sunlight.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Powdercoated
Steel

Powdercoated steel can add a lot of character to a site and reinforce neighborhood or brand identity, but is susceptible to scratching / vandalism.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel
Natural

Raw steel can be coated with an anti-rust coating to slow the weathering process. The steel is dark in appearance and will naturally weather to brown over time.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Steel
Weathering

Weathering steel can enhance site character. It weathers naturally and changes color over time while minimizing glare and enhancing natural site textures.

Resilience

- Durability
- Corrosion Resistance
- Vandal Resistance
- Sustainability
- UV Resistance

Comfort

- Heat Dissipation
- Low Reflectivity
- Freeze Resistance

Character

- Color Branding
- Art Integration

Cost

- Low Life-cycle Cost
- Low Initial Cost
- Low Maintenance Cost

Entrance Monument

Threshold Monument

Park & Rides / Transit Centers

Selection

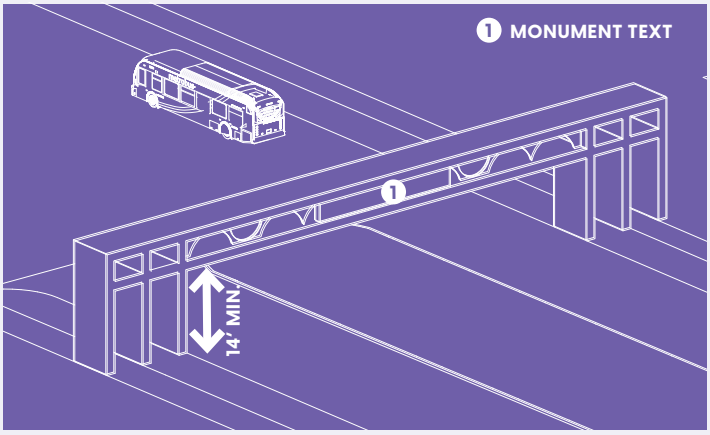
- Threshold monuments welcome riders with an architectural statement that frames the entrance to the site and is easily seen from the roadway
- The architectural character should complement the architectural forms and finishes within the facility

Requirements & Guidelines

- Threshold monuments should span the entire length of the roadway
- The lowest point of the threshold should adhere to minimum station canopy heights
- Fasteners should be non-corrosive to ensure the longevity of the structure
- Monument text should be sized for legibility from the roadway (refer to MUTC Guidelines)

Considerations

- Consider the integration of supplemental lighting to illuminate the facility name and METRO logo
- Provide an entry portal for pedestrians to mirror the vehicular experience into the site



Pillar / Column Monument

Park & Rides / Transit Centers

Selection

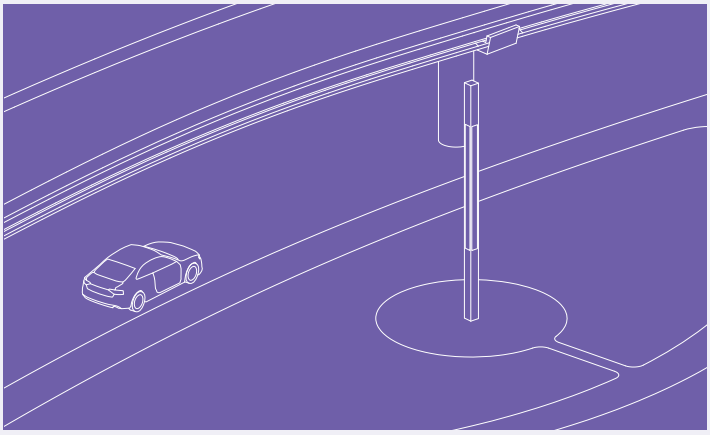
- Pillar / column monuments are beneficial due to their high visibility from the highway
- Pillar / column monuments offer flexibility for compact footprints

Requirements & Guidelines

- The monument should be located near the vehicular entrance in a location highly visible from the roadway
- Monument text should be sized for legibility from the roadway
- Fasteners should be non-corrosive to ensure the longevity of the structure
- Material and character of the monument should reflect the branding, culture, architectural character of the community, and facility aesthetic
- The monument should be unobstructed by trees

Considerations

- Consider lighting column monuments internally or provide backlit lettering to improve visibility at night
- Design monument as a sculptural object with wayfinding information



Sign Wall

Bus Stops / Park & Rides / Transit Centers

Selection

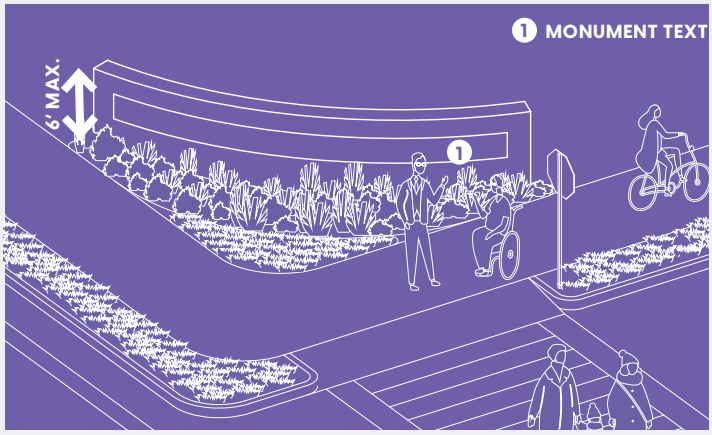
- Sign walls denote METRO facilities while providing architectural interest to Park & Ride and Transit Centers in urban, urban edge, or other sites where a full size pillar or threshold monument cannot be spatially accommodated

Requirements & Guidelines

- Sign walls should adhere to sight visibility triangles from the roadway
- Walls should reflect the architectural character of the community and facility
- Letter height should be chosen based on driver eye height, legibility, and distance from the roadway
- Sign walls should curve or angle back at corners to welcome riders into the facility while maximizing pedestrian visibility

Considerations

- Consider adding planting to soften the appearance of sign walls (refer to Landscape & Green Infrastructure Guidelines)
- Consider washing the front of the sign wall with supplementary light



Directional Wayfinding

Vehicular Directional

Park & Rides / Transit Centers

Selection

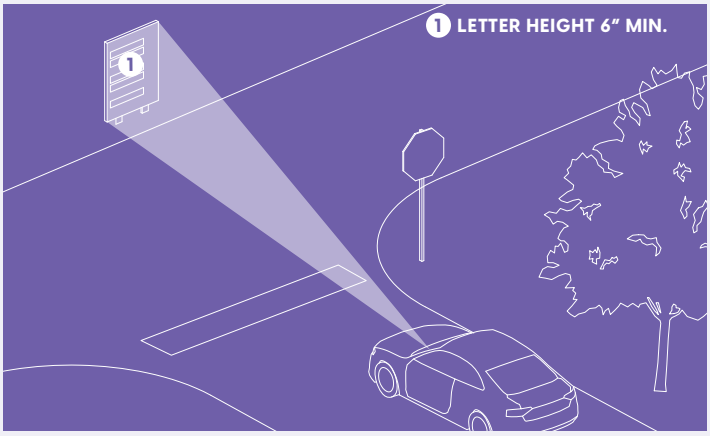
- Vehicular directional wayfinding elements navigate drivers to parking and primary facility areas

Requirements & Guidelines

- Refer to the MUTCD Guidelines for vehicular guide signs leading from the highway
- Vehicular directional wayfinding should be designed as a cohesive system rather than isolated sign structures that sequentially indicate parking location, drop-offs, accessible parking, station platform areas, and exit
- Vehicular directional signage should be located at logical and safe decision points such as roundabouts or large island medians with yield or stop signs to enable drivers to pause, observe, and make a decision in a safe and attentive manner
- Letter and sign height must be legible from the intended viewing location / distance and should be seen prior to reaching the decision point (6" minimum)
- If vehicular signage is located near a pedestrian travelway, ensure that the sign adheres to CPTED principles and eliminates potential hiding places

Considerations

- Consider parking zone banner wayfinding to aid customers in remembrance of parking location



Pedestrian Directional

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

- Pedestrian directional wayfinding elements navigate pedestrians and cyclists to primary facility areas

Requirements & Guidelines

- Pedestrian wayfinding should be designed as a cohesive system and must be planned along strategic decision points; arrows should guide riders
- Pedestrian wayfinding should have a thin profile or should be located parallel to the pedestrian travelway to prevent visibility concerns and hiding places
- Signage should denote the primary walkway, parking areas, station platforms, restrooms, ticket purchasing opportunities, routing info, and system maps
- Pedestrian wayfinding for Park & Rides and Transit Centers should include a map of the site to orient riders
- All maps and text should be visible and approachable from 6' away and an accessible eye height of 4'-5' (*National Endowment for the Arts Needs Assessment Survey)*, and should not protrude into walkway (*ADAAG §307.2*); text should be a minimum of 5/8" for legibility

Considerations

- Consider translating pedestrian wayfinding in multiple languages and braille or including iconography to comfortably accommodate a wider range of users

Suspended Signage

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

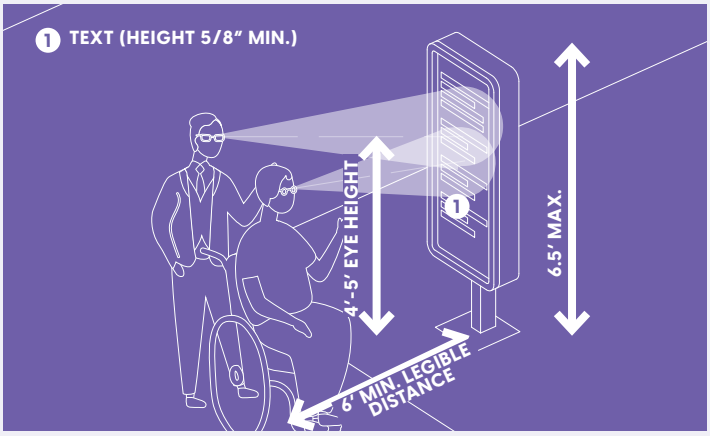
- Suspended signage can either be directional to orient riders to platforms, kiosk information, restrooms, or other facility guidance, or they can be informational to locate the specific location of a site element

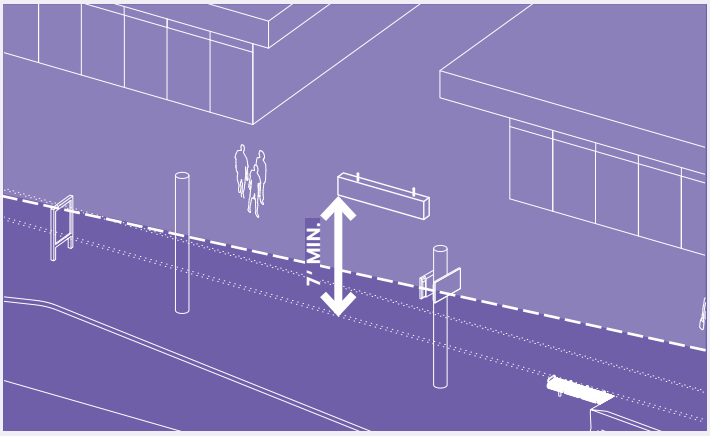
Requirements & Guidelines

- Suspended signage must adhere to ADA clearances and guidelines (*ADAAG §402 and §307.2*)
- Suspended signage over transit boarding areas should accommodate METRO vehicular clearances
- Suspended signage should be visible throughout the platform and information should be consolidated to reduce visual clutter within the platform
- Lettering should be a minimum of 2" minimum for legibility at pedestrian scale and 6" minimum for vehicular scale
- Mount suspended signage complementary to architectural design (i.e., center signage between architectural joints or columns) and ensure illuminated signage is mounted to accommodate electrical service

Considerations

- Consider using clear iconography (including universal ADA symbols) to accommodate a wider range of users





Regulatory Signage

Structure Mounted

Bus Stops / BRT / LRT / Park & Rides / Transit Centers

Selection

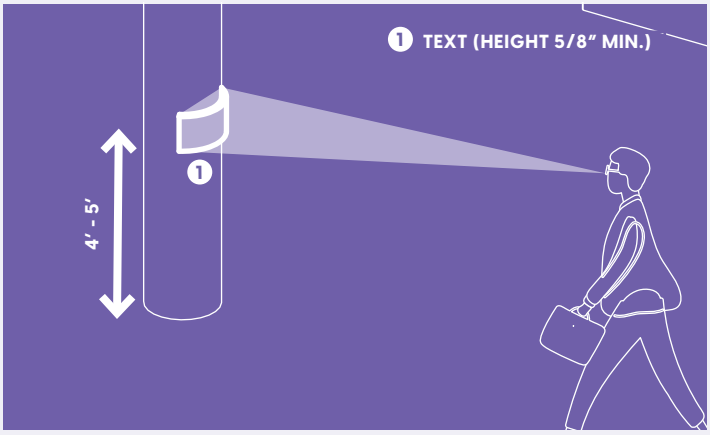
- Regulatory signage adhered to column structures and architectural walls communicates necessary safety information, facility regulations, and METRO resources

Requirements & Guidelines

- Regulatory signage should be located at an accessible height of 4'-5' and should have a minimum text height of 5/8" *(ARCP Report 52; ADAAG §703.4)*
- Regulatory wayfinding should be standardized across all METRO facilities
- Regulatory signage specific to facilities should be translated into multiple languages or should be complemented by clear iconography
- Signage should not project more than 4" into the travelway (ADAAG §307.2)
- Regulatory signs should be consolidated in a highly visible location to avoid confusion

Considerations

- Attachments to architectural features should be seamless and integrated



Freestanding / Pole Mounted

Park & Rides / Transit Centers

Selection

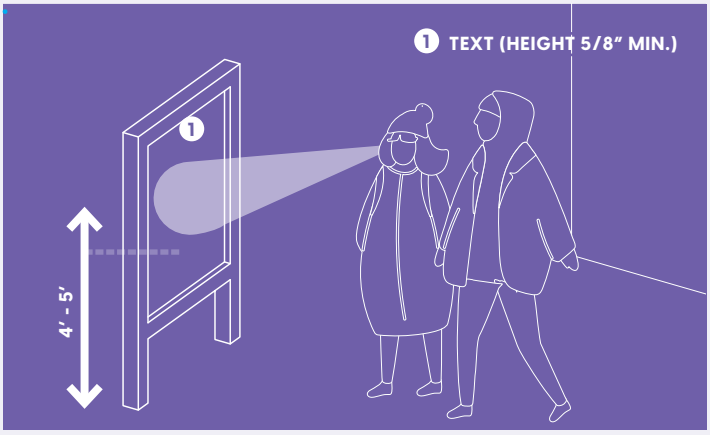
- Freestanding or pole mounted regulatory signage should communicate necessary safety information, facility regulations, and METRO resources in larger transit facilities

Requirements & Guidelines

- Regulatory signage should be located at an accessible height of 4'-5' and should have a minimum text height of 5/8" *(ARCP Report 52; ADAAG §703.4)*
- Regulatory wayfinding should be standardized across all METRO facilities
- Regulatory signage specific to facilities should be translated into multiple languages or should be complemented by clear iconography
- Signage should not project more than 4" into the travelway (ADAAG §307.2) and should be located with at least 4' passing space within the travelway
- Regulatory signs should be consolidated in a highly visible location to avoid confusion

Considerations

- Consider displaying station-specific signage as positive reinforcement rather than negative language (i.e. "Buses Only" in lieu of "No Personal Vehicles"



Art

Temporary

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

- Temporary art can be applied as a decal or removable panel system on vertical or ground surfaces
- Temporary art can reflect neighborhood identity, station character, or a partnership with a local entity to celebrate Houston culture for special events

Requirements & Guidelines

- Temporary art should be made of a UV-resistant material and must be easily removed by METRO to change out featured design
- Temporary paving paint or ground-applied graphics must provide flexibility for easy removal while maintaining durability for intended use

Considerations

- Consider partnering with Houston museums, non-profits, or management districts to create interchangeable museum experiences that celebrate Houston culture, market upcoming museum exhibits, or showcase local art
- No vendor advertisements should be permitted

Structure-Integrated

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

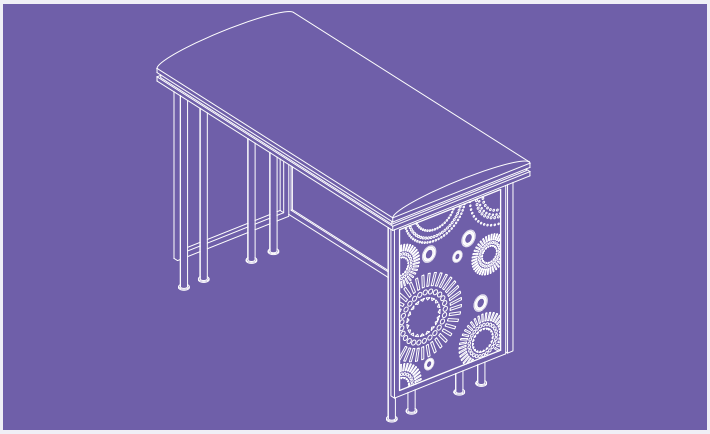
- Sculptural, textural, or visual art can be designed into the structure of bus shelters and architectural canopies to provide branding opportunities

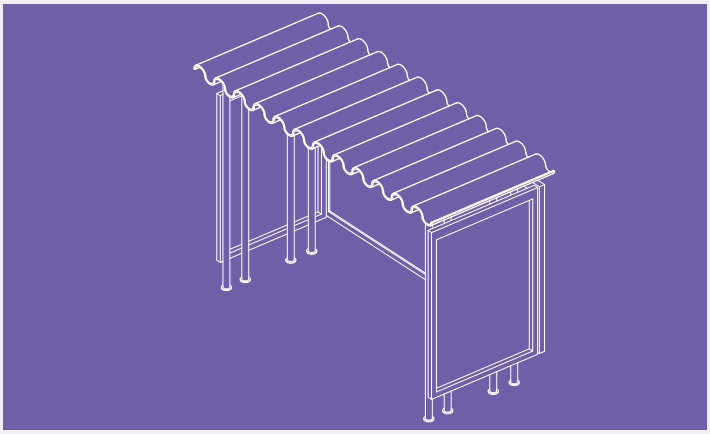
Requirements & Guidelines

- Integrated art must not obstruct or hinder primary functions of the structure design (refer to the Architecture section of Chapter 06 of the Urban Design Guidelines)
- Integrated art should be durable enough to last with consistent use, and should be easily replaced if damaged
- Structure integrated art should adhere to all applicable CPTED principles
- Style and materiality should reflect the character of the surrounding community

Considerations

- Consider subtle and elegant solutions to integrate art into structures to avoid visual clutter





Sculptural

Bus Stops / LRT / BRT / Park & Rides / Transit Centers

Selection

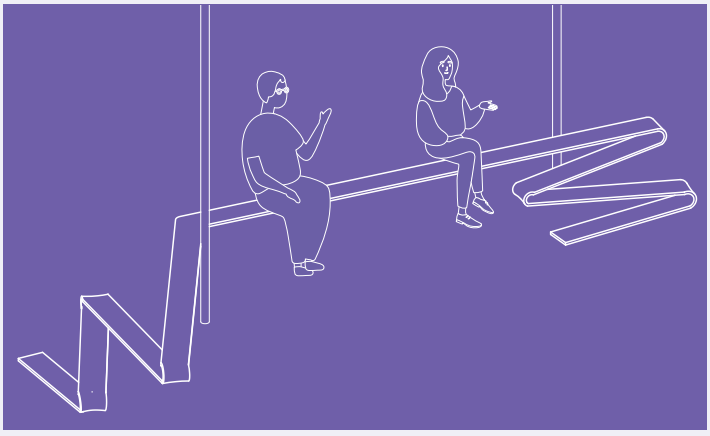
- Sculptural freestanding elements can be designed as a standalone art feature, functional art furnishing, or Transit Center wayfinding element

Requirements & Guidelines

- Structure integrated art should adhere to all applicable CPTED principles
- Style and materiality should reflect the character of the surrounding community
- Permanent sculptures should be composed of materials that age well with the facility and footings should be assessed by a structural engineer
- Temporary sculptures should be easily removable
- Ensure that permanent sculptural art does not protrude 4" into the pedestrian travelway (ADAAG §307.2)

Considerations

- Consult Houston art museums to develop a METRO-wide sculpture programming implementation plan



Embedded

Bus Stops / Park & Rides / Transit Centers

Selection

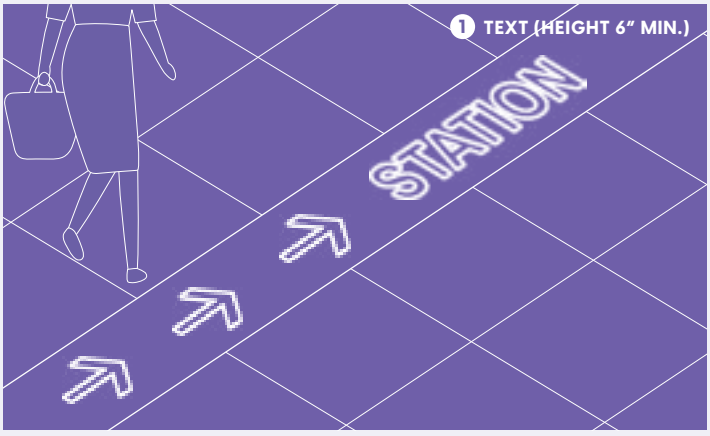
- Embedded art can serve as a wayfinding tool guiding riders to key facility elements, provide accents to the paving motif, or reflect community branding

Requirements & Guidelines

- Embedded art should be designed with a slip-resistant material in the travelway
- Letters should not pose as a tripping hazard; embedded art in the travel way should be flush with adjacent paving materials
- Embedded art should coordinate with and minimize the use of expansion / control joints
- Embedded wayfinding should consider the scale of the site and letter size legibility
- Embedded art should contrast with the surrounding paving

Considerations

- Consider the use of embedded art to denote the direction of travel for LRT and BRT stations



New Horizons for Urban Design

Scale
regional | neighborhood | site

Learning Objective
Prepare for the emerging trends and innovations that may influence transit in our region

Summary
Transit is in a continuous state of evolution and urban design must respond as services are expanded or reorganized, new vehicles or fuel sources are introduced, technological innovations emerge, and development patterns, population distribution, and policy priorities change over time.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Growing Trends

New Horizons for Urban Design & Transit

As METRO looks to the future, transit must be an integral part of regional mobility and urban design will be the tool to weave together different modes of transportation and the fabric of communities. Houston and the surrounding region's defining challenges related to climactic disasters and heat island effect, unrestrained sprawl, social inequity, and misconceived perceptions of transit as a less desirable alternative to vehicular transportation will only continue to aggregate unless corrective and collective actions are taken.

There are also new dynamics that will impact the future of transit and urban design. There are emerging technological innovations in alternative fuels, automated vehicles (AVs), and big data. There may also be disruptive technologies on the horizon yet to be envisioned. The public, private, and civic sectors are initiating concerted efforts to promote economic and environmental equity along with social justice. The COVID pandemic has revealed important transportation and community vulnerabilities that will also demand attention. METRO is tracking these trends and piloting innovative approaches to adapt to the new demands in technological advances, climate adaptation, and social equity.

Flashback to Fast Forward

While it may be difficult to predict exactly what technologies, unexpected disruptions, and challenges will influence transit in the region in the future, historical milestones in the evolution of transportation over the last hundred years demonstrate the significant changes that are possible in a relatively short span of history. Starting in the early 1900s, the automobile became the main factor in determining development patterns and the quality of urban environments. Communities embarked on large-scale projects to accommodate cars, reshaping their streets and public spaces. The results of these projects created car dependence, increased racial and economic segregation, and resulted in high traffic fatalities, long commutes, and rising greenhouse gas (GHG) emissions.

METRO advocates for a path that diverges from the car-centric past. Understanding the transportation milestones that were achieved in the last century should inspire the METRO region to implement the policies, practices, and projects that will deliver an alternative future that adapts to these unforeseen changes and challenges through the organizational framework that the Urban Design Manual provides.

Transportation Milestones

1900s

Railroads at their zenith with approximately 254,00 miles of rail

Streetcars and subway systems emerge changing urban way of life

Transportation systems promote population migration

Streetcars, subways, and the automobile replace horse-drawn carriages (and associated pollution problem – manure)

First drive-in gas station opened in Pennsylvania in 1913 (Today, there are 110,000)

Harris County population fewer than 200,000 (Today, it's 4.7 million)

1920s

Cars in America increase from 8,000 to more than 2 million in 1920 (Today, there are 290 million)

Private companies purchase streetcar systems and convert them to bus lines laying the groundwork for the dominance of the automobile

1956

Interstate Highway Act is signed (Today, there are 49,000 miles of highways in the U.S.)

1979

METRO opened for business (Today, serves 1,300 square miles using multiple types of transit)

2004

METRO's Red Line Light Rail opens. (It is one of the highest performing rail lines in the U.S.)

2014

Ride-Hail services enter Houston market

2015

METRO deploys an electric bus pilot project

2019

METRO's Autonomous Vehicle Pilot Begins

2021

President Biden announced goal to achieve over 50% reduction in net greenhouse gasses (GHG) pollution in 2030 (from 2005 levels)

2022

METRO issues its Climate Action Plan

2030

METRO only procures Zero Emissions vehicles

METRO purchase 35% of its energy from renewable sources

2040

Completion of METRONext Projects

Future Mobility Guidelines

The National Association of City Transportation Officials (NACTO) produced a "Blueprint for Autonomous Urbanism" which helps point to future scenarios that may emerge. NACTO emphasizes that technological changes present a chance to remake streets to shape the new mobility system, reduce driving and vehicle miles traveled (VMT), offer mobility to everyone, reduce carbon emissions, decrease traffic fatalities, and increase economic opportunities. NACTO's Principles for the Autonomous Age are listed below. These principles are not dependent on any specific technology, but rather demand thoughtful consideration of how streets are designed, allocated, and shared among users to result in safety, sustainability, or equity gains. These principles closely align with the objectives of this Urban Design Manual. and demand additional actions around the safety of the region's residents as new technology is developed:

- Design for Safety
- Move People Not Cars
- Distribute the Benefits Equitably
- Data-Driven Decision Making
- Technology is a Tool
- Act Now!

Regional Actions

- Review and implement recommendations from relevant innovation plans available today and yet to be published (e.g. *METRO Climate Action Plan*, *NACTO Blueprint for Autonomous Urbanism*, *Resilient Houston*, *City of Houston Climate Action Plan*, *Houston's Regional Infrastructure Strategy for Electrification (RISE) Report*, etc.)
- Develop and implement regional strategy for deployment of sensor and computing capability infrastructure to optimize traffic management, autonomous cars, industrial robotics, autonomous delivery, drones, automated road and bridge inspection, smart city and national security applications
- Transition transit fleets and support infrastructure to zero emissions with proven new technologies
- Plan and implement charging and fueling infrastructure for municipal fleet vehicles
- Embrace streets as public spaces with design and engineering that balance walking, biking, driving, and transit
- Designate street space for transit that can also accommodate future AVs (it is easier to automate a vehicle that runs on a fixed, routine route). AV-only lanes are reserved solely for automated mass transit
- Promote development at appropriate patterns and densities to support transit
- Develop frameworks to regulate autonomous ride-hail services
- Advocate for appropriate technology programming to balance safety of passengers and passers-by in the event of a crash or potential crash
- Ensure private sector is accountable for safety of their vehicles. Advocate that federal and state governments adopt objective and verifiable safety performance tests that set a high-performance bar to protect all right-of-way users, including those in urban areas
- Agencies and first responders prepare for

how new technologies, AVs, alternative fuels may impact operations, emergency response, and risks of terrorism or cyberattack

- Develop and support digital systems to better enable regulation, monitoring, management, and planning of transit services and assets
- Require public and private sector entities to share data allowing agencies to make better investments in transportation infrastructure (e.g. AV data, journey data, and asset data)
- Develop approaches to protect Personally Identifiable Information (PII)
- Engage workforce to develop policies and job training opportunities for the new economy include more complex, varied jobs in communications, IT, planning, customer service, maintenance, and security

Neighborhood Actions

- Plan for volume and diversity of street users, speeds, and modes that makes urban streets infinitely more complex than limited-access, rural, or suburban roads
- Evaluate the preferred allocation of public space. Consider the impact of technologies on the street right-of-way and leverage it for the improvement of the public realm
- Redesign streets to support high-efficiency and active transportation like buses, biking, and walking
- Take advantage of quick-build tools to rapidly increase the quality and quantity of transit facilities, protected bike lanes, and pedestrian spaces
- Develop strategies for allowing companies to site EVSE infrastructure, considering potential impacts on the energy grid
- Revising on-street parking requirements to better manage curb space usage and enhance the pedestrian experience
- Promote transit-oriented-development, mixed-use development, compact development, and infill development patterns to support transit usage, access to jobs and services, and housing affordability
- Reduce traffic speeds to reduce traffic fatalities
- Collect data from AV and other vehicles to manage streets in real-time, pinpoint hazardous locations, and direct resources towards redesigning streets for safety and efficiency

Site Actions

- Utilize curbside inventories and demand-based pricing to manage curb access in real-time
- Incorporate green infrastructure to manage stormwater, improve water and air quality, cool urban surface temperatures, and improve the public realm
- Ensure transit facility infrastructure is wired for technology to support AV transit, better manage service, and communicate with riders
- Provide alternative fueling and charging infrastructure for fleet vehicles, AVs, and personal vehicles
- Reduce the size of vehicular circulation lanes and design curbs with tighter turning radii
- Create slow zones where vehicles, pedestrians, and cyclists interact
- Provide "flex zones" to serve different users depending on the time of day
- Develop more compact Transit Centers throughout the city
- Create clear, legible striping and wayfinding signage
- Create flush accessible surfaces for level boarding

A Call to Action

Implementing the Urban Design Manual

Through the implementation of UDM guidelines, METRO has the ability to shift negative perception of transit environments throughout the region and influence the way the city continues to develop and grow in a much more transformational way.

Every department within METRO has a role and stake in the success of its operations. The UDM development process revealed that every department also has a direct impact on delivering quality urban design environments integral to that success.

Short-term, it is imperative to socialize the UDM within the Agency, enact the new project delivery process, promote a strong role for the Urban Design Task Force, revise existing METRO facility standards to align with the UDM guidelines, and create coordination, programming, and funding relationships with adjacent planning, non-profit, and private entities.

However, the UDM is just an initial step of a long-term commitment to delivering a high quality of urban design at METRO. The substantive impact of this document on the transit market in the City depends on continuously putting Urban Design principles into practice, maintaining mechanisms for project quality control, periodically revising guideline details based on new best practices while consulting the original framework for decision making, and learning from past project performance and customer feedback on a consistent basis.

By focusing on people's experience, and not just efficiency, METRO will be able to influence preferences for transit services and solidify its reputation as a regional people mover. Despite the unpredictable nature of new challenges and emerging technologies, it is vital that METRO continually prioritizes environmental resilience, diverse communities, sustainable development, and customer experience within all scales of design and facility types. This framework provided within the Manual is comprehensive, and will continue to guide METRO's decision-making for decades to come.

Headlines from 2040 and Beyond

Ecological Resilience Future Scenario

"METRO operates a fleet of zero emissions vehicles"

"Alternative fuel / charging infrastructure is readily available throughout the METRO service area for fleet vehicles, AVs, and personal vehicles"

"Vehicle-to-infrastructure communications reduce emissions and address service bunching"

The single / low-occupancy vehicle is deprioritized making transportation lanes and curbside space available for the public benefit"

"Green infrastructure such as permeable medians or raingardens manage stormwater, keep neighborhoods cool, and provide green space for people to enjoy"

Diverse Communities Future Scenario

"Dedicated transit lanes and improved bike lane networks increase the overall efficiency of the transportation network"

"A seamless, safe, and pleasant walking experience exists and includes required vehicle yielding, flush accessible surfaces, medians for refuge, shorter crossing distances, and amenities such as seating"

"Low vehicle speeds make it safe to move in any mode. Smaller and fewer traffic lanes are needed as vehicle speeds are reduced"

"Street surfaces indicate the rules of the road in place of striping"

"Technologies such as sensors and LIDAR collect data, price, and manage curbs as flexible, or "flex," zones to serve different uses and users at different times"

Sustainable Development Future Scenario

"Transit improves mobility to support growth without congestion"

"Private vehicles and parking are deprioritized"

"Compact development, infill development, and transit-oriented development (TOD) creates areas conducive to transit as well as housing affordability"

"With increased transit usage, travel times improve or remain unchanged even as population grows"

"Pricing and freight management policies reduce the total number of vehicles on the street, freeing up new opportunities for public space"

"Freight and delivery services are consolidated to increase efficiency. Vehicles are downsized"

Customer Experience Future Scenario

"Transit integrates seamlessly with point-to-point options with multiple providers"

"First mile / last mile connections are supported by local transit, shared micro-mobility options, bike lanes, and accessible sidewalks that are abundant"

"AV vehicles effectively detect and yield to people walking and biking in all conditions to protect public health and safety"

"Safe, slow vehicle speeds are managed where vehicles and pedestrians or cyclists are likely to interact. There are frequent pedestrian stopping points or pedestrian islands for safety"

"Plazas, parklets, and pocket parks attract people of all ages"

"Personally Identifiable Information (PII) is fully protected"

Appendices

Scale
regional | neighborhood | site

Learning Objective
Access additional detailed information for site analysis, planning, and design

Summary
Additional details are provided including technical resources for green infrastructure and paving, existing facilities inventory and analysis, glossary, and references.


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Technical Appendix

The following pages consist of technical resources for the selection, design, and maintenance of Green Infrastructure within METRO facilities. Case studies, selection criteria, accreditation considerations, and maintenance guidelines are provided to aid in the adoption of Green Infrastructure into METRO's facility standards.

Watearth

Green Infrastructure Recommendations

Houston Metro Urban Design Master Plan

Project	Houston Metro Urban Design Master Plan
Watearth #	20-016.1
Subject	Green Stormwater Infrastructure (GSI) Recommendations
Date	January 24, 2022
Prepared by	Jennifer Walker, PE, DWRE, CFM
	Megan Gehrke, PH

GSI Recommendations

A summary of recommended green stormwater infrastructure (GSI) options for METRO facilities is provided below. The following GSI practices are recommended for either existing or future facilities, as specified:

1. **Bioretention:** Bioretention areas use soil, plants and microbes to treat stormwater before it is infiltrated or discharged. Bioretention areas are shallow depressions filled with sandy soil, topped with a thick layer of mulch, and planted with dense vegetation. This may or may not include an underdrain to allow for biofiltration. Bioswales are a form of linear bioretention and are effective in slowing runoff velocity and cleansing water while recharging the underlying groundwater table. Due to their flexible siting requirements, bioretention areas can be integrated with existing METRO facilities or alongside sidewalks and parking lots.
2. **Vegetated Swales:** Vegetated swales are open, shallow channels with growing media and vegetation, usually grasses, that are used to improve water quality and slow the velocity of stormwater runoff. Vegetated swales are sloped to provide conveyance of stormwater.
3. **Tree Boxes:** Tree box filters are installed at curb inlets and mimic natural systems such as bioretention areas. They help with water filtration and prevent water loss due to stormwater runoff. Tree boxes can be installed with a small footprint, making them very versatile in use and placement.
4. **Planter Boxes:** In addition to preservation of any existing tree cover, planter boxes are an effective way to introduce greenery and vegetation in already developed urban areas since they can be installed either aboveground or into the ground irrespective of the surrounding soil conditions. They can also be designed as an aesthetic element to provide seating for the facilities.
5. **Vegetated Detention Basin:** These are vegetated depressions designed to hold stormwater runoff and allow the settling of sediments and associated pollutants. Stored water may be slowly drained to a nearby watercourse using an outlet control structure to control the flow rate. Vegetated detention basins can be combined with other systems of water capture or be a part of walking trails set into the landscape.
6. **Permeable Pavement:** Permeable pavements allow stormwater to percolate through the surface rather than running off into surrounding areas or storm drains. As water runs through the permeable pavement the pavement filters urban pollutants. This is a good option that can be easily installed in and around existing METRO facilities, existing walkways, and parking stalls. Underdrains may be needed in areas with soil types C and

D or soils with lower infiltration rates. This is a great option to be included in outer quadrant areas where soil has better infiltration.

7. **Green Roofs:** Existing METRO facilities can be retrofitted to include green roofs to help mitigate the urban heat island effect and to reduce the amount of rainwater runoff. Green roofs can be installed on most roofs including the smallest bus shelter.
8. **Shade Trees:** Trees can be planted in all quadrants (possibly excluding the Core and southwest quadrant due to dense urban development). Trees help reduce the urban heat island effect and align well with the City of Houston's Resilient Houston Plan target of planting 4.6 million new native trees by 2030. Native shade trees would help reduce the urban heat island effect and improve air quality.

GSI recommendations for facility retrofits and new facilities on a quadrant-specific basis are summarized below and in **Table 1**. The METRO Service Area is divided into five areas, including the Core and the North-East, North-West, South-East, and South-West quadrants. All five areas contain existing METRO facilities such as bus stops, transit stops, park & ride facilities. The highest density of facilities are in the Core area due to the presence of the rail line. Future facilities have been proposed in all five areas.

Table 1: GSI Recommendations for Facility Retrofits and New Facilities.

Green Infrastructure	Core	South-West	North-West	North-East	South-East
Bioretention	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit
Vegetated Swales	✓ New	✓ New	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit
Tree Boxes	✓ Retrofit	✓ Retrofit			
Planter Boxes	✓ Retrofit	✓ Retrofit			
Vegetated Detention Basin			✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit
Permeable Pavement	✓ New	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit
Green Roofs	✓ Retrofit	✓ Retrofit			
Shade Trees	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit	✓ New ✓ Retrofit

Watearth

Green Infrastructure Case Studies

Houston Metro Urban Design Master Plan

Project	Houston Metro Urban Design Master Plan
Watearth #	20-016.1
Subject	Green Stormwater Infrastructure (GSI) Case Studies
Date	March 4, 2022
Prepared by	Jennifer J. Walker, PE, DWRE, CFM, ENV SP
	Megan Gehrke, PH

GSI Case Studies

Case studies of recommended green stormwater infrastructure (GSI) options for METRO facilities are provided below. Case studies were chosen based on feasibility of implementation and relevance to the transit environment and Houston climate.

Bioretention

1. **Cottage Grove Rain Gardens (Houston, TX).**

Figure 1 - Rain Garden at Cottage Grove
Photo courtesy and copyright of Watearth, Inc.

TYPE OF INFRASTRUCTURE: Bioretention - Rain Garden

PROJECT SIZE: Two city blocks

COST & FUNDING: $778,243 (Federal 60% and Local 40% Capital Improvements Plan project funded by a grant from the Environmental Protection Agency

LOCATION: Houston, TX (corners of Darling Street and Detering Street and Darling Street and Reinerman Street)

ISSUE: Elevated bacteria concentrations that posed a risk to anyone swimming or wading in the water

INTERVENTION: Deep ditches and culverts on both sides of the street were replaced by bioretention (rain garden)

BENEFITS: Stormwater is filtered in the bioretention, so there is less pollution in downstream rivers to allow for beneficial uses

Source: Cottage Grove O & M Plan

2. **Austin Bergstrom International Airport (Austin, TX).**

TYPE OF INFRASTRUCTURE: Bioretention and Rain Garden

PROJECT SIZE: One airport block

COST AND FUNDING: Information not available

LOCATION: Median of Austin Lane at Austin-Bergstrom International Airport (AUS)

ISSUE: Prevention of stormwater runoff discharges into nearby Onion Creek

INTERVENTION: Bioretention and rain gardens landscape

BENEFITS: Filtration of stormwater runoff

Source: Case Studies of GSI Strategies at Airports

Figure 2 - Bioretention and rain garden at AUS

3. **Bagby Street Redevelopment (Houston, TX).**

Figure 3 - Bagby Street planter box and trees

TYPE OF INFRASTRUCTURE: Bioretention, planter boxes

PROJECT SIZE: 12 city blocks (7.8 acres)

COST & FUNDING: $9,598,220

LOCATION: Midtown, Houston

ISSUE: Water quality improvement needed

INTERVENTION: Bioretention, planter boxes installed along sidewalks; 175 replanted trees

BENEFITS: Treats water, reduces pavement temperatures with increased street shading, improves air quality, increases property values

O&M INFORMATION: Monthly maintenance checks of BMPs; Overall, low-maintenance and local plant palettes were prioritized; water twice a week for the first two months, then occasionally during dry season; weed control; potential debris removal after heavy storm events.

POST-CONSTRUCTION INFORMATION: This project is a model for the city's future street reconstruction projects, and already has formed the basis of design in numerous active projects in Midtown.

Sources:
Convergent Water Technologies – Midtown Redevelopment Bagby Street, Houston TX

Bagby Street | Construction EcoServices

Bagby Street Reconstruction

Watearth

Green Infrastructure Case Studies

Houston Metro Urban Design Master Plan

Vegetated Swales

1. Dallas Fort Worth Airport (Dallas & Fort Worth, TX)

Figure 4 - Vegetated swale in the Grapevine Creek Corridor.

TYPE OF INFRASTRUCTURE: Vegetated Swales

COST AND FUNDING: Information not available

LOCATION: Dallas/Fort Worth Airport (DRW), TX

ISSUE: Stormwater runoff control

INTERVENTION: Filter strips and grassy vegetated swales; vegetated swale mix of 3/8" expanded shale (50%) and sandy clay (50%) in an 8" lift over a sub-base of pea gravel

BENEFITS: Reduces stormwater runoff, filters contaminants such as nitrogen, phosphorus, and total suspended solids (TSS); the 3/8" shale gradation has a saturated hydraulic conductivity to absorb 1,000 inches per hour (35% of its weight in water)

Sources:

Enhanced Vegetated Swales at DFW - ESCSI

Vegetated Filter Strip - ESCSI

2. George W. Bush Presidential Library Prairie Vegetated Bioswales (Dallas, Texas)

Figure 5 - Prairie flowers in the vegetated bioswale.

TYPE OF INFRASTRUCTURE: Vegetated Swales

PROJECT SIZE: 25 acres

COST & FUNDING: Information not available

LOCATION: Dallas, TX

ISSUE: Designed to educate the public on how ecology and sustainability, particularly stormwater and plants, shape the park

INTERVENTION: Vegetated swales

BENEFITS: Increased biodiversity, restoration of native habitat, limits excessive irrigation

POST-CONSTRUCTION INFORMATION: Information not available

Source: American Society of Landscape Architects

Silva Cell

1. Silva Cell Landscape at Arrive Hotel in Austin

Figure 6 - Soil in the Silva cell helps with tree growth and stormwater treatment

Figure 7 - The Silva cell suspends pavement and allows for more soil volume and loosely compacted soil.

TYPE OF INFRASTRUCTURE: Silva Cell

LOCATION: Austin, TX

ISSUE: Enriching landscape, improving stormwater infiltration

INTERVENTION: Vegetated swales

BENEFITS: The DeepRoot's Silva Cell® provides soil volume and loosely compacted soil to grow healthy mature trees while balancing water infiltration; The tree shade will reduce heat island effect and improve air quality; There is also water quality and water pollutant control and peak overflow reduction and flow control.

O&M INFORMATION: Low/no maintenance

POST-CONSTRUCTION INFORMATION: Information not available

Sources:

Austin Hotel Choose Silva Cell

Deep Root - The Silva Cell

Watearth

Green Infrastructure Case Studies

Houston Metro Urban Design Master Plan

Tree Boxes

1. City of Houston Cottage Grove LID Green Street Project (Houston, TX).

Figure 8 - Completed tree box
Photo courtesy of and copyright Watearth, Inc.

TYPE OF INFRASTRUCTURE: Tree boxes

PROJECT SIZE: 6 acres

COST & FUNDING: Information not available

LOCATION: Houston, TX (Darling Street)

ISSUE: Management of stormwater runoff

INTERVENTION: Tree boxes (other parts of the project include porous pavement, vegetated swales, and bioretention)

BENEFITS: Collects and treats stormwater runoff

O&M INFORMATION: Remove trash, evaluate filter media, evaluate plant health, replace mulch as needed

Sources:
Cottage Grove O and M Plan

Fact Sheet: Whiteoak Bayou Low Impact Development Redevelopment (texas.gov)

City of Houston Cottage Grove LID Green Street Pilot – Watearth

2. Orange County Transportation Authority (OCTA) Rail Defense Against Climate Change (Orange County, CA).

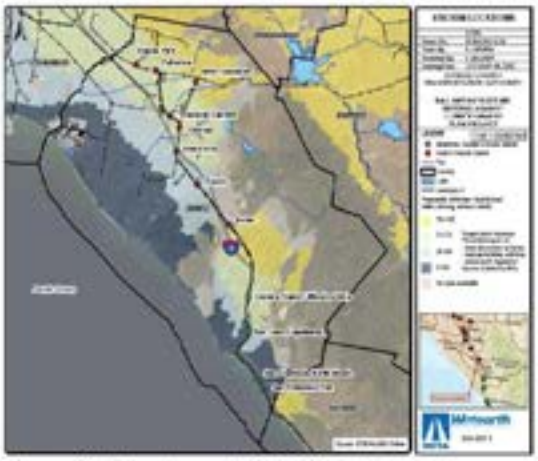

Figure 9 – Map layout of OCTA stations along with the percentile of Urban Heat Island Index among census tracts

TYPE OF INFRASTRUCTURE: Tree boxes

PROJECT SIZE: 12 Rail Stations throughout Orange County

COST & FUNDING: $284,000

LOCATION: Orange County, CA

ISSUE: Mitigation of the urban heat island effect and future climate-related risk

INTERVENTION: Tree boxes, best management practices (BMP's), vegetative and green solutions

BENEFITS: Increases shade, improve drainage in the area, reduces surface temperature at OCTA stations

O&M INFORMATION: Remove trash, evaluate plant health, replace mulch

POST-CONSTRUCTION INFORMATION: Information not available

Sources:

OCTA Rail Defense Against Climate Change Plan

Orange County Transportation Authority OC Rail Infrastructure Defense Against Climate Change Plan – Watearth

3. **The MARQ2 project (Minneapolis, MN).**

Figure 10 – Silva Cell installed in Minneapolis

TYPE OF INFRASTRUCTURE: Tree boxes (Silva Cells)

PROJECT SIZE: Two city blocks

COST & FUNDING: $8,038

LOCATION: Minneapolis, MN

ISSUE: Lane and sidewalk zone improvements needed; stormwater treatment needed

INTERVENTION: Silva Cells treat stormwater and act as a bioretention system

BENEFITS: Collects and treats approximately 1.15 acres of sidewalk runoff

O&M INFORMATION: Low/no maintenance

POST-CONSTRUCTION INFORMATION: Information not available

Sources:

MARQUETTE & 2nd Downtown Streetscape

Case studies for tree trenches and tree boxes - Minnesota Stormwater Manual (state.mn.us)

Planter Boxes and Trees

1. **Columbus Square Stormwater Planters (Philadelphia, PA)**

Figure 11 - Planter box in Columbus Square

TYPE OF INFRASTRUCTURE: Planter Boxes

PROJECT SIZE: One (1) city block

COST & FUNDING: Estimated to have cost between $100,000 and $500,000 (public funding, federal and local)

LOCATION: Philadelphia, PA

ISSUE: To collect runoff from the street and sidewalk

INTERVENTION: Planter boxes manage the first inch of every storm from the drainage area. A rain garden will also manage runoff from the adjacent street and sidewalk. This project manages 5,000 sq/ft per impervious acre

BENEFITS: Manages and treats approximately 0.74 acre-inches of runoff from every storm

O&M INFORMATION: Around 55 hours of annual maintenance – remove trash, evaluate plant health, replace mulch

Sources:

Stormwater Case 466 Columbus Square, Philadelphia PA

PhillyWatersheds

Vegetated Detention Basin

1. **Halls Bayou Sub-Regional Detention Basins (Houston, TX).**

TYPE OF INFRASTRUCTURE: Vegetated Detention Basin

PROJECT SIZE: Approximately 28,000 acres

LOCATION: Houston, TX

ISSUE: Mitigation of stormwater impacts from the Parker Road Capital Improvements Plan (CIP)

Figure 12 – View of Halls Bayou detention area

INTERVENTION: Excess capacity within the detention basin is available for mitigation of future CIP projects, private development projects, or for general flood reduction with the Harris County Flood Control District (HCFCD)

BENEFITS: Improve water quality of discharge into the Halls Bayou regional detention/wetlands basin

Sources:

City of Houston Halls Bayou Sub-Regional Detention Analysis and Parker Road CIP – Watearth

2. **Mill Road Vegetated Stormwater Detention Basin (Monroe County, NY).**

Figure 13 – Mill Road vegetated stormwater detention basin.

TYPE OF INFRASTRUCTURE: Vegetated Stormwater Detention Basin

LOCATION: Monroe County, NY

ISSUE: The nearby Brookside Meadows residential development caused a lot of stormwater runoff and sediment

INTERVENTION: The stormwater impoundment became a permanent wetland due to vegetation growth in the basin

BENEFITS: The basin reduced the average load of most pollutants and did not change the water temperature from inflow to outflow; Therefore, the outflows did not affect the

temperatures of the receiving water body nor adversely affect ecosystems or organisms in the receiving body of water

POST-CONSTRUCTION INFORMATION: Information not available

Source: USGS Vegetated Stormwater-Detention

Permeable Pavement

1. **Los Angeles County Metropolitan Transportation Authority (LACMTA) Water Conservation and Sustainability (Los Angeles, CA).**

Figure 14 - Permeable pavement post-installation
Photo courtesy and copyright of Watearth, Inc.

TYPE OF INFRASTRUCTURE: Permeable Pavement

LOCATION: Los Angeles, CA

ISSUE: Stormwater runoff from bus and railway stations contained pollutants

INTERVENTION: Stormwater capture and treatment of bus and rail wash water was evaluated for reuse using different strategies and BMPs to decide on the best treatment systems for future use

BENEFITS: Reduced runoff, stormwater treatment

O&M INFORMATION: Vacuum two times per year with regenerative air vacuum sweepers, remove trash and debris

POST-CONSTRUCTION INFORMATION: LACMTA implemented permeable pavement to effectively capture and infiltrate site runoff

Source: Watearth internal documents

2. **Orange County Transportation Authority (OCTA) Rail Defense Against Climate Change (Orange County, CA).**

Figures 15 and 16 - Buena Park and Anaheim Canyon station improvements

TYPE OF INFRASTRUCTURE: Permeable Pavement

PROJECT SIZE: Three OCTA stations

COST & FUNDING: Between $714,000 and $2,053,000

LOCATION: Orange County, CA

ISSUE: Flooding from storms and nearby creeks contains pollutants that require treatment

INTERVENTION: Installing permeable pavement to capture stormwater

BENEFITS: Reduced runoff, stormwater will be filtered by the layers of permeable pavement, improve water quality of nearby creeks

O&M INFORMATION: Vacuum two times per year with regenerative air vacuum sweepers, remove trash and debris

Sources:

OCTA Rail Defense Against Climate Change Plan

3. **Whole Foods Marketplace on North Loop West (Houston, TX).**

Figure 17 – View of the Whole Foods parking lot

TYPE OF INFRASTRUCTURE: Permeable Pavement

LOCATION: Houston, TX

ISSUE: The parking lot of Whole Foods and the adjacent intersection have a history of flooding

INTERVENTION: Permeable pavers were installed in the parking stalls to capture and convey stormwater to the stone detention area below both them and the concrete drive aisles. Stone-filled trenches provide conveyance from the outer parking stalls to the detention area.

BENEFITS: Less flooding

O&M INFORMATION: Vacuum two times per year with regenerative air vacuum sweepers, remove trash and debris

POST-CONSTRUCTION INFORMATION: The initial surface infiltration rate of 833 in/hr.

Source: Whole Foods Houston: Stormwater Management Case Study

4. **Westmoreland Neighborhood (Portland, OR).**

TYPE OF INFRASTRUCTURE: Permeable Pavement

PROJECT SIZE: Three neighborhood blocks

COST & FUNDING: $412,000 (in 2004)

LOCATION: Portland, OR

ISSUE: The original concrete and asphalt sections of the streets were deteriorated

INTERVENTION: Permeable pavement (brick-like concrete blocks) were installed on three blocks in the Westmoreland neighborhood

BENEFITS: The permeable pavement absorbs 60 in/hr, 27% faster than the original concrete that was removed

O&M INFORMATION: Vacuum two times per year with regenerative air vacuum sweepers, remove trash and debris

POST-CONSTRUCTION INFORMATION: Information not available

Figure 18 - The completed permeable pavement at Westmoreland Neighborhood

Sources:

Pervious Pavement Projects || Pervious Pavement | The City of Portland, Oregon (portlandoregon.gov)

Westmoreland Permeable Pavement Pilot Project - Mutual Materials

Green Roofs

1. **Austin City Hall (Austin, TX).**

Figure 19 - Austin City Hall green roof

TYPE OF INFRASTRUCTURE: Intensive Green Roofs

PROJECT SIZE: Approximately 12,000 sq. ft.

COST & FUNDING: $30/sq. ft. or approximately $360,000

LOCATION: Austin, TX

INTERVENTION: The plaza on top of the underground parking garage features an innovative garden with a continuous 5-foot-deep trench to nourish several large live oak trees. It also contains a lightweight rooftop landscape soil providing additional volume for root growth for the large trees.

BENEFITS: The green roof contains native plants from various ecosystems in Travis County, TX and uses efficient irrigation technologies to apply water directly to plant roots (no potable water was used as ground water is available

O&M INFORMATION: Monthly structural inspections for the first year after installation – including joints at adjoining walls, roof penetrations for vents, electrical conduits for leaks, sealings below green roofs for water staining or leaking. Once a week maintenance includes removing dead vegetation, sediment accumulation, drainage paths and drainage system components to ensure that surface drainage is maintained. Also, clean out drain inlets as needed.

POST-CONSTRUCTION INFORMATION: Information not available

Sources:

https://www.greenroofs.com/projects/austin-city-hall/

https://www.austintexas.gov/sites/default/files/files/Sustainability/Green_Roof/City_Hall_Case_Study.pdf

2. **Green Roofs on Bus Stops (Utrecht, Netherlands).**

Figure 20 - A bus stop with a green roof in Utrecht, Netherlands

TYPE OF INFRASTRUCTURE: Extensive Green Roofs

PROJECT SIZE: 316 bus shelters

LOCATION: Utrecht, Netherlands

INTERVENTION: Installing sedum-covered extensive green roofs atop 316 bus stops

BENEFITS: Promotes a healthy city living environment; captures particulates, stores rainwater, provides cooling, and promotes the city's biodiversity (bees and other insects)

POST-CONSTRUCTION INFORMATION: Information not available

Source: Green-roofed bus shelters in Utrecht | Gemeente Utrecht

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Shade Trees

1. **Port of Corpus Christi Authority (PCCA) Drainage Master Plan (Corpus Christi, TX).**

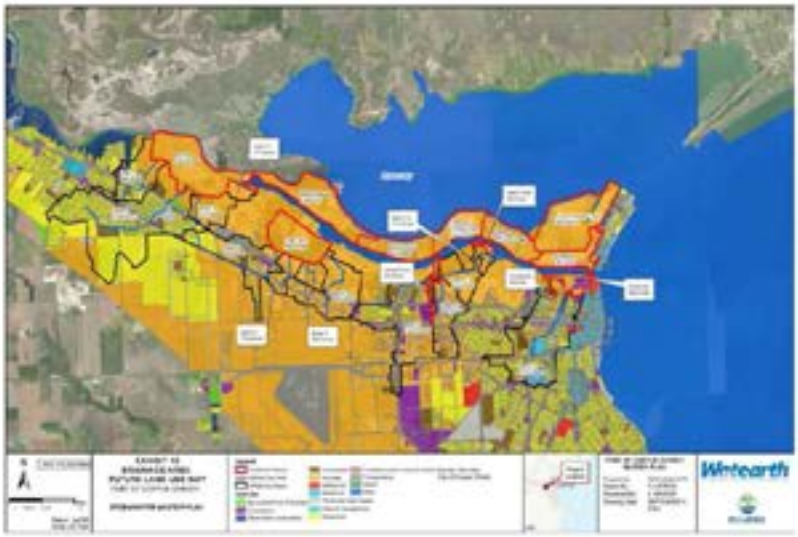

Figure 22 - Drainage Area of the Port of Corpus Christi.

TYPE OF INFRASTRUCTURE: Shade Trees

PROJECT SIZE: 5,481 acres

COST & FUNDING: Information not available

LOCATION: Corpus Christi, TX

ISSUE: Addressing storm water volume and quality as the development of Port of Corpus Christi continues

INTERVENTION: Implementation of green infrastructure such as shade trees throughout commercial and industrial areas

BENEFITS: Cost-effective, improves water quality, and reduces stormwater runoff

Source: Watearth internal documents

2. **Los Angeles Bureau of Engineering (LABOE) Sidewalk Repair Program Environmental Impact Report (EIR) Hydrology and Water Quality Technical Study (Los Angeles, CA).**

TYPE OF INFRASTRUCTURE: Shade Trees

PROJECT SIZE: Throughout the City of Los Angeles

COST & FUNDING: Information not available

LOCATION: Los Angeles, CA

ISSUE: Some sidewalks and driveways were not compliant with the Americans with Disabilities Act (ADA); Four types of trees that were causing damage to the sidewalks were removed throughout the city, including the Indian Laurel Fig tree, Carob tree, Canary Island Pine tree and the Indian Stone Pine tree.

INTERVENTION: Implemented tree replacements that were less damaging to the sidewalk to mitigate the impact of tree removal and improve the city's shade canopy.

BENEFITS: The suggested trees were beneficial to the Mediterranean climate and required less water, so reduced overall maintenance resources.

Source: Watearth internal documents

3. **South Oak Cliff Neighborhood (Dallas, TX).**

Figure 23 - Volunteers with the Texas Tree Foundation apply mulch to one of hundreds of new trees in December 2017

TYPE OF INFRASTRUCTURE: Shade Trees

LOCATION: Dallas, TX (South Oak Cliff neighborhood)

COST & FUNDING: Information not available

ISSUE: Urban Heat Island effect in Dallas due to lack of tree coverage. The unshaded pockets are 11 degrees hotter than the city's average during the peak summer heat.

INTERVENTION: The Texas Free Foundation planted 500 trees by the fall of 2018 and collaborated with residents to map out water schedules until the trees reached maturity. The residents today continue to nurture local tree growth. In addition, over 25 doners gave $2 million to acquire a space that was previously an illegal dumping site to become a community park with planted trees.

BENEFITS: Less urban heat island effect, over 500 trees were planted that are now mature, there is a new community park with planted trees

POST-CONSTRUCTION INFORMATION: After 1,000 trees have been planted, the trees will be evaluated for two years and plans will be developed to further expand access to nature.

Sources:

Shade trees touted as remedy for urban heat islands in Dallas, Phoenix (azcentral.com)

If You Can't Take the Heat, Plant More Trees: The Cool and Connected Oak Cliff Project | Dallas Innovates

Oak Cliff dump site turns into $2.5M state-of-the-art park (spectrumlocalnews.com)

4. Tryon Street Mallscape (Charlotte, NC).

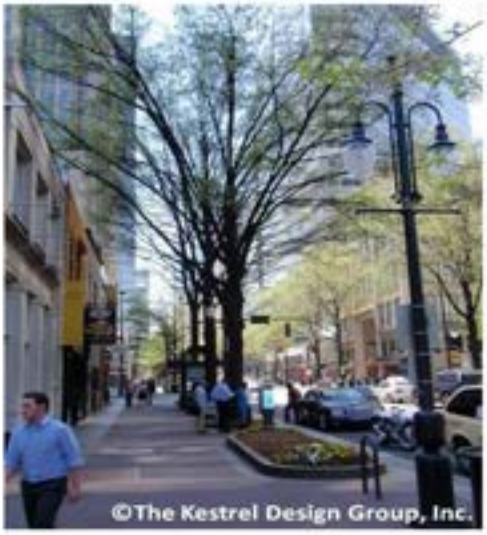

Figure 24 - The Tryon Street Mallscape trees today

TYPE OF INFRASTRUCTURE: Shade Trees

LOCATION: Charlotte, NC

COST & FUNDING: Information not available

ISSUE: Urban heat island, stormwater management

INTERVENTION: Mallscape trees were planted in 1985

BENEFITS: Shade for pedestrians. 10% reduction in peak flows into the City's stormwater system during large storm events (this may also be achieved through use of silva cells)

Source: Case studies for tree trenches and tree boxes - Minnesota Stormwater Manual (state.mn.us)

Green Tracks

3. Green Tracks Pilot Project (Baltimore, MD).

Figure 21 - Light rail traveling on top of vegetated track in the Baltimore area

TYPE OF INFRASTRUCTURE: Green Tracks

PROJECT SIZE: Four track systems in the existing light rail system

COST & FUNDING: $199,067

LOCATION: Baltimore, Maryland

INTERVENTION: The Maryland transit authority evaluated the feasibility of installing and maintaining a vegetated track system on a commuter rail in Maryland.

BENEFITS: Reduces the urban heat island effect, increases water quality, reduces runoff

O&M INFORMATION: Watering, yearly fertilization to replenish soil nutrients (a soil test should be carried out prior to fertilization to avoid an overload of nutrients), weeding

POST-CONSTRUCTION INFORMATION: Information not available

Source: Conserve North Texas - Green Tracks Pilot Project

7. Structural calculations shall be submitted that demonstrate the structure's ability to sustain the additional loading of the green roof appurtenances plus the maximum water weight that could be stored.

***Figure 6**: Green Roof Example – Oakland, California*
Photo courtesy of and copyright, Watearth, Inc.

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Core and South-West Quadrant

The Core and South-West quadrant are densely developed, making large-scale GSI infrastructure not possible in these areas. However, smaller, easy-to-implement features can be used throughout these two quadrants, with a focus on retrofitting. The most appropriate GSI practices for these two quadrants are:

1. Tree Boxes;
2. Planter Boxes;
3. Green Roofs;
4. Permeable Pavement (parking stalls in South-West only);
5. Shade Trees; and/or
6. Bioretention (along sidewalks and parking lots if existing grades permit).

Any future facilities developed should at minimum ensure that the existing urban tree cover is conserved and green stormwater management practices are followed. Future facilities in these areas may utilize these GSI features:

1. Bioretention;
2. Vegetated Swales;
3. Permeable Pavement; and/or
4. Shade Trees.

North-West, North-East, and South-East Quadrants

The North-West, North-East, and South-East quadrants are less densely developed and therefore have more options available in terms of GSI retrofits. A combination of many of the recommended GSI elements may be implemented in these areas, dependent on the facility-specific environmental conditions and the amount of space available. Recommendations for retrofits in these areas include:

1. Permeable Pavement (around existing facilities and parking lots);
2. Vegetated Swales;
3. Bioretention (particularly in outer areas);
4. Vegetated Detention Basins; and/or
5. Shade Trees.

The North-West Quadrant is the largest of the five areas and contains relatively large undeveloped areas. The quadrant has plentiful green spaces, especially towards the northern border, and this open space can be used for runoff capture and treatment elements that supplement or replace existing systems. Both the North-East and South-East quadrants are medium built density and offer space for GSI developments. Other areas of the quadrants that already have built density could benefit from smaller interventions such as vegetated swales. Since the South-East quadrant is closest to the Galveston Bay, it is the first affected by storms or flooding, and since the whole of the South-East quadrant is likely to be affected by sea level rise, bioretention and vegetated swales would help build resiliency in the area. Runoff capture that could be used includes bioretention, vegetated swales, and vegetated detention ponds. The

outer open areas of the quadrant can support detention ponds of different sizes as needed. The most appropriate GSI practices for new facilities in this quadrant include:

1. Bioretention;
2. Vegetated Swales;
3. Shade Trees;
4. Permeable Pavement; and/or
5. Vegetated Detention Basin with walking trails (in outer areas of the quadrant).

Watearth

Houston Metro Urban Design

Green Stormwater Infrastructure Implementation

Project	Houston Metro Urban Design Master Plan
Watearth #	20-016.1
Subject	Green Stormwater Infrastructure (GSI) Implementation Requirements
Date	March 4, 2022
Prepared by	Jennifer Walker, PE, DWRE, CFM, ENV SP
	Megan Gehrke, PH

GSI Implementation Requirements

The COH Public Works *Infrastructure Design Manual (IDM; COH Public Works, 2021)* and Harris County manual on *Low Impact Development & Green Infrastructure Design Criteria for Storm Water Management (Harris County, 2011)* detail GSI design criteria, as summarized below.

Bioretention

Due to their flexible siting requirements, bioretention areas can be integrated with existing METRO facilities or alongside sidewalks and parking lots. The *COH Public Works IDM* (2021) outline the following design criteria:

1. Determine volume of bioretention area below maximum design water surface. Depth of ponding limited to a maximum of 6 inches.
2. Demonstrate that sufficient area contributes stormwater runoff to the bioretention area to fill the area to its maximum design water surface for the design storm under consideration.
3. Using in-situ or new soils, design the bioretention area to empty within 48 hours. This may be accomplished through infiltration, evapotranspiration, and/or the design of a subsurface drainage system.
4. Mitigating detention volume requirements can be reduced by the volume in the bioretention area below its maximum design water surface.
5. Runoff from commercial areas and parking lots requires pretreatment, grass buffer strip or vegetated swales, prior to draining into bioretention area.
6. Infiltration rates less than 0.5 inches per hour will require a subsurface drainage system.
7. Geotechnical testing is required to confirm infiltration rates.

Figure 1: *Bioretention Example – High Point, Seattle, Washington*
Photo courtesy of and copyright, Watearth, Inc.

Bioretention/Planter Box

Stormwater planter boxes, also known as flow-through planters, are bioretention systems enclosed in concrete structures. They can be designed to:

1. Drain runoff from paved areas via curb inlet structures or pipes, or
2. Treat roof runoff when located at the building downspout.

Planter boxes can be installed either above ground or into the ground, irrespective of the surrounding soil conditions. They can also be designed as an aesthetic element to provide seating. Critical planter box design elements include (*HCFCD, 2011*):

1. Underdrain pipe;
2. Waterproofing (for planter boxes sited near buildings and other structures);
3. Most design standards for bioretention systems also apply to stormwater planter boxes, and;
4. Plants can be selected from those used in typical bioretention systems.

Houston Public Works IDM does not contain design criteria specific to planter boxes; however, the 24-inch ponding depth requirement is applicable.

***Figure 2**: Bagby Street planter box and trees*
Source: Convergent Water Technologies – Midtown Redevelopment Bagby Street, Houston TX

Vegetated Swale

Vegetated swales are open, shallow channels with growing media and vegetation, usually grasses, to improve water quality and slow the velocity of stormwater runoff. Vegetated swales are sloped to provide conveyance of stormwater.

Design criteria for vegetated swales from *COH Public Works IDM* are below:

1. Soil infiltration rate of 0.27 to 0.50 inches/hour (in/hr).
2. Trapezoidal or parabolic cross section.
3. Bottom width:

   a. Dry swale bottom width shall be 2 feet wide minimum or 6 feet wide max.
   b. Wet swale bottom width shall be 2 feet wide minimum or 8 feet wide max to avoid gullying or channel braiding.
4. Longitudinal slope shall range from 1% to 6%.
5. Flow depth shall be less than 4 inches for water quality treatment.
6. Flow velocity shall be less than 1 fps for water quality and less than 5 fps for 2-yr storm (non-erosive velocities for grass and soils).
7. Length shall yield a 10 minute residence time.
8. Side slopes shall be flatter than 3:1.
9. Maximum ponding time shall be 48 hours.
10. Use proper vegetation (grass or wetland plants) consistent with climate, ecoregion, soils, and hydric conditions.
11. Provide at least 3 inches of free-board during design storm.
12. Provide pretreatment of runoff into the swale.

Harris County (2011) suggests checking dams for use in typical vegetated swales to act as flow spreaders, inducing sheet flow along the swale. They may also be used as a stormwater detention mechanism to encourage sedimentation and reduce runoff velocity and as pretreatment devices for other structural treatment controls.

***Figure 3**: Vegetated Swale Example – Riverside County Flood Control District, California*
Photo courtesy of and copyright, Watearth, Inc.

Tree Box

Tree box filters are installed at curb inlets and mimic natural systems such as bioretention areas. Tree boxes can be installed with a small footprint, making them versatile in use and placement. They consist of:

1. Precast concrete (or other) container;

2. Mulch layer;
3. Planting media;
4. Observation and cleanout pipes;
5. Under-drain pipes
6. One street tree or large shrub; and,
7. Grate cover.

The filters are installed below grade at the curb line. For low to moderate flows, stormwater enters the tree box inlet, percolates through the media, and exits through an underdrain into the storm drain. Stormwater bypasses the tree box filter once it becomes full and flows directly to the downstream curb inlet for high flows. Under normal conditions, pretreatment is not necessary.

Most general design standards for bioretention systems also apply to tree box filters. Therefore, tree box filters should generally be designed per the bioretention system design criteria and engineered media testing requirements (*Harris County, 2011*).

***Figure 4**: Tree Box Example – Cottage Grove, Houston, Texas*
Photo courtesy of and copyright, Watearth, Inc.

Permeable Pavement

Permeable pavement can easily be installed in and around existing METRO facilities, existing walkways, and parking stalls. Underdrains may be needed in areas with soil types C and D or soils with lower infiltration rates. Permeable pavement typically consists of four layers, with *COH Public Works IDM* design criteria presented below:

Porous Pavement Layer:

1. Open graded pavement mixture, concrete or asphalt, specifically designed to be porous with binding agents that create a cohesive wearing surface;
2. Thickness based on the design of the pavement section and the loading requirements associated with the intended use.
3. Porous pavement may be considered to contain 18% voids (typical range is 16% to 22%).

4. Technical reference for porous concrete is FHWA-HIF-13-006.
5. Technical reference for porous asphalt is FHWA-HIF-15-009.

Top Filter Layer:

1. Crushed stone (0.5 inch diameter) to a depth of 1 to 2 inches serves to stabilize the porous concrete layer.
2. Can be combined with reservoir layer using suitable stone.

Reservoir Layer:

1. Washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a void space of about 40%.
2. Depth depends on desired storage volume:
    a. Function of the soil infiltration rate and void space
    b. Typically ranges from two to four feet.
    c. Minimum depth of nine inches.
3. Must drain completely in 48 hours.
4. Must store, at a minimum, the water quality volume (WQv).
5. Aggregate contaminated with soil shall not be used.
6. A porosity value (void space/total volume) of 0.32 shall be used in calculations unless aggregate specific data exist.

Bottom Filter Layer:

1. 6-inch layer of sand (ASTM C-33 concrete sand) or a 2-inch thick layer of 0.5 inch crushed stone.
2. Completely flat to promote infiltration across the entire surface.

Filter Fabric:

1. Line the entire trench area with filter fabric prior to placement of aggregate.
2. Filter fabric inhibits soil from migrating into the reservoir layer and reducing storage capacity.
3. Fabric shall be MIRFI # 140N or equivalent.

Underlying Soil:

1. Infiltration capacity of at least 0.5 in/hr, but preferably greater than 0.5 in/hr.
    a. Initially determined from NRCS soil textural classification, and subsequently confirmed by field geotechnical tests.
    b. Minimum geotechnical testing is one test hole per 5,000 square feet, with a minimum of two borings per facility (taken within the proposed limits of the facility).
2. Infiltration trenches may not be appropriate for use in fill soils. Soils at the lower end of this range may not be suited for a full infiltration system.
3. Test borings are recommended to determine the soil classification, seasonal high ground water table elevation, impervious substrata, and an initial estimate of permeability.

4. Often a double-ring infiltrometer test is done at subgrade elevation to determine the impermeable layer, and for safety, one-half the measured value is allowed for infiltration calculations.

***Figure 5**: Permeable Pavement Example – LA Metro, California*
Photo courtesy of and copyright, Watearth, Inc.

Green Roofs

Existing METRO facilities can be retrofitted to include extensive green roofs to help mitigate the urban heat island effect, reduce the amount of rainwater runoff, and can be installed on most roofs including the smallest bus shelter.

Design criteria for a typical extensive green roof per the Houston Public Works IDM are below:

1. Vegetation suitable to the climate and preferably a species that is drought tolerant should be used. Choose species appropriately sized for extensive green roofs, for example low-growing succulents, bulbs/corms, native grasses, wildflowers, and/or facultative species.
2. The roof membrane must be sufficiently designed and installed to pond a minimum of 1 inch of water at the most shallow point on the roof for 24 hours without leaks. This shall be tested in the same manner as shower pans are tested under the building code.
3. Special consideration to the plant root structure and prevention of soil migration during membrane selection.
4. A root barrier may also be required to protect the waterproof membrane integrity.
5. The under-drain drainage system shall be designed for the selected plant's tolerance for drought and varying soil moisture contents by maintaining the proper balance of moisture and aerobic conditions within the soil media for optimum vegetation sustainability.
6. Design provisions shall address higher volume rainfall events to keep excessive amounts of water from ponding on top of the soil, to prevent erosion, and to prevent soil media saturation for extended periods.

O&M for Green Stormwater Infrastructure

Vegetation

- ✓ Remove sediment buildup then re-plant or re-seed vegetation as needed (per COH IDM requirement).
- ✓ Remove dead vegetation if it covers greater than 10% of the area (per COH IDM requirement).
- ✓ Replant with low water use, non-invasive vegetation (per COH IDM requirement).
- ✓ Inspect for damage to vegetation after each storm with precipitation greater than 0.75 inches.
- ✓ Remove and replace mulch as needed to ensure vegetation survival (per Harris County LID and GI criteria). Ensure mulch is 3 to 4 inches deep.
- ✓ **Do not** apply fertilizers, herbicides, or pesticides (per Harris County LID and GI criteria).
- ✓ Trim overhanging limbs and bushy vegetation to decrease shading (per COH IDM requirement).
- ✓ Trim to allow sightlines and foot traffic (per COH IDM requirement).
- ✓ Use mulch without animal manure to avoid contaminants leaking into stormwater facilities.
- ✓ Inspect and remove trash and debris (per COH IDM requirement).

Erosion/Sediment Accumulation

- ✓ Inspect for erosion after every storm with precipitation greater than 0.75 inches.
- ✓ Repair erosion control elements (rock-lined depressions, gravel flow spreaders, mulch, etc.).
- ✓ Remove accumulated sediment if 2 or more inches of vegetation growth is inhibited by 2 or more inches of sediment or if sediment is blocking an even distribution and entry of water (per COH IDM requirement).
- ✓ Stabilize 2% to 4% slopes/banks with plantings from the original planting plan.
- ✓ Inspect and remove accumulated sediment and debris as needed (per Harris County LID and GI criteria).
- ✓ Annually inspect facilities upstream that may contribute to sediment loading issues.
- ✓ Note rodent holes/burrows in and around facilities.

Structural Components

- ✓ Remove obstructions from flow spreader. Clean and re-level flow spreader as needed.
- ✓ Inspect inlets for sedimentation and rock cover for integrity and debris – replenish rocks if necessary.

Infiltration

- ✓ Check for ponding 48 hours after a storm event, especially during the peak mosquito breeding months (per COH IDM requirement).
- ✓ Record time, date, and weather conditions when excessive ponding occurs.

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Houston Metro Urban Design

O&M for Green Stormwater Infrastructure

	Post-Construction	Ongoing	Plantings	Special Considerations
Bioretention	✓ Inspect monthly for erosion and ponding during the first year ✓ Inspect inlet and overflow areas ✓ Inspections can be semi-annual once system is proven to work properly	✓ Minimal plant maintenance ✓ Occasional sediment and debris removal ✓ Verify for adequate volume ✓ Verify drainage ability after a rainfall event ✓ Annual mulch replacement	✓ Evaluate plants, trees, and shrubs bi-annually ✓ Pruning, weeding, and trash removal	✓ Easy to inspect ✓ Determine reason for extended ponding and mitigate (especially if ponding occurs during mosquito breeding season) ✓ If spill occurs, remove affected materials immediately and replace as soon as possible
Vegetated Swales		✓ Maintenance includes mowing/pruning, weed control, trash removal, reseeding non-vegetated areas, and replacing plant material ✓ Inspect new swales twice annually ✓ Remove sediment when 25% of the original water quality volume has been exceeded, per COH IDM requirement.	✓ Mow dry swales to 4 to 6-inch grass height, per COH IDM requirement. ✓ Wetlands and low maintenance ground cover do not require mowing	✓ If spill occurs, remove affected materials immediately and replace as soon as possible
Tree Boxes		✓ Most common concerns are poor health, insufficient water, accumulation of litter and debris, and lost mulch ✓ Inspect after large storms to ensure there are no clogs or standing water	✓ Remove dead vegetation	
Vegetated Detention Basin		✓ Inspect observation well for water level and drainage times ✓ Conduct desilting as needed	✓ Conduct landscaping and mowing as needed	✓ Inspect access/egress routes for maintenance needs
Permeable Pavement	✓ Signs posted on parking lots to indicate stormwater function and maintenance requirements ✓ Initial inspection monthly for the first three months, per COH IDM requirement. ✓ Semi-annual inspection for sediment build-up, per COH IDM requirement.	✓ **Do not** store heavy materials on pavement ✓ Keep surrounding landscaped areas well maintained ✓ Maintenance agreements should note which maintenance tasks must be avoided ✓ Vacuum sweep hard porous pavement then complete high-pressure hosing quarterly, per COH IDM requirement. ✓ Vacuum frequency should be adjusted based on intensity of usage ✓ Annual inspection of surface and subsurface drainage system, per COH IDM requirement.		✓ Surface clogging is a frequent maintenance issue ✓ Ensure pavement is sized appropriately for expected structural load ✓ Permeable pavement should be sited in areas without heavy sediment loads ✓ To avoid spills and leaching of chemicals, **do not** stockpile materials (especially hazardous materials) on permeable pavement

	Post-Construction	Ongoing	Plantings	Special Considerations
Green Roof	✓ Develop maintenance plan per membrane manufacturer's instructions and selected plant species, per COH IDM requirement. ✓ Inspect monthly for the first year and after each storm event ✓ Inspections can be reduced to a quarterly schedule once established that system functions properly, per COH IDM requirement.	✓ Ensure there is no ponding ✓ Check erosion control measures ✓ Inspect roof drain for sediment, vegetation, or debris, per COH IDM requirement. ✓ Inspect for broken inlets or pipes ✓ Clean out drain inlets as needed ✓ Inspect ceiling for signs of water damage, per COH IDM requirement.	✓ Remove and replace dead plants, eroding areas, and bare patches ✓ Weed and remove invasive plants ✓ Replace or fill in vegetation ✓ Inspect soil levels semi-annually ✓ Fertilize twice during growing season ✓ Inspect growth medium quarterly	✓ Investigate moisture at bottom of profile (level of filter fabric) ✓ Irrigate in short bursts to prevent runoff ✓ Establish irrigation frequencies using an automated system

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BIORETENTION O&M FACT SHEET

What To Look For	What To Do
Illicit Discharges, including in the surrounding area and within the GSI.	
➢ Illicit discharge	➢ Inspect bioretention and the surrounding area for illicit discharges. Contact the City of Houston if an illicit discharge is identified.
Structural Components	
➢ Flow Spreader	➢ Clean and re-level flow spreader as needed.
➢ Underdrain	➢ Manually remove sediment accumulation to prevent underdrain clogging.
Vegetation	
➢ Dead or strained vegetation	➢ Remove dead vegetation if it covers greater than 10% of the area (per COH IDM). ➢ Replant with low-water use, non-invasive vegetation (per COH ID Mrequirement).
➢ Grasses and vegetation	➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Irrigate as needed, do not overwater. ➢ Verify presence of vegetation considered in design computations (if any) quarterly. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Remove and replace mulch [1] as needed to ensure vegetation survival. DO NOT apply fertilizers, herbicides, or pesticides [2] ➢ Prune overhanging limbs and bushy vegetation to decrease shading that could cause weak vegetation growth (per COH IDM). ➢ Prune larger vegetation twice a year to allow sightlines (per COH IDM). ➢ Re-plant and/or re-seed as needed following sediment removal activities.
➢ Weeds	➢ Manually (or with a weed eater or string trimmer) remove all invasive vegetation, noxious, and nuisance weeds. ➢ DO NOT apply herbicides[2].
➢ Trash and Debris	➢ Inspect and remove trash and debris. ➢ Remove grass clippings, fallen leaves, and debris from surrounding foliage.
Growing/Filter Medium, including soil and gravel, shall sustain healthy plant cover and infiltrate within 48 hours of introduction of runoff, without isolated ponding areas or pockets of ponding (per COH IDM).	
➢ Erosion/Sediment Accumulation	➢ Inspect for erosion after every storm greater than 0.75 inches. ➢ Repair erosion control elements such as rock-lined depressions, gravel flow spreaders, and mulch[1] ➢ Remove accumulated sediment: o as needed, o if vegetation growth is inhibited by 2 inches or more of sediment build-up o if sediment is blocking even distribution and entry of water, Re-plant or re-seed vegetation as needed following sediment removal (per COH IDM). ➢ Verify the bioretention area has adequate volume quarterly by checking whether sediment pollution has encroached on design volume (per COH IDM).
➢ Slopes	➢ Stabilize 2% - 4% slopes/banks with plantings from the original planting plan.
➢ Ponding After 48 Hours	➢ Inspect and remove accumulated sediment and debris as needed. Re-vegetate if necessary. ➢ Annually inspect upstream facilities and/or land use that may contribute to sediment loading issues. ➢ Depth of ponding limited to 6 inches maximum and using in-situ or new soils the bioretention area should empty within 48 hours. ➢ Inspect twice yearly to verify the ability of the bioretention area to drain within 48 hours after a rainfall event.

[1]Use mulch without animal manure to avoid leaching of contaminants.

[2]The use of fertilizers, herbicides, or pesticides shall be monitored and approved by METRO as these are water contaminants that can end up in stormwater runoff. Only certified professionals shall apply any chemical applications (per COH IDM). At a minimum, follow Integrated Pest Management (IPM) practices as outlined by U.S. Environmental Protection Agency (EPA): https://www.epa.gov/ipm/introduction-integrated-pest-management.

Note: See Landscape Based GSI Maintenance Schedule and Inspection Guidelines for additional details

LANDSCAPE-BASED GSI MAINTENANCE SCHEDULE AND INSPECTION GUIDELINES

The following applies to bioretention:

Maintenance Records: Inspect and maintain the bioretention system to ensure proper function and aesthetic appearance. Record date, description, and contractor or staff who performed the inspection in inspection sheets for all structural repairs and clean-out activities. Report any significant changes in stormwater quality control measures to the City of Houston—assessment reports for each pollution-generating operation and the associated stormwater quality control measures to be kept on file by the City of Houston.

Replacement and Reconstruction: Provide adaptive management to determine reconstruction or replacement of the bioretention system. Use adaptive management to restore original or revised design and function or hydrologic equivalent.

Infiltration/Flow Control: The bioretention system shall drain within 48 hours after introduction of runoff, especially during the peak mosquito breeding months (June to October) (per Harris County requirement). Record time, date, and weather conditions when excessive ponding occurs. Use practices specified under Growing/Filter Medium maintenance to restore capacity, if needed.

Pollution Prevention: Implement Best Management Practices (BMPs) such as housekeeping practices, spill control, and employee training to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Use mulch without animal manure (to avoid leaching of contaminants in GSI) where feasible. Visually inspect the bioretention system and surrounding area for illicit discharges and contact the City of Houston immediately if an illicit discharge is identified.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall comply with the local jurisdictions so as to not cause a public nuisance or undermine the facility structure. Note holes/burrows in and around facilities during inspections.

Access: Maintain ingress/egress, including access roads, to design standards.

Maintenance Schedule as Required:

Time of Year Scheduled	What To Do
Summer	Due to the subtropical climate and humid summers, more maintenance will likely be needed in the summer months. ➢ Visually inspect bioretention basin and surrounding area for illicit discharges and contact the City of Houston if any illicit discharges are identified. ➢ Verify the presence of vegetation considered in design computations. ➢ Verify volume of bioretention by comparing actual maximum depth against designed maximum depth and correct any deficiencies. ➢ Irrigate as needed. ➢ Remove plant debris and litter.
Fall	➢ Visually inspect bioretention basin and surrounding area for illicit discharges and contact the City of Houston if any illicit discharges are identified. ➢ Verify the presence of vegetation considered in design computations and correct any deficiencies. ➢ Verify volume of bioretention by comparing actual maximum depth against designed maximum depth and correct any deficiencies. ➢ Verify ability of the bioretention area to drain within 40 hours after a rainfall event, correct deficiency. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Winter	The least amount of precipitation is recorded in the winter months, so less maintenance will likely be needed in the winter months. ➢ Visually inspect bioretention basin and surrounding area for illicit discharges and contact the City of Houston if any illicit discharges are identified. ➢ Verify presence of vegetation considered in design computations. ➢ Verify the presence of vegetation considered in design computations (if any). ➢ Verify volume of bioretention by comparing actual maximum depth against designed maximum depth and correct any deficiencies. ➢ Replant exposed soil and replace dead plants. Make any vegetation and slope repairs as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Spring	➢ Visually inspect bioretention basin and surrounding area for illicit discharges and contact the City of Houston if any illicit discharges are identified. ➢ Verify the presence of vegetation considered in design computations and correct any deficiencies. ➢ Verify volume of bioretention by comparing actual maximum depth against designed maximum depth and correct any deficiencies. ➢ Verify ability of the bioretention area to drain within 48 hours after a rainfall event, correct deficiency. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation as necessary. ➢ Remove and replace mulch[1] as needed.
Annually	➢ Assess and report on each pollution-generating operation associated with bioretention basins.

[1] Use mulch without animal manure to avoid leaching of contaminants.

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GREEN ROOF O&M FACT SHEET

What To Look For	What To Do
Structural Components	
➢ Irrigation	➢ Supplemental irrigation is required during initial establishment and long dry spells (per COH IDM). Use of an automated irrigation system is recommended (Harris County LID Design Manual). ➢ Moisture conditions should be investigated at the bottom of the profile, on the level of the waterproof membrane (per COH IDM). ➢ Irrigate as needed in short bursts (3-5 minutes) to prevent runoff (per Harris County LID Design Manual).
➢ Roof Membrane	➢ Check that the roof membrane is ponding a minimum of 1 inch of water at the shallowest point on the roof for 24 hours without leaks (per COH IDM).
➢ Drainage	➢ Perform structural inspections monthly for the first year following installation (per Harris County LID Design Manual). ➢ Routinely inspect joints at adjoining walls, roof penetrations for vents; inspect electrical conduits for leaks (per COH IDM). ➢ Visually inspect ceilings below green roofs for water staining or leaking (per COH IDM). ➢ Inspect designated drainage paths and drainage system components to verify proper surface drainage is maintained (per COH IDM) ➢ Clean out drain inlets as needed (per Harris County LID Design Manual). ➢ The under-drain shall be designed for the plant species' tolerance for drought and varying soil moisture (per COH IDM). ➢ Inspect for damage.
Vegetation throughout the green roof.	
➢ Dead or strained vegetation	➢ Remove dead vegetation if it covers greater than 10% of the area (per COH IDM).
➢ Grasses and vegetation	➢ Inspect for damage to plant survival after each large storm event (per Harris County LID). Trim and prune according to horticultural practices to keep vegetation aesthetically groomed (per COH IDM). ➢ DO NOT apply fertilizers, herbicides, or pesticides [1]. ➢ Replant with low-water use, non-invasive, native vegetation per the Urban Design Manual – Landscaping section.
➢ Weeds	➢ Remove all invasive vegetation, noxious, and nuisance weeds manually. DO NOT apply herbicides[2].
➢ Trash and Debris	➢ Inspect and remove all trash and debris from the roof.
Growing/ Filter Medium, including soil and gravels, shall sustain healthy plant cover.	
➢ Erosion/Sediment Accumulation	➢ Inspect for erosion after every storm greater than 0.75 inches and once per month for one year following installation (per COH IDM).
➢ Growing Medium	➢ Inspect soil levels semi-annually to ensure plant survival and rainfall absorption (4-8 inches required for extensive green roofs (per Harris County LID Design Manual). ➢ Use lightweight growing medium for extensive roofs (engineered soil).

[1] The use of fertilizers, herbicides, or pesticides shall be monitored and approved by METRO as these are water contaminants that can end up in stormwater runoff. Only certified professionals shall apply any chemical applications (per COH IDM requirement). At a minimum, follow Integrated Pest Management (IPM) practices as outlined by U.S. Environmental Protection Agency (EPA): https://www.epa.gov/ipm/introduction-integrated-pest-management.

Note: See Landscape Based GSI Maintenance Schedule and Inspection Guidelines for additional details.

LANDSCAPE-BASED GSI MAINTENANCE SCHEDULE AND INSPECTION GUIDELINES

The following applies to green roofs.

Maintenance Records: Inspect and maintain the green roofs to ensure proper function and aesthetic appearance at least four times per year. Prepare a maintenance plan for the green roof (per COH IDM requirement). The maintenance plan should consider the green roof membrane manufacturer's instructions and the plant species selected. Record date, description, and contractor or staff who performed the inspection in the maintenance plan for all structural repairs and clean-out activities. This shall include provisions for vegetation maintenance and any replacements needed to maintain a minimum of 80% coverage/survival rate to sustain stormwater quality. Any requirements for initial or intermittent use of fertilizer and pesticides for disease or insect control shall be identified in the maintenance plan (per COH IDM).

Replacement and Reconstruction: Provide adaptive management to determine reconstruction or replacement of the green roof. Use adaptive management to restore original or revised design and function or hydrologic equivalent.

Infiltration/Flow Control: The extensive green roof's membrane must be designed to pond a minimum of 1 inch of water at the shallowest point for 24 hours without leaks

Vectors (Mosquitoes & Rodents): Stormwater facilities shall comply with the local jurisdictions' regulations so as to not cause a public nuisance or undermine the facility structure. Note holes/burrows in and around facilities during inspections.

Maintenance Schedule as Required:

Time of Year Scheduled	What To Do
Summer	Due to the subtropical climate and humid summers, more maintenance will likely be needed in the summer months. ➢ Maintenance inspection required (per Harris County LID Design Manual and COH IDM). ➢ Inspect for erosion, plant survival, proper drainage, and waterproofing damage after each large storm event (per Harris County LID). ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Make any vegetation repairs as needed. ➢ Trim and prune according to horticultural practices to keep vegetation aesthetically groomed (per COH IDM).
Fall	➢ Maintenance inspection required (per Harris County LID Design Manual and COH IDM). ➢ Inspect for erosion, plant survival, proper drainage, and waterproofing damage after each large storm event (per Harris County LID). ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Trim and prune according to horticultural practices to keep vegetation aesthetically groomed (per COH IDM). ➢ Inspect soil levels and maintain the designed level to ensure plant survival (per Harris County LID Design Manual).
Winter	The least amount of precipitation is recorded in the winter months, so less maintenance will likely be needed in the winter season. ➢ Maintenance inspection required (per Harris County LID Design Manual and COH IDM). ➢ Inspect for erosion, plant survival, proper drainage, and waterproofing damage after each large storm event (per Harris County LID). ➢ Make any vegetation repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Trim and prune according to horticultural practices to keep vegetation aesthetically groomed (per COH IDM).
Spring	➢ Maintenance inspection required (per Harris County LID Design Manual and COH IDM). ➢ Inspect for erosion, plant survival, proper drainage, and waterproofing damage after each large storm event (per Harris County LID). ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Trim and prune according to horticultural practices to keep vegetation aesthetically groomed (per COH IDM). ➢ Inspect soil levels and maintain the designed level to ensure plant survival (per Harris County LID Design Manual).
Annually	➢ Monitor infiltration/flow-through rates.

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PERVIOUS PAVING & DRIVABLE LANDSCAPE O&M FACT SHEET

What To Look For	What To Do
Illicit Discharges, including in the surrounded area and within the GSI.	
➢ Illicit discharge	➢ Visually inspect pervious paving, drivable landscape, and surrounding areas for illicit discharges. Contact the City of Houston if an illicit discharge is identified
Maintenance Practices to prevent clogging caused by organic matter and sediment.	
➢ Periodic Vacuuming	➢ Vacuum two times per year with regenerative air vacuum sweepers – once at the end of winter (April) and after autumn leaf-fall (November) (per Harris County LID requirement). ➢ Vacuum frequency should be adjusted based on the intensity of usage (per Harris County LID requirement).
➢ Drivable Landscape & Landscaped Areas	➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Irrigate as needed. ➢ Remove and replace mulch[1] as needed to ensure the survival of vegetation. ➢ DO NOT apply fertilizers, herbicides, or pesticides[2]. ➢ Use weed eater or string trimmer to cut back grass or turf when needed to maintain a height of two to four inches for drivable landscape. ➢ Drivable landscape systems need to be inspected to make sure they do not start "heaving" to avoid tripping hazards, or if there is gravel there may need to be refilling.
➢ Weeds (drivable landscape only)	➢ Manually remove weeds. Remove all plant debris. ➢ Remove all invasive vegetation, noxious, and nuisance weeds and replace with native vegetation.
➢ Trash and Debris	➢ Inspect and remove all trash and debris. ➢ Remove grass clippings, fallen leaves, and debris from surrounding foliage.
➢ Inspection	➢ Initial inspection of porous pavement shall be monthly for the first three months after construction. ➢ Semi annual inspection to ensure pavement surface is free of sediment. Annually inspect pavement surface and subsurface drainage system (if any) for deterioration, spalling, or malfunctioning.
Pavement Material - areas covered in pavement material shall infiltrate within 48 hours of introduction of runoff, without isolated ponding areas or pockets of ponding per COH IDM requirement.	
➢ Erosion/Sediment Accumulation	➢ Repair erosion control elements such as rock-lined depressions, gravel flow spreaders, and mulch[1]. ➢ Remove accumulated sediment as needed or if sediment is blocking even distribution and entry of water (per COH IDM requirement). ➢ Vacuum sweep hard porous pavement followed by high-pressure hosing to keep voids free of sediment[3].
➢ Infiltration	➢ Check that surface of system is draining within 24 hours (per Harris County LID Manual). ➢ Inspect and remove accumulated sediment and debris as needed. ➢ Annually inspect upstream facilities and/or land use that may contribute to sediment loading issues.

[1] Use mulch without animal manure to avoid leaching of contaminants.

[2] The use of fertilizers, herbicides, or pesticides shall be monitored and approved by METRO as these are water contaminants that can end up in stormwater runoff. Only certified professionals shall apply any chemical applications (per COH IDM requirement). At a minimum, follow Integrated Pest Management (IPM) practices as outlined by U.S. Environmental Protection Agency (EPA) see website for details: https://www.epa.gov/ipm/introduction-integrated-pest-management.

[3] Maintenance personnel must be instructed not to seal or pave with non-porous materials (per Harris County LID Design Manual).

Note: See Landscape-Based GSI Maintenance Schedule and Inspection Guidelines for additional details.

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PERVIOUS PAVING & DRIVABLE LANDSCAPE GSI MAINTENANCE SCHEDULE AND INSPECTION GUIDELINES

The following applies to pervious paving and drivable landscape:

Maintenance Records: Inspect and maintain the pervious paving to ensure proper function and aesthetic appearance. The initial inspections shall be performed monthly for the first three months post-construction. After that, semi-annual inspections will verify that the pavement surface is free of sediment. Quarterly vacuum sweeping and annual pavement surface and drainage system inspections are required as long-term maintenance items. Maintenance records should contain the record date, description, and contractor or staff who performed the inspection in the inspection sheets for all structural repairs and clean-out activities. Any significant changes in stormwater quality must be reported to the City of Houston —assessment reports for each pollution-generating operation and the associated stormwater quality control measures to be kept on file by the City of Houston.

Replacement and Reconstruction: Provide adaptive management to determine reconstruction or replacement of the pervious paving. Use adaptive management to restore original or revised design and function or hydrologic equivalent.

Infiltration/Flow Control: The pervious paving shall have the capacity to drain the surface of the system within 24 hours after the introduction of runoff, especially during the peak mosquito breeding months (June to October) (per Harris County LID Design Manual). Record time, date, and weather conditions when excessive ponding occurs. Use practices specified under Pavement Material maintenance to restore capacity, if needed. Inspect and remove accumulated sediment and debris as needed.

Pollution Prevention. Implement Best Management Practices (BMPs) to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Visually inspect pervious paving, drivable landscape, and surrounding areas for illicit discharge. Contact the City of Houston immediately if an illicit discharge has been identified.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall comply with the local jurisdictions to not cause a public nuisance or undermine the facility structure. Note holes/burrows in and around facilities during inspections.

Maintenance Schedule as Required:

Time of Year Scheduled	What To Do
Summer	Due to the subtropical climate and humid summers, more maintenance will likely be needed in the summer months. ➢ Visually inspect pervious paving, drivable landscape, and surrounding areas for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect and remove accumulated sediment as needed. ➢ Remove plant debris and litter. ➢ Cut back grass or turf when needed to maintain a height of two to four inches for drivable landscape.
Fall	➢ Visually inspect pervious paving, drivable landscape, and surrounding areas for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Vacuum sweep once in November with regenerative air vacuum sweepers followed by high-pressure hosing to keep voids free of sediment. ➢ Inspect and remove accumulated sediment. ➢ Remove plant debris and litter. ➢ Cut back grass or turf when needed to maintain a height of two to four inches for drivable landscape.
Winter	The least amount of precipitation is recorded in the winter months, so less maintenance will likely be needed in the winter months. ➢ Visually inspect pervious paving, drivable landscape, and surrounding areas for illicit discharge. Contact the City of Houston if an illicit discharge has been identified. ➢ Inspect and remove accumulated sediment as needed. ➢ Remove plant debris and litter. ➢ Cut back grass or turf when needed to maintain a height of two to four inches for drivable landscape.
Spring	➢ Visually inspect pervious paving, drivable landscape, and surrounding areas for illicit discharge. Contact the City of Houston if an illicit discharge has been identified. ➢ Vacuum sweep once in April with regenerative air vacuum sweepers followed by high-pressure hosing to keep voids free of sediment. ➢ Inspect and remove accumulated sediment. ➢ Remove plant debris and litter. ➢ Cut back grass or turf when needed to maintain a height of two to four inches for drivable landscape.
Annually	➢ Assess and report on each pollution-generating operation associated with pervious pavement and drivable landscape. ➢ Monitor infiltration/flow-through rates. ➢ Annually inspect upstream facilities and/or land use that may contribute to sediment loading issues. ➢ Annually inspect pavement surface and subsurface drainage system for deterioration, spalling, or malfunctioning (per COH IDM). ➢ Cut back grass or turf when needed to maintain a height of two to four inches for drivable landscape.

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TREE BOXES O&M FACT SHEET

What To Look For	What To Do
Illicit Discharges, including in the surrounded area and within the tree box.	
➢ Illicit discharge	➢ Visually inspect tree box and the surrounding area for illicit discharges. Contact the City of Houston if any illicit discharges are identified.
Structural Components to freely convey stormwater.	
➢ Overflow/outlet structure	➢ Inspect tree boxes after every storm with rainfall greater than 0.75 inches to ensure nothing is clogged.
Vegetation	
➢ Tree Opening	➢ Ensure mulch layer is 3" deep. Do not pile mulch against the tree trunk. ➢ Remove and replace mulch[1] as needed. DO NOT apply fertilizers, herbicides, or pesticides[2]. ➢ Well aged (minimum six months), shredded hardwood bark mulch is the only acceptable mulch[1] (per Harris County LID Design Manual). ➢ Irrigate as needed and do not overwater. ➢ Inspect after every storm with rainfall greater than 0.75 inches to ensure nothing is clogged and there is no erosion or standing water.
➢ Trees	➢ Inspect trees for damage, broken or hanging branches, or leaning trunk after every storm greater than 0.75 inches. ➢ Prune to allow sightlines and foot traffic (vertical clearance standard is above 24" and below 8' per COH IDM). Never prune trees or branches that are within 10 feet of utility lines. ➢ When re-planting, select tree species that improve the value of the site; provide shade and windbreaks; improve aesthetics; support wildlife; and absorb noise (per Harris County LID Design Manual).
➢ Weeds	➢ Manually, or using weed eater or string trimmer, remove all invasive vegetation, noxious, and nuisance weeds. ➢ DO NOT apply herbicides[2].
➢ Trash and Debris	➢ Inspect and remove all trash and debris such as grass clippings, fallen leaves, etc. from the tree box.
Growing/Filter Medium, including soil and gravels, shall sustain healthy tree growth and infiltrate within 48 hours of introduction of runoff.	
➢ Erosion/Sediment Accumulation	➢ Inspect for erosion after every storm greater than 0.75 inches. ➢ Repair erosion control elements such as gravel flow spreaders. ➢ Remove accumulated sediment as needed or if sediment is blocking even distribution and entry of water (per COH IDM).
➢ Ponding After 48 Hours	➢ Inspect and remove accumulated sediment and debris as needed. Re-plant if necessary. ➢ Rake, till, or amend (incorporate a minimum of 2" of compost within the root zone to improve soil quality) to restore infiltration rate (per COH IDM requirement). ➢ Annually inspect upstream facilities and/or land use that may contribute to sediment loading issues.

[1] Use mulch without animal manure to avoid the leaching of contaminants into storm water.

[2] The use of fertilizers, herbicides, or pesticides shall be monitored and approved by METRO as these are water contaminants that can end up in stormwater runoff. Only certified professionals shall apply any chemical applications (per COH IDM requirement). At a minimum, follow Integrated Pest Management (IPM) practices as outlined by U.S. Environmental Protection Agency (EPA): https://www.epa.gov/ipm/introduction-integrated-pest-management.

Note: See Landscape-Based GSI Maintenance Schedule and Inspection Guidelines for additional details.

LANDSCAPE-BASED GSI MAINTENANCE SCHEDULE AND INSPECTION GUIDELINES

The following applies to tree boxes:

Maintenance Records:
Inspect and maintain the tree boxes to ensure proper function and aesthetic appearance. Record date, description, and contractor or staff who completed the inspection in inspection sheets for all structural repairs and clean-out activities. Report any significant changes in stormwater quality control measures to the City of Houston —assessment reports for each pollution-generating operation and the associated stormwater quality control measures to be kept on file by the City of Houston.

Replacement and Reconstruction:
Provide adaptive management to determine reconstruction or replacement of the tree boxes. Use adaptive management to restore original or revised design and function or hydrologic equivalent.

Infiltration/Flow Control: The tree boxes shall drain within 48 hours after introduction, especially during the peak mosquito breeding months (June–October). Record time, date, and weather conditions when excessive ponding occurs. Use practices specified under Growing/Filter Medium maintenance to restore infiltration capacity, if needed.

Pollution Prevention: Implement Best Management Practices (BMPs) to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Use mulch without animal manure to avoid leaching of contaminants in tree boxes, where feasible. Visually inspect tree boxes and the surrounding areas for illicit discharges. Immediately contact the City of Houston if any illicit discharges are identified.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall comply with the local jurisdictions to not cause a public nuisance or undermine the facility structure. Note holes/burrows in and around facilities during inspections.

Access: Maintain ingress/egress, including access roads, to design standards.

Maintenance Schedule (as required):

Time of Year Scheduled	What To Do
Summer	Due to the subtropical climate and humid summers, more maintenance will likely be needed in the summer months. ➢ Visually inspect tree boxes and the surrounding areas for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect trees for damage, broken or hanging branches, or leaning trunk after every storm greater than 0.75 inches. ➢ Remove plant debris and litter. ➢ Remove and replace mulch[1] as needed.
Fall	➢ Visually inspect tree boxes and the surrounding areas for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect trees for damage, broken or hanging branches, or leaning trunk after every storm greater than 0.75 inches. ➢ Make any vegetation and structural repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Winter	The least amount of precipitation is recorded in the winter months, so less maintenance will likely be needed in the winter season. ➢ Visually inspect tree boxes and the surrounding areas for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect trees for damage, broken or hanging branches, or leaning trunk after every storm greater than 0.75 inches. ➢ Make any structural repairs as needed. ➢ Irrigate as needed. Remove plant debris and litter. ➢ Prune overhanging limbs as necessary. ➢ Remove and replace mulch[1] as needed.
Spring	➢ Visually inspect tree boxes and the surrounding areas for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect trees for damage, broken or hanging branches, or leaning trunk after every storm greater than 0.75 inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and structural repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Annually	➢ Assess and report on each pollution-generating operation associated with tree boxes. ➢ Monitor infiltration/flow-through rates. ➢ Ensure mulch layer is 3" deep and do not pile mulch against the tree trunk. ➢ Inspect trees leaves, bark, and branches for signs of disease and/or damage from insects, weed whips, or animals.

[1]Use mulch without animal manure to avoid the leaching of contaminants into stormwater.

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VEGETATED DETENTION BASIN O&M FACT SHEET

What To Look For	What To Do
Illicit Discharges, including in the surrounded area and within the vegetated detention basin.	
➢ Illicit discharge	➢ Visually inspect vegetated detention basin and surrounding area for illicit discharges. Contact the City of Houston if any illicit discharge are identified.
Structural Components	
➢ Flow Spreader	➢ Remove obstructions. Clean and re-level flow spreader as needed.
➢ Gravity spillway or overflow structure	➢ Keep free of obstructions, visually inspect (per HCFCD).
Vegetation within the detention basin.	
➢ Dead or strained vegetation	➢ Manually remove sediment accumulation. Re-plant or re-seed vegetation as needed following sediment removal (per COH IDM). ➢ Remove dead vegetation if it covers greater than 10 percent of area (per COH IDM). ➢ Replant with low water use, non-invasive vegetation per the original planting plan (and per COH IDM).
➢ Grasses and vegetation	➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Irrigate as needed. ➢ Remove and replace mulch[1] as needed to ensure survival of vegetation. ➢ Prune overhanging limbs and bushy vegetation to decrease shading that could cause weak vegetation growth in the basin (per COH IDM). ➢ Re-plant and/or re-seed as needed following sediment removal activities. ➢ Maintain minimum maintenance path width of 20 feet along both sides of a grass-lined channel and around the entire detention basin (per HCFCD). ➢ Do not plant trees or shrubs within 20 feet of outfall pipes or manholes (per HCFCD). ➢ Trees and shrubs may be planted individually or in clusters along the top of the bank and spaced 20 feet apart to allow for equipment access (per HCFCD). ➢ Irrigate as needed using permanent irrigation system (per HCFCD).
➢ Weeds	➢ Manually remove weeds. Remove all plant debris. ➢ Remove all invasive vegetation, noxious, and nuisance weeds and replace with native vegetation. ➢ DO NOT apply fertilizers, herbicides, or pesticides[2].
➢ Trash and Debris	➢ Inspect and remove all trash and debris ➢ Remove grass clippings, fallen leaves, and debris from surrounding foliage.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours of introduction of runoff, without isolated ponding areas or pockets of ponding.	
➢ Erosion/Sediment Accumulation	➢ Inspect for erosion after every storm greater than 0.75 inches. ➢ Repair erosion control elements such as rock-lining, gravel flow spreaders, and mulch[1]. ➢ Remove accumulated sediment as needed, or if vegetation growth is inhibited by 2 inches or more of sediment build-up or if sediment is blocking even distribution and entry of water (per COH IDM).
➢ Slopes	➢ Stabilize 2% - 4% slopes/banks with plantings from the original planting plan. ➢ Maintain stability of side slopes per design guidelines.
➢ Ponding After 48 Hours	➢ Inspect and remove accumulated sediment and debris as needed. Re-vegetate if necessary. ➢ Rake, till, or amend to restore infiltration rate (per COH IDM). ➢ Annually inspect upstream facilities and/or land use that may contribute to sediment loading issues.

[1]Use mulch without animal manure to avoid leaching of contaminants.

[2]The use of fertilizers, herbicides, or pesticides shall be monitored and approved by METRO as these are water contaminants that can end up in stormwater runoff. Only certified professionals shall apply any chemical applications (per COH IDM requirement). At a minimum, follow Integrated Pest Management (IPM) practices as outlined by U.S. Environmental Protection Agency (EPA): https://www.epa.gov/ipm/introduction-integrated-pest-management.

Note: See Landscape-Based GSI Maintenance Schedule and Inspection Guidelines for additional details.

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LANDSCAPE-BASED GSI MAINTENANCE SCHEDULE AND INSPECTION GUIDELINES

The following applies to vegetated detention basins:

Maintenance Records: Inspect and maintain the vegetated detention basin to verify proper function and aesthetic appearance. Record date, description, and contractor or staff who performed inspection in inspection sheets for all structural repairs and clean-out activities. Report any significant changes in stormwater quality control measures to the City of Houston—assessment reports for each pollution-generating operation and the associated stormwater quality control measures to be kept on file by the City of Houston.

Replacement and Reconstruction: Provide adaptive management to determine reconstruction or replacement of the vegetated detention basin. Use adaptive management to restore original or revised design and function or hydrologic equivalent.

Infiltration/Flow Control: Per HCFCD, when possible, the vegetated detention basin shall drain within 24 hours after introduction of runoff, especially during the peak mosquito breeding months (June–October). However, maximum drain time is 48 hours. In case of staggered rainfall events, drain time over 96 hours is not allowed. Record time, date, and weather conditions when excessive ponding occurs. Use practices specified under Growing/Filter Medium maintenance to restore infiltration capacity, if needed.

Pollution Prevention: Implement Best Management Practices (BMPs) to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Use mulch without animal manure to avoid leaching of contaminants. Visually inspect the surrounding area and within the detention basin to confirm no illicit discharges have been made. If illicit discharges are observed, contact the City of Houston immediately.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall comply with the local jurisdictions' regulations so as to not cause a public nuisance or undermine the facility structure. Note holes/burrows in and around facilities during inspections.

Access: Maintain ingress/egress, including access roads, to design standards.

Maintenance Schedule (as required):

Time of Year Scheduled	What To Do
Summer	Due to the subtropical climate and humid summers, more maintenance will likely occur in the summer months. ➢ Visually inspect vegetated detention basin and surrounding area for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Fall	➢ Visually inspect vegetated detention basin and surrounding area for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Winter	The least amount of precipitation is recorded in the winter months, so less maintenance will likely occur in the winter season. ➢ Visually inspect vegetated detention basin and surrounding area for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Remove and replace mulch[1] as needed.
Spring	➢ Visually inspect vegetated detention basin and surrounding area for illicit discharges. Contact the City of Houston if any illicit discharges are identified. ➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation as necessary. ➢ Remove and replace mulch[1] as needed.
Annually	➢ Assess and report on each pollution-generating operation associated with vegetated detention basin. ➢ Monitor infiltration rates. ➢ Remove and replace mulch[1] to maintain/restore pre-treatment capacity. ➢ Conduct landscaping, mowing, and desilting of facility. ➢ Inspect observation well for water level and drainage times (per HCFCD).

[1]Use mulch without animal manure to avoid leaching of contaminants.

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VEGETATED SWALE O&M FACTSHEET

What to Look for	What to Do
Illicit Discharges, including in the surrounded area and within the GSI.	
➢ Illicit discharge	➢ Visually inspect vegetated swales and surrounding areas for illicit discharge. Contact the City of Houston if an illicit discharge has been identified.
Structural Components to freely convey stormwater.	
➢ Flow Spreader	➢ Remove obstructions. Clean and re-level flow spreaders as needed.
Vegetation	
➢ Dead or strained vegetation	➢ Remove dead vegetation if greater than 10 percent of area coverage or when filter strip function is impaired (per COH IDM requirement). ➢ Replant with low water use, non-invasive, native vegetation per the original planting plan.
➢ Grasses and vegetation	➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Irrigate as needed, do not overwater. ➢ DO NOT apply fertilizers, herbicides, or pesticides[1]. ➢ Prune overhanging limbs and bushy vegetation to decrease shading that could cause weak vegetation growth in the swale. ➢ Prune larger vegetation twice a year to allow sightlines (minimum 18"horizontal clearance per AASHTO Green Book). ➢ Mow dry swales as required during the growing season to maintain grass heights in the 4-to-6-inch range. Wet swales, employing wetland vegetation or other low maintenance ground cover, do not require frequent mowing (COH IDM). ➢ Re-plant and/or re-seed as needed following sediment removal activities. ➢ Where maintenance issues are most critical, use grass-only landscaped plants.
➢ Weeds	➢ Manually, or using a weed eater or string trimmer, remove all invasive vegetation, noxious, and nuisance weeds, or use a weed eater or string trimmer. ➢ DO NOT apply herbicides[1].
➢ Trash and Debris	➢ Inspect and remove all trash and debris. ➢ Remove grass clippings, fallen leaves, and debris from surrounding foliage.
Growing/ Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours of introduction of runoff, without isolated ponding areas or pockets of ponding.	
➢ Erosion/Sediment Accumulation	➢ Inspect for erosion after every storm greater than 0.75 inches. ➢ Repair erosion control elements such as rock-lined depressions, gravel flow spreaders, and mulch[2]. ➢ Remove and replace mulch[2] as needed. ➢ Remove accumulated sediment: o as needed, o if vegetation growth is inhibited by 2 inches or more of sediment build-up o if sediment is blocking even distribution and entry of water, and o to prevent underdrain clogging. Re-plant or re-seed vegetation as needed following sediment removal. (Per COH IDM).
➢ Slopes	➢ Stabilize 2% - 4% slopes/banks with plantings from the original planting plan.
➢ Surface Ponding After 48 Hours	➢ Inspect and remove accumulated sediment and debris as needed. Re-vegetate if necessary. ➢ Rake, till, or amend, to restore infiltration rate (per COH IDM). ➢ Annually inspect upstream facilities and/or land use that may contribute to sediment loading issues.

[1] The use of fertilizers, herbicides, or pesticides shall be monitored and approved by METRO as these are water contaminants that can end up in stormwater runoff. Only certified professionals shall apply any chemical applications (per COH IDM). At a minimum, follow Integrated Pest Management (IPM) practices as outlined by U.S. Environmental Protection Agency (EPA): https://www.epa.gov/ipm/introduction-integrated-pest-management

[2] Use mulch without animal manure to avoid leaching of contaminants.

Note: See Landscape-Based GSI Maintenance Schedule and Inspection Guidelines for additional details.

LANDSCAPE-BASED GSI MAINTENANCE SCHEDULE AND INSPECTION GUIDELINES

The following applies to vegetated swales:

Maintenance Records: Inspect and maintain vegetated swales to ensure proper function and aesthetic appearance. Record date, description, and contractor or staff who performed the inspection in inspection sheets for all structural repairs and cleanout activities. Report any significant changes in stormwater quality control measures to the City of Houston —assessment reports for each pollution-generating operation and the associated stormwater quality control measures to be kept on file by the City of Houston.

Replacement and Reconstruction: Provide adaptive management to determine reconstruction or replacement of the vegetated swales. Use adaptive management to restore original or revised design and function or hydrologic equivalent.

Infiltration/Flow Control: The vegetated swale shall drain within 48 hours after introduction of runoff, especially during the peak mosquito breeding months (June-October) (per Harris County requirement). Record time, date, and weather conditions when excessive ponding occurs. Use practices specified under Growing/Filter Medium maintenance to restore capacity, if needed.

Pollution Prevention: Implement Best Management Practices (BMPs) to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Use mulch without animal manure to avoid leaching of contaminants into vegetated swales. Visually inspect vegetated swales and surrounding areas for illicit discharges and contact the City of Houston immediately if an illicit discharge is identified.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall comply with the local jurisdictions so as to not cause a public nuisance or undermine the facility structure. Note holes/burrows in and around facilities during inspections.

Access: Maintain ingress/egress, including access roads, to design standards.

Maintenance Schedule (as required):

Time of Year Scheduled	What To Do
Summer	Due to the subtropical climate and humid summers, more maintenance will likely be needed in the summer months. ➢ Visually inspect vegetated swales and surrounding areas for illicit discharges and contact the City of Houston if an illicit discharge is identified. ➢ Inspect for damage to vegetation and structure after every storm greater than 0.75 inches. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Fall	➢ Visually inspect vegetated swales and surrounding areas for illicit discharges and contact the City of Houston if an illicit discharge is identified. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Winter	The least amount of precipitation is recorded in the winter months, so less maintenance will likely occur in the winter season. ➢ Visually inspect vegetated swales and surrounding areas for illicit discharges and contact the City of Houston if an illicit discharge is identified. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation, as necessary. ➢ Remove and replace mulch[1] as needed.
Spring	➢ Visually inspect vegetated swales and surrounding areas for illicit discharges and contact the City of Houston if an illicit discharge is identified. ➢ Inspect for damage to vegetation after every storm greater than 0.75 inches. ➢ Cut back grass or turf when needed to maintain a height of two to four inches. ➢ Replant exposed soil and replace dead plants. ➢ Make any vegetation and slope repairs as needed. ➢ Irrigate as needed. ➢ Remove plant debris and litter. ➢ Prune overhanging limbs and bushy vegetation as necessary. ➢ Remove and replace mulch[1] as needed.
Annually	➢ Assess and report on each pollution-generating operation associated with vegetated swales. ➢ Monitor infiltration/flow-through rates.

[1]Use mulch without animal manure to avoid leaching of contaminants.

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Houston Metro GSI Cost-Benefit Summary

I. Introduction

Green stormwater infrastructure (GSI) recommendations for Houston METRO include bioretention, vegetated swales, tree boxes, planter boxes, vegetated detention basins, green roofs, and shade trees. Following is a planning-level summary of GSI costs and benefits.

II. Green Stormwater Infrastructure Costs

Unit cost determination provides a value for each single GSI option. Some GSI recommendations are standalone manufactured devices or treatments (i.e., tree boxes, planter boxes, and shade trees) whose costs can easily be quantified. Other treatments (i.e., detention basins and green roofs) can vary widely in cost based on existing site conditions and site preparation prior to installation as well as the size of the desired treatment area. The table below offers insight into standalone treatment unit costs.

Table 1: GSI Unit Costs

Item	Sub-Item (if applicable)	Unit Cost	Unit	Notes	Source
Containerized Plants	1 gallon	$10-25	each	Includes Installation	Various TX Nurseries
	5 gallon	$30-60	each	Includes Installation	Various TX Nurseries
Containerized Trees	24-inch box tree	$800-$1000	each	(Boxes not typical in TX) Includes installation	Large TX Nursery
	36-inch box tree	$2000-$4,000	each	(Boxes not typical in TX) Includes installation	Large TX Nursery
	15-30 gallon	$125-$300	each	Includes installation (33-55% unit cost of tree)	Various TX Nurseries; Texas DOT
	45-65 gallon	$350-$825	each	Includes installation (33-55% unit cost of tree)	Various TX Nurseries; Texas DOT
	95 gallon	$800-$1200	each	Includes installation (33-55% unit cost of tree)	Various TX Nurseries; Texas DOT
	200 gallon	$1,500-$3,000	each	Includes installation (33-55% unit cost of tree)	Various TX Nurseries; Texas DOT
Vegetation per Area	Seeding	$0.18-$0.27	square foot	Includes installation; $0.15-$0.22 adjusted to 2022 using CPI	(2013 Data) San Antonio River Authority (2019)
				Includes installation; $0.67	(2013 Data) San Antonio
	General Vegetation	$0.24-$4.27	square foot	Includes installation; $0.20-$3.50 adjusted to 2022 using CPI	(2013 Data) San Antonio River Authority (2019)
Irrigation	Drip Irrigation	$2.57	$1.5 per square foot	1999 prices adjusted to 2022	The Handbook of Water Use and Conservation (1999)
	Controller	$1,000	each	Current market price	Rainbird
Mulch	Shredded Hardwood	$0.29-$0.48	square foot	Native hardwood Mulch; $0.24-$0.39 adjusted to 2022 using CPI	(2013 Data) San Antonio River Authority (2019)
Tree Box	Tree Box prefabricated system	$15,500	per tree	4' x 4' Filterra Tree Box	Contech Engineering Solutions (2022)
	Tree Box installation	$4,000-$5,500	per tree	25-35% Installation Cost of Tree Box	Contech Engineering Solutions (2022)
Silva Cells		$9,600-$12,000	per tree	$16-20 / cubic foot installed (not including base + hardscape); Min. 600 cubic foot per tree	Deep Root
Bioretention		$37- $44	square foot	Excavation, Engineered Soil Media, Soil Media Barrier, Underdrain Pipe, Mulch, Hydraulic Restriction; $30- $36 adjusted to 2022 using CPI	(2013 Data) North Central Texas Green Infrastructure Guidebook (2017)
Porous Asphalt		$20.39-$22.82	square foot	Excavation, Hydraulic Restriction Layer, Bedding Layer, Porous Asphalt; $16.70-$18.69 adjusted to 2022 using CPI	(2013 Data) North Central Texas Green Infrastructure Guidebook (2017)

Houston Metro GSI Cost-Benefit Summary

Item	Sub-Item (if applicable)	Unit Cost	Unit	Notes	Source
Porous Concrete		$25.27-27.70	square foot	Excavation, Hydraulic Restriction Layer, Bedding Layer, Porous Concrete; $20.70-$22.69 adjusted to 2022 using CPI	(2013 Data) North Central Texas Green Infrastructure Guidebook (2017)
Pervious Interlocking Pavers		$21.61-$24.04	square foot	Excavation, Hydraulic Restriction Layer, Bedding Layer, Pervious Interlocking Pavers; $17.70-$19.69 adjusted to 2022 using CPI	(2013 Data) North Central Texas Green Infrastructure Guidebook (2017)
Plastic Grid Pavers		$21.00-$23.43	square foot	Excavation, Hydraulic Restriction Layer, Bedding Layer, Pervious Interlocking Pavers; $17.20-$19.19 adjusted to 2022 using CPI	(2013 Data) North Central Texas Green Infrastructure Guidebook (2017)

Table 2: GSI Construction Cost Estimates

BMP Type	Units	Unit Cost	Final Unit Cost with Mobilization, Overhead and Profit, and Contingency
Biofiltration	Sq. Ft.	$31.65	$50.00
Vegetated Swales	Sq. Ft.	$16.67	$26.34
Permeable Pavement	Sq. Ft.	$12.83	$20.27
Trees	Ea.	$200.00	$316.00
Tree Boxes	Ea.	$7,408.00	$11,704.64

Assumptions:

1. All unit costs include 10% mobilization, 18% overhead and profit, and 30% contingency.
2. Biofiltration includes five feet excavation, 18-inch growing media, four-inch gravel sublayer, and underdrain.
3. Vegetative grass swales include 30-inch excavation, three-foot bottom width, 3:1 side slopes, 6-inch topsoil, and grass seeding.
4. Permeable pavement includes pavement, subbase, excavation, and curbing.
5. Trees – 15 gallons, planted and staked.
6. Tree boxes include chamber, soil media, and planting.

7. Hydro-seeding includes slurry with tackifier, seed and mulch.

III. Green Stormwater Infrastructure (GSI) Pollutant Removal Efficiencies

Coupling GSI within a transit area like Houston METRO's provides benefits to the surrounding urban and suburban environments and its users. Quantifiable benefits of GSI in relation to stormwater include decreased pollutant loads and peak flow attenuation during storm events. The table below presents estimated benefits for GSI features measured as pollutant load reductions.

Table 3: GSI Pollutant Removal Efficiencies

Green Infrastructure Type	TSS	Nitrogen	Phosphorus	Fecal Coliform	Aluminum	Zinc	Iron	Lead	Copper
Biofiltration (Bioretention with Liner/Underdrain)	90[9]	40[9]	95[9]	65-100[15]	80[8]	85[9]	80[8]	80[8]	75[9]
Bioretention	90[9]	40[9]	72[14]	70-92[16]	80[8]	85[9]	80[8]	80[8]	75[9]
Infiltration Trenches	50-80[15]	55[10]	60[10]	65-100[15]	50-80[15]	50-80[15]	50-80[15]	50-80[15]	50-80[15]
Modular Wetlands[4]	80[11]	62[11]	66[11]	<30[15]	69[8]	62	69[8]	76	69[8]
Permeable Pavement	91[10]	81[10]	61[10]	65-100[15]	74[8]	74[8]	74[8]	74[10]	74[8]
Stormwater capture/reuse[5]									
Stormwater Wetlands	80[11]	62[11]	66[11]	<30[15]	69[8]	62	69[8]	76	69[8]
Tree Boxes	85[12]	68[12]	74[12]	70-92[16]	82[8]	82	82	82	82
Trees[7]									
Vegetated Swales	70[13]	15-45[15]	30[13]	<30[15]	15-45[15]	15-45[15]	15-45[15]	15-45[15]	15-45[15]

Notes:

1. Blue shaded areas are pollutant removal rates that can be determined if the GSI feature is implemented.
2. Blue font indicates data from Watearth projects.
3. Assume Biofiltration (bioretention with liner/underdrain) behaves as bioretention.
4. Pollutant removal rates for modular wetlands assumed to be the same as stormwater wetlands.
5. Percent removal varies depending on filtering or treatment and removes volume from receiving system.

6. Typically incorporated as a runoff reduction measure through interception or depression storage, which translates into removal of runoff volume and associated pollutants.
7. Percent removal will behave the same as other metals removed from the same Green Infrastructure Type.
8. Nitrogen-reducing Green Infrastructure in Environmental Justice Communities, April 2016.
9. The Green Visions Plan for the 21st Century Southern California, April 2006.
10. City Greens: Innovative Green Infrastructure Solutions for Downtowns and Infill Locations, May 2016.
11. Understanding Tree Box Filters, Pioneer Valley Sustainability Toolkit.
12. Green Infrastructure: How to Manage Water in a Sustainable Way, March 2019.
13. National Pollutant Removal Database/Other Sources Summarized by Cost and Pollutant Removal of Storm-water Treatment Practices by Weiss, Gulliver, and Erickson in May/June 2007 ASCE Journal of Water Resources Planning and Management.
14. LID percent removal numbers were obtained from the U.S. EPA Handbook Urban Runoff and Pollution Prevention Planning.
15. From selected field and laboratory studies summarized in Bioretention Technology: Overview of Current Practice and Future Needs by Davis, Hunt, Traver, and Clar in March 2009, Journal of Environmental Engineering.
16. Fecal Coliform removal rate for tree boxes assumed to be the same as bioretention.

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

Project	Houston Metro Urban Design Master Plan
Watearth #	20-016.1
Subject	LEED and Envision Implementation Opportunities
Date	March 4, 2022
Prepared by	Sanja Martic
	Brandon Estanislao Cornejo, RLA

LEED and Envision

Leadership in Energy and Environmental Design (LEED) is a sustainable rating system that guides the design, construction, operations, and maintenance of buildings and sites toward sustainability. **Envision** is an urban design objective framework of criteria and performance factors that identifies green and sustainable approaches to plan, design, construct, and operate infrastructure projects.

LEED has several rating systems that can be applied to a variety of project types. **LEED BD+C**: New Construction and Major Renovations and **LEED ND**: Neighborhood Development are the two LEED v4 rating systems applicable to the Houston Metro Urban Design Master Plan. Careful planning shall determine which of the two rating systems is best to utilize.

LEED BD+C is applicable to METRO transit center buildings. It provides a framework for new construction of holistic green buildings or major renovations to existing buildings and structures, with a focus on managing occupant comfort and energy efficiency. LEED BD+C concentrates on seven themes:

1. Sustainable Sites (SS)
2. Water Efficiency (WE)
3. Energy and Atmosphere (EA)
4. Materials and Resources (MR)
5. Indoor Environmental Quality (EQ)
6. Innovation in Design Process (IDP)
7. Location and Transportation (LT)

LEED ND is applicable to traditional neighborhood design and multimodal travel. It is a potentially better choice for METRO projects that could make them exemplars of innovative leadership in achieving sustainability goals. LEED ND concentrates on five areas:

1. Smart Location and Linkage (SLL)
2. Neighborhood Pattern and Design (NPD)
3. Green Infrastructure and Buildings (GIB)
4. Innovation and Design Process (IDP)
5. Regional Priority (RP)

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

LEED ND is further divided into two categories: **LEED ND: Plan** and **LEED ND: Built Project.** A project must use the LEED ND Plan rating system if it is in a planning stage or has constructed less than 75% of its total building floor area. If a project is at full build-out, it must use the LEED ND rating system.

Envision is applicable to METRO infrastructure such as railways, bus routes, and park and ride locations and focuses on the extended social, environmental, and economic impacts infrastructure projects have on communities. Envision is organized under themes of:

1. Quality of Life (QL)
2. Leadership (L)
3. Resource Allocation (RA)
4. Natural World (NW)
5. Climate and Resilience (CR)

Envision v3 verifies infrastructure projects that completed the verification process and achieved sufficient points to earn an Envision Award. Award levels are based on the percentage of applicable points achieved. Using Envision has the potential to benefit the project through increased resiliency, lower cost, reduced negative impacts to the community and environment, and increased public confidence and involvement in decision making.

The following outlines the Urban Design Master Plan themes (Amenities and Furnishings, Pedestrian Pavements, Lighting, Technology, Landscape, Architecture, and Identity and Wayfinding) and the LEED and Envision objectives that apply.

Note: Abbreviations in parentheses above will be used when referencing various LEED and Envision themes below.

Amenities and Furnishings

LEED BD+C:

MR – 1 Storage and Collection of Recyclables

Provide amenities, accessible to waste haulers, to facilitate separation, collection, and storage of recyclable materials for the top four recyclable waste streams.

LEED ND:

NPD-1 Walkable Streets

Improve public health by providing safe and comfortable street environments that encourage daily physical activity.

Envision:

QL1.1 Improve Community Quality of Life (26max pt.)

Select appropriate amenities and furnishings that address local community needs, community goals and objectives. Improve the net quality of life of all communities affected by the project.

RA1.1 Support Sustainable Procurement Practices (9max pt.)

Obtain materials and equipment from manufacturers and suppliers that implement sustainable practices. Compliance is measured by the percentage of materials sourced from such manufacturers.

RA 1.2 Use Recycled Materials (14max pt.)

Reduce the use of virgin materials and avoid sending useful materials to landfills by specifying reused materials, including structures, and material with recycled content.

LD2.4 Plan for End-of-Life (14max pt.)

Extend furnishing's useful life through a more durable, flexible, and resilient design.

QL3.4 Enhance Public Space & Amenities (14max pt.)

Improve public spaces and community livability by creating plans and commitments to preserve, conserve, enhance, and/or restore the defining elements of the public space.

Pedestrian Pavements

LEED BD+C:

SS Rainwater Management

Consider the use of permeable pavement. Retain runoff from the associated percentile of regional or local rainfall events on-site by replicating natural site hydrology.

LEED ND:

NPD – Connected and Open Community

Promote projects that have high levels of internal connectivity and are well connected to the community. Encourage development within existing communities that promote transportation efficiency through multimodal transportation.

Envision:

LD3.3 Conduct a Life-Cycle Economic Evaluation (14max pt.)

Extend pavement's useful life through a more durable, flexible, and resilient design.

LD2.3 Plan for Long-Term Monitoring & Maintenance (12max pt.)

Ensure monitoring and maintenance plans include assessments that the completed project is functioning as designed and that environmental impacts are within design parameters. Commit to allocating sufficient resources to fund monitoring and maintenance.

QL2.1 Improve Community Mobility Access (14max pt.)

Ease traffic congestion, improve mobility and access, prevent urban sprawl, and otherwise improve community livability. Improve access and walkability. Reduce commute and traverse times to existing facilities and transportation. Improve user safety across all modes of transportation.

QL2.5 Encourage Alternative Modes of Transportation (15max pt.)

Improve accessibility to nonmotorized transportation and public transit. Promote alternative transportation and reduce congestion.

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

Lighting

LEED BD+C:

SS Light Pollution Reduction

Minimize light trespass from the building and site. Reduce sky-glow to increase night sky access. Improve nighttime visibility through glare reduction. Reduce development impact from lighting on nocturnal environments.

PBT Source Reduction - Mercury

Do not specify or install preheat, T-9, T-10, or T-12 fluorescents or mercury vapor high-intensity discharge (HID) lamps. Do not specify or install probe-start metal halide HID lamps in any interior spaces. Specify and install illuminated exit signs that do not contain mercury and use less than 5 watts of electricity.

LEED ND:

GIB – Solar Orientation

Minimize artificial light use. Orient sites in such a way to encourage efficient energy use by maximizing daylight.

SLL – Site Design for Habitat or Wetland and Water Body Conservation

Do not disturb significant habitat. Design with an appropriate buffer around the habitat. Conserve wildlife habitat by using dark sky-approved lighting features to reduce light pollution.

Envision:

QL1.5 Minimize Light Pollution (12max pt.)

Conserve energy and reduce obtrusive lighting. Prevent excessive glare, the light at night, and light directed skyward. Lighting should meet minimum standards for safety but should not spill over into areas beyond site boundaries.

RA2.1 Reduce Operational Energy Consumption (26max pt.)

Conserve energy by reducing overall operation and maintenance energy consumption.

RA2.2 Use Renewable Energy (24max pt.)

Meet energy needs through renewable energy sources.

RA2.3 Commission and Monitor Energy Systems (20max pt.)

Ensure efficient functioning and extend useful life by specifying third-party commissioning and monitoring of the performance of electrical systems and documentation of system monitoring.

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

Technology

LEED BD+C:

IN – 1 Innovation

Provide public education focusing on green building strategies and solutions. Use technology to achieve innovative performance.

EA – 6 Optimize Energy Performance

Achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

LEED-ND:

NPD – Community Outreach and Involvement

Use technology for community outreach. Encourage people who live or work in the community to participate in project design and planning, thus encouraging responsiveness to community needs.

Envision:

QL2.3 Improve Access & Wayfinding (14max pt.)

Use technology to improve user accessibility, safety, and wayfinding of the site and surrounding areas, enhance clarity, simplicity, readability, and broad-population reliability.

QL3.3 Enhance Public Space & Amenities (14max pt.)

Use technology to improve public spaces to enhance community livability.

Landscape

LEED BD+C:

SS – 6 Rainwater Management

Reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of the site. Review historical conditions and undeveloped ecosystems in the region to avoid contributing to flooding downstream in frontline communities.

SS – 7 Heat Island Reduction

Minimize low solar reflectance indexed surfaces to reduce localized heat accumulation and manage microclimates. Maximize the percentage of site area that meets solar reflective index criteria.

LEED-ND:

SLL – Steep Slope Protection

Minimize erosion and protect habitat by preserving steep slopes in a natural, vegetated state.

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

SLL – Restoration of Habitat or Wetlands and Water Bodies.

Restore native plants, wildlife habitat, and water bodies previously harmed by human activities.

SLL – Long-Term Conservation Management of Habitat or Wetlands and Water Bodies.

Conserve native plants, wildlife habitat, and water bodies.

NPD – Access to Civic and Public Space

Provide open space close to work and home, thus enhancing community participation and improving health.

NPD – Tree Lined and Shaded Streetscapes

Provide trees to encourage walking and bicycling, reduce speeding, reduce urban heat island effect, improve air quality, increase evapotranspiration, and reduce cooling loads in buildings.

Envision:

QL2.1 Enhance Public Health & Safety (20max pt.)

Consider the health and safety implications of using new materials, technologies, or methodologies above and beyond meeting regulatory requirements.

QL3.2 Enhance/Preserve Views & Local Character (14max pt.)

Maintain the local character of the community in the design, and do not impact community views. Identify important community views and aspects of the local landscape, including communities, and incorporate them into the project design.

RA1.5 Divert Waste from Landfills (8max pt.)

Reduce waste and divert waste streams from disposal to recycling and reuse. Reuse or recycle materials on-site, compost materials on-site or send to a composting facility, send materials to recycle or reclamation facilities, and balance cut and fill.

RA3.2 Reduce Operational Water Consumption (22max pt.)

Reduce overall potable water consumption and encourage the use of greywater, recycled water, and stormwater to meet water needs.

CR2.5 Maximize Resilience (26max. pt.)

Design landscapes for long-term resilience and adaptation. Prepare infrastructure systems to be resilient and adaptable to the consequences of long-term climate change.

Architecture

LEED BD+C:

LT-5 Access to quality transit

Encourage development in locations that have multimodal transportation choices or otherwise reduced motor vehicle use, to reduce greenhouse gas emissions, air pollution, and other environmental and public health harms associated with motor vehicle use.

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

LT-6 Bicycle Facilities

Increase transportation efficiency and reduce vehicle distance traveled by promoting bicycling. Provide bicycle facilities such as storage.

LT-7 Reduce Parking Footprint

Do not exceed the minimum local code requirements for parking capacity. Parking facilities are associated with environmental issues such as automobile dependence, land consumption, and rainwater runoff.

WE-5 Indoor Water Use Reduction

Reduce indoor potable water consumption. Preserve free and low-cost potable water resources in all facilities.

EA – 9 Renewable Energy Production

Use renewable energy systems to offset building energy costs.

EQ -5 Thermal Comfort

Increase the quality of life by providing quality controls for at least 50% of individual occupant spaces. Provide group thermal comfort controls for all shared multi-occupant spaces. Thermal comfort controls allow occupants, whether in individual spaces or shared multi-occupant spaces, to adjust at least one of the following in their local environment: air temperature, radiant temperature, airspeed, and humidity.

LEED ND:

LEED BD+C: LT5, LT6, LT7, WE5, and EA 9 are also included in LEED ND.

NPD – Transit Facilities

Encourage transit use and reduce vehicle distance traveled by providing safe, convenient, and comfortable transit waiting areas.

NPD – Transportation Demand Management

Reduce energy consumption, pollution, and harm to human health from motor vehicles by encouraging multimodal travel.

Envision:

QL2.4 Improve Community Mobility Access (14max pl.)

Ease traffic congestion, improve mobility and access, prevent urban sprawl, and otherwise improve community livability. Broaden mode choices, reduce commute times, reduce vehicle distance traveled, and improve levels of service.

Identity and Wayfinding

LEED BD+C:

Not applicable.

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LEED and Envision Implementation Opportunities

Houston Metro Urban Design Master Plan

LEED ND:

NPD - Visitability and Universal Design

Provide wayfinding measures accessible by a wide spectrum of people, regardless of age or ability. Build or retrofit ADA-ABA travel routes and rights-of-way even where not legally required.

Envision:

QL2.3 Improve Access and Wayfinding (14max pt.)

Incorporate and provide clear access, safety, and wayfinding measures to accommodate emergency services and regular vehicular or pedestrian traffic. The project should provide safe and appropriate access in and/or around the project in a way that integrates the project with the surrounding community.

QL3.1 Advance Equity and Social Justice (18max pt.)

Ensure that equity and social justice are fundamental considerations within project processes and decision-making. The project should aim to clearly communicate and provide equitable access to benefits.

Pedestrian Paving

Materials Criteria

The following criteria are per the *Houston Public Works Standard Construction Specifications (2021)*:

1. Expansion joints and control joints must be considered in relation to other amenities to ensure facility longevity.
2. Concrete and Reinforcing Steel: Conform to material requirements from Section 02751 – Concrete Paving.
3. Expansion Join Material: Conform to material requirements for preformed expansion joint material from Section 02752 – Concrete Pavement Joints.
4. Subgrade Materials: Conform to subgrade material requirements of:
    a. Section 02336 – Lime Stabilized Subgrade
    b. Section 02337 - Lime/Fly-Ash Stabilized Subgrade, and
    c. Section 02338 - Portland Cement Stabilized Subgrade.
5. Colored concrete for medians and sidewalks: Provide dry-shake color hardener consisting of quartz-silica mixture of finely-graded, non-metallic aggregates, plasticizer and cement binder for producing color, per Section 02761.
6. Coloring for wheelchair ramps: Conform to material requirements for colored concrete of Section 02761.
    a. Color shall be brick red or as shown on drawings in Section 02761.

Sidewalks ADA

The following sidewalk ADA requirements are per the COH Planning and Development Department:

1. All sidewalks shall be constructed in a manner consistent with applicable state and federal disability rights laws, per Section 40-555 of COH Code of Ordinances.
    a. Texas Accessibility Standards
    b. Americans with Disabilities Act (ADA)
2. All new developments require a sidewalk in front of the subject property.
    a. There are exceptions to this requirement when sidewalks are impractical along certain streets.
    b. No overhang objects are allowed along the length of the sidewalk (8 feet minimum clearance).
3. The sidewalk cross slope cannot be greater than 2%.

Ramps ADA

The following ADA requirements for ramps are from the Texas Department of Licensing & Regulation (TDLR):

1. Ramps shall not have a running slope steeper than 1:12

2. Changes in slope are not permitted on the ramp runs
3. To accommodate the most users, have ramps with the least possible running slope
4. Also accommodate ramps with stairs (individuals whose distance presents a greater barrier than stairs)
5. The rise for any ramp shall be 30 inches maximum
6. Ramps must have landings at the top and bottom of each ramp run
    a. Must be level landings
7. The widest clear width shall be at least as wide as the widest ramp run leading to the landing
8. Ramps that change direction between runs must have a clear landing of 60 inches by 60 inches minimum
9. Ramps with a rise greater than 6 inches must have handrails
10. Edge protection on each side of ramp landings
    a. Not required if handrails are not required (exception)
    b. Not required on the side of ramp landing serving an adjoining ramp run or stairway
11. Counter slopes on adjoining gutters and road surfaces must not be steeper than 1:20

Crosswalks ADA

The following ADA requirements for crosswalks are per the Texas Department of Transportation (TxDoT, 2016):

1. Curb ramps must be installed at each crossing where there is a marked crosswalk
    a. Installed with warning mats and/or grooved pavement at curb ramps
2. ADA does not require installation of ramps or curb ramps in the absence of a pedestrian walkway
3. If resurfacing of the roadway affects the crosswalk, curb ramps must be provided at both ends of the crosswalk

Watearth

Houston Metro Urban Design

Pedestrian Paving Requirements

Pedestrian Paving

Materials Criteria

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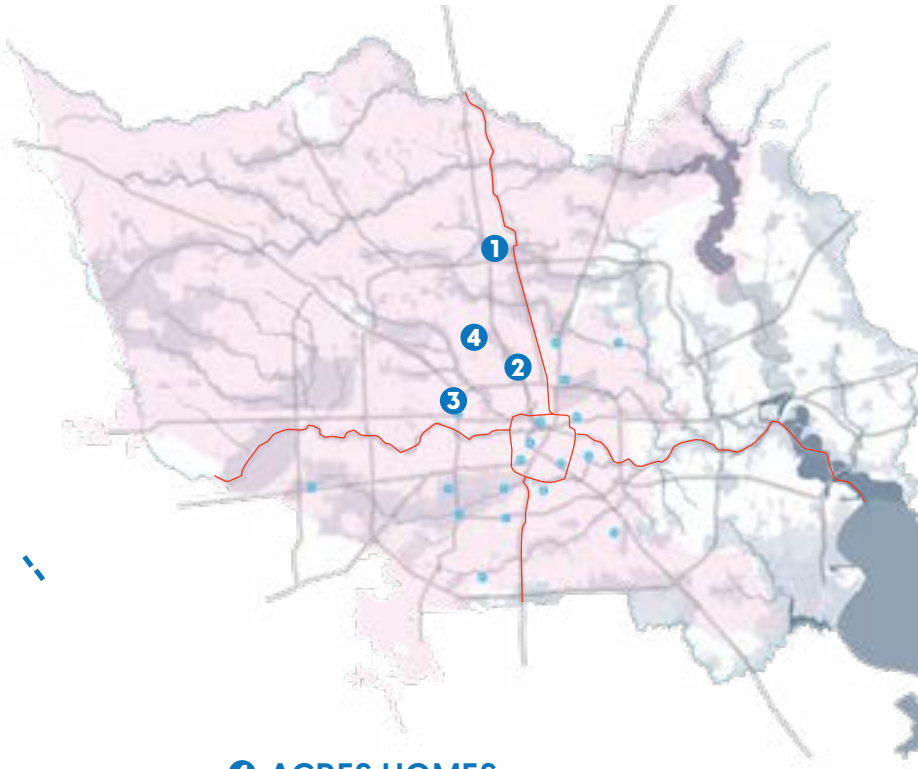
Analysis of METRO Facilities

The UDM consultant team analyzed the size and layout of existing METRO facilities, as well as visited many of them to perform site analysis. The UDM consultant team assessed existing site circulation, quality of existing conditions, observed design and field errors, as well as compared the existing facilities to the criteria provided in the Transportation Facility Checklists. This analysis provided a basis of empirical knowledge that heavily informed the development of the Urban Design Manual.

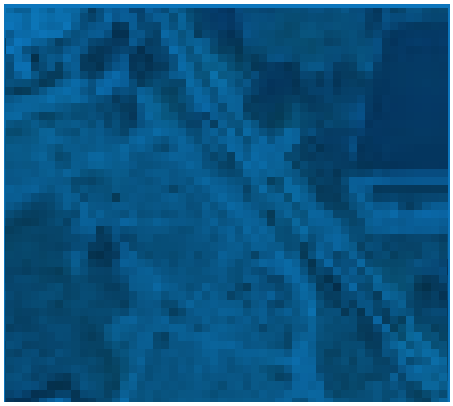
Northwest

Transit Centers



1 GREENSPOINT

Bus Only | Shared Parking with Shopping Mall



BUS STOP

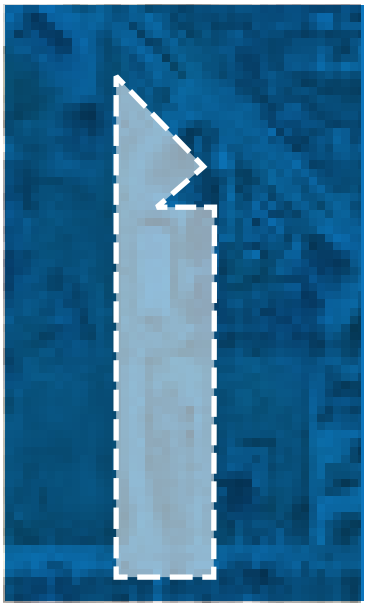
2 NORTHLINE

Bus + LRT+ Minimal Parking | Retail / Low Density Residential | 2013

PARKING
SHELTER BLDG
BUS STOP
LR STOP

4 ACRES HOMES

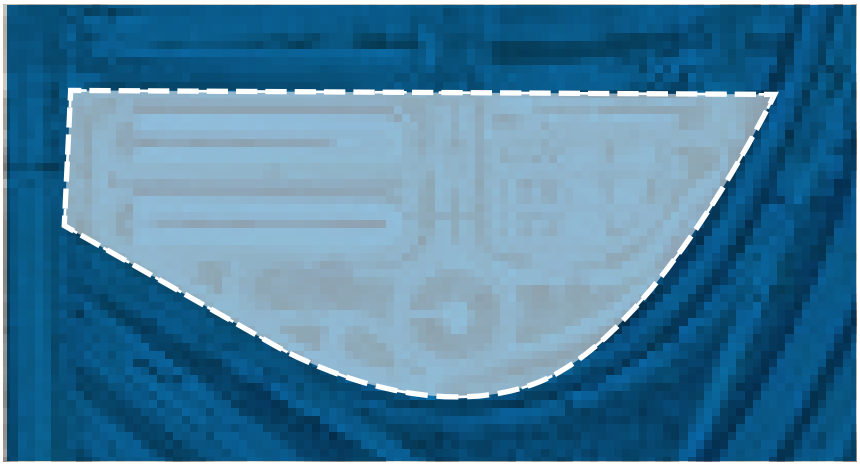
Bus Only | Low Density Residential



SHELTER BLDG
BUS STOP

3 NORTHWEST

Bus + Minimal Parking | Business Park



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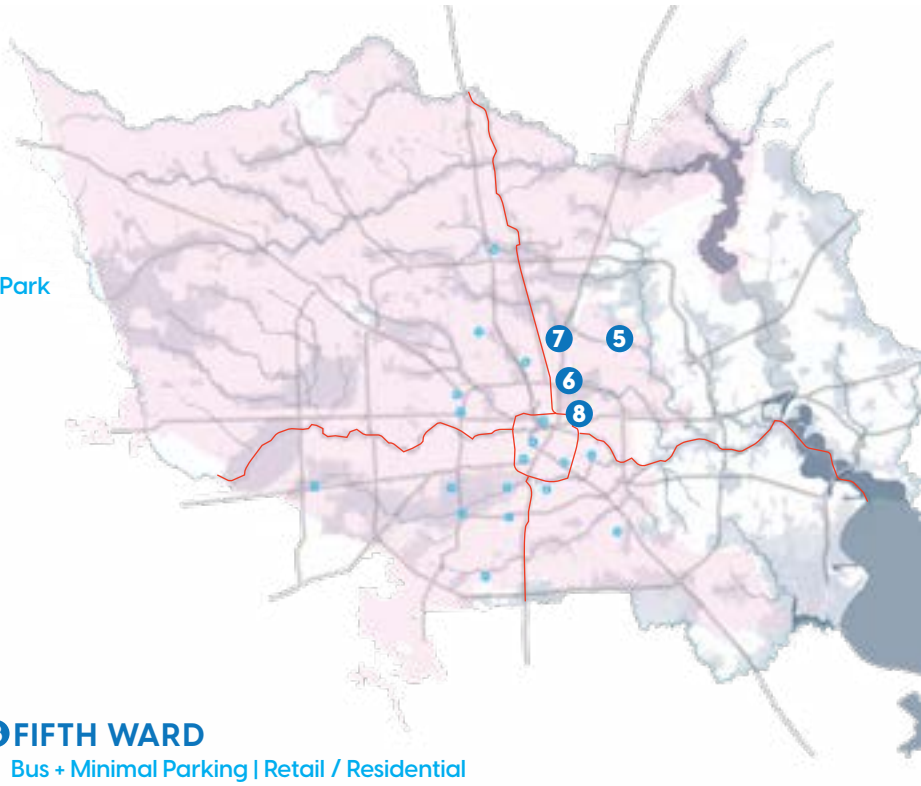
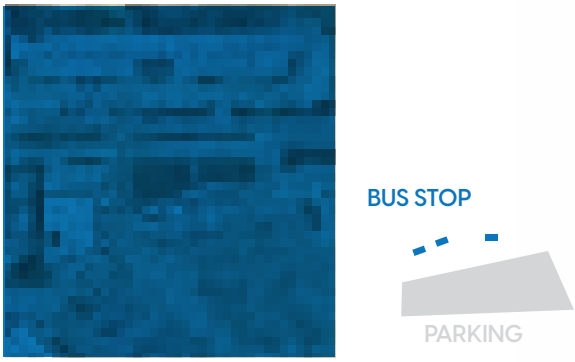
BUS STOP
PARKING

Northeast



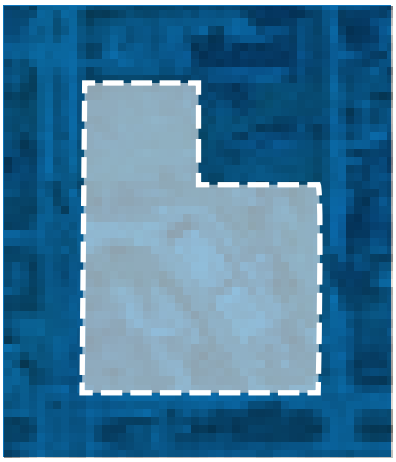
5 MESA

Bus + Minimal Parking | Low Density Residential / Bayou Park



6 KASHMERE

Bus + Minimal Parking | Low Density Residential

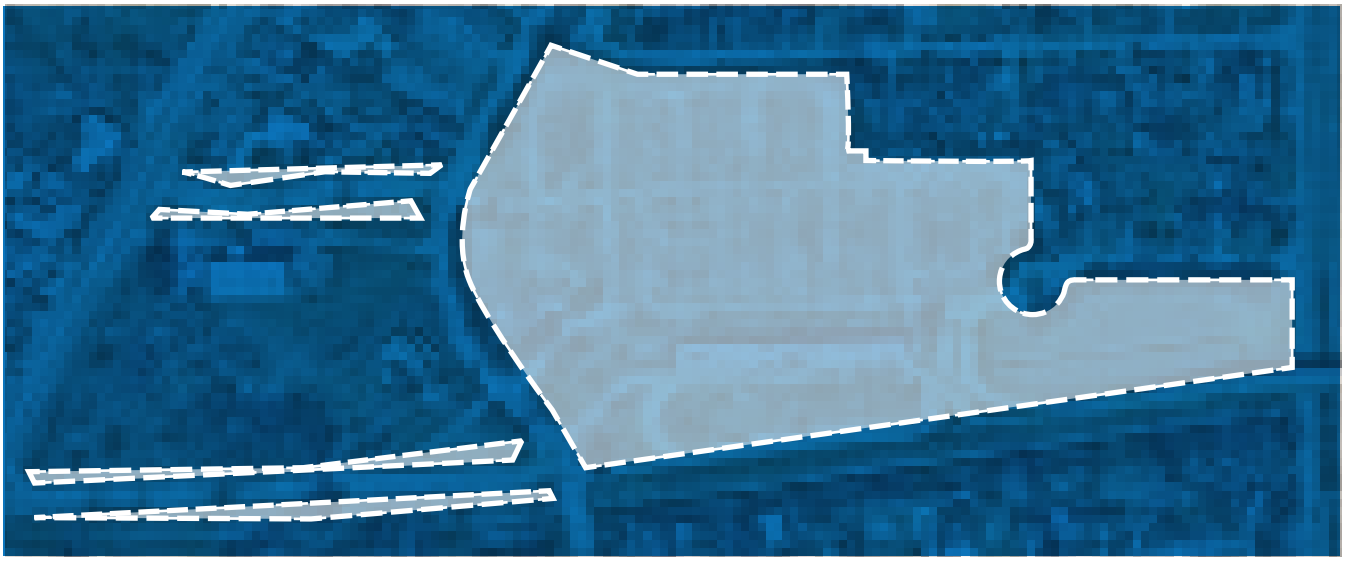


8 FIFTH WARD

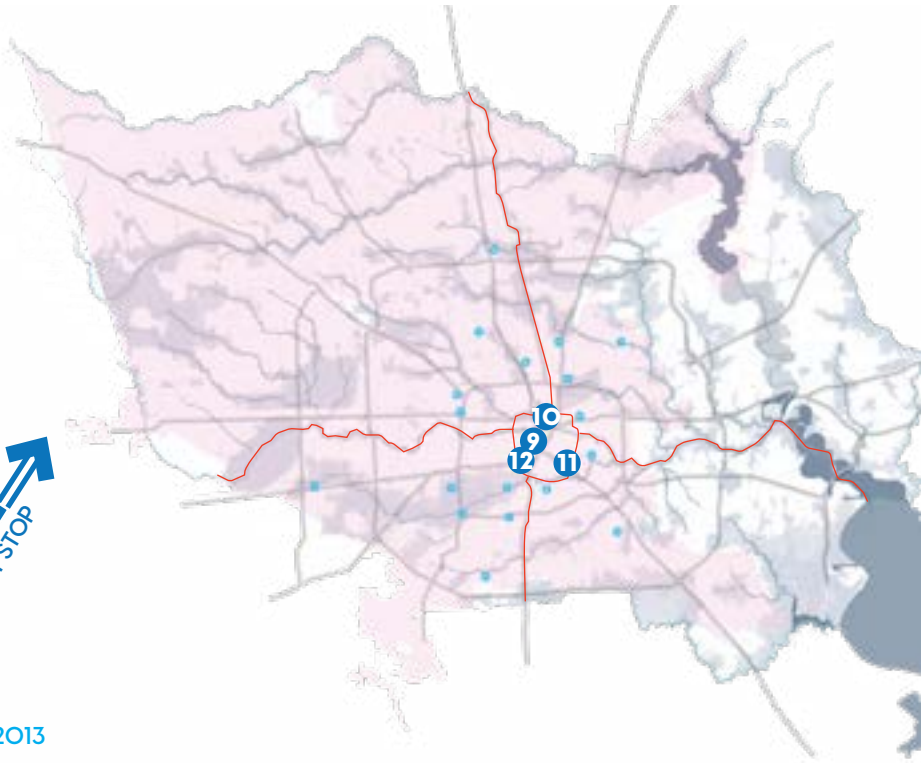
Bus + Minimal Parking | Retail / Residential

7 TIDWELL

Bus + Minimal Parking | Low Density Residential / Auto Services

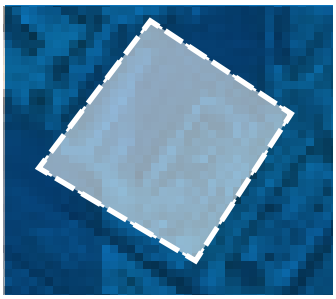


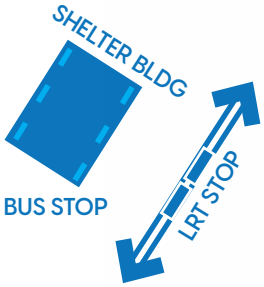
The Core



9 DOWNTOWN

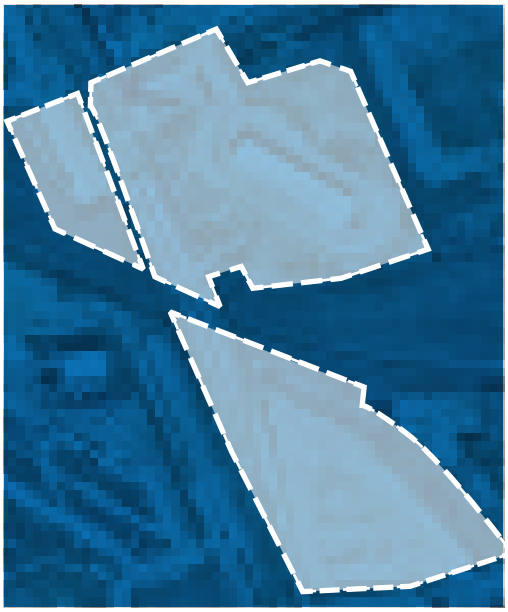
Bus + LRT | Business / Apartments | 2004

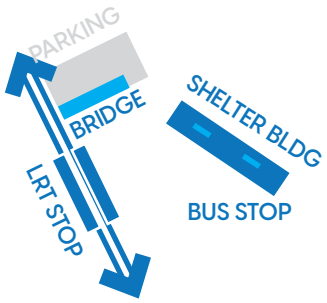




10 BURNETT

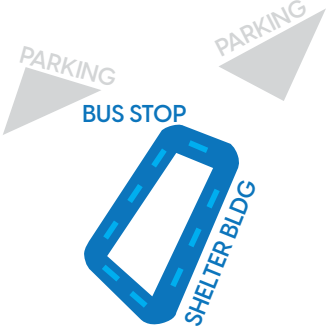
Bus + LRT + Minimal Parking | Apartments / Residential | 2013





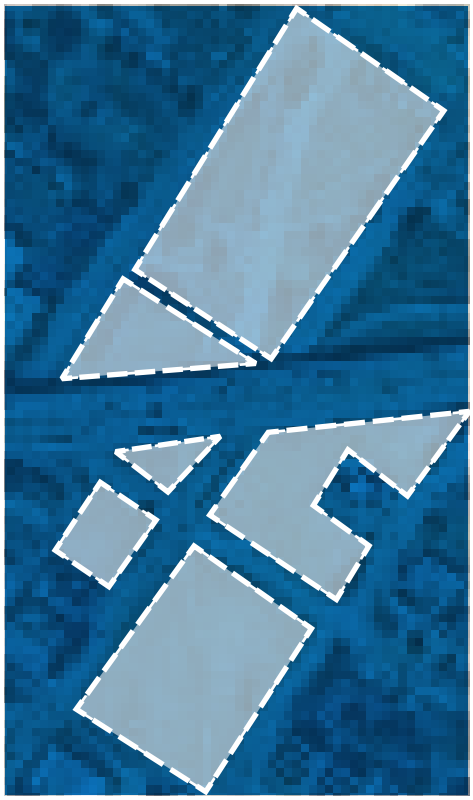
11 EASTWOOD

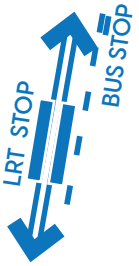
Bus + Minimal Parking | Warehouse / Residential | 2015



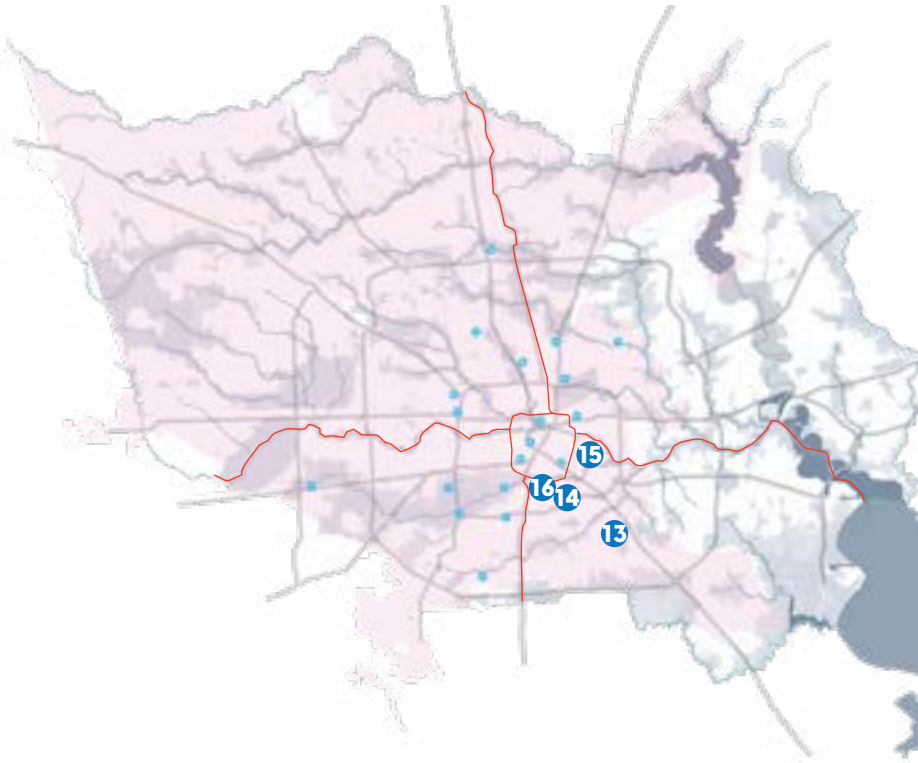
12 WHEELER

Bus + LRT | Residential / Business | 2004





Southeast

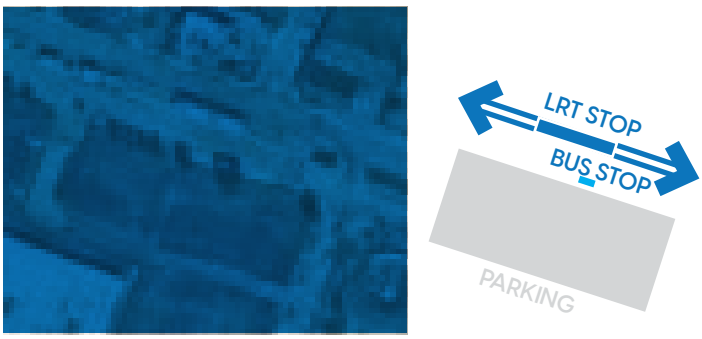


13 HOBBY AIRPORT

Bus Only | Shared Parking w/ Airport

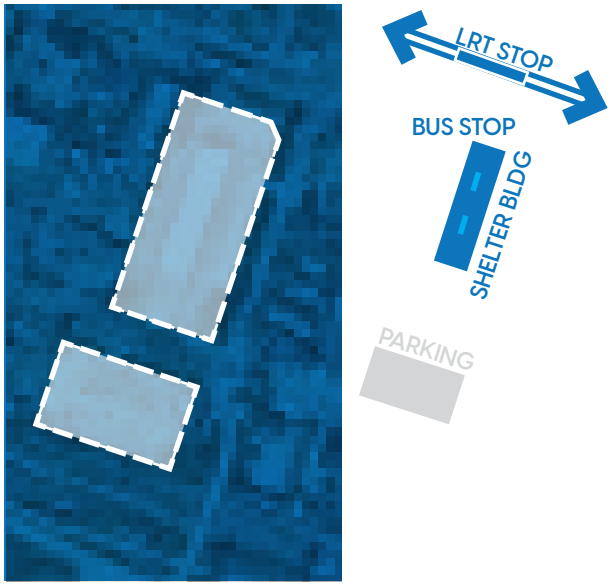
14 PALM CENTER

Bus + LRT+ Minimal Parking | Apartments / Retail | 2015



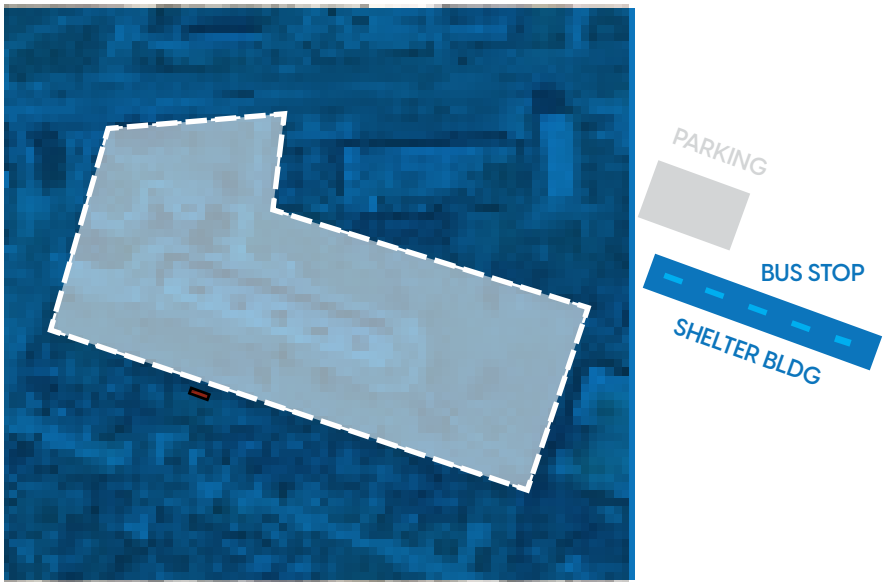
15 MAGNOLIA PARK

Bus + LRT+ Minimal Parking | Retail / Residential | 2017

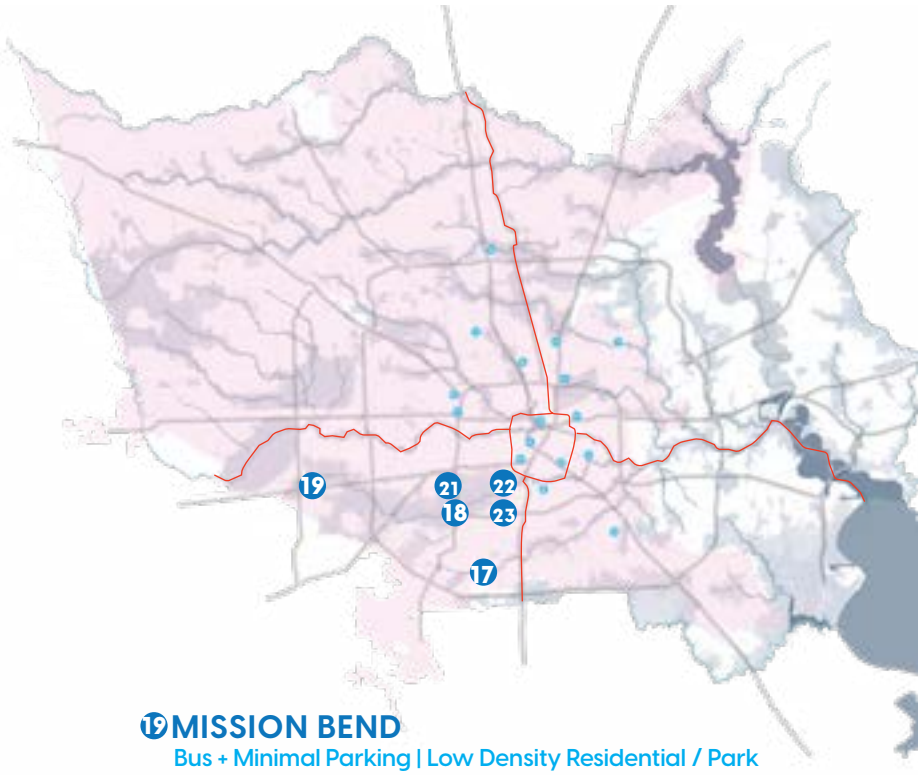


16 SOUTHEAST

Bus + Minimal Parking | Retail / Restaurants / Residential

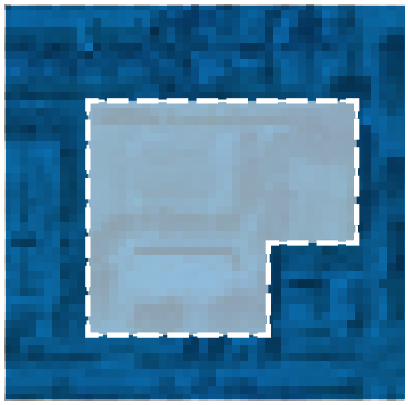


Southwest



17 HIRAM CLARKE

Bus + Minimal Parking | Low Density Residential



PARKING

BUS STOP

SHELTER BLDG

18 WEST LOOP

Bus + Minimal Parking | Apartment / Low Density Residential

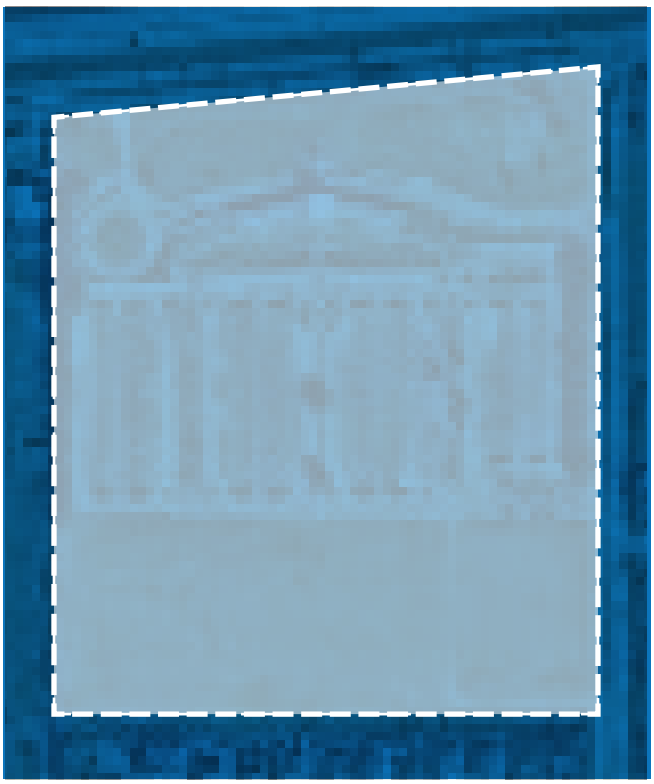
PARKING

BUS STOP

SHELTER BLDG

19 MISSION BEND

Bus + Minimal Parking | Low Density Residential / Park



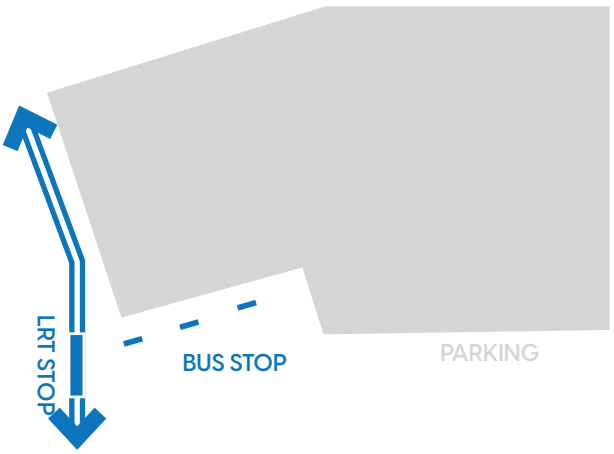
SHELTER BLDG

BUS STOP

PARKING

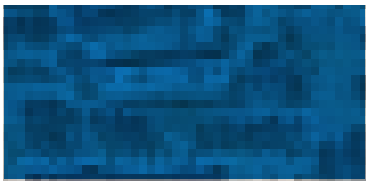
20 FANNIN SOUTH

Bus + LRT + Minimal Parking | Auto Services / Business Park | 2004



21 BELLAIRE

Bus Only | Retail / Restaurants | 1987

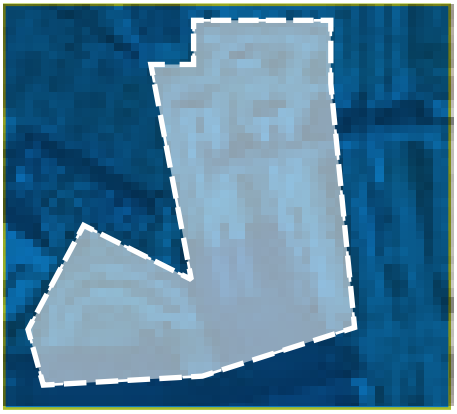


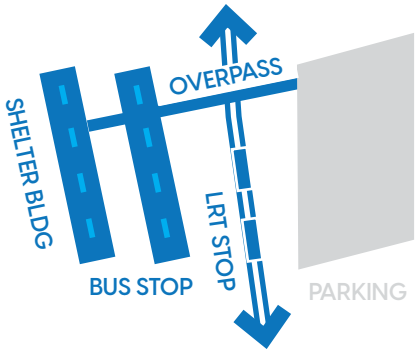
BUS STOP

SHELTER BLDG

22 TEXAS MEDICAL

Bus + LRT + Minimal Parking | Hospitals / Hotels | 2004

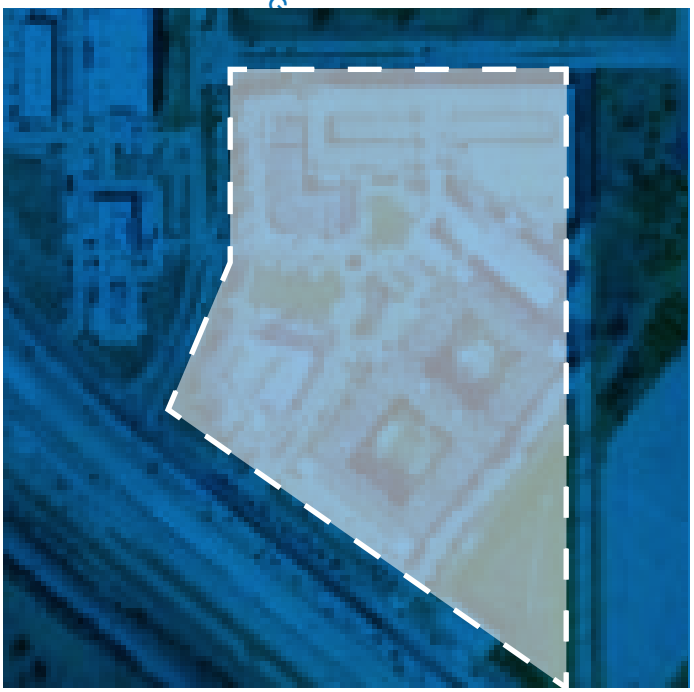




Northwest

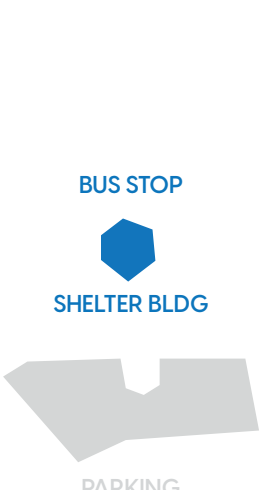
23 CYPRESS

Bus + Parking | Retail / Restaurants



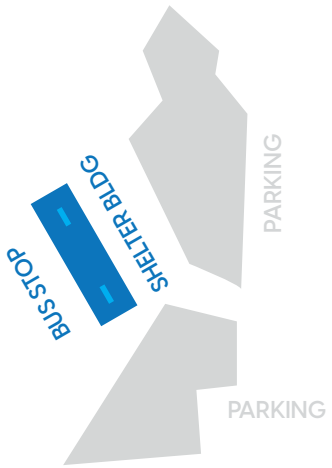
24 KUYKENDAHL

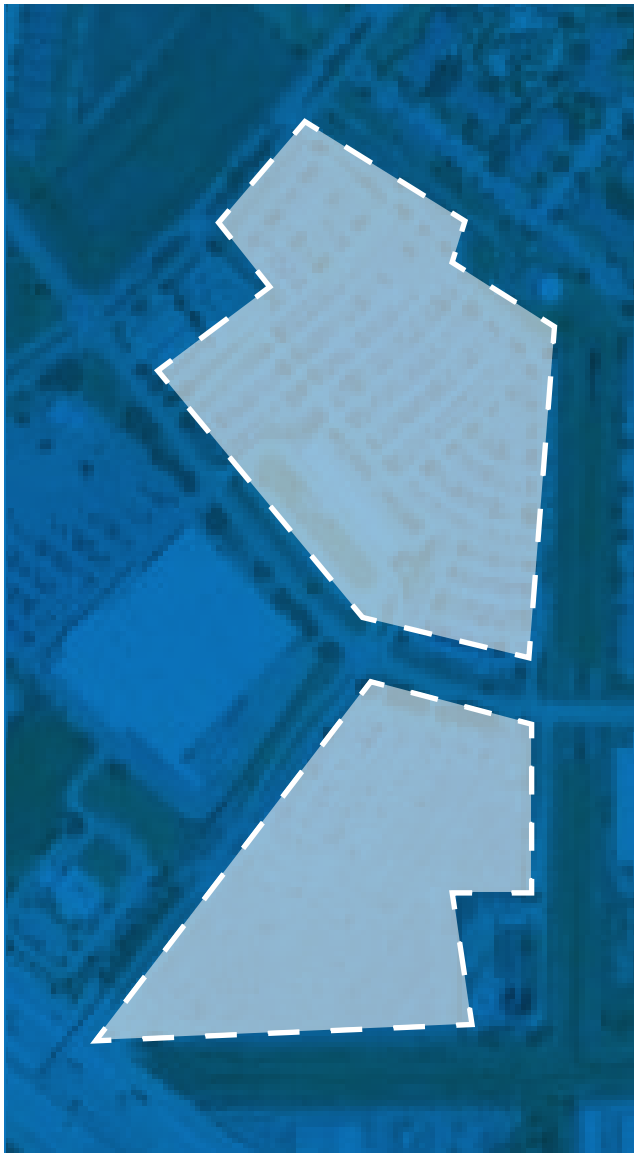
Bus + Parking | Business / Residential



25 NORTHWEST STATION

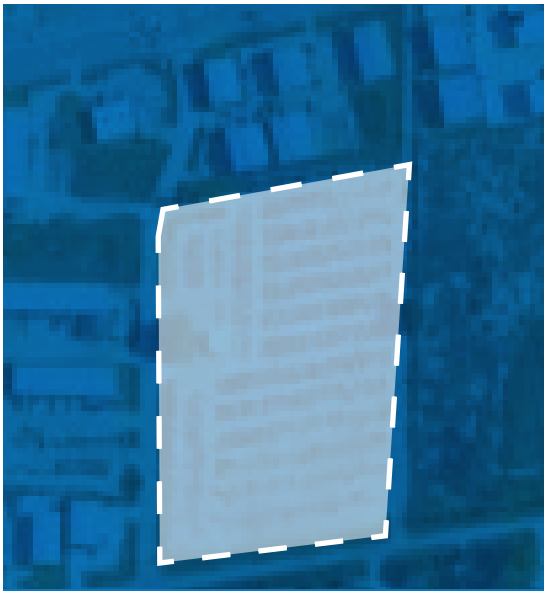
Bus + Parking | Retail / Residential

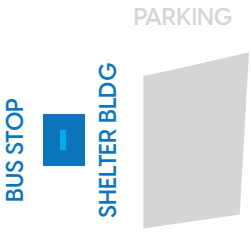




26 SPRING

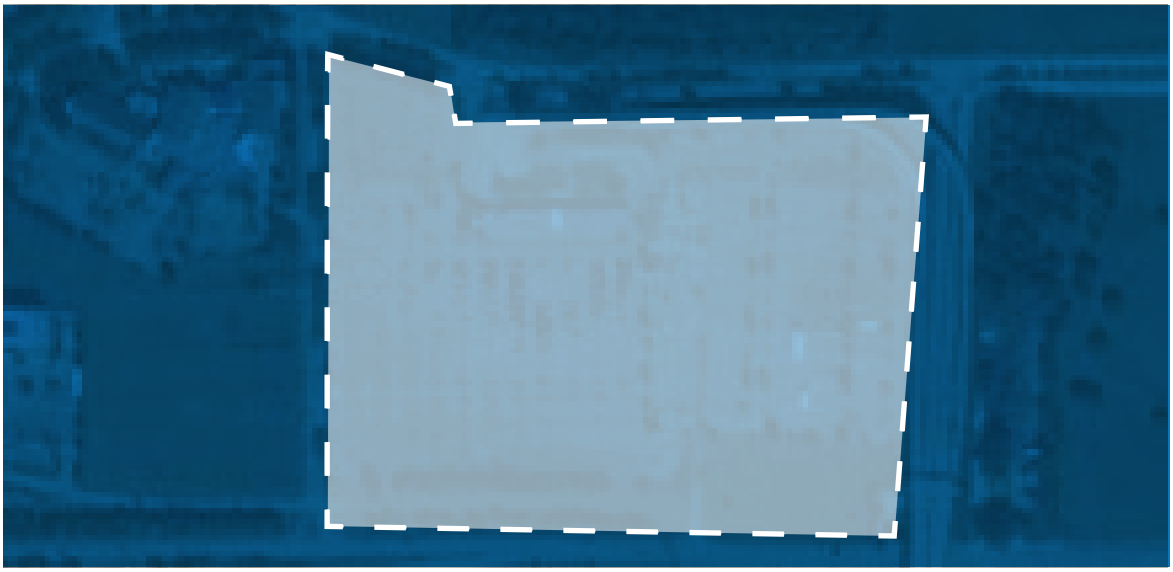
Bus + Parking | Retail / Residential





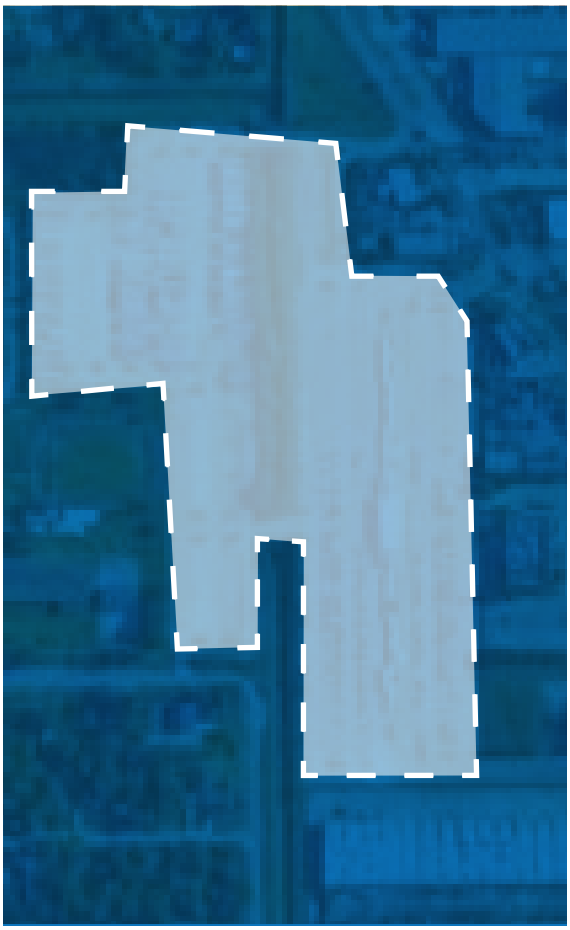
27 ADDICKS

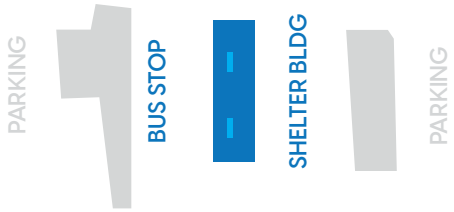
Bus + Parking | Residential / Low Density Restaurants



28 NORTH SHEPHERD

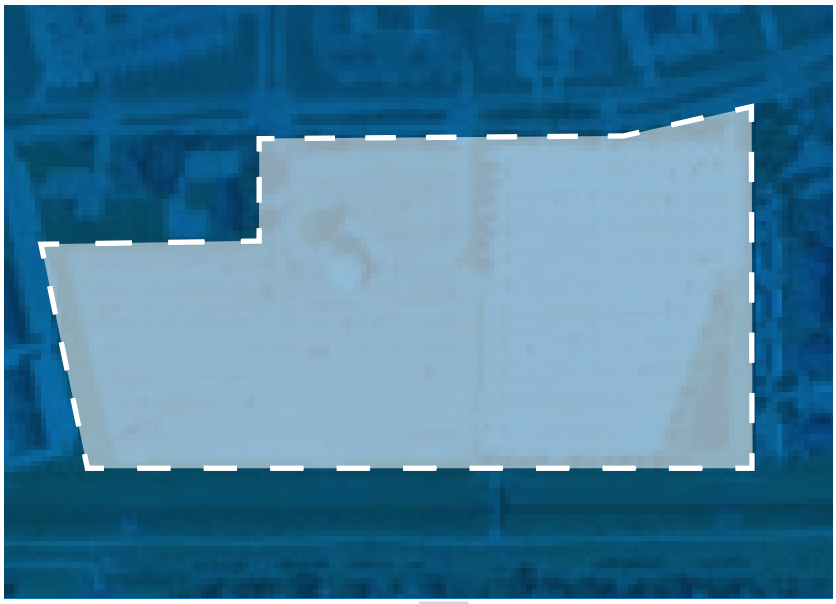
Bus + Parking | Retail / Residential / Restaurants





29 KINGSLAND

Bus + Parking | Medical Facilities / Residential



30 SETON LAKE

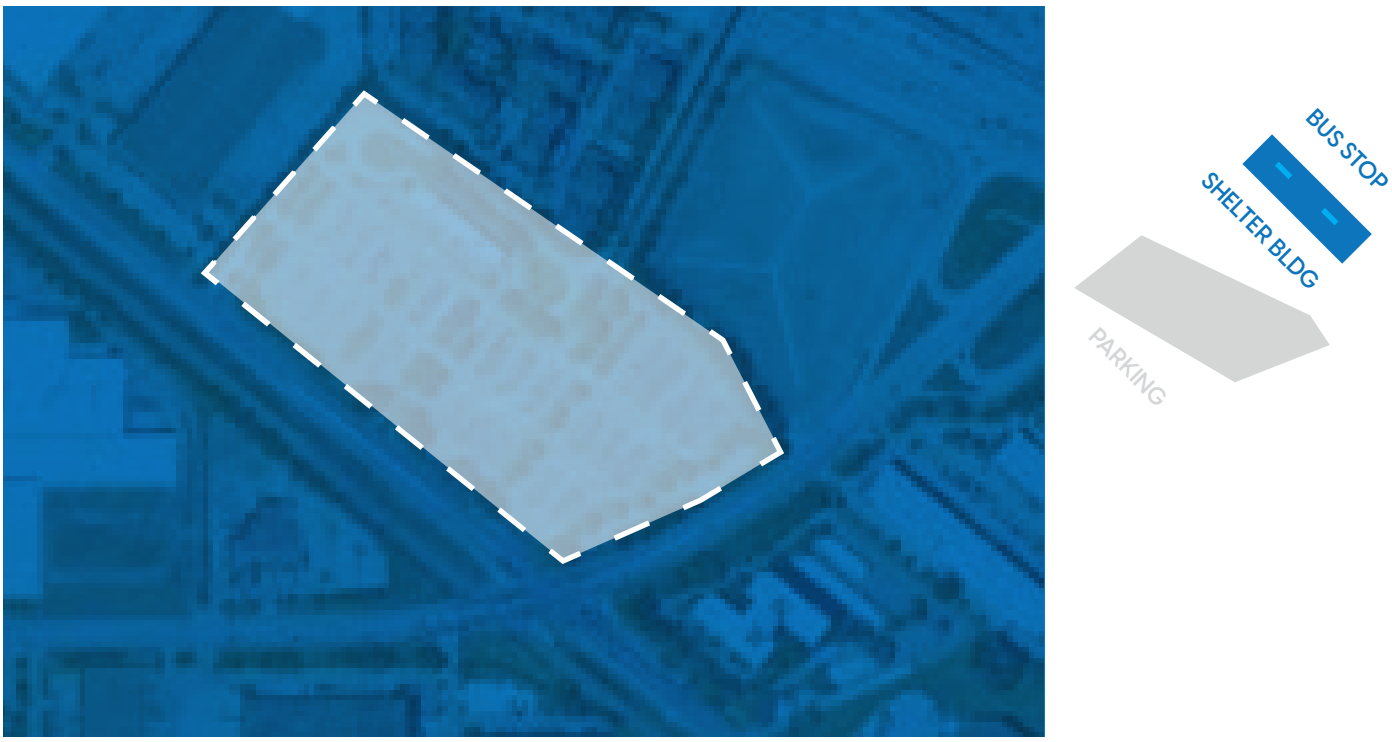
Bus + Parking | Business / Residential / Schools

31 GRAND PARKWAY

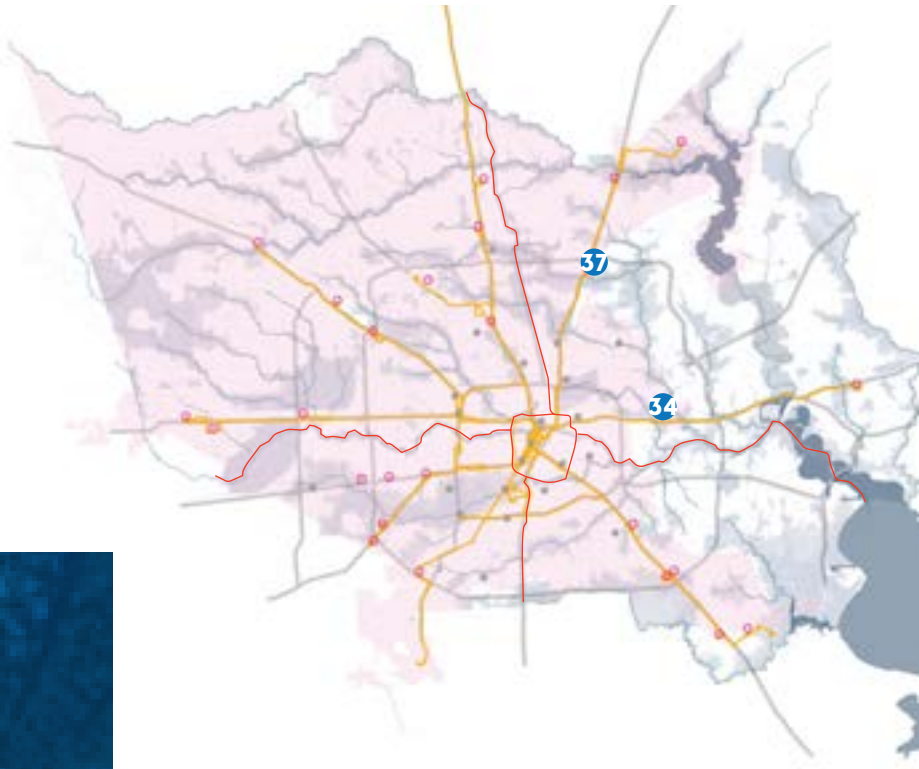
Bus + Parking | Residential / Retail

32 WEST LITTLE YORK

Bus + Parking | Business Park / Retail



Northeast

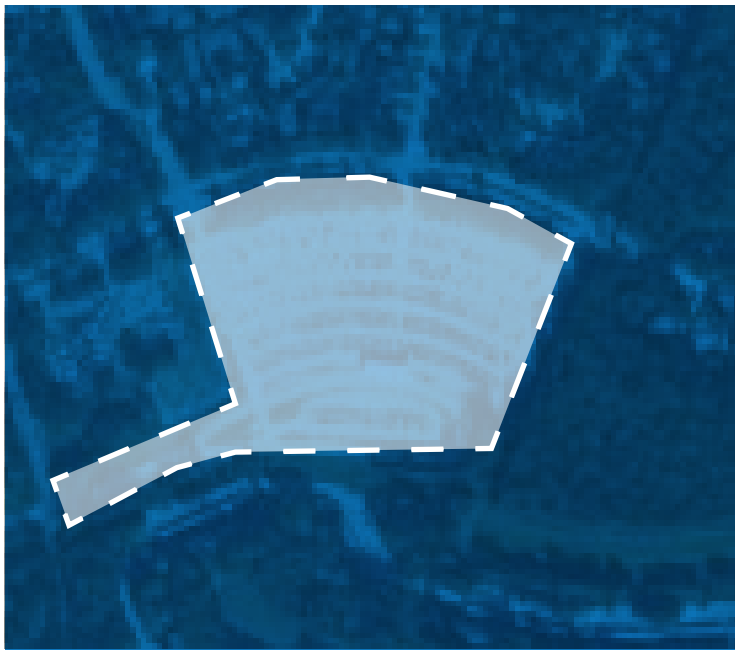


KINGWOOD
Bus + Parking | Retail / Restaurants / Residential

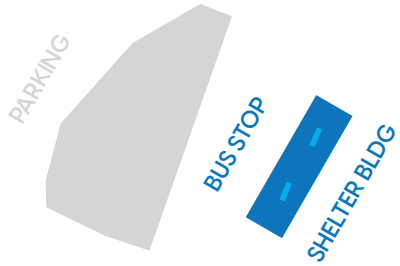
PARKING

BUS STOP

SHELTER BLDG



TOWNSEN
Bus + Parking | Retail / Restaurants / Residential

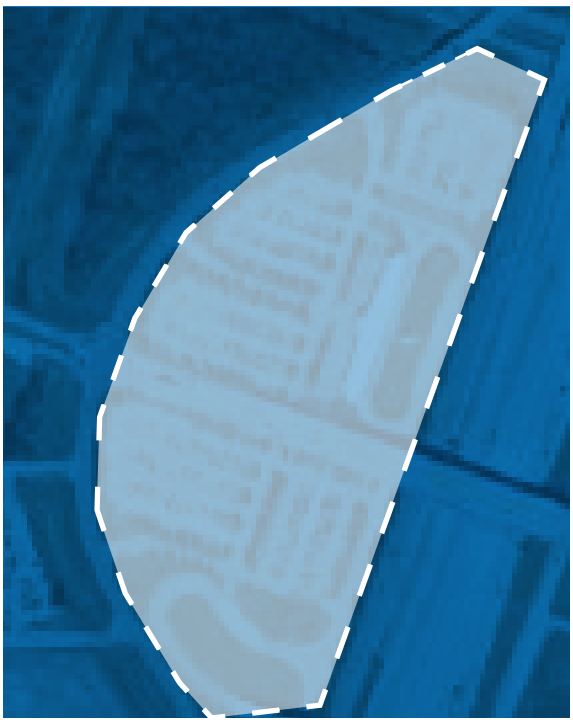


MAXEY
Bus + Parking | Retail / Restaurants/ Residential

BUS STOP

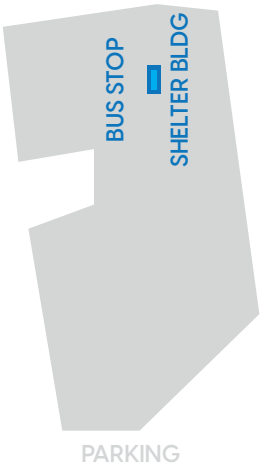
SHELTER BLDG

PARKING



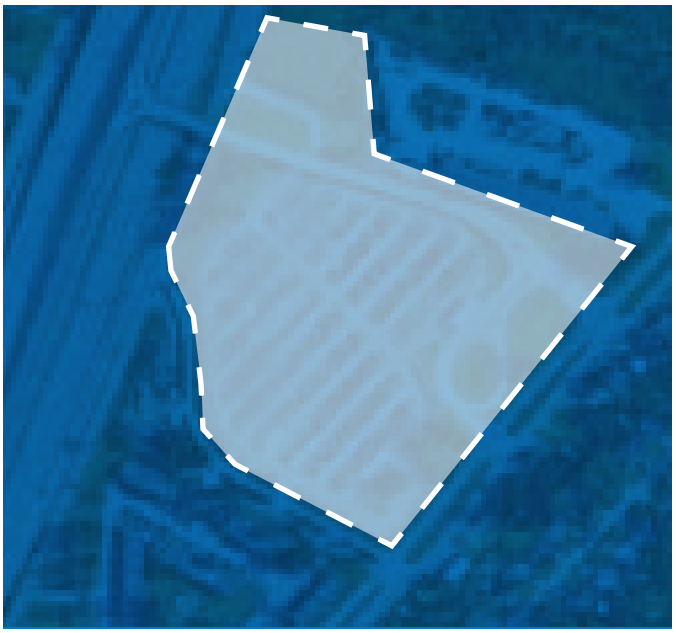
56 BAYTOWN

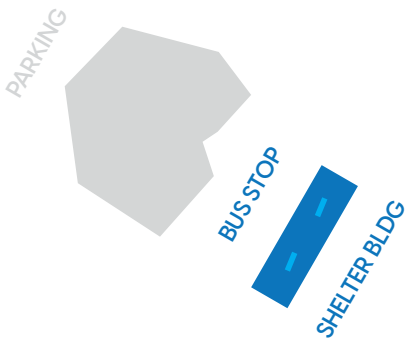
Bus + Parking |
Retail / Restaurants / Residential



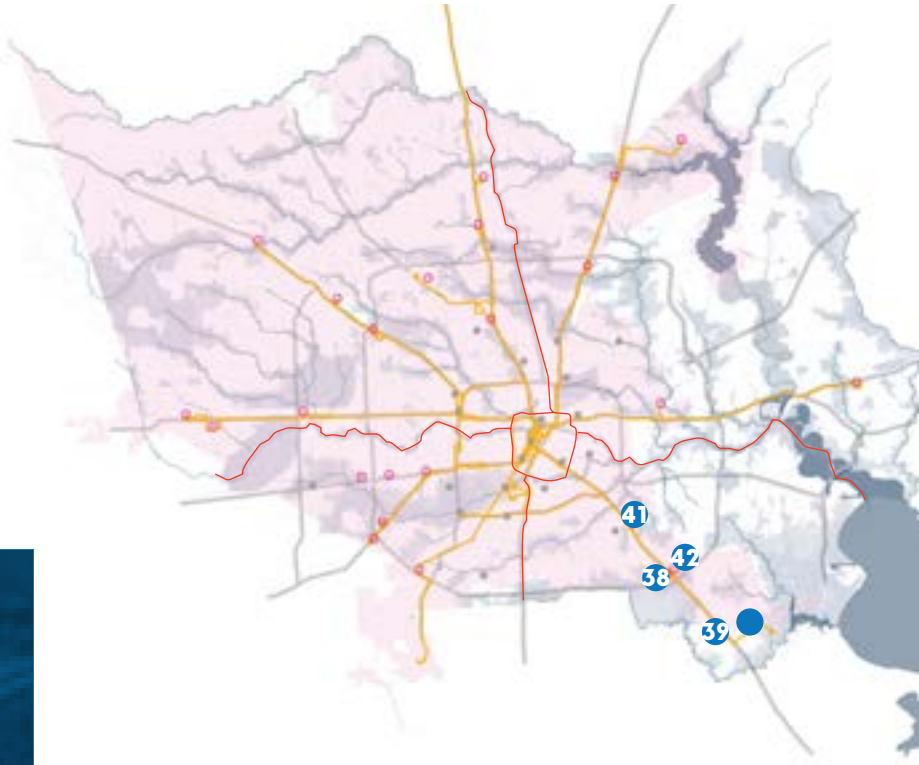
57 EASTEX

Bus + Parking | Retail / Residential



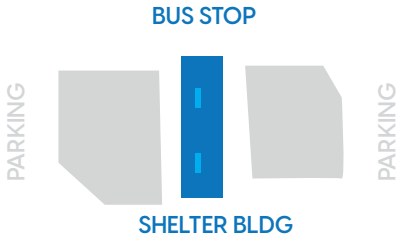


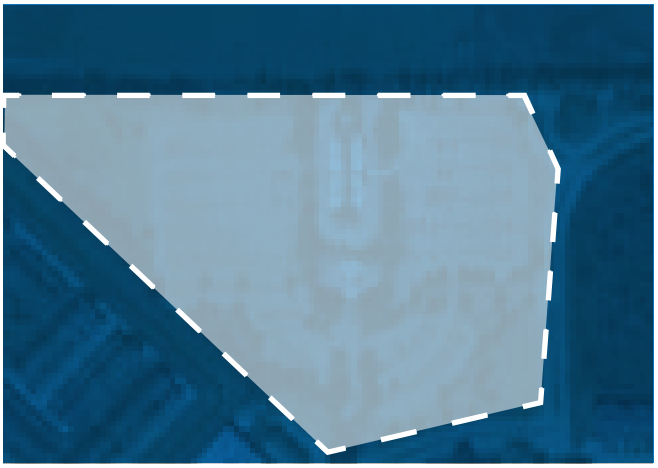
Southeast



38 FUQUA

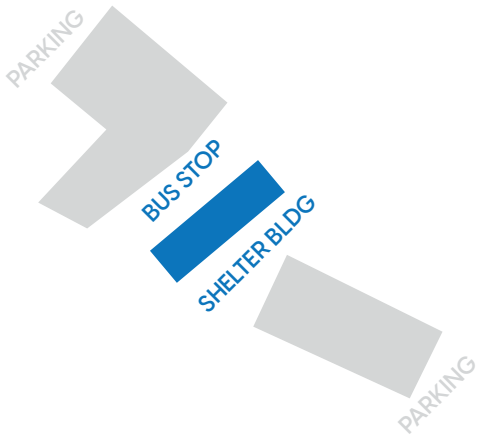
Bus + Parking | Retail / Restaurants / Residential

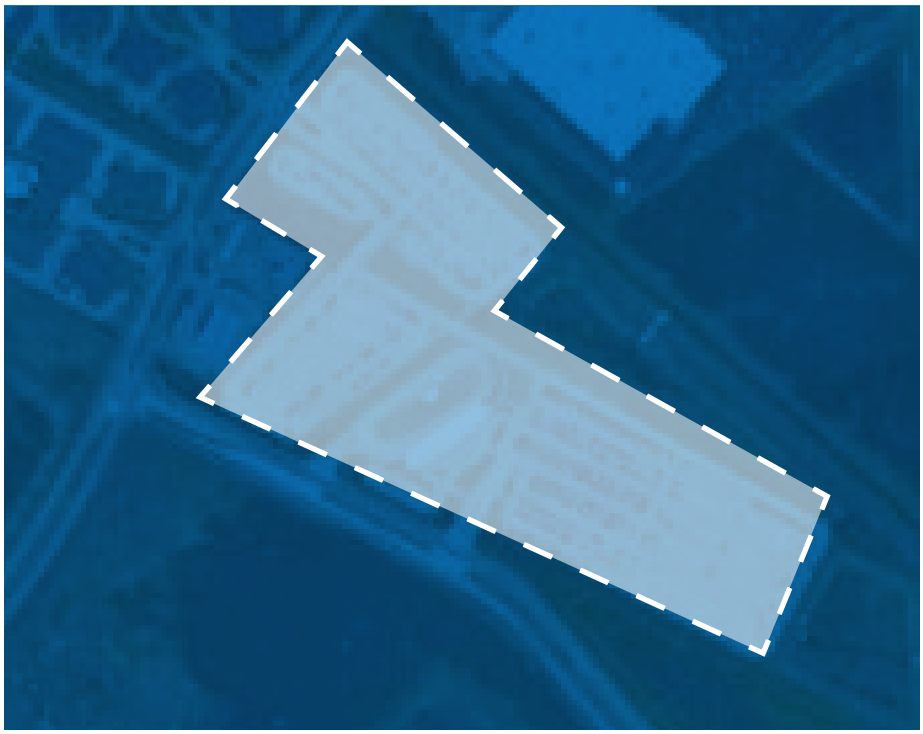




39 EL DORADO

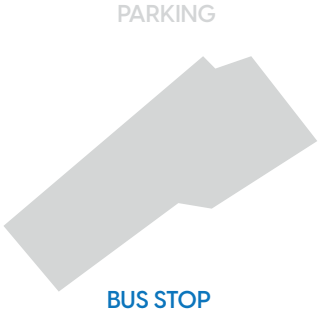
Bus + Parking | Retail / Restaurants / Residential

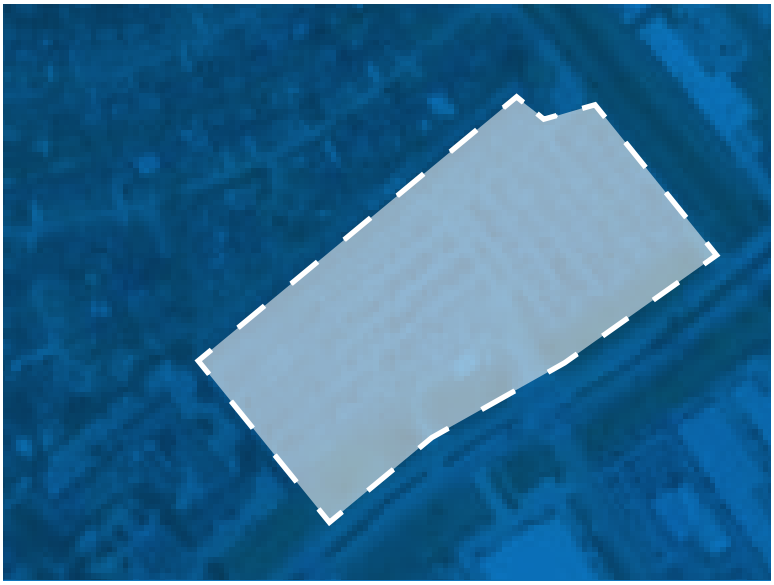




40 BAY AREA

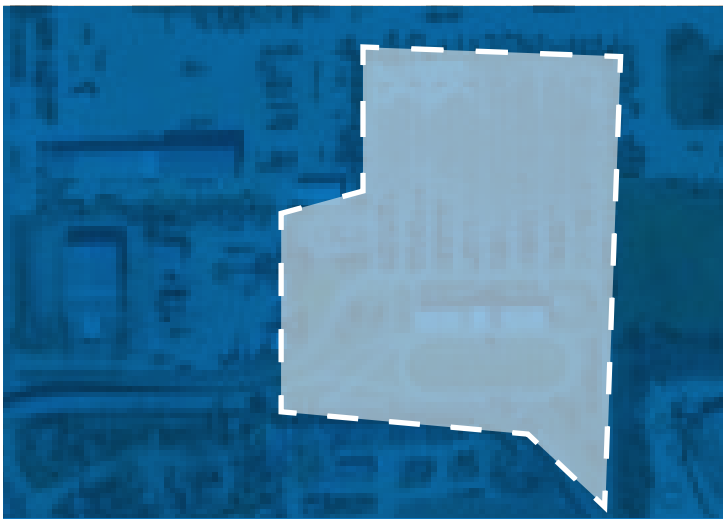
Bus + Parking | Retail / Restaurants / Residential

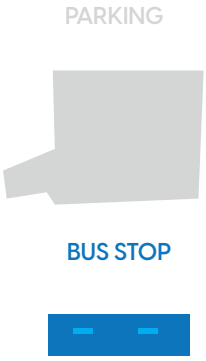




41 MONROE

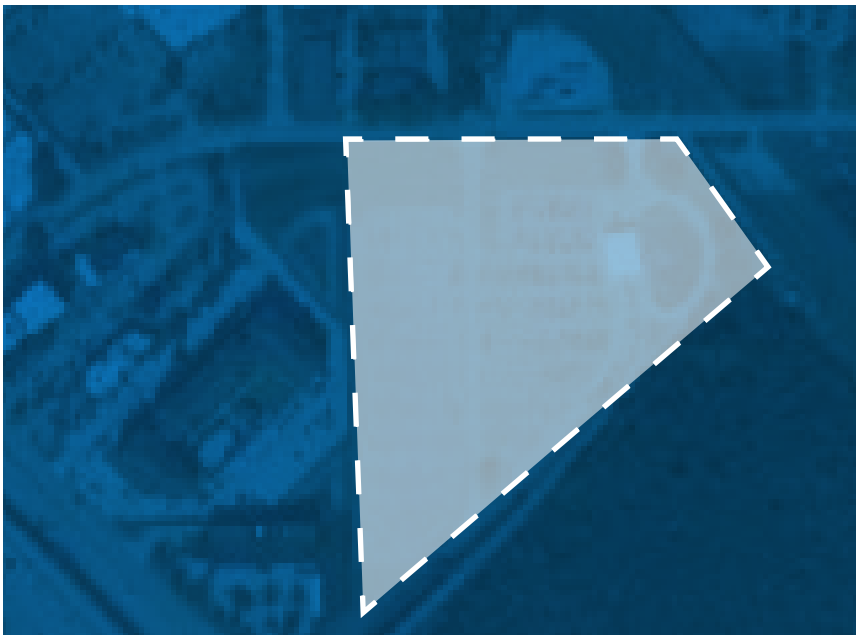
Bus + Parking | Retail / Restaurants / Residential



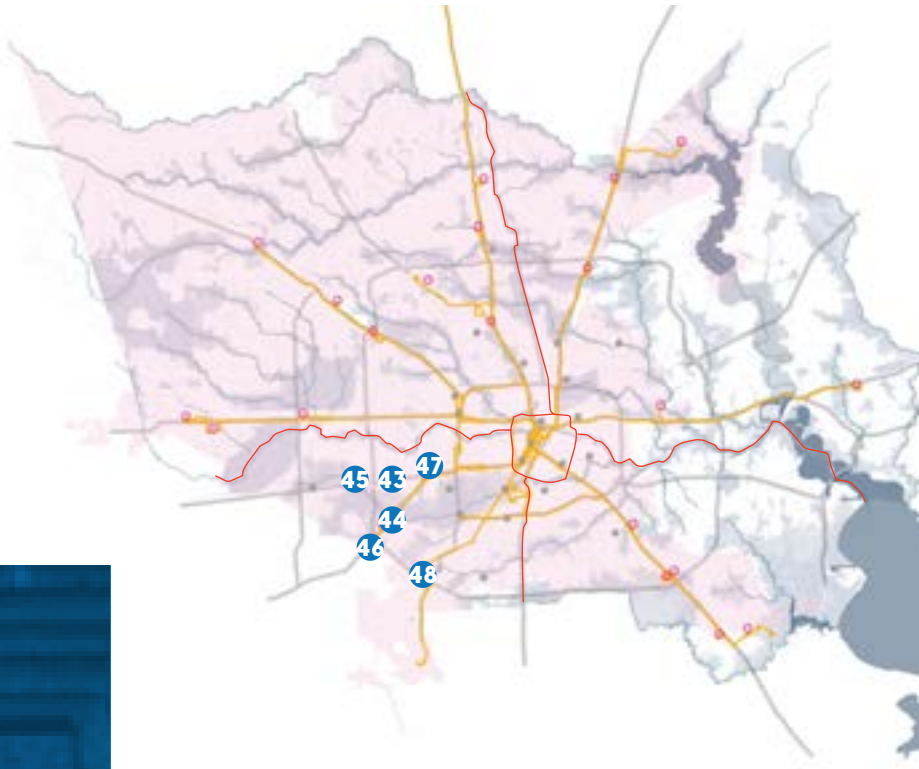


42 SOUTH POINT

Bus + Parking | Retail / Restaurants / Residential

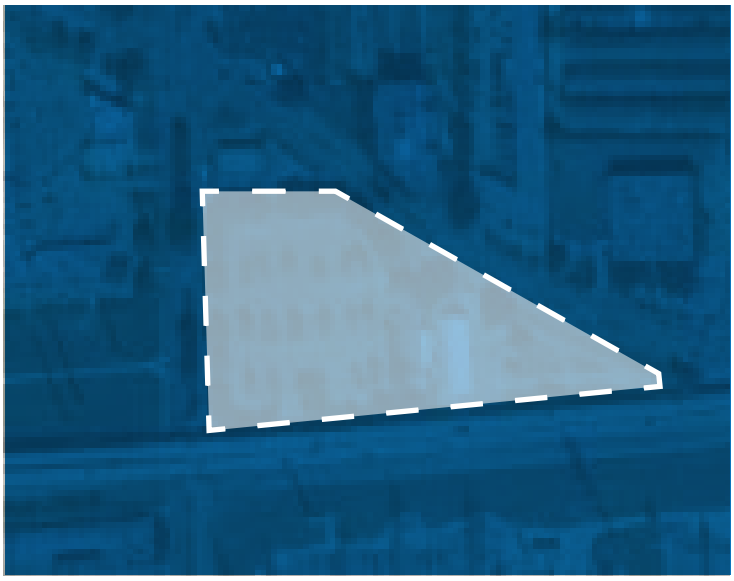


Southwest



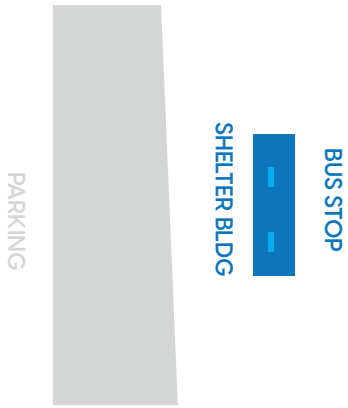
43 GESSNER

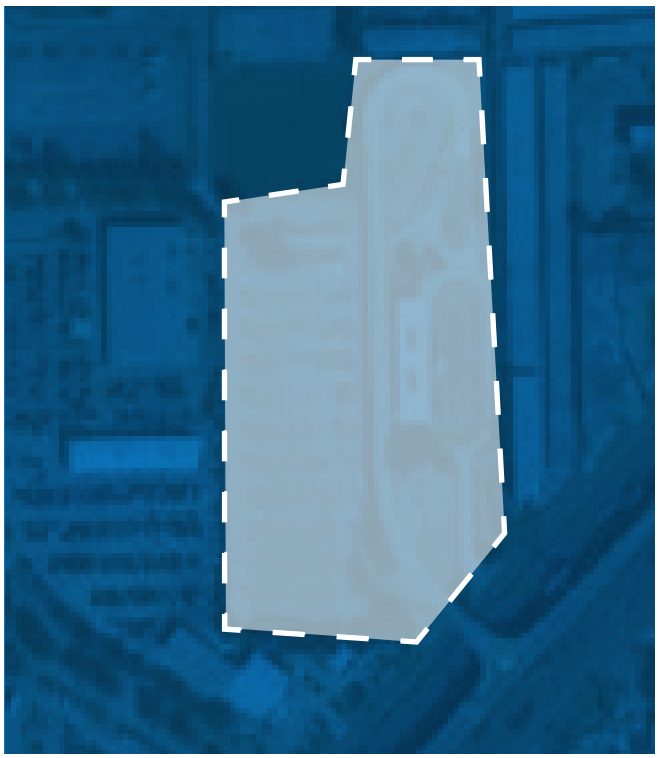
Bus + Parking | Business / Residential



44 WESTWOOD

Bus + Parking | Business / Residential





45 WESTCHASE

Bus + Parking | Business / Residential

BUS STOP

SHELTER BLDG

PARKING

46 WEST BELLFORT

Bus + Parking | Business Park / Residential

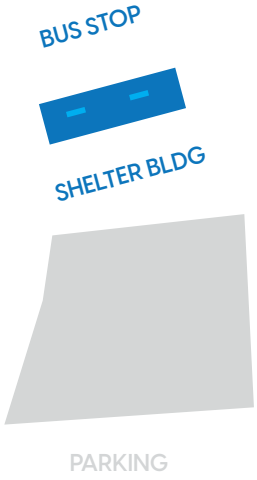
BUS STOP

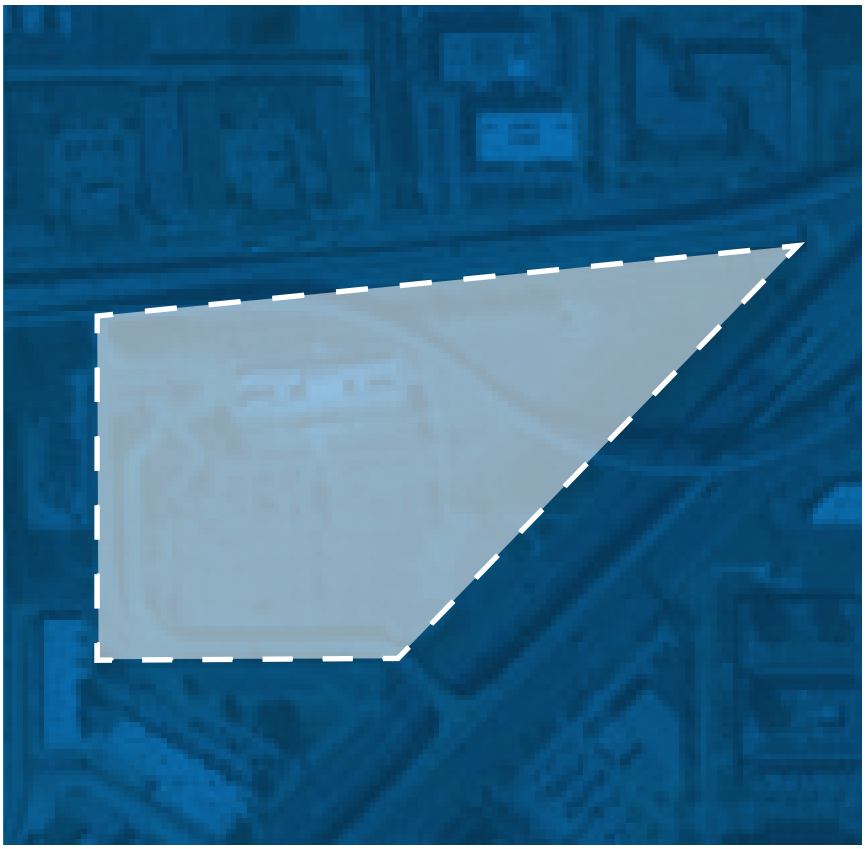
SHELTER BLDG

PARKING

47 HILLCROFT

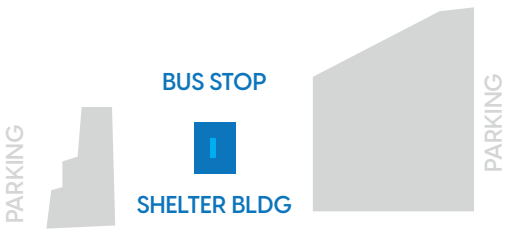
Bus + Parking | Business / Residential





48 MISSOURI CITY

Bus + Parking | Business / Residential



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Tour of Metro

Magnolia Park Transit Center

Character

EXTERNAL WAYFINDING


LIGHT RAIL ART


PAVED PLAZA


RENOVATED STRUCTURE

GATEWAY


LIGHT RAIL CONNECTIVITY

Context

The Magnolia Park Transit Center is located in the East End and serves as the final stop along the Green Line and Harrisburg Boulevard at 70th Street. The Transit Center consists of a light rail stop, bus station, and a parking lot. Historically a bus station, it was converted to a Transit Center in 2017 to serve as a light rail extension of the Green Line (previously terminating at the Altic / Howard Hughes station).

In 2020, a site specific master plan was conducted to study and propose multi-modal connectivity opportunities, sustainability improvements, and identity of place enhancements.

BUS-SCALE SHELTER

Needs

The light rail is connected via crosswalk to the bus station but fading pavement markings are need of improvement. Pedestrian connectivity surrounding the site could be more intuitive and connect to the greater community. The access from the primary plaza space to the bus shelter does not adequately prioritize pedestrians. The existing shelter on site shades from the sun but does not maximize windflows, and is not scaled to the pedestrian environment. Given the multiple modes of transit, better real-time ride data and wayfinding signage is needed.


SIGHT-LINE OBSTRUCTIONS

Opportunities

In accordance with the 2020 Plan for the Magnolia Park Transit Center, greater site connectivity can be implemented to create a more intuitive, safe, and functional pedestrian experience through more frequent and visible crosswalk connections. Bike amenities can be added to promote micro-mobility. Wayfinding and art can promote neighborhood identity and serve as a community attractor. Stormwater management BMPs can be overlaid on existing site greenspace to improve ecological functions.


AGING PAVEMENT MARKINGS

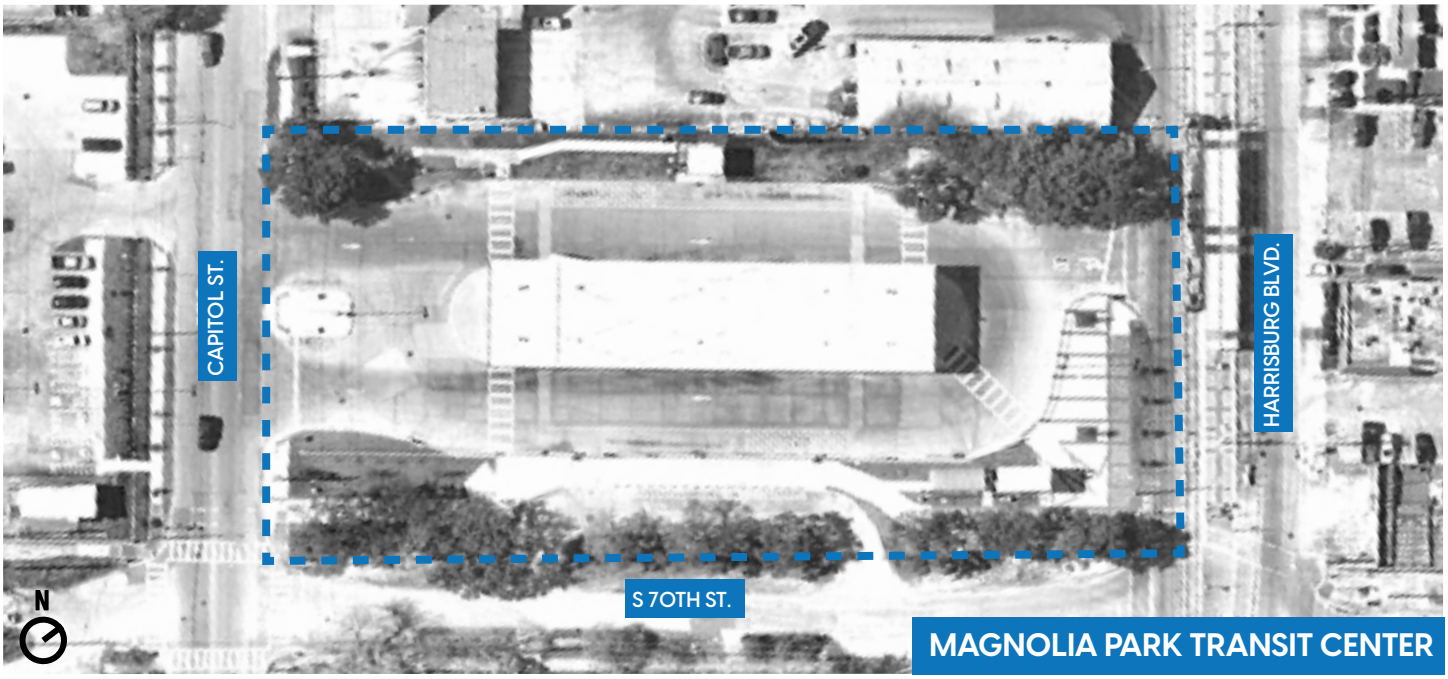
Benefits

Improving site circulation features can improve pedestrian experience and safety, while stormwater management can reduce ecological footprint and help cool the site. Fans or a more aerodynamic shelter design can make the bus riding experience more enjoyable. The transit center can greater physically and symbolically connect the community,


INCONSISTENT PEDESTRIAN CIRCULATION

Tour of Metro

Magnolia Park Transit Center



METRO Environment Check List

Rider Operation Amenities

Bus Only | **Bus Minimum Parking** | Bus Light Rail | Bus Light Rail Minimum Parking

Lot Layout

Circulation

2.1 Layout Does the layout of the site appear to be designed to meet all universal accessibility requirements?	yes **no** n/a
2.3 Vehicle Circulation Does current vehicle circulation plan work with local traffic patterns to reduce traffic congestion on surrounding roads?	**yes** no n/a
2.4 Pedestrian Circulation Does the existing pedestrian circulation provide safe direct access throughout the parking lot to the station platform?	yes **no** n/a
2.5 Bike Circulation Does the existing bike circulation provide safe and easy access to the Transit Center?	**yes** no n/a
2.6 Pedestrian Barriers Are there barriers to the pedestrian flow between the transit center facility and adjacent residential / commercial zones?	**yes** no n/a

Parking

3.1 ADA Parking Does the current parking design include the required number of accessible parking spaces with one of every six accessible parking spaces van-accessible?	**yes** no n/a
3.2 Short Term Parking Is short term parking provided within the current design?	**yes** no n/a
3.3 Bike Parking Are bike and scooter parking provided inside and outside the Transit Station?	yes **no** n/a

Lot Layout (Cont.)

Drop-Off + Pick Up

4.1 Bus Loading / Unloading Are the bus platforms appropriate for buses to pull out of the flow of traffic to safely pick up / drop off passengers?	**yes** no n/a
4.2 Transportation Network Companies Are on-street parking or parking areas on the project site designed for METROLift and TNC vehicles?	**yes** no n/a

Design For All

Pedestrian Movement

5.1 Waiting Area Does the platform passenger waiting area provide a feeling of comfort and safety?	yes **no** n/a
5.2 Platform Bays Do the platform bays allow buses to pull out to pick up and drop off passengers?	**yes** no n/a
5.3 Sidewalks Is there a continuous paved sidewalk surrounding the perimeter of the facility clear of disruption for pedestrian easement? Curb to curb?	**yes** no n/a
5.4 Crosswalks and Street Crossings Are pedestrian crossings well marked, and do they safely direct pedestrians from the parking lot to station platform?	yes **no** n/a
5.5 Bulb-Outs + Island Refuge Is there a bulb-out or island refuge that helps minimize crosswalk distance to the bus stop location?	yes **no** n/a
5.6 Utilities Are surrounding utilities effectively integrated and clear of pedestrian travel?	yes **no** n/a

METRO Environment Check List

Design For Comfort

Neighborhood Context

6.1 Site Identity Does the existing site design strengthen the identity of the Transit Center and contribute to the METRO brand?	yes **no** n/a
6.2 Connectivity Does the public have an adequate view of the Transit Center?	**yes** no n/a
6.3 Visibility Is the site visible (marquee, lighting techniques) from all public views of the facility?	yes **no** n/a

Architecture

7.1 Platform and Canopy Size Do the platform and canopy accommodate both scale of pedestrian as well as scale of bus?	yes **no** n/a
7.2 Materials Do all the materials complement the Transit Center in design and minimally collect or radiate heat?	yes **no** n/a
7.3 Wind + Rain Protection Is the Transit Center designed to minimize wind and rain impact on pedestrians walking to and waiting at the station platform?	**yes** no n/a
7.4 Sun Protection Is the Transit Center designed to minimize sun impact on pedestrians walking to and waiting at the station platform?	yes **no** n/a

Lot Amenities

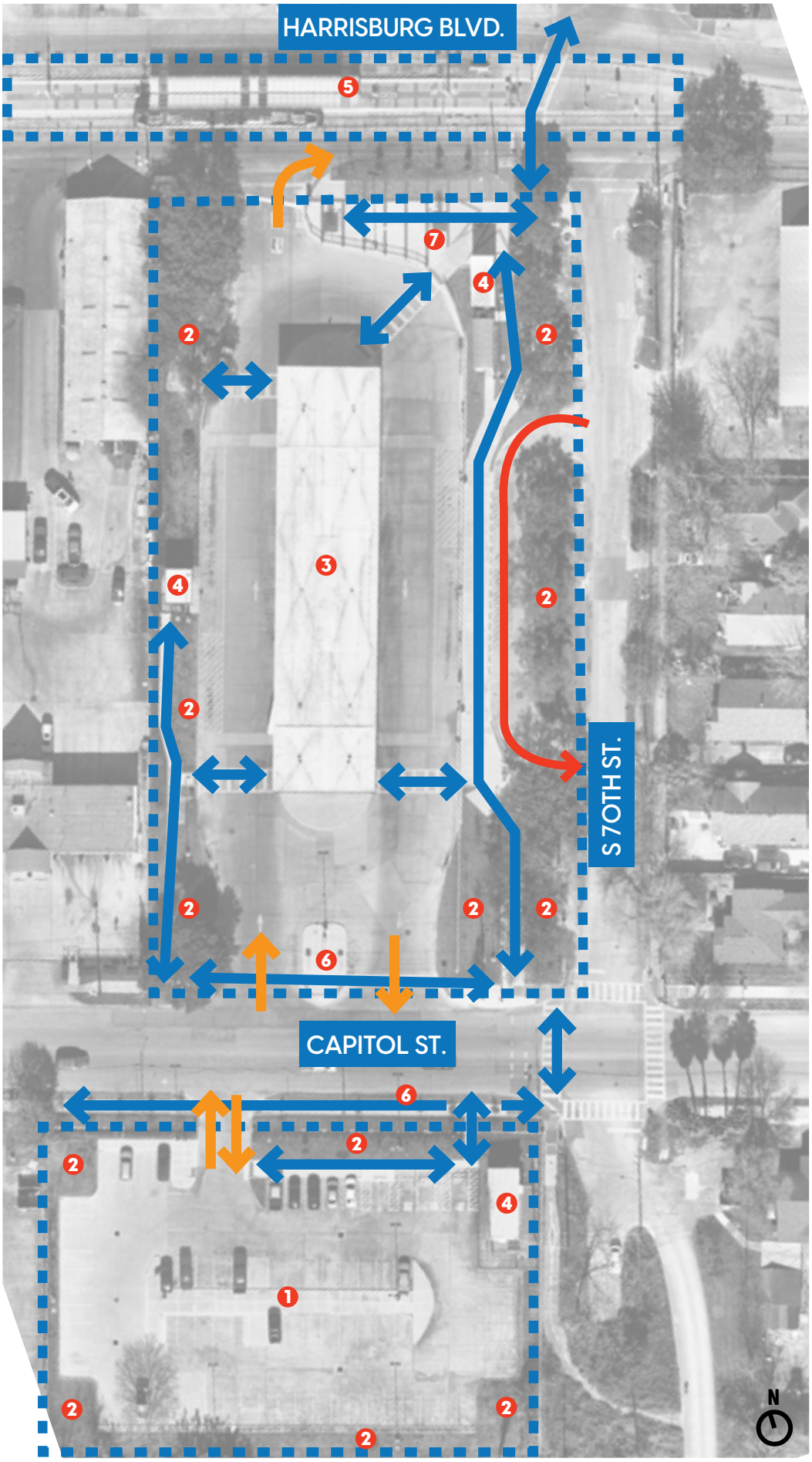
Preferred Amenities

8.1 Bus Shelters Are bus shelters placed at all nearby stops? If not, are module seats placed at stops?	**yes** no n/a
8.2 Seating Are shaded and well-lit seating areas located throughout the station for comfort and convenience?	**yes** no n/a

Lot Amenities (Cont.)

8.3 Lighting Does the lighting enable riders to experience safe, comfortable, and efficient use of the station at all hours of operation?	**yes** no n/a
8.4 Bike Storage Is bike storage provided inside and outside the Transit Center station?	yes **no** n/a
8.5 Trash Receptacles Are trash receptacles placed around the Transit Center?	**yes** no n/a
8.6 Wayfinding Do all graphics and wayfinding clearly and easily direct all patrons safely to the station platform? Can they be easily identified and read by all riders?	yes **no** n/a
8.7 Trip Planning Are real-time (next-time) arrival marquees, regional and table maps showing distance, route, and bus arrival times available at station platform?	yes **no** n/a
8.8 Public Art Is there public art that adequately contributes to the identity of the Transit Center?	**yes** no n/a
8.9 Mobile Charging Stations Are mobile charging stations or electrical plugs available at the transit center?	yes **no** n/a
8.10 Wi-Fi Is Wi-Fi available at the Transit Center?	yes **no** n/a
8.11 Ticket Machines Are ticket machines conveniently located at platform station?	**yes** no n/a
8.12 End-of-Trip Facilities Is there an end-of-trip facility?	yes **no** n/a
8.13 Electric Vehicle Charging Stations Are EV charging stations located at the facility for all electric vehicles?	yes **no** n/a

SKETCH BASE / ADDITIONAL NOTES

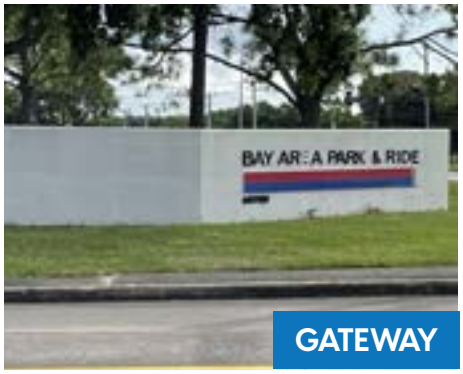


- Vehicular Circulation
- Pedestrian Circulation
- Drop-Off
- 7 Plaza
- 6 Wayfinding
- 5 Light Rail Station
- 4 Supporting Structure
- 3 Primary Structure
- 2 Greenspace/Buffer
- 1 Parking Lot

Tour of Metro

Bay Area Park & Ride

Character



Context

The Bay Area Park & Ride is located at 8011 Bay Area Blvd., Houston, TX 77062. Morning and evening services are provided. This Park & Ride services downtown, Monroe, Fuqua, and El Dorado. The site is approximately 11.5 acres and sits just East of I-45. The East portion of the parking lot is adjacent to Cow Bayou. Nearby Destinations include Space Center Houston, the NASA Johnson Space Center, the Armand Bayou Nature Center, and the Baybrook Mall.

VISIBLE ENTRY

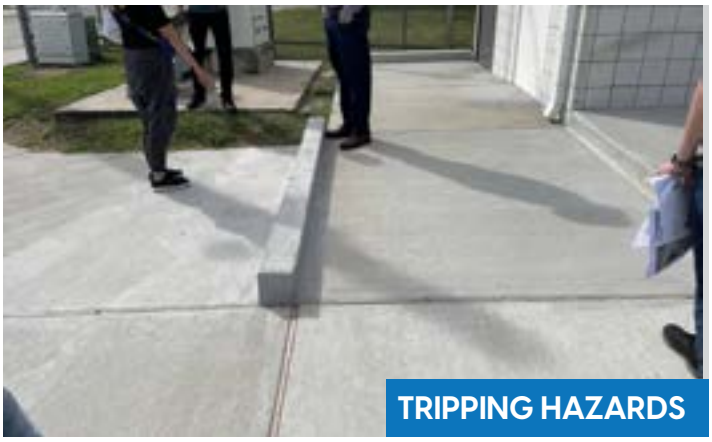
Needs

The site is disjointed by incongruous paving and site circulation. The striping for ADA paths is unclear and some ramps do not connect to accessible paths of travel. Renovations to the site have created several tripping hazards and alterations to the shelter are improperly integrated into the structure. Signage interior to the site is small and difficult to read from a distance. Large expanses of asphalt have a large heat island effect surrounding the site. Aged amenities and site materials do not meet modern standards of comfort and placemaking potential. Regulatory signs are spread around the site and are not translated in commonly spoken languages.

UNCLEAR ADA CIRCULATION

Opportunities

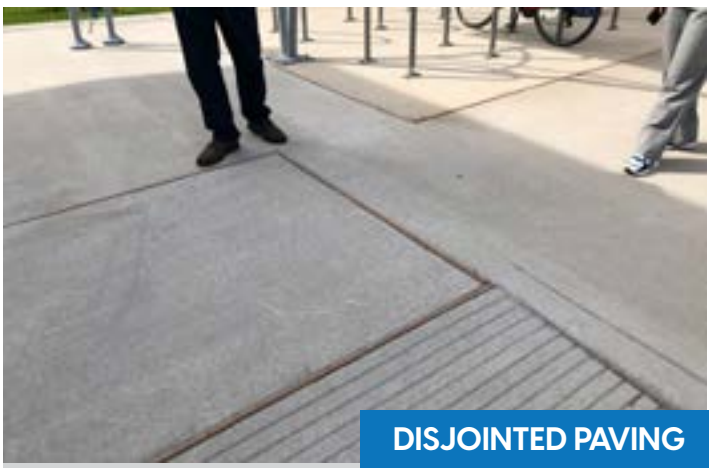
Portions of the site can be repaved to create a safe and intuitive site circulation system that improves ADA and wayfinding ability on-site. Comprehensive and language accessible signage for both wayfinding, informational, and regulatory signage can be implemented to help direct riders, inform them of route, changes, and accommodate different languages spoken within the community. Parking bays within the parking lot can be strategically removed to add parking lot islands to accommodate tree plantings to reduce the temperature of the site.



TRIPPING HAZARDS

Benefits

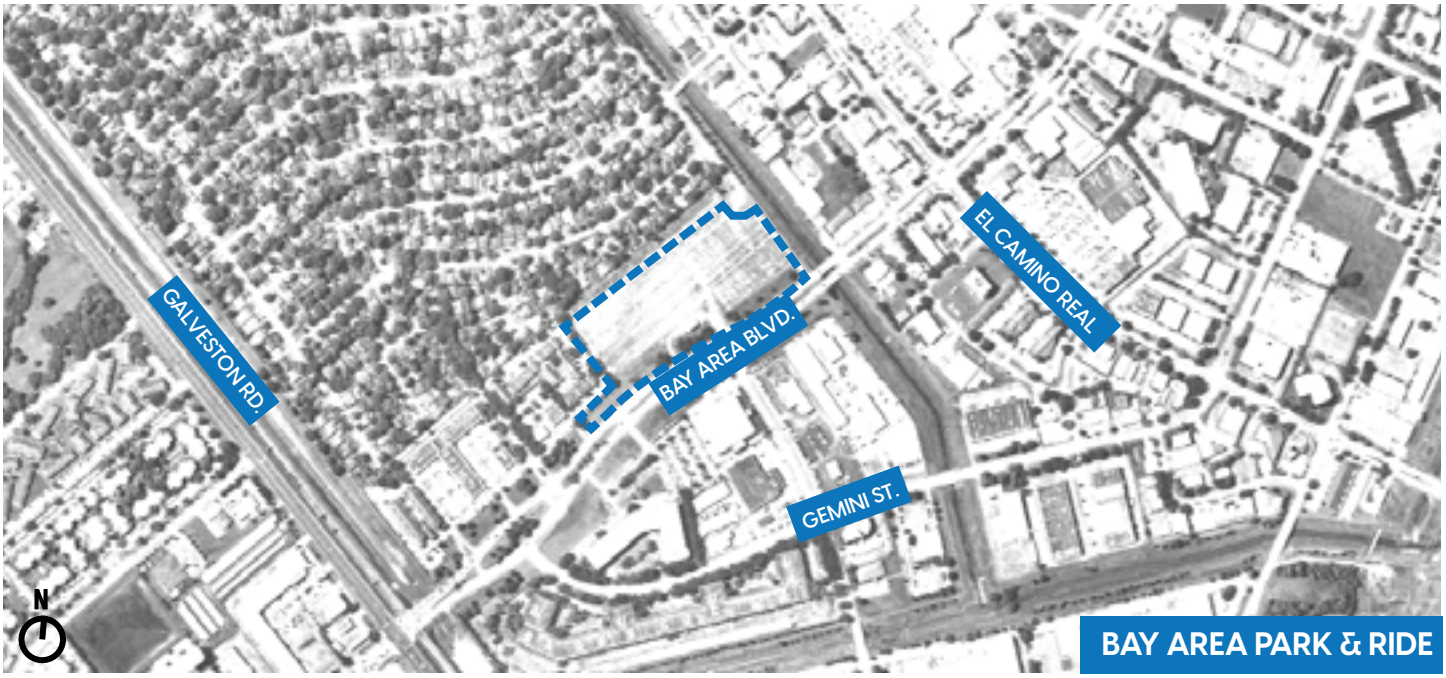
New bike amenities are positive additions to the site that increase micromobility opportunities. The facility overall is clean and well maintained. Improvements to the site can increase pedestrian and cyclist safety, increase site legibility, and create a more pleasurable environment for riders. Urban heat can be reduced through selective additions of tree canopy and ecologically conscious planting.



DISJOINTED PAVING

Tour of Metro

Bay Area Park & Ride



METRO Environment Check List

Frequency (Annual Rider Use)

HIGH RIDERSHIP | **MEDIUM RIDERSHIP** | LOW RIDERSHIP

Lot Layout

Circulation

2.1 Layout Does the layout of the site appear to be designed to meet all universal accessibility requirements?	yes **no** n/a
2.3 Vehicle Circulation Does current vehicle circulation plan work with local traffic patterns to reduce traffic congestion on surrounding roads?	yes **no** n/a
2.4 Pedestrian Circulation Does the existing pedestrian circulation provide safe direct access throughout the parking lot to the station platform?	yes **no** n/a
2.5 Bike Circulation Does the existing bike circulation provide safe and easy access to the Transit Center?	**yes** no n/a
2.6 Pedestrian Barriers Are there barriers to the pedestrian flow between the transit center facility and adjacent residential / commercial zones?	yes **no** n/a

Parking

3.1 ADA Parking Does the current parking design include the required number of accessible parking spaces with one of every six accessible parking spaces van-accessible?	**yes** no n/a
3.2 Short Term Parking Is short term parking provided within the current design?	**yes** no n/a
3.3 Bike Parking Are bike and scooter parking provided inside and outside the transit station?	**yes** no n/a

Lot Layout (Cont.)

Drop-Off + Pick Up

4.1 Bus Loading / Unloading Are the bus platforms appropriate for buses to pull out of the flow of traffic to safely pick up / drop off passengers?	**yes** no n/a
4.2 Transportation Network Companies Are on-street parking or parking areas on the project site designed for METROLift and TNC vehicles?	yes **no** n/a

Design For All

Pedestrian Movement

5.1 Waiting Area Does the platform passenger waiting area provide a feeling of comfort and safety?	yes **no** n/a
5.2 Platform Bays Do the platform bays allow buses to pull out to pick up and drop off passengers?	**yes** no n/a
5.3 Sidewalks Is there a continuous paved sidewalk surrounding the perimeter of the facility clear of disruption for pedestrian easement? Curb to curb?	yes **no** n/a
5.4 Crosswalks and Street Crossings Are pedestrian crossings well marked, and do they safely direct pedestrians from the parking lot to station platform?	yes **no** n/a
5.5 Bulb-Outs + Island Refuge Is there a bulb-out or island refuge that helps minimize crosswalk distance to the bus stop location?	**yes** no n/a
5.6 Utilities Are surrounding utilities effectively integrated and clear of pedestrian travel?	yes **no** n/a

METRO Environment Check List

Design For Comfort

Neighborhood Context

6.1 Site Identity Does the existing site design strengthen the identity of the Transit Center and contribute to the METRO brand?	yes **no**
6.2 Connectivity Does the public have an adequate view of the Transit Center?	**yes** no n/a
6.3 Visibility Is the site visible (marquee, lighting techniques) from all public views of the facility?	**yes** no n/a

Architecture

7.1 Platform and Canopy Size Do the platform and canopy accommodate both scale of pedestrian as well as scale of bus?	yes **no** n/a
7.2 Materials Do all the materials complement the Transit Center in design and minimally collect or radiate heat?	yes **no** n/a
7.3 Wind + Rain Protection Is the Transit Center designed to minimize wind and rain impact on pedestrians walking to and waiting at the station platform?	yes **no** n/a
7.4 Sun Protection Is the Transit Center designed to minimize sun impact on pedestrians walking to and waiting at the station platform?	yes **no** n/a

Lot Amenities

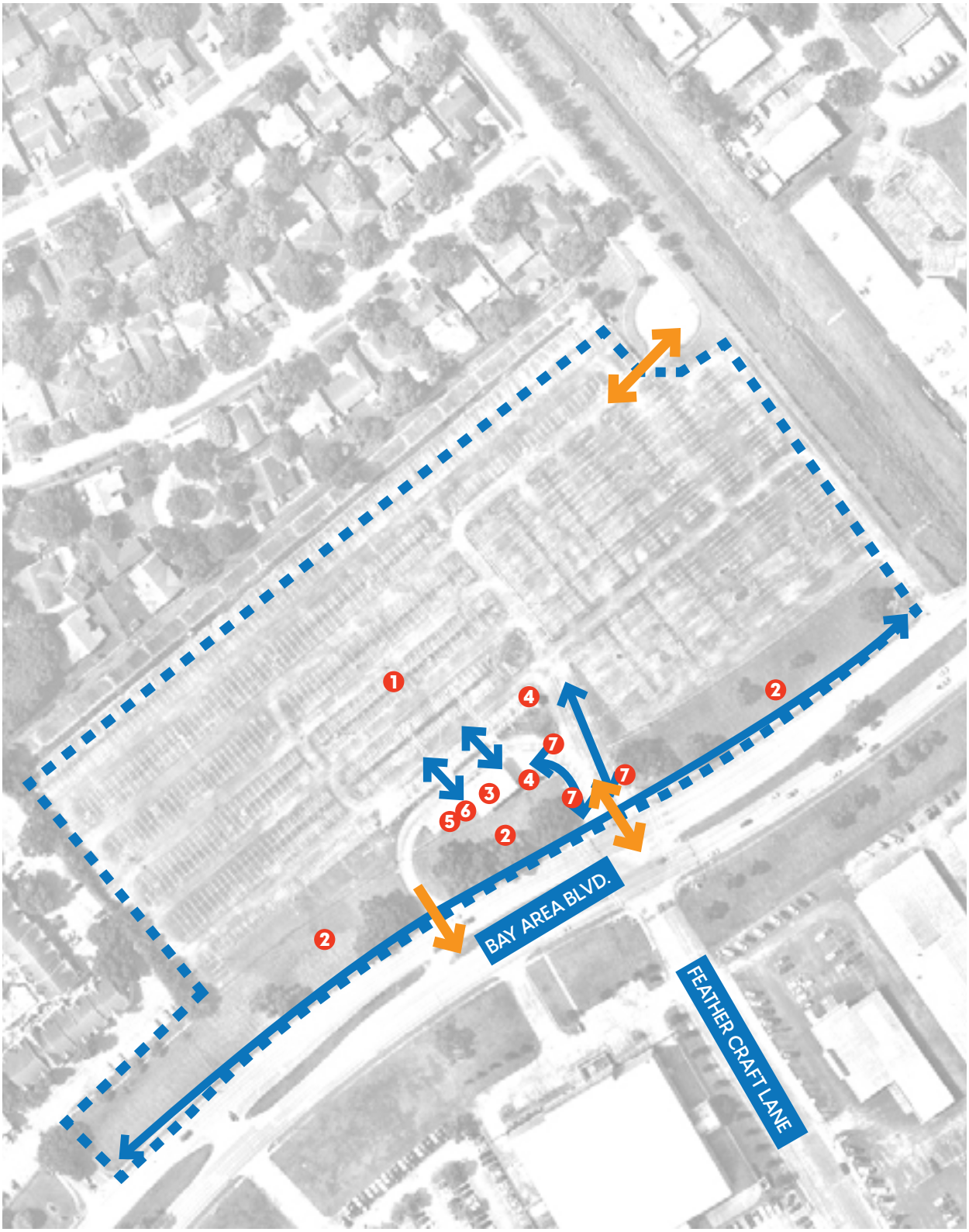
Preferred Amenities

8.1 Bus Shelters Are bus shelters placed at all nearby stops? If not, are module seats placed at stops?	**yes** no n/a
8.2 Seating Are shaded and well-lit seating areas located throughout the station for comfort and convenience?	yes **no** n/a

Lot Amenities (Cont.)

8.3 Lighting Does the lighting enable riders to experience safe, comfortable, and efficient use of the station at all hours of operation?	**yes** no n/a
8.4 Bike Storage Is bike storage provided inside and outside the Transit Center station?	**yes** no n/a
8.5 Trash Receptacles Are trash receptacles placed around the Transit Center?	**yes** no n/a
8.6 Wayfinding Do all graphics and wayfinding clearly and easily direct all patrons safely to the station platform? Can they be easily identified and read by all riders?	yes **no** n/a
8.7 Trip Planning Are real-time (next-time) arrival marquees, regional and table maps showing distance, route, and bus arrival times available at station platform?	yes **no** n/a
8.8 Public Art Are there public art installations that complement the Transit Center / Park & Ride?	yes **no** n/a
8.9 Mobile Charging Stations Are mobile charging stations or electrical plugs available at the Transit Center?	yes **no** n/a
8.10 Wi-Fi Is Wi-Fi available at the Transit Center?	yes **no** n/a
8.11 Ticket Machines Are ticket machines conveniently located at platform station?	**yes** no n/a
8.12 End-of-Trip Facilities Is there an end-of-trip facility?	yes **no** n/a
8.13 Electric Vehicle Charging Stations Are EV charging stations located at the facility for all electric vehicles?	yes **no** n/a
10.0 Ecology + Stormwater Management Was ecology considered as part of the design of the architecture or site? Is site scaled green infrastructure used for stormwater?	yes **no** n/a

SKETCH BASE / ADDITIONAL NOTES



N

- Vehicular Circulation
- Pedestrian Circulation
- 7 Wayfinding
- 6 Bike Amenity
- 5 Bus Shelter
- 4 Supporting Structure
- 3 Primary Shelter
- 2 Greenspace/Buffer
- 1 Parking Lot

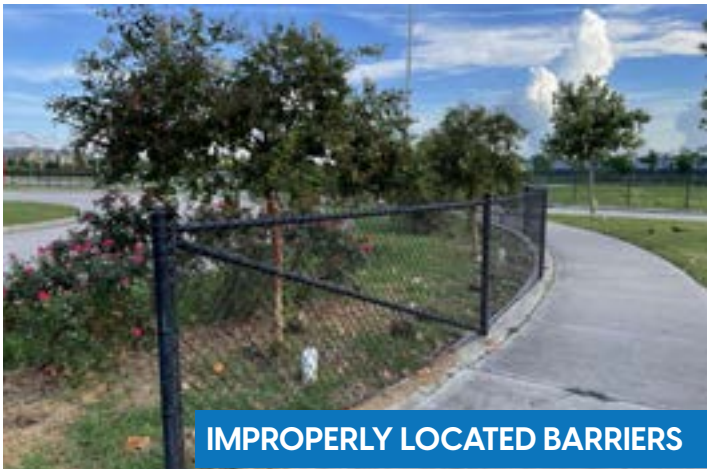
Tour of Metro

El Dorado Park & Ride

Character

Context

The El Dorado Park & Ride is located at 203 El Dorado Boulevard. The recently completed facility is located along I-45, and neighbors retail developments, Challenger Seven Memorial Park, Pearland Regional Airport, Friendswood, and Centennial Park. Operating for both morning and evening service, the routes service downtown, 244 Monroe, 246 Bay Area and 247 Fuqua. The site is proximate to quick dining options, a large retail store, and several gas stations. Large detention sites mitigate runoff from the Park & Ride parking lot to the northeast and eastern portions of the site.



IMPROPERLY LOCATED BARRIERS

Needs

As one of the newest Park & Rides within the METRO network, El Dorado has many contemporary features that enhance comfort and safety within the site. While the parking lot has more trees than many of the older Park & Ride developments, they are spaced too far apart to provide shade to vehicles and pedestrian areas and do not reduce heat from the lot paving. Safety barriers are located on the pedestrian pathways rather than adjacent to the roadway. Additionally, the quality of sitework is poor despite attention to detail within design-work that may reduce the longevity of the built environment.

WELL INTEGRATED SAFETY FEATURES

Opportunities

While the site contains softscape stormwater detention, ecological benefits could be improved. The detention slopes could be feathered back to create a less intense slope, while the feature could be enlarged to include the use of native grasses and raingarden planting. This would further filter the feature of site pollutants, purify stormwater, and prevent erosion—which threaten the longevity of the detention amenities. More bays of parking could be converted to tree islands with trees located closer together to increase shade value and cool the pavements. Thoughtful design into the wayfinding elements enable them to readily receive real-time bus schedule information.

STORMWATER DETENTION

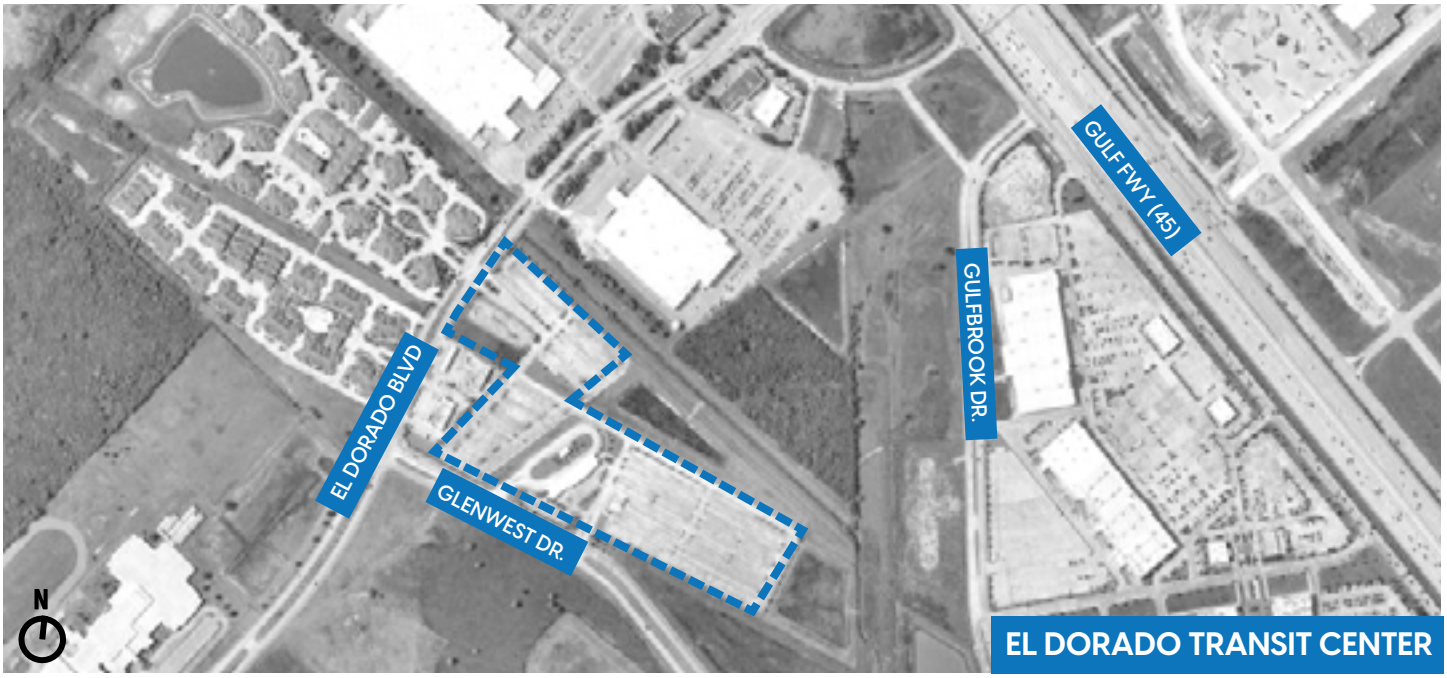
Benefits

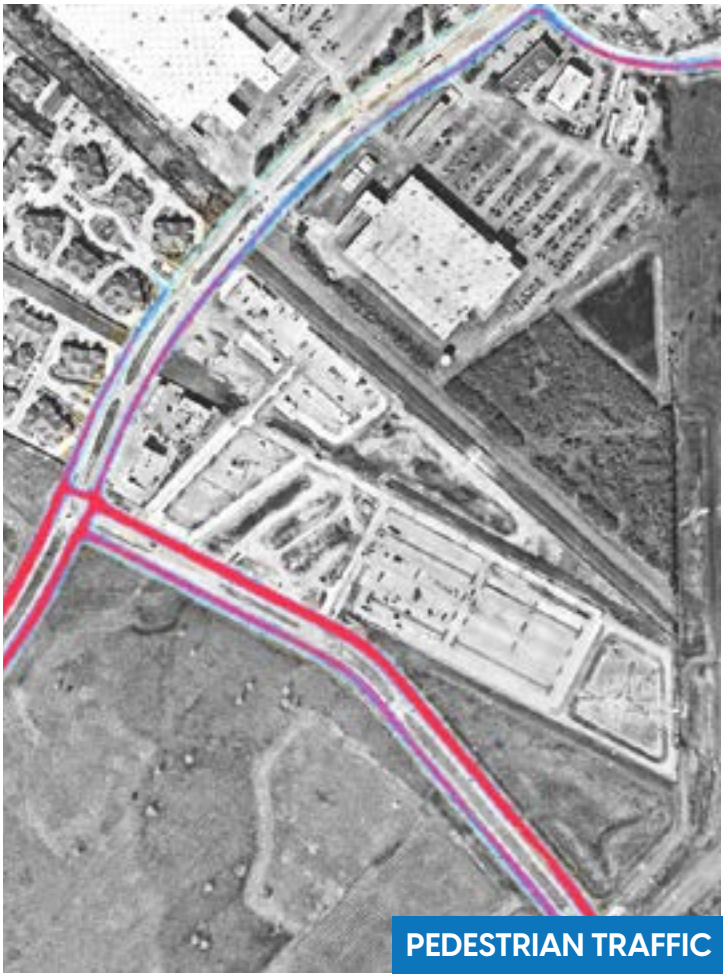
Overall, the El Dorado Park & Ride is a comfortable experience for riders. End-of-trip facilities can be added to further enhance rider comfort. A larger wayfinding feature could help direct drivers more clearly. Utilizing best practices within the design of the landscape could improve the ecological value of the site, offsetting the negative environmental impacts of the Park & Ride development. Utilizing natural barriers instead of fences can enable the site to feel more inviting at the pedestrian scale while enhancing crime prevention principles.

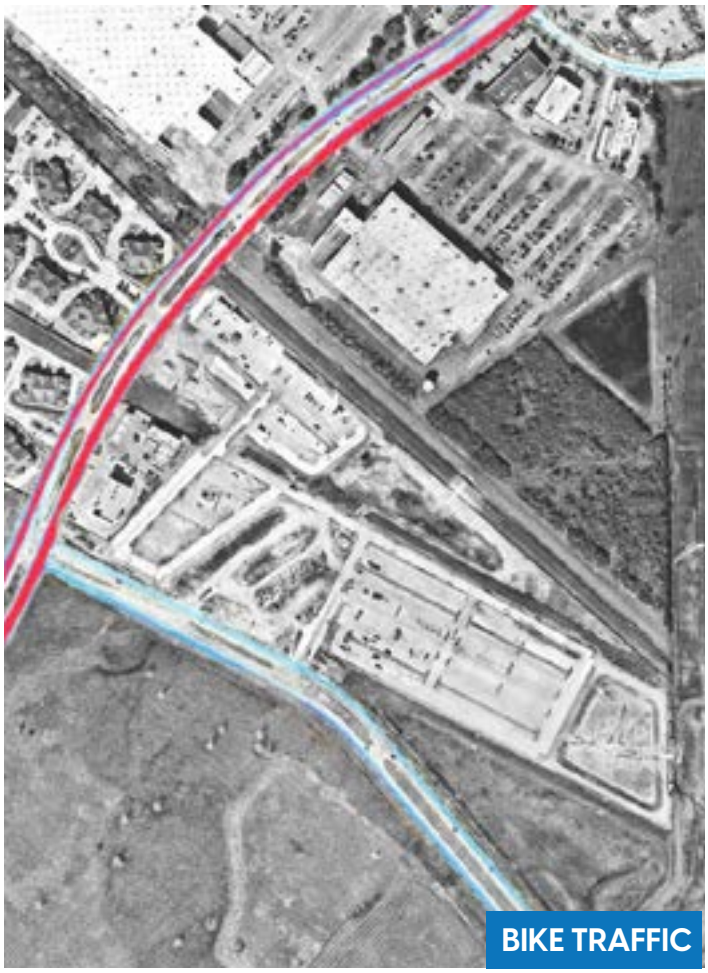
AMPLE LIGHTING

Tour of Metro

El Dorado Park & Ride







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Lot Layout (Cont.)

Drop-Off + Pick Up

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Lot Amenities (Cont.)

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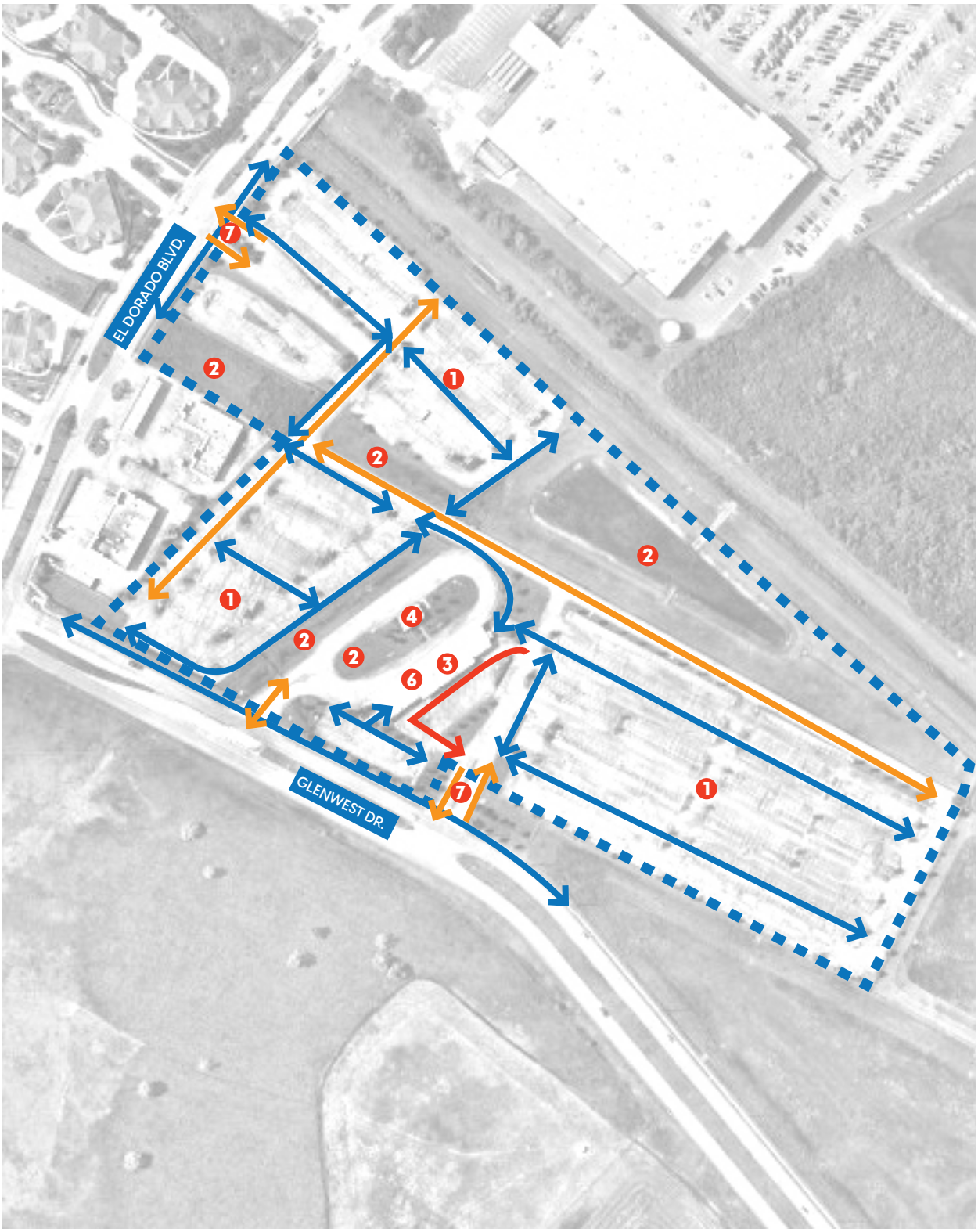

N

- Vehicular Drop-off
- Vehicular Circulation
- Pedestrian Circulation
- 7 Wayfinding
- 6 Bike Amenity
- 5 Bus Shelter
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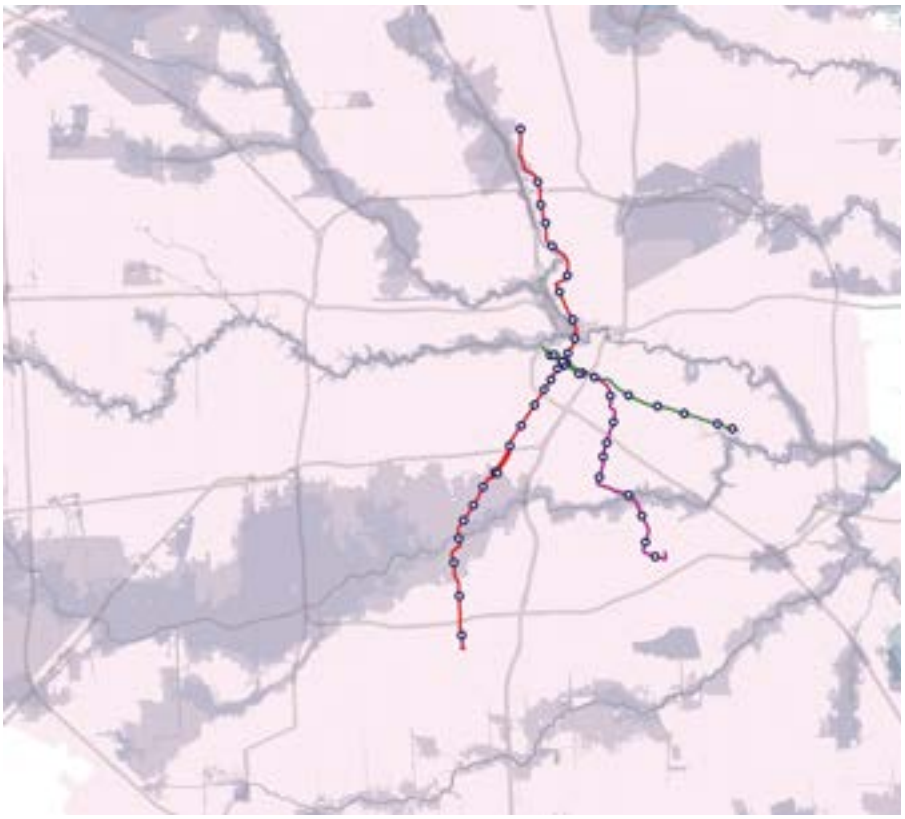
- 1 Parking Lot

Tour of Metro

Purple Line LRT Stations



Character

Context

The Purple LRT line extends from the Theater District Downtown to the Palm Center. This LRT line primarily serves University students, as it passes through TSU and UH. This line will eventually extend to Hobby Airport.

This route passes through several historic communities with strong identities, and reflects several examples of community art. Additionally. the line also connects to EADO/ Stadium and the Convention District for sports games and special events.

SEATING OPPORTUNITITES

Needs

The LRT system has a fairly consistent design language for METRO stations, but vary in application of hardscape materials and art elements. Some applications of art have appeared to hold up over-time such as elements embedded in paving, while glass panels and mosaics tend to fall out or break. Many art panels have been replaced with regular glass rather than matched to the original design.

The amount of amenities often correspond to the length of the platform. While the stainless steel elements have proven durable over time, they are uncomfortable when not in the shade. Some amenities, such as ticketing kiosks, are rather large and create visibility/safety concerns.

SAFETY ELEMENTS

Opportunities

The LRT system passes through many diverse communities and destinations along stops. There are numerous opportunities to provide durable art applications that reflect community character while reflecting a consistent METRO brand quality. Seating and other amenities can be chosen for better accessibility and station character. Amenities at stations should be shaded from the sun.

Unsafe pedestrian movements to the station platform are deterred by the use of metal fencing but they can also be unwelcoming and hostile. The use of hedge planting with tightly spaced bollards could be more inviting while addressing security concerns.

COMFORT AMENITIES

Benefits

The LRT system is a continuous opportunity to create a cohesive and engaging transit experience from stop to stop. Routes to LRT stations should be assessed for accessibility concerns, safety, and wayfinding considerations

The use of real-time arrival information is fairly consistent across LRT lines, and is a helpful element within the station. The LRT line graphics are the easiest to navigate amongst other transportation systems and connect to the central stations in a legible manner.

REAL-TIME INFORMATION

Tour of Metro

Post Oak BRT Station

Character

Context

The Post Oak BRT is the first of its kind within the METRO system and opened in 2020. Serving as a more flexible alternative to light rail, the BRT Silver Line connects riders to the Galleria area. Post Oak Boulevard is filled with many shopping destinations. The introduction of the BRT line improved the pedestrian experience in an otherwise automobile-centric corridor. The existing route connects eight stops to the Northwest Transit Center.

DEDICATED BUS LANE

Needs

The BRT is currently underutilized due to lack of connectivity to a broader transportation network. Further expansion of the BRT line and increased reach of a safe pedestrian realm will increase the successes of the line in the future. Large utilities at the base of the boarding platform cause visual obstructions towards on-coming bus traffic and create hiding places that diminish the perception of safety.

PEDESTRIAN ACCESS

Opportunities

The design of the site enables the line to convert to an LRT line in the future. Considerations for the inclusion of LRT cables may need to be thoughtfully considered in the future. The dedicated bus lanes offer safety and efficiency while the native tree canopy offers a natural barrier (soft separation) between bus lanes and the adjacent vehicular roadway. Bollards increase safety for pedestrians. Thoughtful pedestrian amenities, structures, paving, and landscape create an engaging and comfortable urban realm. Supplemental lighting aids in place-making efforts while providing an additional layer of security / visibility.

SOFT INTERVENTION SEPERATION

Benefits

The introduction of green stormwater infrastructure elements could increase the performative impact of this streetscape. Wayfinding graphics could more adequately direct customers to the station platform. Better integration of utilities in future stops could improve the feeling of safety within the BRT platform.

REAL-TIME INFORMATION

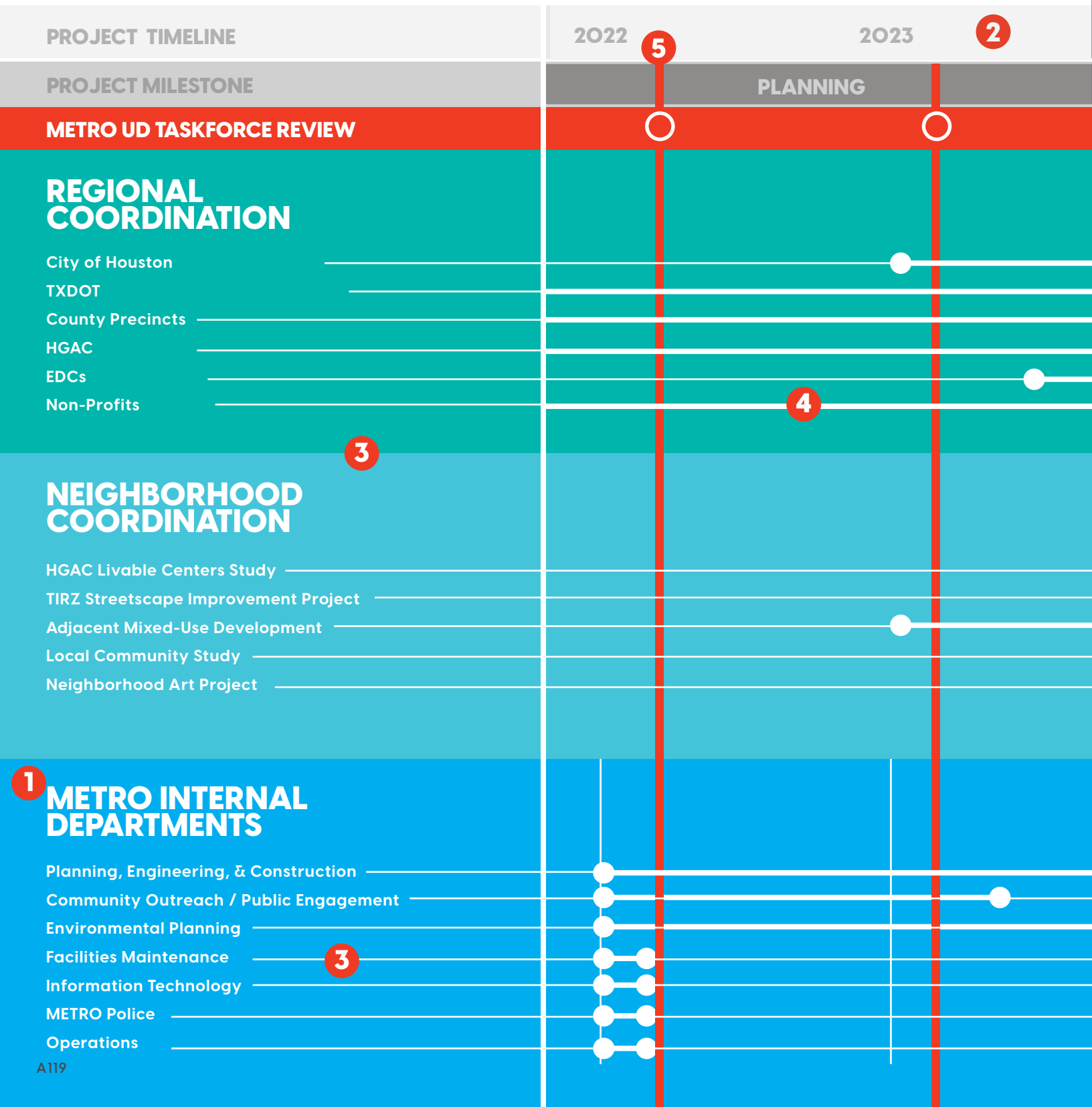
UD Taskforce Activities

The following Urban Design Taskforce activities are printable materials to be used within the facility design review process in key stages outlined in Chapter 03 of the METRO Urban Design Manual. These activities will be updated in future additions of the Urban Design Manual at the discretion of the Urban Design Lead and Urban Design Taskforce.

ACTIVITY EXAMPLE:
Project Timeline Coordination

Timeline Coordination

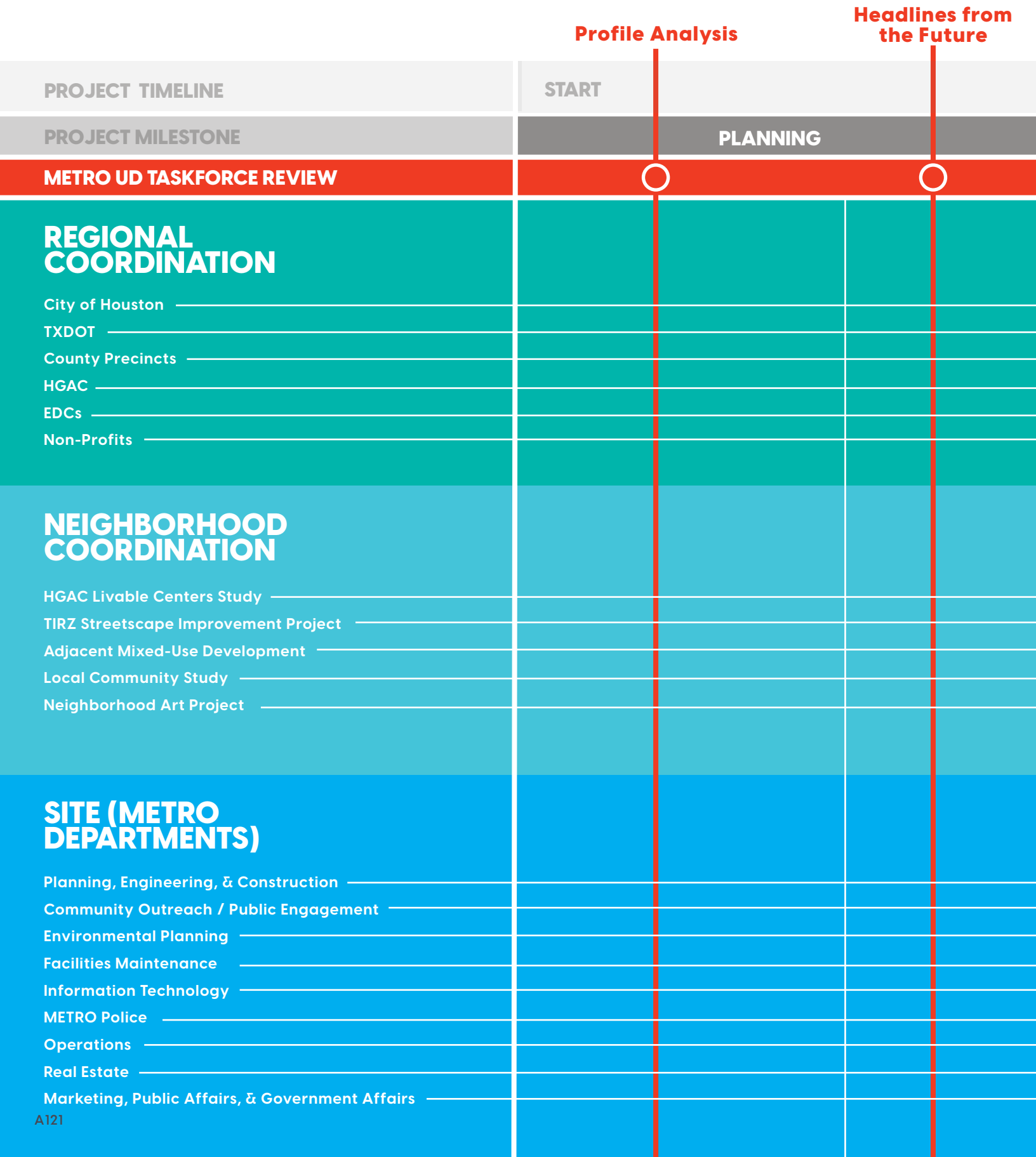
COORDINATING ACROSS SCALES AND DEPARTMENTS

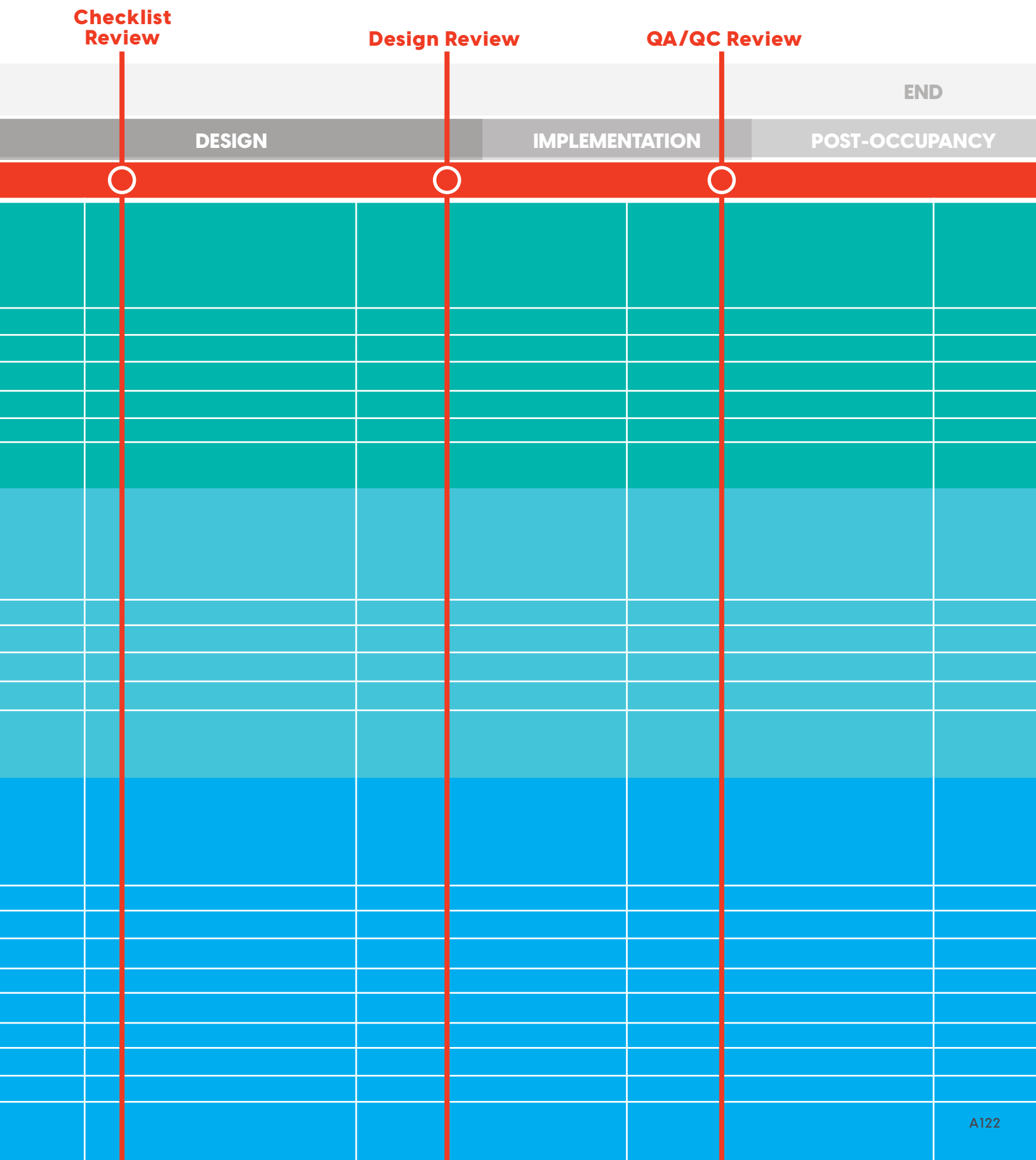


1. **Identify Project Scale**
2. **Chart Timeline**
3. **Identify Internal & External Stakeholders**
4. **Chart Concurrent Timelines**
5. **Schedule METRO Taskforce Review at Indicated Intervals**

Roles & Responsibilities

COORDINATING ACROSS SCALES AND DEPARTMENTS




Checklist Review
Design Review
QA/QC Review
END
DESIGN
IMPLEMENTATION
POST-OCCUPANCY

Proposed Facility Profile Activity

At the project milestone indicated by the METRO Urban Design Taskforce schedule, fill out the Proposed Facility Profile on the adjacent page. This information will enable the design team to fine-tune the application of the Urban Design Guidelines to accommodate unique project considerations, as well as seek out neighborhood and regional partners to enhance the Urban Design Experience leading to proposed facilities, in addition to coordinating with existing efforts.

01 Refer to page 41 of the manual to determine the ecoregional zone of the facility. Additional recommendations per zone can be found in the Technical Appendix.

02 Indicate the CDC Social Vulnerability Index for the surrounding neighborhood. This information can be found on the City of Houston GIS website.

03 Indicate all of the applicable diversity overlays for the neighborhood context. Refer to pages 46 and 47 of the Urban Design Manual for types of overlays.

04 Identify the appropriate regional corridor types of adjacent facility roadways as found on page 44 of the METRO Urban Design Manual.

05 Select the applicable roadway character overlays as indicated on page 45 of the manual.

06 Select project type, refer to page 103 of the METRO Urban Design Manual.

07 Identify whether any of the adjacent streets within a 1/2 mi. radius have a special city designation. Refer to the City of Houston User's Guide for Walkable Places and Transit Oriented Development and the City of Houston Code of Ordinances.

08 Select proposed and anticipated future modes of transit for the facility.

09 Select neighborhood walkability and bikeability scores determined by walkscore.com.

10 Identify all streets within 1/2 mi. radius of the proposed transit facility and indicate the existing Level of Roadway Service.

Proposed Facility Profile

Facility Name

Facility Type
bus stop brt / lrt park & ride transit center

Environmental Resilience

01 **Ecoregional Zone**
northwest southwest central southeast northeast

02 **CDC Social Vulnerability Index (SVI)**
low (0.0 - 0.25) moderate (0.25 - 0.50) high (0.50 - 0.75) critical (0.75 - 1.0)

Diverse Communities

03 **Diversity Overlay**
diverse abilities* cultural town linguistically significant ethnically significant culturally significant muti-ethnic

04 **Regional Corridor Type**
freeway / tollway principal thoroughfare major thoroughfare major collector minor collector

05 **Neighborhood Corridor Type**
commercial/economic cultural/historic green/scenic/ceremonial neighborhood services high-speed access

Sustainable Development

06 **Project Type**
retrofit redesign new construction

07 **Urban Context**
downtown urban urban edge dense suburban developing suburban

08 **City of Houston Special Street Designation**
walkable place primary TOD street (1/4 mi.) secondary TOD street (1/2 mi.) none

Customer Service

09 **Transit Modes (Proposed and Future)**
pedestrian/cyclist* 40' bus 45' bus 60' bus rideshare vehicle/tnc personal vehicle LRT/BRT

10 **Neighborhood Walkability Score**
walker's paradise (90-100) very walkable (70-89) somewhat walkable (50-69) car-dependent (0-49)

Neighborhood Bikeability Score
biker's paradise (90-100) very bikeable (70-89) bikeable (50-69) somewhat bikeable (0-49)

11 **Existing Street Conditions and Level of Service (Immediate Adjacency)**
Street Names / LOS (A-F):

Headlines from the Future

Headline

"New Downtown Bus Stops Foster Environmental Resilience and Provide Civic Services"

Subheading

Houston METRO Partners with the Houston Public Library to Implement a Bookshare System at Bus Shelters

First Paragraph

The first of innovative bus shelter collaborations, Houston METRO has rolled out a pilot program for shelters across the city that serve as a mini library. Resources regarding local libraries will be provided at each shelter, in addition to digital resources to get connected. In addition, the shelter provides accessible real-time arrival information, multiple seating options, shelter underlighting, and system routing information to enhance safety, comfort, and quality of life.

Urban Design Taskforce Exercise

Imagine that a local newspaper wrote a front-page article regarding the proposed METRO facility. The headline should reflect how the proposed facility primarily achieves urban design guidelines related to Socio-Economic Resilience, Diverse Communities, Sustainable Development, and Customer Experience. In the subheading, consider how partnerships can further enhance the facility or surrounding neighborhood or regional system. Finally, in the first paragraph, imagine how the design guidelines can be applied to the design of the city and integrate the toolkit of amenities to promote desirable outcomes of safety, comfort, and quality of life.


Environmental Resilience
Diverse Communities
Sustainable Development
Customer Experience
Regional Scale
Neighborhood Scale
Site Scale
Bus Stop
BRT / LRT
Park & Ride
Transit Center
Amenities & Furnishings
Pedestrian Pavements
Lighting
Landscape & Green Infrastructure
Technology
Architecture
Wayfinding & Art
Safety
Comfort
Quality of Life

METRO Workshops

The design team held a series of workshops with METRO staff and leadership to learn about METRO's design implementation process, expectations for the METRO Urban Design Manual, and contribute feedback. These three interactive workshops consisted of members from each department, which greatly influenced the content of the METRO Urban Design Manual.

METRO Transit Urban Design Guidelines
Focus Group Results

SWA Team | Prepared by CAS Group

November 11, 2021

Contents

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B	11/11/2021	FINAL REPORT	JKL	RB	JKL
REV.	**DATE**	**DESCRIPTION**	**BY:**	**CHKD BY:**	**APP. BY:**

1.0 Introduction to the Project

The METRO Transit Urban Design Manual is a tool for Project Design and Management. The Design Manual will provide METRO with a comprehensive set of best practices, context-specific preferences, implementation strategies, and illustrations of sufficient detail and quality to guide sound decision-making for design excellence and a high standard for quality development in the METRO region. The Manual will support METRO's goal to design transit environments as functional public spaces to be resilient and maintained in appearance, relevancy, and need over time.

A consultant team ("SWA Team") was engaged by METRO to prepare the Transit Urban Design Manual ("Project"). The team is lead by SWA and includes RDLR, CAS Group, and Watearth. The Project milestones, developed by the SWA Team and pictured below, includes a series of workshops and deliverables.

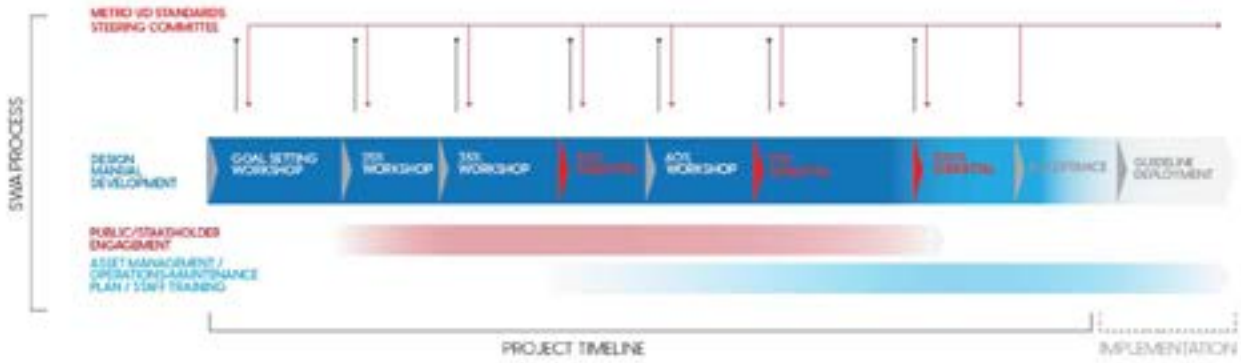


Figure 1: Transit Urban Design Manual Project Milestones.

For the purposes of the Project, it is important that all participants have a shared understanding of the meaning of urban design generally and specifically to transit environments. The following definition is being used at this time for the Project.

Urban design is an interdisciplinary approach to creating the look, the feel, and the function of public spaces. It combines architectural, landscape, urban planning, and civil engineering expertise.

In Transit Environments, Urban Design defines what makes facilities and their surroundings feel safe, comfortable, convenient, and enjoyable to transit users. The high quality of built transit environment directly correlates to higher ridership. Poor quality takes away from the customer base with other available transportation options.

During the initial stages of the Project, it became clear that there were specific questions and considerations for which the Team needed guidance from METRO staff in order to generate the deliverables. This input would assist the Team in preparing a responsive and practical yet ambitious Urban Design Manual that will support METRO's goals and objectives for its facilities, its customers, and neighboring communities. As such, the SWA Team proposed and METRO organized Focus Groups with key METRO departments and SWA Team members.

This report documents the results of the Focus Group Meetings. The section that follows includes an overview of the Focus Group agenda and objectives as well as the consolidated results of the seven meetings. The balance of this report includes the meeting notes from each of the individual Focus Groups as well as the results of online polling that was conducted with the METRO participants.

2.0 Focus Group Overview

Five (5) Focus Group meetings were originally scheduled with METRO representatives and an additional two (2) were added based on the recommendations of the Focus Group participants themselves for a total of seven (7) Focus Groups.

2.1 Meeting Objectives

There were three main objectives of the Focus Group discussions:

- Solicit guidance on preferred form and content of the urban design manual
- Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities
- Listening session for ideas, concerns, or considerations

2.2 Agenda & Presentation

The agenda for the Focus Groups is listed below. The full PowerPoint Presentation can be found at the end of this report.

The narrative sections that follow will focus on participant input shared during the Focus Group during small group discussion on online polling. For material related to Establishing the UD Manual Track please refer to the PowerPoint included at the end of this report.

1. Introduction and Objectives (10 min)
    - Polling Test Drive
2. Establishing the UD Manual Track (15 min)
    - The Mandate
    - The Project Management Process
    - Macro/Micro Design
    - Manual Contents (Participant Poll)
3. Input & Insights (30 minutes)
    - Big Picture
    - Topical Discussions
4. Closing & Next Steps (5 min)

2.3 Online Polling

Due to the ongoing remote work environment required due to the COVID-19 pandemic, the Focus Groups were virtual meetings. As such, the SWA Team utilized an online polling tool – PollEverywhere – during the course of the meetings. The online polling created an opportunity to engage participants, share participant feedback in real-time, and, subsequently, to consolidate the participants' feedback across the seven Focus Groups. The polling results are included for each of the Focus Groups at the back of this report and are summarized in Section 3.

2.4 Participants

Twenty-eight (28) METRO staff members participated in the Focus Groups providing a broad range of perspectives and valuable insights for the SWA Team. The table below lists the participants for each of the Focus Group topics.

Planning + Engineering + Construction	Marketing + Public Affairs + Government Affairs	Innovation	Safety & Security
September 30, 2021	September 30, 2021	October 6, 2021	October 7, 2021
▸ Clint Harbert ▸ Aubin Pickens (UD-PM) ▸ Yuhayna Mahmud ▸ Bridgette Towns ▸ Timothy Mills ▸ Mustaque Rumi ▸ Michael (Bruce) Krantz ▸ Scott Grogan ▸ Larry Horst ▸ Edmund Petry	▸ Eduardo Miranda ▸ Sydney Scardino ▸ Mike Kramer ▸ Tanya McWashington ▸ Aubin Pickens (UD-PM)	▸ Jamila Gomez ▸ Aubin Pickens (UD-PM)	▸ Chief Vera Bumpers ▸ Santiago Osorio ▸ Mohamed Boukhriss ▸ Aubin Pickens (UD-PM)

Operations & Facilities Maintenance	State of Good Repair + Facilities Maintenance	IT + Environment
October 7, 2021	October 14, 2021	October 15, 2021
▸ Arturo Jackson ▸ Ken Luebeck ▸ Kurt Luhrsen ▸ Israel Garcia ▸ Charles Berkshire ▸ Aubin Pickens (UD-PM)	▸ Frank Cordero ▸ Alexi Miller ▸ Miguel Zavala ▸ Aubin Pickens (UD-PM)	▸ Miriam Barranco ▸ Randy Frazier ▸ Aubin Pickens (UD-PM)

The participants were satisfied with the Focus Groups. At the end of each session, participants were asked to rate the meeting on a scale of 1-5, where 1 = poor, 3 = fair, and 5 = excellent. Sixty-seven percent (67%) of participants rated the Focus Groups a 5 and the remaining thirty-three percent (33%) rated the meetings a 4 on the scale.

3.0 Online Polling Results

Included below are the consolidated results from the seven Focus Groups for the online polling questions that were presented. It is important to note that the results varied between the Focus Groups based on their role/responsibilities at METRO. The results from each meeting can be found in the section of the report dedicated to the individual Focus Group.

3.1 METRO's Urban Design Goals

How will METRO know it has achieved high quality urban design of its facilities?

As both an icebreaker and an opportunity to explore how METRO staff define high quality urban design, Focus Group participants were asked to enter key words or phrases into the online polling software in response to the question: How will METRO know it has achieved high quality urban design of its facilities? The resulting word cloud below includes the terms shared by METRO staff and are sized to reflect the number of repeat entries.

Figure 2: Online Polling: Definition of High Quality Urban Word Cloud.

In addition to presenting the word cloud above, it is interesting to note there were some specific and unique entries, three of which are included below. The verbatim results for all entries can be found in the consolidated polling results at the back of this report.

- Feeling-like-we're-in-Europe.
- The-complete-safety-management-system-process-is-followed-starting-with-a-preliminary-hazard-analysis-and-carried-through-to-a-complete-hazard-verifcation-matrix-nd-the-other-SMS-steps-carried-through-for-the-life-of-the-project.
- The-evidence-of-a-developed-country-is-not-that-everyone-has-a-car-it-is-that-everyone-uses-public-transportation.

3.2 Success Factors

Please rank the following in terms of importance to delivering high quality urban design for METRO Facilities.

During Workshop 1 of the Project, METRO staff were asked to identify success factors to quality urban design. Five of those suggestions were presented during the Focus Groups and ranked by the participants. Listed below are the online polling results in rank order. The ranking reinforces the importance of this Project to create an Urban Design Manual and Project Management Process.

1. Clear, concise guidelines that can be applied to any project (by METRO and consultants)
2. Clear process that includes urban design from the beginning (not as an afterthought)
3. Operational budget for all new/improved facilities (above traditional funding)
4. Stakeholder/community acceptance and support
5. Partnerships with external stakeholders

3.3 METRO Urban Design Champions

What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development?

The SWA Team continually emphasizes the importance of both the Urban Design Process as well as the Urban Design Manual. Due to recent staffing changes and reorganization, the question as to what department(s) could take ownership of the manual was presented to the Focus Groups.

Figure 3: Online Polling: Department Ownership of Urban Design Word Cloud.

As illustrated in the word cloud above, a vast majority of participants indicated that Planning + Engineering + Construction (PEC) should take ownership. At the same time, nearly every participants indicated that their department should be included in the urban design process at the earliest stages and at key decision-making points. For example, the selection of finishes and materials in the planning and engineering design stages has significant impacts on facilities maintenance. METRO's operations is inherently related to the decisions that are made in planning and engineering design process, including value engineering.

The sentiments of the participants can be summarized as follows:

Quality urban design is a joint effort that has to be maintained throughout the entire process from planning to engineering, construction, maintenance, and repair.

3.4 Case Studies

Please rank case studies that would be valuable to include in the Urban Design Manual.

As described in section 1 of this report, the Design Manual will provide METRO with a comprehensive set of best practices, context-specific preferences, implementation strategies, and illustrations. As such, the SWA Team asked METRO participants to rank order the types of case studies that would be most relevant to the agency. They are listed below from most to least valuable.

1. Retrofit of existing facility to create/promote Transit Oriented Development.
2. Future METRO facilities: P&R, Transit Center, Transit Stop.
3. Retrofit of existing METRO Facilities: P&R, Transit Center, Transit Stop.
4. Examples from other Sunbelt cities.
5. Future Transit Oriented Development.

3.5 Manual Level of Detail

What level of detail should be included in the UD Manual?

The SWA Team solicited guidance from the participants on the level of detail they felt was most appropriate for METRO's urban design manual. More than half (54%) indicated that fewer urban design options that are easily duplicated is preferable. It is important to note that seventeen percent (17%) of respondents were undecided at the time of the polling. As the project proceeds, it may be helpful to test this concept again to ensure that METRO will receive the level of detail most appropriate to achieve its objectives over time.

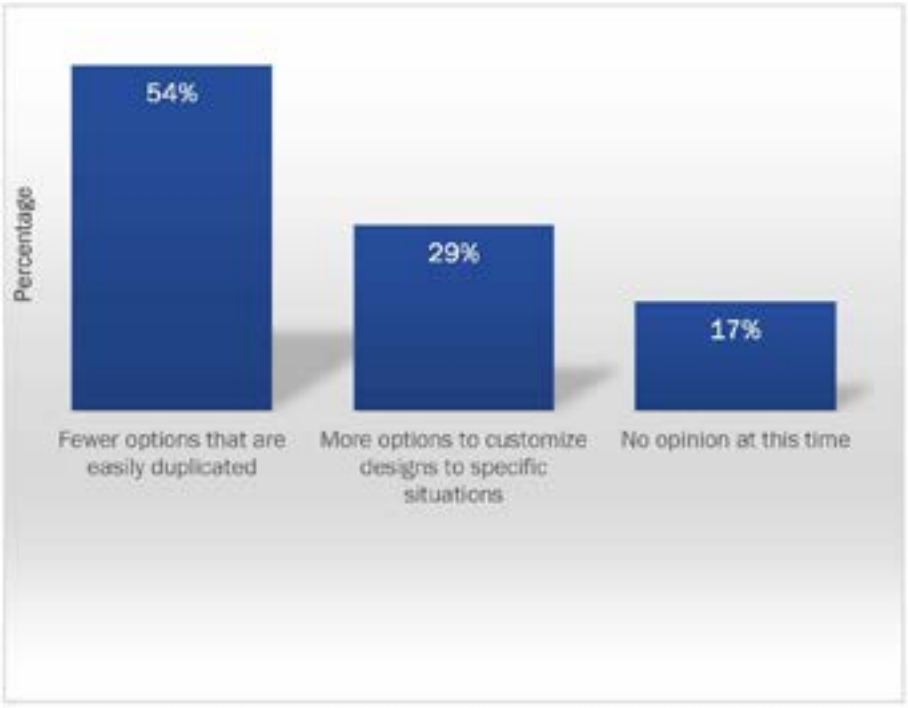


Figure 4: Focus Group Participants' Preference for Level of Detail of Urban Design Manual.

4.0 Focus Group Interview Emerging Themes & Conclusions

Throughout the seven Focus Group interviews that were conducted, the SWA Consultant Team facilitated discussions with METRO staff regarding a variety of questions and considerations related to METRO's urban design. In all of the Focus Groups, participants were able to clearly identify and articulate the relationship of their roles and responsibilities to urban design elements at METRO facilities.

METRO staff were actively engaged and open in sharing their insights and ideas. The meeting notes for each of the seven Focus Groups is included in Section 4 of the report. These include the polling results by Focus Group as well as detailed comments shared during the group discussions.

In addition to documenting the individual meetings, it is important to examine the themes that emerged across multiple – or even all – of the Focus Groups. Listed below is a summary of the important takeaways organized into six major themes.

1. Customer Service & Experience
2. Security & Safety
3. IT & Innovation
4. Environment & Sustainability
5. Cost/Budget Considerations
6. Operations & Maintenance

4.1 Customer Service & Experience

All Focus Groups spoke at length about their objective of serving customer needs by providing high quality services and facilities. There were various terms used to define the METRO customer, including customer, rider, user, and patron.

Listed below are some of the key concepts that were discussed.

- Customer focus
- High quality services and facilities
- Customer terminology & interaction vary (rider, user, patron, customer, neighbor)
- Customer surveys and public feedback as a tool
- Maintain and promote the METRO Brand
- Consistent messaging, communication, & navigation online and built environment
- Pedestrian experience is integral (interior & exterior)
- Anticipating changes in future customer base
- ADA considerations
- Relationship to surrounding community
- Public restrooms

4.2 Security & Safety

All Focus Groups discussed the importance of security and safety. Security in particular was discussed at length because it has impacts on both METRO customers and METRO personnel.

Listed below are some of the key concepts that were discussed for each.

Security

- Secure environment for METRO customers and staff (and their property)
- Promote a sense of security
- Data security
- Community Ambassadors
- Role of cameras
- Foot traffic reduces potential for crime
- Discourage sleeping / encampment
- Secure park & ride facilities

Safety

- Pedestrian-bus conflict
- Pedestrian-rail conflict
- Silent vehicles

4.3 IT & Innovation

IT and Innovation impact many departments within METRO from operations to facilities maintenance. Listed below are some of the key concepts that were discussed.

- METRO is actively evaluating, testing, and implementing new technologies
- Futureproofing / Future casting is a challenge because many technologies are in early stages, new technologies often need to be introduced/incorporated into existing METRO facilities, budget considerations may impact current decision-making that impacts future opportunities
- Alternative fuel powered vehicles on METRO is ever-evolving (e.g. CNG, hydrogen fuel, A/V, METRO E/V, customer E/V charging, and more)
- Relationship of impacts of natural disasters or emergencies on METRO's ability to operate its fleet (e.g. ability charge electric vehicles, etc.)
- Support maintenance efforts with remote sensing
- Security cameras could play an important role in security as well as maintenance, but need to be upgraded and potential for monitoring considered
- Cashless systems decision pends
- New signage rolling out
- Dedicated IT/Control rooms may be needed at new facilities

4.4 Environment & Sustainability

Environment and sustainability were not cited consistently by METRO Focus Group participants. The main environmental focus of METRO at present is diversifying its fleet with alternative fuel vehicles. Listed below are some of the key concepts that were discussed and were generally prompted by the SWA Team:

- Air quality is the critical environmental metric
- LEED or ENVISION certifications are not yet part of METRO's approach; FTA is pushing for LEED
- Solar power can be applied on many METRO facilities
- Role of landscaping in terms of both a visual amenity and an environmental asset
- Energy efficiency objectives apply to METRO vehicles as well as other assets (HVAC, lighting, etc.)

4.5 Cost/Budget Considerations

The availability of funds was cited by many Focus Groups as a key driver in their ability to achieve high quality services and facilities. Listed below are some of the key concepts that were discussed.

- Maintenance budgets were cited by many Focus Groups as having a significant impact on the ability of METRO to maintain its preferred standards at facilities
- Buy American requirements impact selection of materials and finishes
- Grant funding and metrics were discussed, but require further exploration to determine whether and how the Urban Design Manual can incorporate useful metrics
- Evaluating life cycle costs and return on investment in terms of both capital cost and operating costs should drive METRO decision making

4.6 Operations & Maintenance

Many of the topics outlined above related to operations and facilities maintenance and are, generally, not repeated below. During the Focus Groups, there were specific concepts shared in relation to operations and maintenance that are listed below.

Operations

- Lifespan of facilities should align with anticipated innovations
- Dedicated layover spaces for buses
- Efficient transfer experience
- Realtime updates / information
- METRO amenities
    - Breakrooms
    - Private shaded area for bus operators

Maintenance

- Local vendors preferred
- Standardization (e.g. stop signs, shelters, amenities)
- Landscaping no easy solution (irrigation, contractors, etc.)
- Remote monitoring of systems and facilities
- Energy efficiency
- Storage rooms at METRO facilities

5.0 Next Steps

5.1 Additional UD Objectives

Based on the Focus Group feedback, the SWA Team has updated the proposed contents of the Urban Design Manual to reflect the needs and wants of the METRO participants.

The table below was presented during Workshop 1 and the Focus Groups and depicts the urban design objectives of the Project and the specific elements that will be address in the manual. The elements that are highlighted are elements that will be added to the Manual based on the feedback received from the Focus Group participants.

Figure 5: Micro UD Objectives.

5.2 Workshop 2 Preparation

The results of the Focus Groups were used to support the preparation of the agenda, objectives, format, and content of Workshop 2, which was held on October 21, 2021. A report of the Workshop 2 results is available under separate cover.

Appendix A

METRO Transit Urban Design Guidelines Focus Group Results

SWA Team

November 11, 2021

Focus Group Online Poll
Consolidated Results

METRO_Urban Design_Focus Groups_Combined Results_20211015

All runs (last updated Oct 15, 2021 2:31pm)

11	26	19	64%
Activities	Participants	Average responses	Average engagement

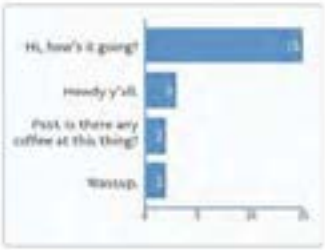
1. Are you connected to PollEverywhere?

Response options	Count	Percentage
19	**19**	**100%**

69% Engagement

19 Responses

2. How would you greet everyone today?

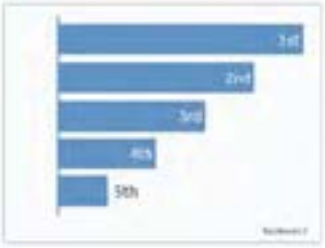


Response options	Count	Percentage
Hi, how's it going?	**15**	**68%**
Howdy y'all.	3	14%
Psst. Is there any coffee at this thing?	2	9%
Wassup.	2	9%

81% Engagement

22 Responses

3. Please rank your preferred mode of transport. Use arrows to reorder (most preferred on top). Click submit.



Response options

Rank

1st

2nd

3rd

4th

5th

35%

Engagement

10

Responses

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

Responses

88%
Engagement

40
Responses

well-designed-facilities reflects-publics-expectations thoughtful easy-to-use easy-to-support

The-evidence-of-a-developed-country-is-not-that-everyone-has-a-car-it-is-that-everyone-uses-public-transportation.

longer-asset-service-life

Functional-but-sustainable-and-easy-to-maintain

awards-for-planning-department

fewer-complaints

Higher-ridership

comfort-safe-welcoming-exciting-new-beauty

Positive impact on ridership including a cross-section of riders-positive feedback from riders, community, business partners- employee feedback

User -friendly

Positive impact on ridership including a cross-section of riders-positive feedback from riders, community, business partners- employee feedback

The-complete-safety-management-system-process-is-followed-starting-with-a-preliminary-hazard-analysis-and-carried-through-to-a-complete-hazard-verifcation-matrix-nd-the-other-SMS-steps-carried-through-for-the-life-of-the-project.

functional attractive accessible maintainable

Positive-feedback

Employee/Patron feedback

Employee feedback

pedestrian friendly-multi-modal

integrated

work-health-safety

up to date sytyle

connectivity

safe

modern

safety

Responses

modern, customer-friendly, innovative, accessible

custome-ease-of-use

enhanced customer experience

sustainable-classic-intuitive-innovative

customer-satisfaction

form-and-function

easier-access

welcoming

Know your neighbors

Environmentally-Friendly

feeling-like-we're-in-Europe

Try to be environmentally conscious

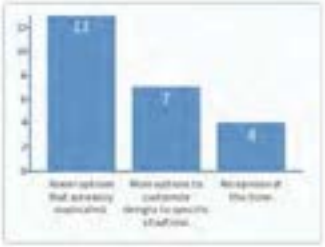
Patron feedback-increased use of facility

Ease-of-use

Patron-response

1. Getting buy-in & feedback from stakeholders

5. What level of detail should be included in the UD Manual?



Response options	Count	Percentage
Fewer options that are easily duplicated.	**13**	**54%**
More options to customize designs to specific situations.	7	29%
No opinion at this time.	4	17%

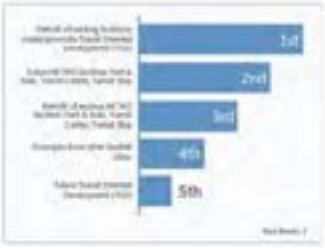
88%

Engagement

24

Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

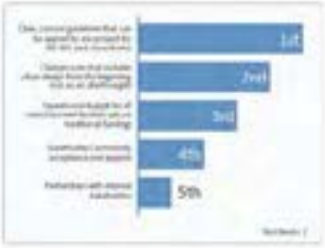


Response options	Rank
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	1st
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	2nd
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Examples from other Sunbelt cities.	4th
Future Transit Oriented Development (TOD)	5th

88% Engagement

24 Responses

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	1st
Clear process that includes urban design from the beginning (not as an afterthought)	2nd
Operational budget for all new/improved facilities (above traditional funding)	3rd
Stakeholder/Community acceptance and support	4th
Partnerships with external stakeholders	5th

92% Engagement

25 Responses

8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
PEC	2	0
Planning, Engineering & Construction	1	0
Planning/Engineering/Construction	1	0
Planning Department	1	0
Engineering	1	0
Not one department but a joint effort	1	1
Planning-Engineering-Construction-Department	0	0
PEC	0	0
Planning, Engineering & Construction	0	0
PEC	0	0
PEC-JOINT EFFORT TO GET BUY IN FOR ALL DEPARTMENTS	0	0
Communications/Marketing	1	1
Operations or Planning Department	0	0
Facilities maintenance	0	0
Partnership-Facilities-Engineering	0	0
Planning	0	0
Planning/Engineering/Construction	0	0
Communications	0	1

Engagement

18

Responses

9. Do you have any additional input, ideas, or insights to share?

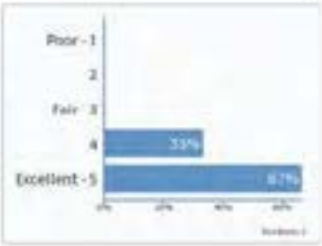
Responses

No

4%
Engagement

1
Response

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	7	33%
Excellent - 5	**14**	**67%**

77%
Engagement

21
Responses

PDD1. What are the critical stages of a project that impact achieving high quality urban design?

Responses

Conceptual Design (15%), Advanced Design, Value Engineering, Maintenance	
It must be included early, conceptual & preliminary design.	
timeline	Throughout the lifecycle of the project

15%
Engagement

4
Responses

Focus Group Meeting Notes and Online Poll Results

Planning, Engineering, and Construction

METRO Planning, Engineering, & Construction (PEC) Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Clint Herbert, Aubin Pickens (JD-PM), Yuhayna Mahmud, Bridgette Towns, Timothy Mills, Mustaque Rumi, Michael (Bruce) Krantz, Scott Grogan, Larry Horst, Edmund Petry **SWA Team:** SWA, RDLR, CAS Group, Watearth	**Meeting Date:** September 30, 2021
Recorded By: J. Lindbom, N. Blumberg, & SWA Consultant Team	
Subject: METRO Planning, Engineering, & Construction Focus Group	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

The following is intended to be an accurate summary of the meeting. If there are any comments/corrections, please notify the author(s) within 48 hours of receipt.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
1.0 Introduction & Objectives	SWA Team (N. Beard) presented the list of the participants of the five scheduled METRO Focus Groups and explained the agenda and objectives of these meetings. She noted that the 35% Deliverable METRO Workshop is scheduled for 10/21/21 and that the SWA Team 50% submittal will be delivered soon after. SWA Team (J. Lindbom) led the participants through an online electronic polling exercise to test the platform (PollEverywhere), which was used at the meeting to collect participant ideas and input.	1. A copy of the PowerPoint used during the workshop is attached for reference. – Info 2. PollEverywhere results are attached to these meeting notes for each individual Focus Group. – Info
2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location-specific) urban design elements being developed by the SWA Team. ○ Engineering requested a definition of Urban Design so that there would be a collective understanding of the meaning of UD. ○ SWA then provided the following definition in response to the request: • Urban design is an interdisciplinary approach to creating the look, the feel, and the function of public spaces. It combines architectural, landscape, urban planning, and civil engineering expertise. • In Transit Environments...Urban Design defines what makes facilities and their surroundings feel safe, comfortable, convenient, and enjoyable to transit users. The high quality of built transit environment directly correlates to higher ridership. Poor quality takes away from the customer base with other available transportation options. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? ○ Fewer options that are easily duplicated. (80% of responses) ▸ Please rank case studies that would be most valuable to included in the UD manual? ○ The top ranked idea was Retrofit of existing facility to create/promote Transit Oriented Development and second was Future METRO facilities (Park & Ride, Transit Center, Transit Stop), followed by retrofit of existing METRO facilities.	3. Include definition of Urban Design in future presentations. – SWA Team (Completed)
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture & Topical Discussions** **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. Participants were asked to consider what was key to successful examples and what factors influenced the lower quality examples. ▸ A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO Facilities. ○ Clear process that includes urban design from the beginning (not as an afterthought) ranked first followed by clear, concise guidelines that can be applied to any project, and coming in third was the operational budget for all new/improved facilities. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. ○ Participants indicated that it should be a joint effort of Planning-Engineering-Construction. ○ Discussion of the importance of "Buy American" as well as practicality and cost-effectiveness. **Topical Discussions** The SWA Team presented a series of specific questions for the participants' consideration: ▸ What are the critical stages of a project that impact achieving high quality urban design? ○ Participants raised the importance of linking Urban Design to grant requirements (e.g. FTA)	4. Reach out to Clint Herbert to discuss "walkability" and other criteria that are part of grant funding opportunities and the possibility of addressing these metrics within the UD PM process and deliverables. 5. SWA Team provide list of potential facilities types and specific locations for case studies in the UD Manual to Aubin. METRO to shortlist options with internal team. – SWA & A. Pickens 6. METRO provide Org Chart of PEC and other relevant METRO departments integral to UD. – A. Pickens 7. Connect with Scott Grogan and determine potential role in UD and this project – A. Pickens 8. Provide copies of the studies prepared for Northwest Transit

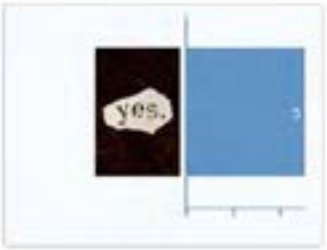
Item	Discussion	Follow-Up Actions (Responsibility/Date)
	to help position METRO for funding and advocacy. For example, walkability criteria, ridership metrics, environment/sustainability metrics, impact of "Buy American" requirements, etc. o Discussion of whether UD aspects were impacted during value engineering phase. Engineering noted that cost was not the sole factor in the value engineering process. o Discussion of whether potential long-term operational costs are adequately address in the planning, design, and budgeting process to support a high-quality built environment. o Recommended to reach out to Scott Grogan at METRO to discuss ridership data and factors. ▸ How can practical application of the UD Manual by internal designers & outside consultants be managed and monitored? – There was not sufficient time to address this question. ▸ What should be the focus of the UD Manual: Future facility improvement priorities? New construction or retrofit? How to address TOD? o METRO team would like to participate in the selection of the case studies for inclusion in the UD Manual. METRO may add its priority projects to that list in order to study specific sites that are of particular importance to METRO.	Center / Magnolia Transit Center – A. Pickens
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). o The participants ranked the meeting a 4 (60%) and a 5 (40%). SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	
MISC		
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. 1. What are the critical stages of the project that typically see change/reduction in urban design elements quality and scope? 2. Who can be the critical party that oversees application of the manual in practice and creates a compliance strategy for the internal designers and outside consultants?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO input.
	3. What are the project systems that can benefit from additional research/emphasis/support in the manual?(smart tech, lighting, autonomous bus fleets, case studies from other sunbelt cities, etc.?) 4. Is there interest in focusing our efforts on specific priority facilities or sites? Is there a future facility improvement priority list? 5. Is there a preference to consider retrofit approaches as opposed to new construction? What is a percentage of one v. the other? 6. What are the TOD study needs in terms of creating guidance? Also, any recommendations to focus on specific sites as case studies? (Wheeler, Eastwood, others?) 7. Is there a sustainability officer or someone who oversees LEED, Envision, green energy conversion, carbon footprint reduction goals, etc. 8. What METRO design/procurement/construction practices has the potential to negatively impact the final Urban Design product delivered to the public? 9. Is there a desire to pursue ENVISION certification or to incorporate ENVISION scoring for sustainable infrastructure? 10. Fewer options that are easily duplicated to reduce maintenance and improve design and constructability as well as monitoring for future improvements? 11. More options to customize designs to specific situations?	

METRO Focus Group PollEV_PEC_20210930_ExecSum

Current run (last updated Sep 30, 2021 11:37am)

11	8	5	63%
Activities	Participants	Average responses	Average engagement

1. Are you connected to PollEverywhere?

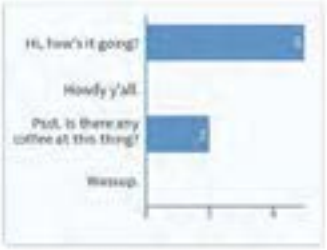


Response options	Count	Percentage
yes.	**5**	**100%**

63% Engagement

5 Responses

2. How would you greet everyone today?

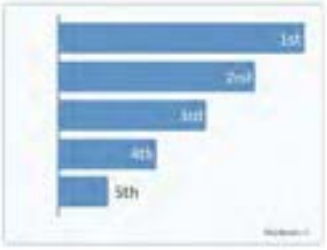


Response options	Count	Percentage
Hi, how's it going?	**5**	**71%**
Howdy y'all.	0	0%
Psst. Is there any coffee at this thing?	2	29%
Wassup.	0	0%

88% Engagement

7 Responses

3. Please rank your preferred mode of transport. Use arrows to reorder (most preferred on top). Click submit.



Response options

Rank

1st

2nd

3rd

4th

5th

63%

Engagement

5

Responses

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

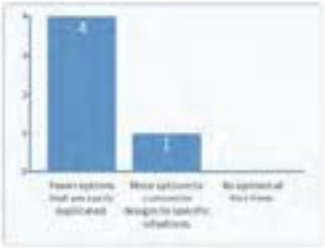
Responses

- welcoming
- Know your neighbors
- Environmentally-Friendly
- feeling-like-we're-in-Europe
- Try to be environmentally conscious
- Patron feedback-increased use of facility
- Ease-of-use
- Patron-response
- 1. Getting buy-in & feedback from stakeholders

75% Engagement

9 Responses

5. What level of detail should be included in the UD Manual?

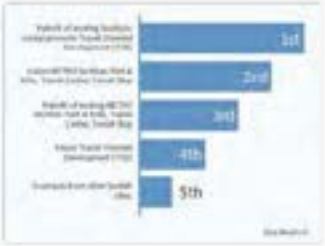


Response options	Count	Percentage
Fewer options that are easily duplicated.	**4**	**80%**
More options to customize designs to specific situations.	1	20%
No opinion at this time.	0	0%

63% Engagement

5 Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

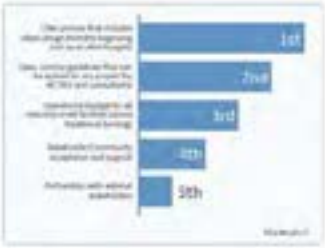


Response options	Rank
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	1st
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	2nd
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Future Transit Oriented Development (TOD)	4th
Examples from other Sunbelt cities.	5th

75% Engagement

6 Responses

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Clear process that includes urban design from the beginning (not as an afterthought)	1st
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	2nd
Operational budget for all new/improved facilities (above traditional funding)	3rd
Stakeholder/Community acceptance and support	4th
Partnerships with external stakeholders	5th

75% Engagement

6 Responses

8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
Planning, Engineering & Construction	1	0
PEC-JOINT EFFORT TO GET BUY IN FOR ALL DEPARTMENTS	0	0
PEC	0	0
Planning, Engineering & Construction	0	0
PEC	0	0
Planning-Engineering-Construction-Department	0	0
Not one department but a joint effort	1	1

75% Engagement

7 Responses

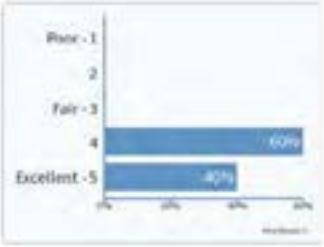
9. Do you have any additional input, ideas, or insights to share?

Responses

0%
Engagement

0
Responses

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	**3**	**60%**
Excellent - 5	2	40%

63%
Engagement

5
Responses

PDD1. What are the critical stages of a project that impact achieving high quality urban design?

Responses

Conceptual Design (15%), Advanced Design, Value Engineering, Maintenance

It must be included early, conceptual & preliminary design.

timeline

Throughout the lifecycle of the project

50%
Engagement

4
Responses

Focus Group Meeting Notes and Online Poll Results

Marketing, Public Affairs, and Government Affairs

METRO Marketing, Public Affairs, & Government Affairs (MPG) Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Eduardo Miranda, Sydney Scardino, Mike Kramer, Tanya McWashington, Aubin Pickens (UD PM) **SWA Team:** SWA, RDLR, CAS Group, Watearth	**Meeting Date:** September 30, 2021
Recorded By: J. Lindbom, N. Blumberg, & SWA Consultant Team	
Subject: METRO Marketing, Public Affairs, & Government Affairs	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

The following is intended to be an accurate summary of the meeting. If there are any comments/corrections, please notify the author(s) within 48 hours of receipt.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
1.0 Introduction & Objectives	SWA Team (N. Beard) presented the list of the participants of the five scheduled METRO Focus Groups and explained the agenda and objectives of these meetings. She noted that the 35% Deliverable METRO Workshop is scheduled for 10/21/21 and that the SWA Team 50% submittal will be delivered soon after. SWA Team (J. Lindbom) led the participants through an online electronic polling exercise to test the platform (PollEverywhere), which was used at the meeting to collect participant ideas and input.	1. A copy of the PowerPoint used during the workshop is attached for reference. – Info 2. PollEverywhere results are attached to these meeting notes. – Info
2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location-specific) urban design elements being developed by the SWA Team. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? o Participant selected: More options to customize designs to specific situations. (50% of responses) ▸ Please rank case studies that would be most valuable to included in the UD manual? o The participants ranked the two Retrofit case studies at the top followed by future metro facilities.	
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO facilities. o Clear, concise guidelines came in first followed by clear process. Stakeholder/Community acceptance and support was ranked third. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participants indicated Engineering, Planning, and Construction. Communications/marketing was also suggested but it was not generally supported. The communications team seeks to be part of the process to ensure customer needs are met and that the METRO brand is maintained. **Topical Discussions** The SWA Team presented a series of specific questions for the participant's consideration: ▸ How important is community outreach and engagement for improving existing or developing new facilities? (Past and future.) o Use consumer research to make better decisions. Find out what is most important to customers and where are the problems to be solved (e.g. market research, consumer surveys, etc.). • Lisa Tidwell is a Market Research Analyst at METRO who may be able to assist. • Public Affairs can do outreach to customers. • Consider the different customers bases: (1) customers that utilize METRO; (2) Residents/businesses where we are a neighbor; and (3) Potential new riders. • How do we get information from the public about what is more important to them? o METRO observations include: • Better selection of urban design elements based customer needs • Customers want future/slick design • Adequate maintenance budget required	3. Secure copy of METRO's style guide. (Does it include signage?) 4. Make contact with Lisa Tidwell to discuss available data sources within METRO (e.g. Comments / Complaints database; METRO Next surveys / meetings results, etc.)

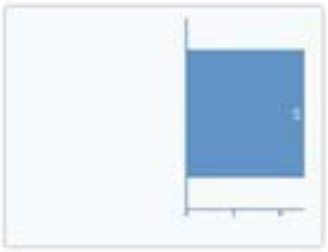
Item	Discussion	Follow-Up Actions (Responsibility/Date)
	○ This Focus Group includes METRO staff who are customer facing. The entire METRO organization and METRO's built facilities should be responsive to customer needs and wants. ▸ What is role of critical external partners and stakeholders for most METRO initiatives (planning/dev't/improvement/maintenance)? Who are they? ○ Although the question focused on external parties, METRO shared internal parties. ○ Engineering and maintenance are critical elements of the built environment. Sometimes there is no significant maintenance/upgrade in 30 years. There needs to be sufficient budget to continually upgrade facilities. ○ METRO staff noted that from their perspective there is resistance in some departments to adopt urban design concepts and standards. It is particularly important that Planning and Engineering actively adopt good urban design and ensure implementation in METRO facilities. Staff were encouraged by past Urban Design METRO Staff Member who sought higher design standards and invited Marketing, Public Outreach, and Government Relations to participate in UD initiatives, but that staff member has moved on. ▸ How can the UD Manual help market transit services to potential users? ○ The Urban Design Manual can be compared to METRO's style guide. Urban design is part of brand marketing. METRO noted that it is updating its website to make it easier for visitors to navigate but not other major branding exercises planned or ongoing. ○ METRO's physical and online facilities should be intuitive and easy to navigate. ○ METRO questioned how facilities can be incorporated into surrounding areas. ○ There should be baseline requirements for all facilities for design, safety, etc. ○ Signage should be consistent with branding. ○ It is unclear where Metro NEXT can contribute to this effort.	
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). ○ The Meeting was rated a 5 by all participants. SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. ○ Are there any past surveys or engagement activities that would provide useful input with regards to urban design considerations? ○ How important has community outreach been and going to be in the future for improving existing or developing new facilities? ○ How does METRO effectively engage stakeholders in materially supporting the development/improvement/maintenance of METRO facilities? ○ METRO public affairs promotes sustainability and other items to the public – is there a desire to pursue ENVISION certification or to incorporate ENVISION scoring for sustainable infrastructure? ○ Who are the critical external partners for the majority of METRO planning/building initiatives? ○ Are there existing METRO PR/communication campaigns that can be leveraged in the process of developing the manual, publicizing it and applying it in practice? ○ Are there frequent surveys conducted to gauge community feedback on the experience and frequency of use?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO follow up input, if required.

METRO_Focus Group_PollEV_MPG_20210930_ExecSum

Current run (last updated Oct 5, 2021 9:34pm)

13	6	4	62%
Activities	Participants	Average responses	Average engagement

1. Are you connected to PollEverywhere?



Response options	Count	Percentage
	5	**100%**

83% Engagement

5 Responses

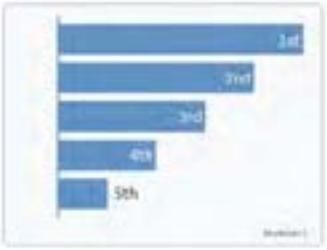
2. How would you greet everyone today?

Response options	Count	Percentage
Hi, how's it going?	**3**	**60%**
Howdy y'all.	1	20%
Psst. Is there any coffee at this thing?	0	0%
Wassup.	1	20%

83% Engagement

5 Responses

3. Please rank your preferred mode of transport. Use arrows to reorder (most preferred on top). Click submit.



Response options

Rank

1st

2nd

3rd

4th

5th

83%

Engagement

5

Responses

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

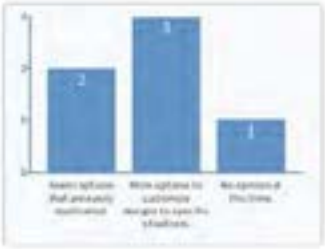
Responses

up to date sytyle | connectivity | safe | modern | safety | modern, customer-friendly, innovative, accessible | custome-ease-of-use | enhanced customer experience | sustainable-classic-intuitive-innovative | customer-satisfaction | form-and-function | easier-access

100%
Engagement

12
Responses

5. What level of detail should be included in the UD Manual?

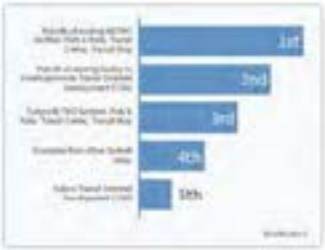


Response options	Count	Percentage
Fewer options that are easily duplicated.	2	33%
More options to customize designs to specific situations.	**3**	**50%**
No opinion at this time.	1	17%

100%
Engagement

6
Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

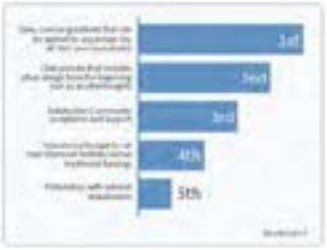


Response options	Rank
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	1st
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	2nd
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Examples from other Sunbelt cities.	4th
Future Transit Oriented Development (TOD)	5th

100%
Engagement

6
Responses

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	1st
Clear process that includes urban design from the beginning (not as an afterthought)	2nd
Stakeholder/Community acceptance and support	3rd
Operational budget for all new/improved facilities (above traditional funding)	4th
Partnerships with external stakeholders	5th

100%
Engagement

6
Responses

8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
Engineering	1	0
Planning Department	1	0
Planning/Engineering/Construction	1	0
Communications/Marketing	1	1
Communications	0	1

83%
Engagement

5
Responses

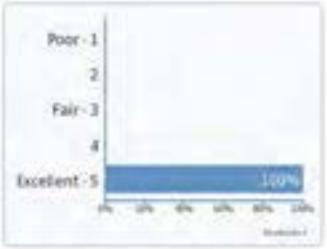
9. Do you have any additional input, ideas, or insights to share?

Responses

0%
Engagement

0
Responses

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	0	0%
Excellent - 5	**4**	**100%**

67%
Engagement

4
Responses

MPG1. How important is community outreach and engagement for improving existing or developing new facilities? (Past and future.)

Responses

0%
Engagement

0
Responses

MPG2. What is role of critical external partners and stakeholders for most METRO initiatives? Who are they?

Responses

0%
Engagement

0
Responses

MPG3. How can the UD Manual help market transit services to potential users?

Responses

Engagement

0

Responses

Focus Group Meeting Notes and Online Poll Results

Innovation

SWA Team | Prepared by CAS Group

METRO Innovation Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Jamila Gomez, Aubin Pickens (UD-PM) **SWA Team:** SWA, RDLR, CAS Group, Watearth	**Meeting Date:** October 6,2021
Recorded By: J. Lindbom & SWA Consultant Team	
Subject: METRO Innovation Focus Group	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

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Item	Discussion	Follow-Up Actions (Responsibility/Date)
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2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location-specific) urban design elements being developed by the SWA Team. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? o Participant selected: More options to customize designs to specific situations. ▸ Please rank case studies that would be most valuable to included in the UD manual?	
	o Ms. Gomez noted that she ranked "case studies from other Sunbelt Cities" as most valuable because the Innovation Department looks to best practices from other jurisdictions across the nation as a great source of ideas for METRO. They prefer not to "reinvent the wheel." o Ms. Gomez also noted that retrofit of existing facilities was important because METRO is landlocked and so upgrading existing facilities is a focus of improving the network.	
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO Facilities. o Stakeholder/Community acceptance and support was ranked first followed by a clear process that includes urban design from the beginning. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participant indicated Operations or Planning. **Topical Discussions** The SWA Team presented a series of specific questions for the participant's consideration: ▸ What transit technologies are being integrated or on the horizon that new facilities should make accommodations for to futureproof facilities design? o Innovation provided a detailed overview of their ongoing activities as well as the general process that drives the innovation research that they do. The Innovation Department helps with research to support other departments and also connects external vendors with internal METRO contacts as appropriate. o Recent innovation projects include: • Safety/security technology such as gunshot detectors, high-def cameras, security drones (2 METRO staff are licensed drone pilots, perimeter surveillance, security robot (which was vandalized). • Significant emphasis on Autonomous Vehicles (A/V) including an A/V Shuttle slated for delivery in 2022. In addition, Houston was an A/V proving ground to demonstrate the safety and functionality of A/V, which has afforded Houston/METRO some prestige.	3. METRO Innovation Dept. to provide Policies & Procedures to SWA Team, if permitted. – A. Pickens to request document. 4. SWA Team provide list of potential facilities types and specific locations for case studies in the UD Manual to Aubin. – METRO to short list options with internal team. 5. In terms of futureproofing, Ms. Gomez was not as familiar with what is being done in this arena. She suggested reaching out to Kim or to Operations. – SWA Team & A. Pickens 6. SWA Consultant Team consider having a rep attend the Texas Innovation Alliance Conference in October. – SWA Team 7. A. Pickens advise if there are any METRO materials that document the various metrics categories that J. Gomez discussed. – A. Pickens

	• Emphasize customer/ride experience – Continuously trying to improve customers' ability to gauge when bus will arrive at their stop. • Pilot Wi-Fi Projects – METRO has been piloting Wi-Fi on buses and it has been popular. Despite its popularity, METRO is working to resolve concerns with privacy issues, protecting customers personal data, or potential cyberattacks. These types of programs also relate to "data equity" and level of convenience. ○ Policies/Procedures • They currently have a Policy and Procedures for Innovation so that everyone within METRO is on the same page. This may be made available to the SWA Consultant Team. • In terms of the timeline / cycle of innovation, ideas or objectives are typically generated by the CEO, the Board, and, sometimes, METRO departments themselves. Innovation then conducts research on the project idea and creates Working Group with pertinent departments. They engage external stakeholders and the community. They develop goals and metrics. Then goes to Board for approval of budget. A good example is the BRT project which was implemented fairly quickly. • Decision making is with metrics and internal/external engagement. Then goes to board and gets approved. Depends on board and cost. Mitigation or public engagement can draw out the process. There is a process in place but the timeline can change based on urgency. • In terms of futureproofing, Ms. Gomez was not as familiar with what is being done in this arena. She suggested reaching out to Kim or to Operations. ▸ Is there an inter-agency national forum/exchange on the topic of innovation that METRO prefers referencing and tracks? (NACTO, APTA, others?) ○ METRO is very active with a variety of different agencies and industry groups regionally, in Texas, and nationally. Their focus is on best practices, sharing challenges and lesson learned, collaborating with peers, funding opportunities, and more. Some organizations include: • Bimonthly "Team Houston" meetings • HGAC partnership • U of H (Students are even doing school projects and collaborating on transit.) • TSU (Students are even doing school projects and collaborating on transit.) • Texas Innovation Alliance – Engage on transit and policy issues; grant opportunities; Conference (to be held this month on October 27-29; Texas Innovation Alliance Home (txinnovationalliance.org))	
	▸ Are there public health- or environment-related metrics that drive future decisions and priorities? ○ Safety is Innovation's primary metric, which includes a variety of sub-sets, such as public health, security, personal data integrity, weather and disaster considerations, etc. ○ These metrics are both internal METRO metrics as well as external Federal metrics that are generally related to funding. ○ Other considerations in addition to Safety include: • Environment • Customer Service Metrics • Operational Metrics • Planning Metrics • Diversity ○ Innovation is interested in exploring ways to better manage the data that is generated within METRO in terms of pilot projects and what worked and what did not work. This is related to metrics, because there is not yet a consistent method for defining success. ▸ Ms. Gomez asked the Consultant Team how the Manual would be useful to departments within METRO? ○ Ms. Beard explained that the manual is intended to be a toolbox that provides Urban Design guidance for the range of facility types in METRO's network. It will be a highly visual manual for both external design professionals and for internal departments. At present, one of the largest questions remains who will be the stewards of urban design within METRO, with the emerging suggestions being that it is a join effort framework.	
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). ○ The Meeting was rated a 5 and Ms. Gomez noted her satisfaction with the meeting format and content. SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	

Item	Discussion	Follow-Up Actions (Responsibility/Date)
MISC		
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. o What are the "future-proofing" priority topics and strategies currently employed by METRO? o Is there interest in focusing our efforts on specific priority facilities or sites? Is there a future facility improvement priority list? o What are the project systems that can benefit from additional research/emphasis/support in the manual?(smart tech, lighting, autonomous bus fleets, interactive tech, case studies from other sunbelt cities, etc?,) o Are there specific technologies being integrated into METRO system currently? o Is there an inter-agency national forum/exchange on the topic of innovation that METRO prefers referencing and trusts? (NACTO, APTA, others?) o What is METRO's take on LEED, Envision, green energy conversion, carbon footprint reduction goals, other climate-friendly initiatives? o Are there environmental impact metrics/standards/goals that are incorporated or followed or planned to be introduced? o Are there public health related metrics that drive future decisions and priorities? (impact of pollution, activity, access to transit and mobility, etc.) o What transit technologies do you see on the horizon that new facilities should start making accommodations for to futureproof facilities design? o Is there a desire to pursue ENVISION certification or to incorporate ENVISION scoring for sustainable infrastructure?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO follow up input, if required.

METRO_FocusGroup_Innovation_20211006_PollEV_ExecSum

Current run (last updated Oct 6, 2021 12:18pm)

8	1	1	100%
Activities	Participants	Average responses	Average engagement

1. Are you connected to PollEverywhere?

Response options	Count	Percentage
1	**1**	**100%**

100% Engagement

1 Response

2. How would you greet everyone today?

Response options	Count	Percentage
Hi, how's it going?	**1**	**100%**
Howdy y'all.	0	0%
Psst. Is there any coffee at this thing?	0	0%
Wassup.	0	0%

100% Engagement

1 Response

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

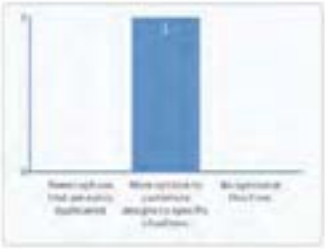
Responses

pedestrian friendly-multi-modal | integrated | work-health-safety

100%
Engagement

3
Responses

5. What level of detail should be included in the UD Manual?

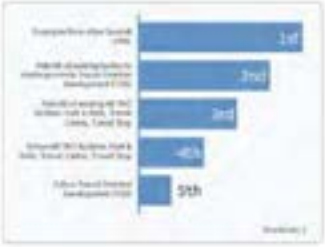


Response options	Count	Percentage
Fewer options that are easily duplicated.	0	0%
More options to customize designs to specific situations.	**1**	**100%**
No opinion at this time.	0	0%

100%
Engagement

1
Response

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

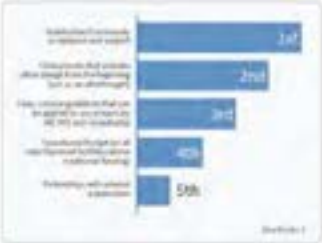


Response options	Rank
Examples from other Sunbelt cities.	1st
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	2nd
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	4th
Future Transit Oriented Development (TOD)	5th

100%
Engagement

1
Response

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Stakeholder/Community acceptance and support	1st
Clear process that includes urban design from the beginning (not as an afterthought)	2nd
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	3rd
Operational budget for all new/improved facilities (above traditional funding)	4th
Partnerships with external stakeholders	5th

100%
Engagement

1
Response

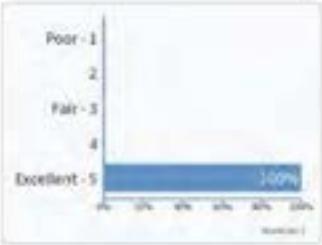
8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
Operations or Planning Department	0	0

100%
Engagement

1
Response

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	0	0%
Excellent - 5	**1**	**100%**

100%
Engagement

1
Response

Focus Group Meeting Notes and Online Poll Results

Safety and Security

METRO Safety & Security Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Chief Vera Bumpers, Santiago Osorio, Mohamed Boukhriss, Aubin Pickens (UD-PM) **SWA Team:** SWA, RDLR, CAS Group, Wateairth	**Meeting Date:** October 7,2021
Recorded By: J. Lindbom, N. Blumberg, & SWA Consultant Team	
Subject: METRO Safety & Security Focus Group	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

The following is intended to be an accurate summary of the meeting. If there are any comments/corrections, please notify the author(s) within 48 hours of receipt.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
1.0 Introduction & Objectives	SWA Team (N. Beard) presented the list of participants of the five scheduled METRO Focus Groups and explained the agenda and objectives of these meetings. She noted that the 35% Deliverable METRO Workshop is scheduled for 10/21/21 and that the SWA Team 50% submittal will be delivered soon after. SWA Team (J. Lindbom) led the participants through an online electronic polling exercise to test the platform (PollEverywhere), which was used at the meeting to collect participant ideas and input.	1. A copy of the PowerPoint used during the workshop is attached for reference. – Info 2. PollEverywhere results are attached to these meeting notes. – Info
2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location-specific) urban design elements being developed by the SWA Team. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? o The Focus Group was evenly split between "fewer options that are easily duplicated" and "more options to customize designs to specific situations."	
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO facilities. o Operational budget for all new/improved facilities was ranked first followed by Stakeholder/Community acceptance and support. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participants suggested planning, engineering, construction. **Topical Discussions** The SWA Team presented a series of specific questions for the participant's consideration: ▸ What are the specific safety and security concerns, practices, or equipment that need to be addressed in the UD Manual and the built environment? o Current / anticipated challenges • Most crimes are crimes of opportunity. Quick in, quick out. Targets include cellphone thefts, personal belongings. • Safety of METRO staff and security of their property is also a concern. • Difficulty dealing with homeless, displaced persons, and encampments. METRO is setting up an outreach unit to try to address the issue. • There is a trend toward "Ambassadors" versus traditional law enforcement. These Ambassadors are people from a community that are "friendlier" eyes and ears at facilities. Ambassadors or other METRO representatives can play multiple roles at facilities: security, provide directions, and help with issues/concerns. o Different onsite needs for different types of facilities • Select locations are very vulnerable. METRO tracks crime data on a monthly basis. Two facilities with high crime rates include Wheeler Transit Center and Northline Transit Center. Northline Transit Center is a "home base" where METRO Police are based and respond from. • Clear lines of site are important for patrons. Shrubbery cannot block lines of site.	3. METRO to provide crime data and/or list of most vulnerable facilities. 4. METRO to provide METRO Police district map. 5. METRO provide locations with highest number of pedestrian safety incidents (if available). 6. METRO mentioned Ava Travenio in Special Projects. A. Pickens: Is this a good contact for UD Project?

Item	Discussion	Follow-Up Actions (Responsibility/Date)
	• May be important to consider if there are schools or community centers/facilities near a transit stop and create clear lines of site from those facilities to the transit stop and provide easy access. Safety of children and elderly is important. • Lighting is very important (this was repeated multiple times). • Facilities near shopping have more foot traffic and are safer than stops that are more isolated. (Note this may lend itself to concept of TOD.) • In terms of safety, some bus stops are too close to the curb. • Park and Ride Lots are also subject to crime (e.g. catalytic converter theft). They are open 24 hours. There are issues with the entries/exits close to freeways where it's easy to make a quick getaway. METRO began limiting ingress/egress during non-peak hours by reducing the number of open gates. o Onsite security versus camera-based solutions • Cameras are typically used post-crime not to stop crime in progress as cameras are unmanned. There are no cameras at bus stops; rely on the bus cameras. • iPhone app immediately connects with dispatch, but not all patrons know about that option. Call boxes at some locations. • The need for guard booths has largely been eliminated once METRO began outsourcing security services to contractors. o First response • There were no specific observations with regards to emergency response except to reiterate the call boxes. o Vulnerable homeless population • Facilities cannot be so comfortable as to encourage homeless to stay / encamp. • Seating that does not allow people to lay down. • METRO is establishing a CARE Team to do outreach to homeless at METRO facilities. o Other Considerations • METRO's system covers 1,300 square miles and has 10,000 bus stops. It is a large	
	• Concerns about shelters becoming hangouts which creates a public nuisance and may frighten patrons. (e.g. narcotics activity at one location). • METRO provided a fairly thorough description of the crime reporting and response process. METRO has an MOU with Houston Police Department. Generally, if call is from METRO facility, HPD will roll it over to METRO Police. But, the focus is generally on providing the fastest response. METRO, HPD, and the counties have the same reporting systems. Routes with higher number of patrons get more patrols. There is a dedicated police force on foot for the LRV. There are also officers for the HOV lane. • Signage with emergency call information at METRO facilities. • METRO Police are able to work from their vehicles (MDT). It would be nice to have an office with a computer, but that is a want not a need. Restroom facilities for METRO Police and staff are a need. • N. Beard asked about pedestrian safety concerns and potential pedestrian, train, bus, car, conflict. METRO responded that it tracks pedestrian safety and separation of traffic; that there is a need to mitigate hazards; and they work with City of Houston to make enhancements. In addition, a "Plan Review Group" has been created in the last 1.5 years that does planning, engineering, & safety reviews. • METRO Police participate in law enforcement / transit industry groups. • Riding LRV without paying fares is a concern. • Participants noted that many of their concerns intersect with the scope of this project.	
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). o The Meeting was rated a 5 and Chief Bumpers noted her satisfaction with the meeting format and content. SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	

Item	Discussion	Follow-Up Actions (Responsibility/Date)
MISC		
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. o Older METRO facilities incorporate security booths, confirm that these design elements are no longer necessary and have been supplanted with camera-based solutions? o Describe some current Safety or Policing challenges that could be improved by modifications to the built urban design environment? o What are the security protocols for monitoring, patrolling, and providing first response for facilities' customers o What is the on-site security management for different facilities? o What are the specific security concerns/practices/equipment that need to be addressed in the UD manual? o What are the management strategies/practices around vulnerable homeless population?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO follow up input, if required.

METRO_Focus Group_Safety_20211007

Current run (last updated Oct 7, 2021 10:25am)

8	2	1	63%
Activities	Participants	Average responses	Average engagement

1. Are you connected to PollEverywhere?

Response options	Count	Percentage
1	**1**	**100%**

50% Engagement

1 Response

2. How would you greet everyone today?

Response options	Count	Percentage
Hi, how's it going?	**1**	**100%**
Howdy y'all.	0	0%
Psst. Is there any coffee at this thing?	0	0%
Wassup.	0	0%

50% Engagement

1 Response

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

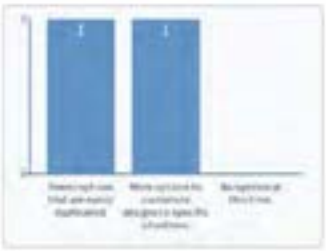
Responses

Employee/Patron feedback	Employee feedback

50%
Engagement

2
Responses

5. What level of detail should be included in the UD Manual?

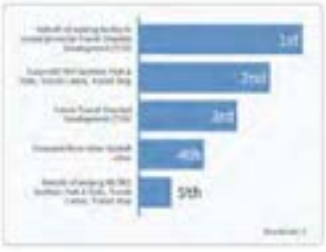


Response options	Count	Percentage
Fewer options that are easily duplicated.	**1**	**50%**
More options to customize designs to specific situations.	**1**	**50%**
No opinion at this time.	0	0%

100%
Engagement

2
Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

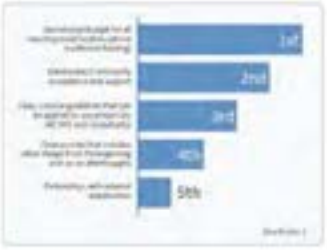


Response options	Rank
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	1st
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	2nd
Future Transit Oriented Development (TOD)	3rd
Examples from other Sunbelt cities.	4th
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	5th

50%
Engagement

1
Response

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Operational budget for all new/improved facilities (above traditional funding)	1st
Stakeholder/Community acceptance and support	2nd
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	3rd
Clear process that includes urban design from the beginning (not as an afterthought)	4th
Partnerships with external stakeholders	5th

100%
Engagement

2
Responses

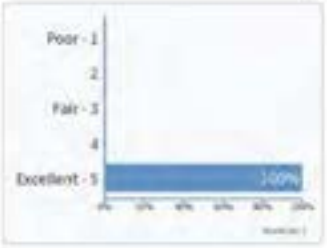
8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes

0%
Engagement

0
Responses

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	0	0%
Excellent - 5	**2**	**100%**

100%
Engagement

2
Responses

Focus Group Meeting Notes and Online Poll Results

Facilities and Operations

SWA Team | Prepared by CAS Group

METRO Facilities & Operations Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Arturo Jackson, Ken Luebeck, Kurt Luhrsen, Israel Garcia, Charles Berkshire, Aubin Pickens (UD-PM) **SWA Team:** SWA, RDLR, CAS Group, Wateairth	**Meeting Date:** October 7, 2021
Recorded By: J. Lindbom, N. Blumberg, & SWA Consultant Team	
Subject: METRO Facilities & Operations Focus Group	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

The following is intended to be an accurate summary of the meeting. If there are any comments/corrections, please notify the author(s) within 48 hours of receipt.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
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2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location-specific) urban design elements being developed by the SWA Team. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? o 60% of participants selected "No opinion at this time." ▸ Please rank case studies that would be most valuable to included in the UD manual?	
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO Facilities. o Clear process ranked first followed by clear, concise guidelines, and operational budget. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participants indicated there could be a partnership between Facilities & Engineering or that facilities maintenance could take ownership. **Topical Discussions** The SWA Team presented a series of specific questions for the participant's consideration: ▸ What maintenance and operational challenges could be improved through thoughtful urban design? Through processes? o Anything that delivers processes with defined outcomes. There needs to be consideration of storage requirements and operational budgets. The SAP System should be an asset and include defined maintenance and inspection frequencies. o Lack of process is a concern. Configuration Management should be incorporated. Example provided of METRO installing 20 miles of fencing. If Urban Design is a requirement of METRO Projects than it should be part of Configuration Management system. Definition below provided post-meeting by CAS Group: • *Configuration Management is the process of managing physical configurations and their supporting processes through documents, records and data. Formal processes requiring Configuration Management are frequently seen in "high tech" industries such as aero-space, and nuclear energy. As higher technology begins to play a major role in the transportation industry the need for Configuration Management processes becomes greater. Configuration Management is a process which is one that accommodates changes and perpetually documents how a physical system is configured. It also ensures that documents, records, and data remain concise and valid.* Source: Configuration Management	FTA (dot.gov)	3. METRO to schedule call with State of Good Repair group. – Completed.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO facilities. o Clear process ranked first followed by clear, concise guidelines, and operational budget. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participants indicated there could be a partnership between Facilities & Engineering or that facilities maintenance could take ownership. **Topical Discussions** The SWA Team presented a series of specific questions for the participant's consideration: ▸ What maintenance and operational challenges could be improved through thoughtful urban design? Through processes? o Anything that delivers processes with defined outcomes. There needs to be consideration of storage requirements and operational budgets. The SAP System should be an asset and include defined maintenance and inspection frequencies. o Lack of process is a concern. Configuration Management should be incorporated. Example provided of METRO installing 20 miles of fencing. If Urban Design is a requirement of METRO Projects than it should be part of Configuration Management system. Definition below provided post meeting by CAS Group: • *Configuration Management is the process of managing physical configurations and their supporting processes through documents, records and data. Formal processes requiring Configuration Management are frequently seen in "high tech" industries such as aero-space, and nuclear energy. As higher technology begins to play a major role in the transportation industry the need for Configuration Management processes becomes greater. Configuration Management is a process which is one that accommodates changes and perpetually documents how a physical system is configured. It also ensures that documents, records, and data remain concise and valid.* Source: Configuration Management	FTA (dot.gov)	3. METRO to schedule call with State of Good Repair group. – Completed.
	o Concern raised that many planning and design teams are not transit riders nor have they been involved in the operations of a facility. Lack of understanding of customer requirements and experience. For example, the Northwest Transit center lacks a covered pedestrian connection within the facility. There is the need to have good lighting to help customers feel safe. o There are operational issues that are not adequately addressed in planning, design and construction. This has both a level of service and cost impact. For example, if buses have to wait (e.g. because there are not enough bays) this reduces speed on the routes and may increase the need for additional buses, which have an estimated $250,000/year operational cost. Layouts should be optimized for operational efficiency and should also take into account anticipated future requirements. For example, the length of future buses. It repeatedly happens that anticipated future requirements are eliminated from the design of facilities. o Safety and security of METRO personnel is important. There are blind spots for cameras. Landscaping that allows people to hide. ▸ What are the guideline components critical to successful operations and maintenance? o Landscaping needs to be properly designed. "Nothing looks worse than dead landscaping." Minimal type of landscaping that does not require significant labor or water. Maintenance is done by a combination of METRO staff and contract staff, which can impact quality of maintenance. o There should be a reasonable lifespan for products / materials that are selected and installed. Often times, lower cost and lower quality products/materials are selected and do not even live up to their planned lifespan and are replaced early, which defeats the purpose of selecting a lower cost product to achieve cost savings. ▸ Is there a monitoring/inspection program that evaluates the state of facilities overtime? What is addressed? o METRO noted that it would be important to reach out to the State of Good Repair group at METRO. They catalogue METRO's significant assets and document when significant maintenance or repair is necessary. ▸ What transit technologies are on the horizon that METRO should start making accommodations for to futureproof facilities design? o It is important to anticipate changes to the customer base, which may be getting older and have mobility challenges.	

Item	Discussion	Follow-Up Actions (Responsibility/Date)
	○ It is necessary to consider climate in design particularly heat, hottest time of day, and direction of the sun. There are shelters that do little to protect riders from the sun. ○ Technology needs for the future. • Customers may require additional charging ports for personal devices. • E/V charging for customer vehicles. • METRO may want to install conduits and fiber during construction of facilities even if they are not required immediately. • Electric Buses and A/V may need to have "opportunity" charging stations at METRO facilities throughout the network due to both the length of many routes and the average working range of electric vehicles. It is unclear if electric buses currently available can handle the length of many of METRO's routes. • Transit Centers and/or Park & Rides may need to incorporate communications facilities for A/V technology and sensors. • Explore the possibility of incorporating solar power generation into design, particularly at Park & Rides, where solar panels can also serve as shade structures. Power generated can serve METRO facility or be sold to the grid to create net reduction in energy costs. ○ Discussion of whether case studies from abroad will be considered. SWA Team responded that most case studies will be US-based since the applicable regulations, development patterns, and funding sources are generally different between foreign and local jurisdictions. ○ Emphasis on what is practical, productive, and efficient. Things do not necessarily need to be innovative if they have been tested and work well.	
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). ○ The Meeting was rated a 5 by all participants. SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. ○ What transit technologies do you see on the horizon that new facilities should start making accommodations for to futureproof facilities design? ○ What maintenance and operational challenges could be improved through thoughtful urban design? ○ What are the percentages of facility maintenance internal to METRO v. under different parties? ○ How is the life-cycle funding approached in the design of facilities? ○ What are the guideline components critical to successful operations and maintenance? (materials matrices, details, cost estimates? etc.) ○ Is there a monitoring/inspection program that evaluates the state of facilities overtime? ○ What are the basis of focusing maintenance services and planning for them in the future? ○ Are there specific facility elements (end of line comfort stations, technology components, drainage infra, etc.) that are being reimagined/downsized/eliminated for easier O&M in the future? ○ How are the design speeds around the facilities being evaluated for safe accommodation of ped and bike traffic and access? ○ Fewer options that are easily duplicated to reduce maintenance? ○ More options to customize designs to specific situations? ○ Is landscape and/or stormwater maintenance done in-house or by vendors/contractors? If outside METRO, how are they selected, contracted, and trained? ○ What are the top concerns for landscape/stormwater infrastructure O&M? ○ What design elements or considerations are most important for streamlining O&M, especially related to green infrastructure and stormwater management?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO follow up input, if required.

METRO_FG_PollEv_Fac&Ops_ExecSum_20211007

Current run (last updated Oct 11, 2021 12:26pm)

10	5	4	68%
Activities	Participants	Average responses	Average engagement

1. Are you connected to PollEverywhere?

Response options

Count	Percentage
2	**100%**

40% Engagement

2 Responses

2. How would you greet everyone today?

Response options	Count	Percentage
Hi, how's it going?	**1**	**33%**
Howdy y'all.	**1**	**33%**
Psst. Is there any coffee at this thing?	0	0%
Wassup.	**1**	**33%**

60% Engagement

3 Responses

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

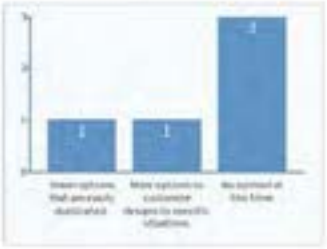
Responses

Positive impact on ridership including a cross-section of riders-positive feedback from riders, community, business partners- employee feedback
User -friendly
Positive impact on ridership including a cross-section of riders-positive feedback from riders, community, business partners- employee feedback
The-complete-safety-management-system-process-is-followed-starting-with-a-preliminary-hazard-analysis-and-carried-through-to-a-complete-hazard-verifcation-matrix-nd-the-other-SMS-steps-carried-through-for-the-life-of-the-project.
functional attractive accessible maintainable
Positive-feedback

100%
Engagement

6
Responses

5. What level of detail should be included in the UD Manual?

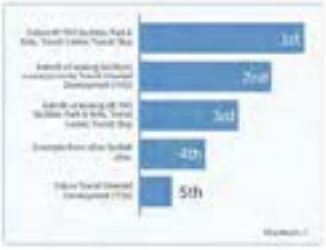


Response options	Count	Percentage
Fewer options that are easily duplicated.	1	20%
More options to customize designs to specific situations.	1	20%
No opinion at this time.	**3**	**60%**

100%
Engagement

5
Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

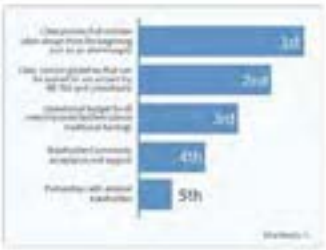


Response options	Rank
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	1st
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	2nd
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Examples from other Sunbelt cities.	4th
Future Transit Oriented Development (TOD)	5th

100%
Engagement

5
Responses

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Clear process that includes urban design from the beginning (not as an afterthought)	1st
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	2nd
Operational budget for all new/improved facilities (above traditional funding)	3rd
Stakeholder/Community acceptance and support	4th
Partnerships with external stakeholders	5th

100%
Engagement

5
Responses

8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
Partnership-Facilities-Engineering	0	0
Facilities maintenance	0	0

40%
Engagement

2
Responses

9. Do you have any additional input, ideas, or insights to share?

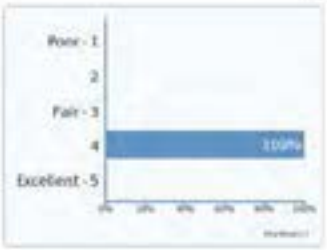
Responses

No

20%
Engagement

1
Response

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	**4**	**100%**
Excellent - 5	0	0%

80%
Engagement

4
Responses

What maintenance and operational challenges could be improved through thoughtful urban design?

Responses

Overall efficiency | Timeliness of service

40%
Engagement

2
Responses

Focus Group Meeting Notes and Online Poll Results

Facilities Maintenance and State of Good Repair

SWA Team | Prepared by CAS Group

METRO Facilities Maintenance & State of Good Repair Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Frank Cordero, Alexi Miller, Miguel Zavala, Aubin Pickens (UD PM) **SWA Team:** SWA, RDLR, CAS Group, Watearth	**Meeting Date:** 10/14/2021
Recorded By: J. Lindbom & SWA Team	
Subject: METRO Maintenance & State of Good Repair	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

The following is intended to be an accurate summary of the meeting. If there are any comments/corrections, please notify the author(s) within 48 hours of receipt.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
1.0 Introduction & Objectives	SWA Team (N. Beard) presented the list participants of the original five scheduled METRO Focus Groups and explained the agenda and objectives of these meetings. She noted that the 35% Deliverable METRO Workshop is scheduled for 10/21/21 and that the SWA Team 50% submittal will be delivered soon after. SWA Team (J. Lindbom) led the participants through an online electronic polling exercise to test the platform (PollEverywhere), which was used at the meeting to collect participant ideas and input.	1. A copy of the PowerPoint used during the workshop is attached for reference. – Info 2. PollEverywhere results are attached to these meeting notes. – Info
2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location-specific) urban design elements being developed by the SWA Team. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? o All participants selected: Fewer options that are easily duplicated. ▸ Please rank case studies that would be most valuable to included in the UD manual? o Retrofit options ranked as the top two.	
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO Facilities. o Operational budget for all new/improved facilities was ranked first followed by clear concise guidelines that can be applied to any project and clear process ranked third. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participants indicated PDC or Planning. Specifically they named Aubin Pickens as the point of contact. **Topical Discussions** The SWA Team presented a series of specific questions for the participant's consideration: ▸ What maintenance and operational challenges could be improved through thoughtful urban design? Through processes? o It's important to have items that are easily available to maintain and keep looking nice. No customized designs. Need to have items that are easily repaired without having to replace. Simplistic designs. Items that can be sourced from local vendors. o Standardization and "Plug and play" assets would be useful. For example, standardize signage (e.g. multiple sizes of stop signs currently, which makes complicates supply inventory and replacement). o Maintenance is not just related to age, but issues of vandalism, people sleeping on amenities, vehicles hitting objects, etc. Elements with a short shelf life include: Shelters, pavement, roadways, signage (damaged, stolen, faded), striping. Trash cans and benches usually fair relatively well. o Operating budget is a concern. Maintenance ability is based on the annual budget. Federal funds are not typically used for maintenance. This is particularly the case if repair/replacement cannot conform to "buy American" requirement. o Recognition that maintenance is connected to branding. o Irrigation has traditionally been a challenge. METRO is making its first irrigation technician hire to begin to address this concern as irrigation is turned off at many locations. Major repairs often result in damaging irrigation systems. METRO is open to long term irrigation,	3. A. Pickens consider inviting Environmental Point of Contact to participate (Miriam).

Item	Discussion	Follow-Up Actions (Responsibility/Date)
	plantings for green infrastructure, climate appropriate landscaping. J. Walker questioned if METRO would be open to pre-qualifying vendors. METRO is interested, but currently is will all come down to cost. Bigger budget would be needed to secure a higher-grade vendor. o In terms of stormwater management, there were no issues noted by METRO. They did say that stormwater is managed through retention ponds; ½ are concrete and ½ are grass. J. Walker asked if METRO would be open to using local grasses that might require less frequent mowing. METRO is interested. METRO also suggested contacting Miriam who is METRO's environmental point person. ▸ What are the guideline components critical to successful operations and maintenance? o Facilities Maintenance is usually an afterthought after all the decisions have been made. They would like to be included in decisions about materials and finishes before the planning and design process moves to far. o In terms of the design of the facilities themselves, METRO suggested the following: • Breakrooms for bus operators. They are often incorporated after the fact, which is problematic. • Protected/shaded seating area for employees separate from patrons. • Avoid hidden spaces where people can sleep or relieve themselves or create security risk (e.g. Ticket Vending Machine (TVM) was placed in a way that created hidden spaces). • Area for MPD (e.g. new Northwest Transit Center has no MPD space so officers have to do paperwork in their vehicles) • Storage for cleaners – They usually wind up putting cleaning supplies and other supplies in the mechanical / electrical room because there is no dedicated space • Provide final as-builts – Designs should be provided to relevant departments. Provide all OEM data, manuals, etc. Document control and receiving all materials during commissioning is an issue. • Bus parking spacings during bus operator breaks. • Would like to have camera systems to see properties from all locations, particularly locations farther away from central offices. Currently, cameras are static, cannot zoom in or out, there are blind spots. Currently, high level of security to access camera footage so access is challenging to verify issues (even if the camera captures the issue).	
	• "Relieve the relief problem." The 1st METRO public bathroom was implemented at Northwest Transit Center. It is only open when the transit ride store is open and closes to the public at 5 PM. The bathroom at Burnett is self-cleaning (and perhaps a standalone unit). METRO staff supports the inclusion of public bathrooms at METRO facilities. People will relieve themselves whether there is a bathroom or not. ▸ Is there a monitoring/inspection program that evaluates the state of facilities overtime? What is addressed? o METRO uses a variety of avenues to gather information about facility condition. They do visual inspections, monthly PM, and street supervisors report when there are maintenance concerns. o When vandalism is involved, this is reported to METRO Police Department. ▸ What transit technologies are on the horizon that METRO should start making accommodations for to futureproof facilities design? o Controls Monitoring. METRO is undertaking large energy efficiency program (e.g. HVAC replacement). Looking to save energy with more efficient equipment. METRO would like to monitor schedules of equipment so they don't need to run 24/7. It would be valuable to have monitoring meters at METRO facilities with a central dashboard. o With transition to more E/V, METRO will need to hire team members with those specific capabilities / expertise to maintain those assets.	
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). o The Meeting was rated a 5 by all participants. SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	

Item	Discussion	Follow-Up Actions (Responsibility/Date)
MISC		
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. o What transit technologies do you see on the horizon that new facilities should start making accommodations for to futureproof facilities design? o What maintenance and operational challenges could be improved through thoughtful urban design? o What are the percentages of facility maintenance internal to METRO v. under different parties? o How is the life-cycle funding approached in the design of facilities? o What are the guideline components critical to successful operations and maintenance? (materials matrices, details, cost estimates? etc.) o Is there a monitoring/inspection program that evaluates the state of facilities overtime? o What are the basis of focusing maintenance services and planning for them in the future? o Are there specific facility elements (end of line comfort stations, technology components, drainage infra, etc.) that are being reimagined/downsized/eliminated for easier O&M in the future? o How are the design speeds around the facilities being evaluated for safe accommodation of ped and bike traffic and access? o Fewer options that are easily duplicated to reduce maintenance? o More options to customize designs to specific situations? o Is landscape and/or stormwater maintenance done in-house or by vendors/contractors? If outside METRO, how are they selected, contracted, and trained? o What are the top concerns for landscape/stormwater infrastructure O&M? o What design elements or considerations are most important for streamlining O&M, especially related to green infrastructure and stormwater management?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO follow up input, if required.

O&M_Part II_PollEv_ExecSum_20211014

Current run (last updated Oct 14, 2021 1:37pm)

8	3	3	96%
Activities	Participants	Average responses	Average engagement

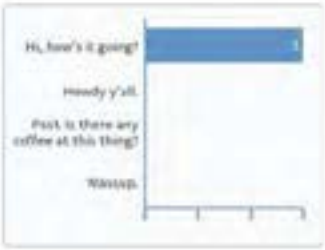
1. Are you connected to PollEverywhere?

Response options	Count	Percentage
	3	**100%**

100% Engagement

3 Responses

2. How would you greet everyone today?



Response options	Count	Percentage
Hi, how's it going?	**3**	**100%**
Howdy y'all.	0	0%
Psst. Is there any coffee at this thing?	0	0%
Wassup.	0	0%

100% Engagement

3 Responses

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

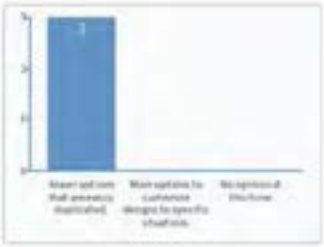
Responses

- longer-asset-service-life
- Functional-but-sustainable-and-easy-to-maintain
- awards-for-planning-department
- fewer-complaints
- Higher-ridership
- comfort-safe-welcoming-exciting-new-beauty

100% Engagement

6 Responses

5. What level of detail should be included in the UD Manual?

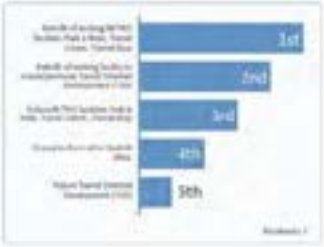


Response options	Count	Percentage
Fewer options that are easily duplicated.	**3**	**100%**
More options to customize designs to specific situations.	0	0%
No opinion at this time.	0	0%

100% Engagement

3 Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).

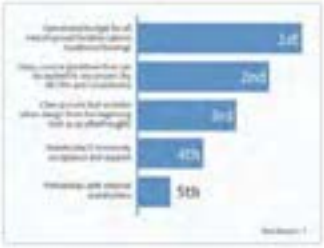


Response options	Rank
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	1st
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	2nd
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Examples from other Sunbelt cities.	4th
Future Transit Oriented Development (TOD)	5th

100% Engagement

3 Responses

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.



Response options	Rank
Operational budget for all new/improved facilities (above traditional funding)	1st
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	2nd
Clear process that includes urban design from the beginning (not as an afterthought)	3rd
Stakeholder/Community acceptance and support	4th
Partnerships with external stakeholders	5th

100% Engagement

3 Responses

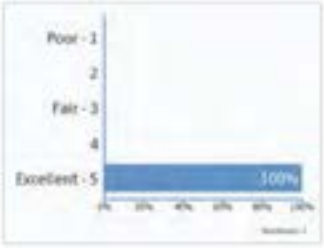
8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
PEC	2	0
Planning	0	0

67% Engagement

2 Responses

10. On a scale of 1-5, how would you rate today's meeting?



Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	0	0%
Excellent - 5	**3**	**100%**

100% Engagement

3 Responses

Focus Group Meeting Notes and Online Poll Results

IT and Environment

METRO IT & Environment Focus Group Meeting Notes

Attendees / Affiliation: **METRO:** Miriam Barranco, Randy Frazier, Aubin Pickens (UD PM) **SWA Team:** SWA, RDLR, CAS Group, Watearth	**Meeting Date:** October 15, 2021
Recorded By: J. Lindbom, N. Blumberg, & SWA Consultant Team	
Subject: METRO IT & Environment Focus Group	
Meeting Objective(s): (1) Solicit guidance on preferred form and content of the urban design manual. (2) Gain insights on achieving urban design goals in project delivery and over the lifespan of facilities. (3) Listening session for ideas, concerns, or considerations	

The following is intended to be an accurate summary of the meeting. If there are any comments/corrections, please notify the author(s) within 48 hours of receipt.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
1.0 Introduction & Objectives	SWA Team (N. Beard) presented the participants of the five scheduled METRO Focus Groups and explained the agenda and objectives of these meetings. She noted that the 35% Deliverable METRO Workshop is scheduled for 10/21/21 and that the SWA Team 50% submittal will be delivered soon after. SWA Team (J. Lindbom) led the participants through an online electronic polling exercise to test the platform (PollEverywhere), which was used at the meeting to collect participant ideas and input.	1. A copy of the PowerPoint used during the workshop is attached for reference. – Info 2. PollEverywhere results are attached to these meeting notes for each individual Focus Group. – Info
2.0 Establishing the UD Manual Track	SWA Team (N. Beard) reviewed the scope of the Transit Urban Design Guidelines Project in brief referencing the recently completed METRO Transit Design Guidelines (December 2019) in which Chapter 7 is dedicated to Transit Environment Design Resources (the focus of this current project). The Project Management Process – per the METRO PM manual – was shared. N. Beard discussed the emerging Macro (regional) and Micro (location specific) urban design elements being developed by the SWA Team. Focus Group participants from METRO were polled on the type of material they would like to see included in the UD Manual, including: ▸ What level of detail should be included in the UD manual? o Fewer options that are easily duplicated. ▸ Please rank case studies that would be most valuable to included in the UD manual? o The top ranked idea was Retrofit of existing facility to create/promote Transit Oriented Development and second was Future METRO facilities (Park & Ride, Transit Center, Transit Stop), followed by future TOD.	
3.0 Input & Insights	This portion of the meeting was divided into two sections. **The Big Picture & Topical Discussions** ▸ The SWA Team presented a slide with photographs of more and less successful urban design elements at existing METRO facilities. Participants were asked to consider what was key to successful examples and what factors influenced the lower quality examples. ▸ A ranking exercise was conducted on what considerations were most important to delivering high quality urban design for METRO Facilities. o Stakeholder/community acceptance and support was ranked first followed by clear concise guidelines in second, and clear process that includes urban design from the beginning (not as an afterthought) in third place. ▸ A polling question and discussion was conducted regarding what METRO department could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development. o Participants indicated that it is responsibility of Planning-Engineering-Construction. **Topical Discussions** The SWA Team presented a series of specific questions for the participants consideration: ▸ What transit technologies are being integrated or on the horizon that new facilities should make accommodations for to future-proof facilities design? o There was an extensive discussion of new fuel supplies which require new infrastructure. METRO already has some buses that utilize CNG, which requires appropriate suppliers. In terms of E/V, there are 20 new E/V buses coming to METRO. o There was discussion of issues related to E/V buses including the length of the routes and ability for buses to complete routes on a charge, need for charging stations / lay over spaces on routes, the high power usage of heaters on the buses in cold weather, and ability to charge buses during power outages. The backup would be to use diesel generators to charge buses in case of a disaster affecting the power network, but that may undermine the goals of E/V bus emissions reductions. o A/V is too new a technology to be considered a reality for METRO in the near future. There are considerable safety considerations that will need to be tested/addressed before it can be adopted.	3. M. Barranco interested to explore oil/water separators.

Item	Discussion	Follow-Up Actions (Responsibility/Date)
	○ Realtime passenger information technology / alerts are being deployed throughout the METRO network. In the next 6-7 years, more than 3,000 signs will be installed at METRO facilities (Park & Ride, New BRT, Transit Center, and Light Rail). Signs are ADA compliant. In addition to providing transit info, it is possible to transmit safety broadcasts to all these signs. ○ In terms of Wi-Fi, METRO will provide it on its vehicles since that is where their patrons spend the majority of their time. They will only provide Wi-Fi at facilities for staff since patrons are not typically there for an extended period of time and because public Wi-Fi could attract "bad elements." ○ The need / plans for ticket vending machines (TVM) is not settled as METRO has not decided if it will go completely cashless. ○ It is preferable to include conduits for electrical and data in facilities. It is easy and relatively inexpensive to install extra conduit (without the power or fiber) during construction than to retrofit at a later date. It is also preferable to plan ahead and have the ability to expand electrical capacity at METRO facilities. The example of "dark fiber" was discussed where additional fiber is installed before roads are laid as it is easier to install in advance than to disrupt the road network. ▸ Who is METRO champion / POC for environment? (LEED, ENVISION, Carbon footprint reduction, etc.) What is METRO's approach to sustainable infrastructure (ENVISION certification or scoring)? ○ FTA is pushing LEED, but there is no METRO policy yet. ○ J. Walker explained that ENVISION is for infrastructure (not buildings). ○ METRO Next is to address more environmental considerations. An important issue is Air Quality, which is part of planning and coordinated with H-GAC. ○ In terms of METRO stormwater management, the focus is on flood control not environmental. Miriam noted the potential importance of oil/water separators and will take action to explore.	
4.0 Closing & Next Steps	SWA Team asked participants to rate the meeting on a scale of 1 (Poor) to 5 (Excellent). ○ The participants ranked the meeting a 5. SWA Team briefly explained next steps in terms of the upcoming 35% workshop and 50% deliverable. Meeting was adjourned.	
Inventory of Topical Questions	Listed below are the questions / prompts that were developed by the SWA Team in advance of the Focus Group meeting. They are listed here for reference of both the consultant team and METRO as there was not sufficient time to address all the questions or clarifications identified by the consultants. These are questions that may need to be addressed moving forward. 1. Innovation a. What transit technologies are being integrated or on the horizon that new facilities should make accommodations for to future-proof facilities design? b. Is there an inter-agency national forum/exchange on the topic of innovation that METRO prefers referencing and trusts? (NACTO, APTA, others?) c. What are the project systems that can benefit from additional research/emphasis in the UD manual? (e.g. smart tech, lighting, autonomous bus fleets, etc.) d. Are there public health- or environment-related metrics that drive future decisions and priorities? 2. Environment/Sustainability a. Who is METRO champion / POC for environment? (LEED, ENVISION, Carbon footprint reduction, etc.) b. What is METRO's approach to sustainable infrastructure (ENVISION certification or scoring)? c. Is there specific guidance or objectives in terms of green infrastructure and stormwater management? d. Are there public health- or environment-related metrics that drive future decisions and priorities?	SWA Team to determine what critical questions remain unanswered and coordinate with A. Pickens to arrange method to solicit METRO input.

METRO_FG_IT & Env_20211015

Current run (last updated Oct 15, 2021 2:09pm)

8	2	2	94%
Activities	Participants	Average responses	Average engagement

1. Are you connected to PollEverywhere?

Response options	Count	Percentage
2	**2**	**100%**

100%
Engagement

2
Responses

2. How would you greet everyone today?

Response options	Count	Percentage
Hi, how's it going?	**1**	**50%**
Howdy y'all.	**1**	**50%**
Psst. Is there any coffee at this thing?	0	0%
Wassup.	0	0%

100%
Engagement

2
Responses

4. How will METRO know it has achieved high quality urban design of its facilities? (Connect-words-with-dashes.)

Image not loaded

Responses

well-designed-facilities reflects-publics-expectations thoughtful easy-to-use easy-to-support

The-evidence-of-a-developed-country-is-not-that-everyone-has-a-car-it-is-that-everyone-uses-public-transportation.

100% Engagement

2 Responses

5. What level of detail should be included in the UD Manual?

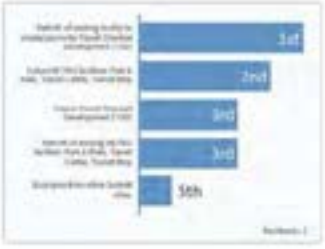
Image not loaded

Response options	Count	Percentage
Fewer options that are easily duplicated.	**2**	**100%**
More options to customize designs to specific situations.	0	0%
No opinion at this time.	0	0%

100% Engagement

2 Responses

6. Please rank case studies that would be valuable to include in the UD Manual (from most to least valuable).



Response options	Rank
Retrofit of existing facility to create/promote Transit Oriented Development (TOD)	1st
Future METRO facilities: Park & Ride, Transit Center, Transit Stop	2nd
Future Transit Oriented Development (TOD)	3rd
Retrofit of existing METRO facilities: Park & Ride, Transit Center, Transit Stop	3rd
Examples from other Sunbelt cities.	5th

100% Engagement

2 Responses

7. Please rank the following in terms of importance to delivering high quality urban design for METRO facilities.

Response options	Rank
Stakeholder/Community acceptance and support	1st
Clear, concise guidelines that can be applied to any project (by METRO and consultants)	2nd
Clear process that includes urban design from the beginning (not as an afterthought)	2nd
Partnerships with external stakeholders	4th
Operational budget for all new/improved facilities (above traditional funding)	5th

Engagement

2

Responses

8. What department(s) could take ownership of METRO's Urban Design Manual to ensure a high standard for quality development? (Please also indicate role.)

Responses	Upvotes	Downvotes
Planning/Engineering/Construction	0	0

Engagement

1

Response

10. On a scale of 1-5, how would you rate today's meeting?

Response options	Count	Percentage
Poor - 1	0	0%
2	0	0%
Fair - 3	0	0%
4	0	0%
Excellent - 5	**2**	**100%**

Engagement

2

Responses

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Glossary & References

The next pages of the Urban Design Manual contain abbreviations, definitions, and references. The references include attribution as well as additional resources that will be useful to the user.

Glossary & Abbreviations

AASHTO
(abbreviation):
American Association of State Highway and Transportation Officials.

ACTIVE TRANSPORTATION
(adjective / noun):
Active transportation is any human-powered mode of transportation, such as walking, biking, riding a scooter or roller blading when traveling from one place to another. Active transportation helps increase physical activity and prevent chronic disease outcomes.

ADA
(abbreviation):
Refers to standards for design that uphold the *Americans with Disabilities Act of 1990* and all the amendments since in order to create accessible spaces.

ADAAG
(abbreviation):
Americans with Disabilities Act of 1990 Accessibility Guidelines– nationally regulated guidelines for accessibility (see ADA).

AMA
(abbreviation):
American Medical Association.

APTA
(abbreviation):
American Public Transportation Association.

BOOST
(abbreviation):
Bus Operations Optimized System– METRO program that 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.

BMP / BMPs
(abbreviation):
Best Management Practices– a combination of proven sustainable design and management practices proven to prevent water pollution, prevent soil erosion, promote stormwater infiltration, improve accessibility, and reduce flooding (see LID)

BRT
(abbreviation):
Bus Rapid Transit–a high capacity bus system (METRORapid) with dedicated lanes and upgraded stations that provides a similar experience and efficiency to an LRT line.

COH
(abbreviation):
City of Houston

CPTED
(abbreviation):
Crime Prevention Through Environmental Design– a multi-disciplinary approach to crime prevention that uses urban and architectural design and the management of built and natural environments.

DOT
(abbreviation):
Department of Transportation

EASEMENT
(noun):
A legal right to use someone else's land for public or private purposes.

EMPIRICAL EVIDENCE
(adjective / noun):
Factual data originating in or based on direct observation or experience.

FHWA
(abbreviation):
Federal Highway Administration

H-GAC
(abbreviation):
Houston-Galveston Area Council

GSI
(abbreviation):
Green Stormwater Infrastructure—the range of measures that use plant or soil systems, permeable surfaces, stormwater harvest and reuse, infiltrate or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters.

IBC
(abbreviation):
International Building Council

IDM
(abbreviation):
City of Houston Infrastructure Design Manual

JD
(abbreviation):
Joint-Development—the simultaneous improvement of a transit system and the surrounding real estate coordinated between METRO and real estate developers or other public / private entities.

LID
(abbreviation):
Low Impact Development—refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat.

LRT
(abbreviation):
Light Rail Train— (METRORail) rapid transit that operates electric-powered single cars or short trains on fixed rails.

FOOTPRINT
(noun):
The cumulative area occupied or affected by something (may be continuous or non-continuous).

MICRO-MOBILITY
(noun):
Transportation using lightweight vehicles such as bicycles, skateboards, electric scooters, hoverboards, and electric skateboards with operating speeds typically below 25 KM/H.

MIXED-USE DEVELOPMENT
(adjective / noun):
Developments that incorporate two or more uses into the same building, or in the same general area and is typically characterized as walkable and pedestrian-friendly, offering more chances to live, work, and shop in a single area and reducing dependence on car travel.

MTFP
(abbreviation):
City of Houston Major Thoroughfare & Freeway Plan

Glossary & Abbreviations

MULTI-MODAL
(adjective):
Having or using a variety of modes or methods to travel within the pedestrian realm – physical space for pedestrian activity, buffering from vehicular and bicycle traffic along the street, and space for shade and other elements that affect pedestrian comfort.

MUTCD
(abbreviation):
The Manual on Uniform Traffic Control Devices for Streets and Highways– a document issued by the Federal Highway Administration of the United States Department of Transportation to specify the standards by which traffic signs, road surface markings, and signals are designed, installed, and used.

NACTO
(abbreviation):
The National Association of City Transportation Officials– a coalition of the Departments of Transportation in North American cities that have participated in a number of research initiatives dealing with surface transportation in urban areas.

PEDESTRIAN REALM
(noun):
Portion of streetscape or facility dedicated to pedestrian travel.

PEDESTRIAN TRAVELWAY
(noun):
Primary accessible pedestrian route.

PUBLIC REALM
(noun):
Any publicly owned streets, pathways, right of ways, parks, publicly accessible open spaces, and any public and civic building and facilities.

RETROFIT
(verb):
The addition of new components or features to older systems.

SCALAR
(adjective):
Dependent on scale of study.

SETBACK
(noun):
The minimum distance at which a building or other structure must be set back from a street or road, a river or other stream, or any place which is deemed to need protection.

SOCIAL EQUITY
(noun):
The fair, just, and equitable distribution of public services, and implementation of public policy; and the commitment to promote fairness, justice and equity in the formation of public policy.

SPATIAL
(adjective):
Relating to or occupying space.

TDLR
(abbreviation):
Texas Department of Licensing and Regulation

TOD

(abbreviation):

Transit Oriented Development—Urban development patterns that maximize the amount of residential, business and leisure space within walking distance of public transit.

TRAFFIC CALMING

(noun):

The physical design and other measures put in place on existing roads to reduce vehicle speeds and improve safety for pedestrians and cyclists.

TRANSIT CORRIDOR

(noun):

Corridors are served by light rail (LRT), streetcar, and bus rapid transit (BRT), while fostering a pedestrian scale in which walking and biking actively complement public transit. Transit corridors also promote economic development around high-quality transit service.

TRANSIT ENVIRONMENT

(noun):

A predominantly multi-modal space designed to prioritize a high level of comfort for people and accessibility to public transportation.

TXDOT

(abbreviation):

Texas Department of Transportation

URBAN DESIGN

(noun):

urban design is an interdisciplinary approach to creating the look, feel, and function of public spaces.

URBAN FABRIC

(noun):

The physical characteristics of urban areas, that is, cities, and towns including streetscapes, buildings, soft and hard landscaping, signage, lighting, roads and other infrastructure.

UDM

(abbreviation):

Houston METRO Urban Design Manual

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