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Bus Rapid Transit Working Group

Bus Rapid Transit Stations

Abstract: This recommended practice provides guidance for planning and designing stations for bus rapid transit systems.

Keywords: BRT, Basic BRT, bus rapid transit, Premium BRT, station, stop, platform, transit center, transit-oriented development, TOD

Summary: Bus rapid transit (BRT) service creates a premium rapid transit experience using rubber-tired vehicles. The station is one of the elements of BRT service that serves to distinguish it from other bus services. This document provides a set of recommended practices for planning, design and development of BRT stations for planners, transit agencies, local governments, developers and others interested in developing new, or enhancing existing, BRT systems.

This document is part of a suite of recommended practices covering the key elements that comprise BRT service. Because BRT elements perform best when working together as a system, this document may reference others in this series of recommended practices. Users of this document are advised to review all guidance documents to better understand how different BRT elements are interrelated in delivering a high impact transit project.

Scope and purpose: The recommended practice provides guidance for the planning and development of BRT stations. The document provides guidance for design and implementation of BRT stations (covering station elements and considerations for the overall station area) and on dimensions and layouts of BRT stations (including elements such as curb height, platform width, etc). This document does not review aspects of stations that are universally applicable to other public transportation service as well as BRT systems.

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Introduction

This introduction is not part of APTA BTS-BRT-RP-002-10, Rev 1, "Bus Rapid Transit Stations."

Bus rapid transit (BRT) consists of a suite of elements that create a high-quality rapid transit experience using rubber-tired vehicles. This experience often includes a high degree of performance (especially speed and reliability), ease of use, careful attention to aesthetics, and comprehensive planning that includes associated land uses. BRT seeks to meet or exceed these characteristics through the careful application of selected elements.

This recommended practice, *Bus Rapid Transit Stations*, is intended to provide guidance for the planning and design of a BRT station. This document has been organized into two primary sections: "General Guidelines for Design and Implementation of BRT Stations," and "BRT Stations Dimensions and Layout." The first section focuses on the station elements and considerations that should be incorporated and/or considered for a BRT station area (architectural elements, station amenities, location criteria, way-finding, etc.). The second section focuses on the physical design of the station elements: geometry (curb height, shelter length, platform width, etc.), preferred best practices and recommended minimums, decision matrices, and design process flow chart.

APTA recommends the use of this document by:

- individuals or organizations that plan, design, build and/or operate bus rapid transit systems and those that are considering doing so;
- individuals or organizations that contract with others to plan, design, build and/or operate bus rapid transit systems; and
- individuals or organizations that influence how bus rapid transit systems are planned, designed, built and/or operated.

This recommended practice is one in a suite of BRT recommended practices published by APTA; the full list can be found under "Related APTA Standards".

Bus Rapid Transit Stations

GENERAL GUIDELINES FOR DESIGN AND IMPLEMENTATION OF BRT STATIONS

1. The role of stations

Stations play a key role in defining a BRT system and reinforcing the riders' premium transit experience. As stations are often the first and last impression of the BRT experience, it is important to strategically design the stations for ease of flow and access and to locate the stations conveniently along the route. For purposes of this document, the station includes the platform, the structure or shelter, and all the featured amenities associated with the station including but not limited to, real-time passenger information, trash receptacles, bike parking, lighting and signage.

BRT is a premium form of bus transit that should provide an enhanced transit experience. To reinforce this premium experience, BRT stations shall, at a minimum, incorporate the following characteristics and amenities:

- Facilitate improved route speeds
- Universal accessibility
- Be welcoming and inviting, promoting visibility and facilitating the identified brand of the system.
- Provide passengers with basic premium amenities such as waste and recycling receptacles, seating, basic covered shelter, and bicycle parking.
- Provide a safe waiting environment through lighting, running-way barriers and Crime Prevention Through Environmental Design (CPTED) standards.
- Provide relevant passenger information including system maps, area destinations and real-time information
- Facilitate multi-door boarding.
- Enable near-level boarding.
- Coordinate with design features and identity of the surrounding neighborhood/community.
- Ensure ease of transfer to other transit modes such as rail, bike share, transportation network companies (TNCs) and e-scooters through signage.

2. Station types

BRT station types can range from simple bus stops to full-size stations comparable to large rail terminals. The type selected will depend on several parameters, including project budget, estimated passenger demand, surrounding land uses, zoning and available right-of-way. A single BRT corridor or system may use several station types. The following is a summary of the basic types, their advantages and disadvantages, and recommended usage practices.

2.1 Basic bus stop

A basic stop is a designated point, typically on the side of a road, that provides a location for passengers to board and alight buses. This type of stop may include a small bus shelter but few, if any, additional passenger amenities. Basic stops generally are not recommended for BRT service. They do little to distinguish BRT from traditional bus service and do not communicate permanence. They have low capacity and few, if any, passenger amenities. These features reduce a basic stop's ability to attract choice riders and its ability to encourage transit-oriented development (TOD).

They may be used for temporary conditions or as a transitional strategy. If they are used, they should include branding elements at a minimum.

FIGURE 1
Basic Bus Stop

AC Transit, Rapid Line (Oakland, CA)

2.2 Basic BRT station

A basic BRT station is a designated point for passenger boarding and alighting that may include a few amenities, such as a small shelter, passenger information, seating, lighting and branding elements. Typically, these stations are smaller in size and scale.

The advantages of basic BRT stations are that they are quick and easy to install and inexpensive in comparison with more robust, premium BRT stations. Platforms can also be useful where right-of-way is lacking, and/or a larger station area would be out of scale with the surrounding land uses. The disadvantages are that such treatments may only moderately distinguish the BRT service from traditional bus service; may offer few, if any, passenger amenities; and may provide limited opportunities to attract TOD.

Generally, Basic BRT stations are recommended in the following situations:

- When travel demand is expected to be low
- When space limitations preclude installation of stations
- When the enhanced stop is planned for short-term use due to temporary conditions or as a transitional strategy

FIGURE 2
Basic BRT Stations

METRO Transit, Red Line,
(Minneapolis, MN)

LA Metro, Rapid,
(Los Angeles, CA)

2.3 Premium BRT station

A premium station is a substantial facility that can include all the attributes of basic stops and basic BRT stations, plus added amenities, such as shelters, level boarding, opportunity for off-board fare collection, a unique name, distinctive branding, passenger information, lighting, security, seating, and other features typically associated with rapid or rail transit stations.

Premium stations are recommended for most BRT applications, especially under the following circumstances:

- When sufficient space permits installation of stations
- When high demand is expected
- When passenger experience is a high priority
- When it is desired to protect passengers from weather conditions
- When transit-oriented development is desired or proposed

FIGURE 3
Premium BRT Stations

RTA, Healthline (Cleveland, OH)

KCATA, Main Street MAX BRT
(Kansas City, MO)

CTtransit, CTfastrak BRT (Hartford, CT)

RFTA,VelociRFTA (Aspen, CO)

The U.S. Federal Transit Administration (FTA) has its own definitions of BRT service that establish whether the BRT is eligible for New Starts or Small Starts funding under the Capital Investment Grants Program: Corridor-Based BRT and Fixed Guideway BRT. Below is a brief overview of the FTA's definitions of BRT:

TABLE 1
U.S. Federal Transit Administration BRT Definition

FTA BRT Definition
Fixed Guideway BRT operates in majority separate right-of-way (ROW) during peak periods
Corridor based BRT operates in mixed traffic
Defined stations that are accessible, offer shelter, real-time information
Traffic signal priority for public transportation vehicles
Short bi-directional headways
Weekday for Corridor based BRT; Weekdays and weekends for Fixed Guideway BRT
Any other feature as the Secretary may determine are necessary to produce high quality public transit services.

Users of this document are advised to be aware of the elements of BRT that are required to qualify for these two funding sources if they plan to apply for Capital Investment Grants Program funding. For more information, review the FTA's Capital Investment Grants Program website: https://www.transit.dot.gov/funding/grant-programs/capital-investments/about-program.

2.4 Freeway/highway stations

In recent years, freeway and highway running BRTs have been developed across the country in places such as Los Angeles, Suburban Chicago, and Minneapolis. Stations and platforms for such locations present unique challenges with respect to accessing the station area from nearby land uses as a pedestrian or cyclist. Depending on the running way configuration, stations may be median platforms or side platforms. Typically, these stations will be located near major activity centers or park-and-ride lots with supporting infrastructure including, pedestrian overpasses, multiuse paths, pedestrian tunnels, or nonmotorized crossings to facilitate last-mile connections. Transit vehicle access to these facilities can vary from bus-only dedicated running ways, general purpose ramps, shoulder lanes, and specialty lanes such as high-occupancy vehicle or express lanes.

2.4.1 Median in-line stations/Center platform

Median in-line stations provide quick access to destinations from the BRT running way without adding additional delay caused by lengthy route diversions and the need to exit and reenter the highway. When sufficient right-of-way is available, these stations are most beneficial when the BRT services use the centermost lanes of the highway as a running way, either in a dedicated busway or in mixed-flow lane. Using the centermost lanes in combination with median in-line stations/center platforms also reduces weaving movements for vehicles which is beneficial from a safety perspective.

Median in-line stations can utilize either a single center platform or two directional offset side platforms.

2.4.1.1 Center platform

If vehicles with one door are used, operators will have to operate in a "crossover" fashion for the vehicle's doors to align with station platforms. If vehicles are equipped with doors on both sides, vehicles will not have to operate in this manner. These types of stations can also be used when there is limited right-of-way to accommodate ramps for side platforms. Compared with offset-side platforms, center platforms have lower construction costs due to requiring only one set of station amenities and access routes (stairways and elevators), require less linear space along the running way, and provide a simpler customer experience with a single platform.

An example of this type of station application is the I-35W and 46th Street Station in Minneapolis, MN. The station is situated on dedicated busways. Buses operate in the crossover pattern so that right-side vehicle doors are open to the centerline platform. The highway platform is connected to the local street by stairwells and elevators to facilitate transfers to local buses on the 46th Street Bridge.

2.4.1.2 At-grade vs. grade-separated

Both center and offset side platforms can be either at-grade or grade-separated from the running way. At-grade stations reduce vehicle travel times but place a larger burden on the customer to access the stations via a stairway or elevator and to walk between connections to local bus routes. Grade-separated platforms consist of center ramps from the running way to the level of the cross street. While bus travel times can be impacted by the signal operations required to cross the cross street, the customer experience is improved by removing stairways and elevators and by providing easier and quicker transfers to local transit routes.

2.4.2 Side platform

Side platform stations can be implemented as an alternative to center running stations when concerns about pedestrian access to expressway traffic exist, or if sufficient running way is not available in the center of a highway. These stations are also beneficial when right-side shoulders or running ways are deployed. The stations do not require crossover operations since right-side door vehicle boarding and alighting is accommodated.

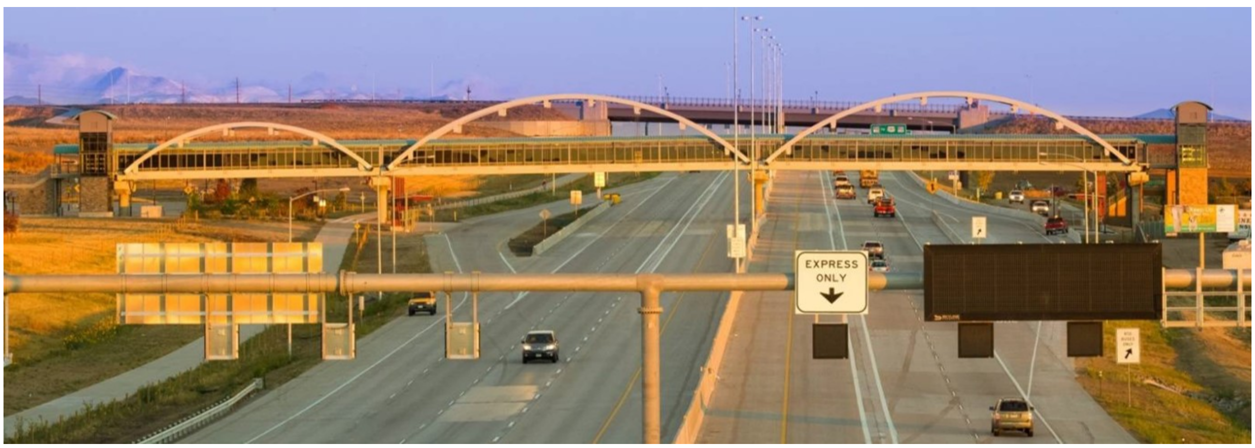
An example of this type of station is the Pace I-90/Barrington Road Station in Hoffman Estates, IL. At this location, buses exit the mainline using bus-only slip ramps to access station drop-off locations on the side of the highway. A fully-enclosed pedestrian bridge allows for passengers to traverse the highway separate from local traffic. Pedestrian tunnels connect passengers to the bridge, multiuse paths and adjacent land uses as well as park-and-ride and kiss-and-ride facilities.

FIGURE 4
Freeway and Highway Stations

Pace Suburban Bus, I-90/Barrington Road Station
(Hoffman Estates, IL)

METRO Transit, I-35W/46th Street Station
(Minneapolis, MN)

Similar to the Pace station, Denver's RTD operates to side platform stations along US 36 as part of the Flatiron Flyer operation. An example of this can be seen at the Broomfield Station, which connects eastbound and westbound operations, a parking garage and adjacent land uses via a pedestrian bridge.



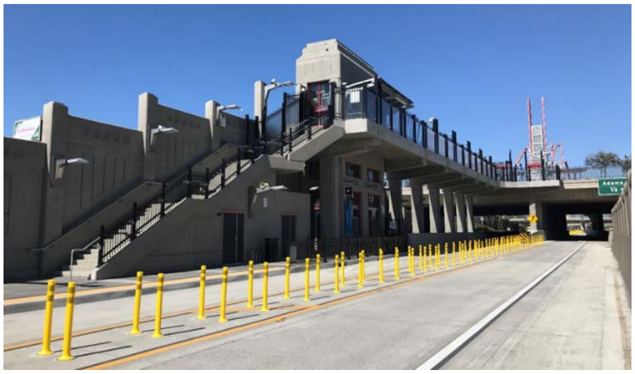
RTD, US 36 & Broomfield Station (Broomfield, CO)

2.4.2.1 Offset side platform stations

An offset side platform station allows for the same quick access from a BRT center running way, but instead of a shared platform, buses operate to separate platforms offset in a manner that areas allows for conventional, right-side boarding without the need for crossover operations. Compared with center platforms, side offset platforms have higher construction costs due to needing two sets of station amenities and access routes (stairways and elevators), require more linear space along the running way, and provide a more complex customer experience as customers must select the correct platform when entering the station.

Examples of this station type can be found at San Diego's Rapid, Boulevard Transit and City Heights Transit plazas along the SR-15 Mid-City Centerline BRT. These stations are served by transit-only lanes that run down the center of I-15. To access the northbound and southbound platforms, passengers are required to cross the street on the adjacent bridge deck. The transit-only lanes are separated from general traffic by a barrier wall. Northbound and southbound transit lanes are separated by plastic bollards at station areas.

FIGURE 5
Offset Side Platform Stations



MTS, Boulevard Transit Plaza, southbound station, Mid-City Centerline BRT (San Diego, CA)

MTS, City Heights Transit Plaza, southbound station, Mid-City Centerline BRT (San Diego, CA)

2.5 Transit center

A transit center is a station located on or off a transit line that enables passengers to transfer to other transit services, generally without leaving the physical boundaries of the station. It also may function as an end-of-line facility for some routes.

Transit centers can increase convenience for transferring riders, allow for the creation of a fare-paid zone that further eases transfers, and maximize the interface of BRT and local services. They also may provide a greater opportunity for commercial and food services, as well as transit-supportive land uses. Agencies should be aware that transit centers typically require much more space and a greater capital investment.

Transit centers are recommended where the BRT alignment interfaces with other modes and/or other transit services. In many cases, existing transit centers have been converted to support BRT.

FIGURE 6
Transit Centers

CTtransit, CTFastrak Transfer Station (Hartford, CT)

VIA Metropolitan Transit, Primo Rapid Transit Transfer Station (San Antonio, TX)

2.6 End-of-line or terminus facility

An end-of-line or terminus facility is an endpoint that may also include a place for vehicles to turn around and layover, a rest facility for drivers, an area to perform minor vehicle maintenance or charging, the opportunity for transfers to local buses or other modes, a park-and-ride lot, and other facilities.

A terminus facility clearly identifies the endpoint of the BRT guideway. Agencies should keep in mind that this option may require more space to accommodate spare or replacement vehicles.

A terminus facility is recommended under the following circumstances:

- When BRT alignment ends or interfaces with a network of other transit services on local streets
- When demand warrants placement of an end-point station
- When operational strategies require it

FIGURE 7
Terminus Station

CTtransit, CTfastrak transfer/terminus station
(Hartford, CT)

3. Amenities

Amenities refer to the many features at a station that can help enhance the rider experience while waiting. Some examples of station amenities include shelters, bus benches and/or leaning rails, real-time passenger information, trash receptacles, lighting, and signage. At a minimum, BRT stations should include platforms, as well as shelters and their associated support structures for both cover and protection from the weather. Additional amenities increase a station's utility for transit riders and can enhance the appeal of stations for nearby residents and businesses.

3.1 Accessibility

Accessibility refers to the ability to easily access the BRT system and/or stations by all segments of the population and by all modes. With the growing emphasis on active transportation, it is important to make sure there is good connectivity between the stations and the existing adjacent pedestrian and bicycle networks. Good connections between the neighborhood and its surrounding areas help encourage individuals to walk or cycle more as they feel more comfortable making those first/last-mile connections. Good access to the stations can be achieved in several ways, including ensuring that there is continuous sidewalk leading to and from the stations and that sidewalk widths provide for pedestrian comfort. Station access points and loading areas should also be designed to provide convenient and comfortable access to the system, particularly for senior citizens as well as for those using mobility devices and families with strollers. As always, station areas need to be in compliance with ADA requirements. (See section 4.4.5 Universal design/enhanced ADA, for additional information).

Bicycle infrastructure, such as bike lanes, bike racks and bike lockers, are important considerations at stations, since commuters are more likely to ride their bikes to the station if given the option. Parking should also be a consideration if warranted and if there is a demand for it.

3.2 Shelter and seating

A primary objective in providing a convenient, comfortable BRT station environment is the provision of basic shelter and seating for passengers. Consistent with the system brand, local design and development requirements, each BRT station should incorporate a reasonable degree of weather protection and places to sit while waiting. Design considerations and elements are generally described in **Table 2**.

FIGURE 8
Shelter and Seating

CTtransit CTfastrak BRT station (Hartford, CT)

TABLE 2
Design Considerations for Station Shelters and Seating

Shelter	
Configuration	• Freestanding shelter with vertical wall panels and roof • Optional canopy attached to adjacent privately-owned building • Shelter canopy may extend beyond shelter structure footprint, providing more covered space
Modularity	• Composed of standard components that can be modified to suit ridership levels • Standard components can be oriented to site conditions and/or available right-of-way
Design considerations	• Provide consistency among all stations, be unique enough to distinguish them from other system bus stops and/or services and reflect the BRT brand; use shelter design to enhance visibility of the service • Explore concepts for integrating existing shelters, facilities and public amenities along each corridor, while creating an overall design that can be read as an integrated whole • Provide consistency (in materials, colors and design) with other site elements, including lighting, railings, signage, litter receptacles, bike racks, etc. • Materials and components must be easy to maintain, repair and refurbish; be vandal-resistant; be transportable; and have a proven and dependable performance history

Area	• The size of the shelter depends on the climate, as well as the number of people expected to use it • Minimum allowable shelter or canopy lengths and widths should be based on 10 sq. ft coverage area per passenger served • Waiting passengers should have a clear view of approaching buses and be themselves visible to the bus operators • Provide maximum visibility of and access to adjacent development
Furnishings within the shelter	• Benches or leaning rails should be considered inside all shelters (see seating requirements in Section 3.2) • Hardwired internal shelter lighting preferred (see lighting requirements in Section 3.5); minimum 4 fc (43 lux) illumination average within the shelter is recommended
Vertical panels	• Shelter structure should accommodate the placement of advertising, art or information panels within or in place of some vertical panels • Orientation of vertical panels to protect from prevailing winds and wind-driven rain and other inclement weather is preferred • Vertical panels should be sized to enable portability by one person for purposes of installation and maintenance • Transparent vertical panels on the side of the approaching vehicle for visibility purposes are required
Roof	• Translucent roof panels should be considered for ambient light • Avoid placing drip lines over pedestrian travel paths • Cover over the boarding area is not required
Seating	
Options	• Benches • Leaning rails (appropriate where wait times are expected to be short due to short headways or at high-volume locations) • Retaining walls or landscape elements
Quantity	• One seating or leaning position for every five waiting passengers is desirable • At least one covered seating position is required • Ample area under cover must be provided for at least one person using a wheelchair or other mobility device without obstructing other seating
Design considerations	• Design must discourage the use of seating for sleeping; maximum bench length is 4 ft, and dividers along the length of the bench are recommended • Backs and arm rests are optional • Seating must optimize pedestrian circulation and waiting capacity • Seating requirements may need to be minimized where passenger volumes are very high or where there is a high level of pedestrian activity • Most provided seating should be located under cover when practical
Size requirements	• Depth and height of leaning rails should provide maximum comfort and utility for the average user • The size of the bench seating area should be minimized

3.3 Real-time passenger information

One of the most significant barriers to using buses is customer uncertainty about bus arrival times. Posting schedule information can help reduce the uncertainty, but this may be impractical where BRT stations are served by many different routes and posted schedules cannot reflect bus delays. Providing real-time information in the form of variable message signs at stations that provide the status of bus operations eliminates this uncertainty for transit users.

An alternative to installing variable message signs at all BRT stations is making it possible for riders to access real-time information through cellphones. Customers can enter information about the station and routes, and bus status information can be provided through automated voice messages or text or by using a mobile application.

For additional information, refer to APTA's recommended practice "Implementing BRT Intelligent Transportation Systems."

3.4 Maps and other way-finding devices

Maps and other way-finding devices can help riders who have just alighted to orient themselves with the area surrounding a station. Maps can be placed within the station itself. Way-finding can be comprised of special signage as well as special markings within the pavement that helps direct people to and from the station and other connecting services. Integration of design elements and way-finding can be a creative application of station art. For more information, please refer to the APTA Recommended Practice "BRT Branding, Imaging and Marketing" document.

3.5 Lighting

Station lighting serves several functions. It provides illumination, assists in station location and identification, and makes station features visible during periods of darkness. It aids bus operators in locating stations and determining whether passengers are waiting to board. Station lighting also provides a sense of safety and security for riders waiting to board a vehicle through increased visibility. Attractive station lighting can further highlight station architectural and design elements, which enhance the rider experience and the appeal of the BRT station for the community. Lighting can also communicate when the station is closed or not operating, such as by changing the color and intensity of the lighting.

FIGURE 9
Station Lighting

KCATA, Troost MAX Line (Kansas City, MO)

3.6 Trash and recycling receptacles

Trash and recycling receptacles are necessary to minimize litter at BRT stations and on buses, as many riders have food and drink containers and other items to dispose of before boarding a vehicle. However, the placement of trash containers at transit stations and stops may also be considered a security issue, and thus specially designed trash or recycling receptacles may be required. CPTED design principles, such as natural surveillance, should be considered when selecting amenities for BRT stations. Trash and recycling receptacles that are clear or round can help minimize security threats for items thrown in the receptacle and allow transit users to be able to see through and around the object easily.

3.7 Landscaping

Landscaping adds visual interest to both the station and the area around the station. It can also soften the aesthetic impacts of "hard" edges associated with BRT infrastructure. Where sufficient space is available (e.g., along busways), landscaping can help to define station areas. Landscaping and other improvements enhance the appeal of the station to new riders and to the community while making the station more attractive to potential developers. Landscaping should be attractive and blend in well with the local environment. It should be designed to make the station a comfortable and desirable place to be. To minimize maintenance costs, native species requiring minimal watering should be used.

FIGURE 10
Busway Landscaping

LA Metro, Orange Line (Los Angeles, CA)

3.8 Bike lockers and racks

Providing bike racks or lockers at or near stations provides another option for riders to access the BRT system. In places where it is feasible for commuters to regularly use bicycles throughout the year, the provision of bicycle storage facilities can reduce the number of park-and-ride spaces needed.

Bike racks are relatively inexpensive and pose no security issues, but they leave bicycles exposed to the elements and to theft. Enclosed bike lockers cost more and may pose security concerns, but many patrons are more comfortable leaving their bicycles in an enclosed, secure facility. Bike racks or lockers should be placed in a location that does not impede access for other passengers to the station.

FIGURE 11
Bike Racks

Port Authority of Allegheny County, West Busway ,Ingram Station (Pittsburgh, PA)

3.9 Parking

When planning stations, it is important to consider the potential parking demand at those stations. Some BRT systems provide park-and-ride lots. At stations where no off-street parking is provided, commuters may use existing streets near the stations. This could lead to concerns from residents and businesses about commuters reducing available parking and/or parking spilling onto adjacent residential streets.

Development proposed near stations can also create additional demand for parking, which must be accommodated. Ideally, the parking would be housed within the development (e.g., in a garage), but shared parking arrangements with other property owners, such as churches or theaters or with the transit agency (shared use of park-and-ride facility), could also be considered.

3.10 Climate control strategies

Protection from the elements is also a consideration for station areas and platforms. For extreme climates, issues such as snow/ice, rain, and heat should be addressed as part of facility design.

Extreme climate issues:

- Snow – in areas where snow and ice are a regularly occurring issue, transit agencies will need to consider appropriate maintenance and operations designs to deal with removal of snow at station areas.

  One climate control element is the use of snowmelt systems. These improve the customer experience and reduce return maintenance trips to clear snow and ice. Snow melt systems can vary from passive design (solar access and dark-tinted platform surface) to active heating systems powered by hydronic or electric resistance heating. Hydronic systems require a heating and liquid distribution system but are generally higher capacity and longer lasting. Though they need a location for pumps and liquid reservoirs. Often electric resistance heating is used. Newer systems have also employed electrically conductive concrete. Systems may vary depending on the level of melting required, power sources, operating and capital cost constraints, and drainage to avoid pooling and refreeze. When considering snow melt systems, operators should evaluate energy use, sustainability goals and cost/benefit for the project. During heavy snow events, piles of snow building up along the platform edge from snow plows will not melt quickly and may need maintenance.

FIGURE 12
Pavement Snowmelt Systems

The Rapid, Silverline (Grand Rapids, MI)

Pace Suburban Bus, Pulse Milwaukee Line (Chicago, IL)

- Rain – most areas will deal with rain. Providing a covered shelter within the station area or platform will generally provide adequate cover for passengers during the occasional rain event. For areas where rain and cold are a concern, a shelter that provides coverage on three sides are a common solution for providing protection from the elements. In some extreme climates adding radiant heaters within the station canopy can provide additional comfort for waiting passengers. In those cases, station canopies may need to be higher to reduce vandalism or interference with heating elements.

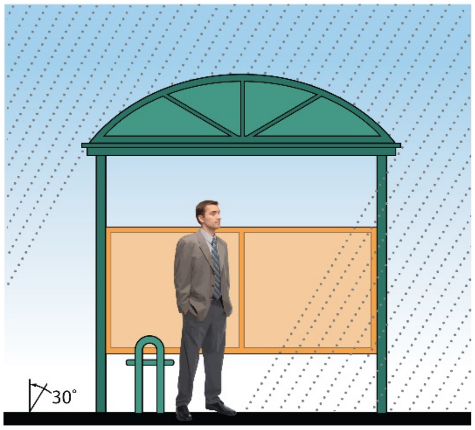
  In warm, humid climates, ventilation is also an important design consideration. The angle of the shelter roof as well as the overall height of the shelter canopy can provide additional coverage from wind- driven rain while allowing for ventilation. Typically, the angle of falling rain can be 30°, sufficient shelter depth should be incorporated into the design for such events. For high volume station areas, canopies along the entire length of the station area to provide sufficient space for waiting passengers should be considered. Station designs will also need to account for drainage including conveyance of rain water off the canopy during high-volume events.

  In areas subject to hurricane or other extreme wind/rain events, canopies and any other structures will need to meet state and local building codes.

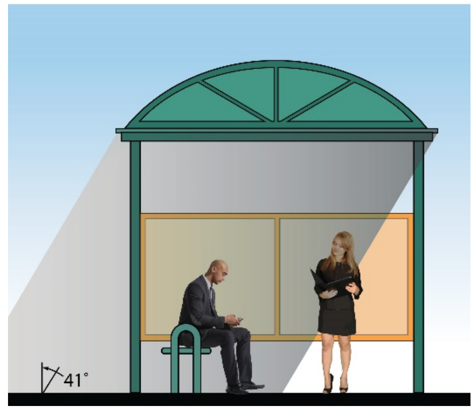
- Heat- shade should be considered in hot climates as well as materials and colors that prevent seats and railings from getting too hot. Having adequate canopy depth will be necessary to account for the angle of the late afternoon sun (typically 41° in the south) and maximize the shade provided by the canopy. For stations oriented to the southeast and southwest additional consideration should be given to placing the canopy in such a way as to maximize the shade provided during the late afternoon commuting times

FIGURE 13
Climate Design Considerations: Rain and Sun

Typical angle (30˚) of falling rain and the related bus shelter canopy depth required for protection.



Approximate angle (41˚) of sun during late afternoon hours in mid-summer in southern latitudes in North America.



3.11 Fare collection equipment

To effort to lower dwell times and improve operating speeds and corridor travel times, many BRT systems include fare purchasing/payment equipment such as ticket vending machines (TVMs) at stations. Fare payment at the stations, instead of on the vehicles, eliminates the delay caused by passengers queuing at the front door waiting to pay onboard, enhancing the passenger experience.

3.12 Shared mobility considerations

In recent years, many areas have experienced a growth in car-sharing, bike-sharing, ride-sourcing (TNCs such as Uber and Lyft) and other forms of shared mobility. BRT and these shared modes of transportation can potentially work together to lessen traffic congestion, reduce greenhouse gas emissions and offer cost-effective transportation options to the communities they serve. Shared mobility can also help spur growth, as it extends the reach of the BRT stations and/or systems and while providing first/last-mile connections. Many transit agencies are exploring ways to incorporate and embrace shared mobility, including partnerships with TNCs to subsidize first/last-mile rides.

4. Planning and development considerations

4.1 Land use, development activity and zoning

BRT stations can function as development nodes in a BRT corridor. The stations can introduce new activity centers into a community or reinforce existing ones. They benefit developers by attracting new markets (people who either do not have automobiles or prefer not to drive) and by reducing the parking requirements for new development.

Significant real estate investment has been identified at and near BRT stations in several North American cities, such as Boston, Cleveland, Pittsburgh and Los Angeles.

When planning for BRT stations, local zoning ordinances should be reviewed to ensure that existing regulations allow for stations and support facilities. Special consideration should be given to local sign ordinances with regard to the installation of vertical markers along a BRT corridor. Zoning also should be reviewed to determine what uses are permitted within walking distance of the station. If a station is proposed for an area zoned for industrial or automobile-oriented commercial uses, planners can recommend a change in zoning or consider moving the station to another location. Conversely, areas zoned for high-density residential or a mixture of residential, commercial and office uses would be compatible with a new transit station.

In addition to adjacent land uses and zoning, other factors should be considered when siting BRT stations. These factors include but are not limited to the following:

- existing ridership and connectivity to other transit services
- safety conditions (safe pedestrian crossings, sight distances at driveways, curb cuts, etc.)
- sidewalk connectivity
- impact on transit signal priority treatments when choosing near- or far-side station locations
- impact to lane width

Local plans should be reviewed to determine how the BRT station would support the community's vision for the area and how uses will connect to stations. For example, the city of Pittsburgh's Baum-Centre Corridor Development Strategy specifically calls for transit-oriented development at three hubs defined by two existing stations and one stop along the Martin Luther King Jr. East Busway.

When considering existing and future development activity, both the type and amount of development should be evaluated. Stations proposed in areas with high levels of existing or future development activity have the benefit of maximizing ridership for the BRT system and helping to alleviate potential community concerns about traffic generated by the new development.

Land-use factors are a key criterion in the FTA's evaluation of projects being considered for New Starts funding, as well as a factor considered in environmental assessments. The factors considered include transit-supportive plans, policies, performance, impacts of policies and other land use considerations. The FTA's document "Guidelines for Land Use and Economic Development Effects for New Starts and Small Starts Projects" provides further information on the land-use information required by FTA for New Starts projects.

4.2 Transit-oriented development

Transit-oriented development (TOD) is a planning approach that is increasingly used in planning related to transit facilities and transit stations. TOD consists of the development of vibrant, pedestrian- and bicycle-friendly, amenity-rich, mixed-use developments benefitting from proximity to transit. TOD generally generates and benefits from significant transit ridership. TODs are relatively high-density developments incorporating residential, retail, office, institutional and civic spaces. TOD is often of high quality, planned for sustainability and economic vitality, and designed to take advantage of market opportunity created by transit users and others.

TOD has been applied around light rail, commuter rail and intercity rail stations. Increasingly, there are several examples of bus rapid transit TOD. In Minneapolis-St. Paul, Metro Transit has identified "BRTOD" occurring along BRT routes and other examples of this investment existing along the Cleveland HealthLine and at the Pittsburgh Martin Luther King Jr. East Busway East Liberty Station.

From Metro Transit's research and experience, the following factors help create good TOD planning:

- Rezoning and higher permissible zoning density
- Creating a comprehensive plan with a specific focus on the BRT corridor
- Targeting of supportive infrastructure improvements
- Blight removal
- Proactive outreach to developer

- Environmental cleanup
- Land assembly
- Extensive marketing of the corridor
- Range of financial incentives
- Presence of large institutions, such as hospitals and universities at or along the corridor
- Vibrant local real estate market

4.3 Value capture

Sponsors of BRT projects may want to consider value-capture opportunities to help fund a portion of a project and/or use value capture monies to fund related transit needs.

Value capture refers to a set of techniques that generally take advantage of increases in property values, economic activity, and growth linked to infrastructure investments. Under the right circumstances, value capture may allow BRT sponsors to close funding gaps and provide other real estate-related benefits. Often, good TOD planning creates positive conditions for value capture by creating more real estate development at stations and along lines. Some of this increased value can be captured through several mechanisms and then used to help fund the project and/or pay the debt related to the project.

Value capture has helped fund some rail transit, commuter rail and intercity projects, primarily stations and sometimes corridors. Academics such as Professor Arthur Nelson at the University of Arizona Phoenix and University of South Florida research associate Victoria Perk conducted studies indicating that BRT lines and stations can enhance the value of properties that are within ¼ to ½ mile from stations or lines.

The Federal Highway Administration is fostering value capture for all surface transportation modes, including a value capture implementation manual for highways, roads and transit available at www.fhwa.dot.gov/innovation/everydaycounts/edc_5/value_capture.cfm.

Best practice steps in implementing surface transportation value capture include the following:

- Identify the funding and financing opportunities value capture is intended to address.
- Identify value capture techniques applicable to the project, including impact fees, special assessment districts, tax increment financing, joint development and/or naming rights.
- Define the BRT project’s business and economic case, based on goals and objectives defined through stakeholder consultation.
- Assess the broader real estate market as well as the unique project characteristics that may impact property values along the BRT line and around stations.
- Ensure that value capture techniques are used within the appropriate local, state and federal supporting regulations.
- Develop and implement a funding and financing plan utilizing value capture, based on the unique features of the chosen value capture technique(s).

Some examples:

- Two-thirds of the $100 million two-mile Kansas City streetcar was funded from a combination special assessment district sales taxes, special assessment district property taxes, and a parking lot assessment.
- The $500 million Denver Union Station, which includes a bus station for area buses including the Flatiron Express, a BRT between Denver and Boulder, was funded in part by a special assessment district, a tax increment financing district and land sales.

- In Minneapolis-St. Paul, the transit agency, Metro Transit, fostered the development of Allianz Field, a professional soccer stadium, and expected other developments on its property that is at the intersection of the agency's Green Line light rail and A Line bus rapid transit.

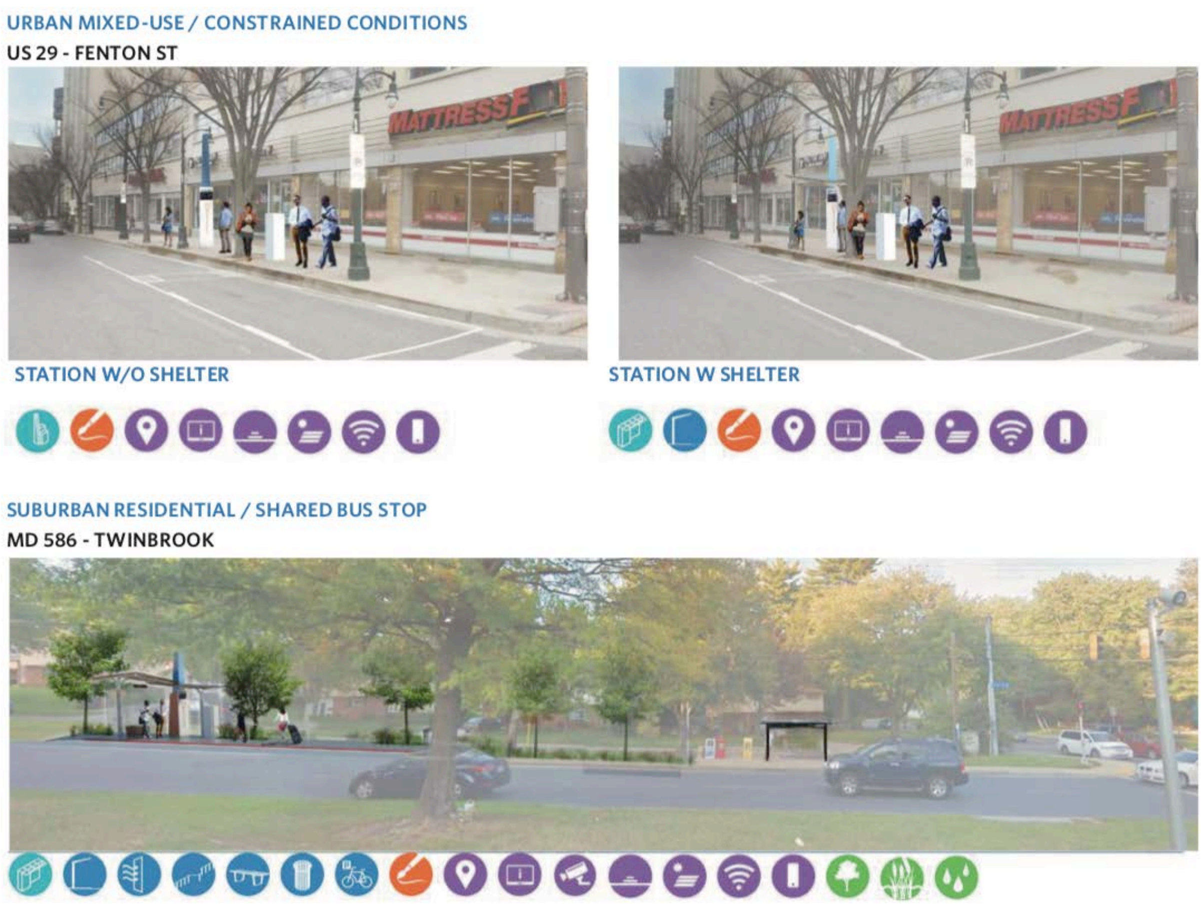
4.4 Architectural treatments

Architectural treatments such as specially designed canopies, shelters and vertical markers help to make stations more visible and can help in developing a brand identity for the BRT system. Creative approaches to designing fencing, stairs and ramps will help to create community support for the BRT system and will add to the rider's experience. Station art may also be incorporated into fencing, walkways and shelters.

Strong and consistent architectural treatments help foster the unique branding of the BRT. They help to show real estate developers the permanence of the stations and service and often the higher-quality treatments, compared with regular bus service, which can enhance property values along the line.

An example of this is the prototype designs for Montgomery County, Maryland's "Flash" program consisting of a number of BRT lines in suburban Washington, D.C. Montgomery County has developed station prototypes for a variety of locations along the proposed routes, including urban mixed-use, suburban, residential and commercial, and park-and-ride. An example is shown in **Figure 14**.

FIGURE 14
Montgomery County, Maryland Station Prototypes



4.4.1 Visual and aesthetic impacts

While concerns may arise about visual and aesthetic impacts of a station, the planning process provides an opportunity to engage the public in developing a station that would be a source of community pride. This may be done through design workshops, charrettes and involving the community in decisions concerning architecture, colors, finishing materials, signage, and pedestrian and ADA access. Installation art can further enhance the appeal of a new station for residents and businesses.

4.4.2 Historic, archaeological, cultural resources, park, recreation lands, wildlife and waterfowl refugees

As BRT stations typically are located in urbanized areas, an assessment of impacts on historic, archaeological and cultural resources is likely to be required in the planning process. For example, the introduction of a station could have a visual impact on nearby historic properties, or its construction may impact a historic structure or archaeological artifacts.

BRT stations, however, may provide an opportunity for mitigation of impacts on cultural resources. An example of this mitigation would be the incorporation of characteristics of the historic features of the station area into the station design.

In addition to the evaluation of historic sites through a process like the Section 106 review outlined under the National Environmental Protection Act (NEPA), an assessment of impacts to park, recreation lands and wildlife refuges may also warrant consideration to satisfy the Section 4(f) requirements of NEPA.

4.4.3 Environmentally sustainable materials and practices

The design phase of a new station offers opportunities to introduce environmentally sensitive materials and practices into its construction and operation. Assessment of energy usage is typically performed for the overall project to determine the energy conservation benefits of a BRT system. However, architects can also consider energy conservation measures for BRT stations, such as designs that make use of natural lighting and low-power-consuming lighting, use of solar panels, and incorporation of recycled materials in building construction. Transit operators pursuing Leadership in Energy and Environmental Design (LEED) certification for BRT stations may see the added benefit of reduced operating costs and local grants for “green” projects. Principles of green design can be implemented even if the transit operator does not pursue LEED certification.

4.4.4 Noise and vibrations

In a new BRT project, stations may present more of a noise concern than the rest of the line or corridor since noise emissions are greater where vehicles are accelerating from a stop. Noise associated with increased traffic generated by a station also will need to be considered, as will noise associated with other features such as passenger announcements or crosswalk signals. Determination of noise impacts requires identification of sensitive receptors near the station, such as retail establishments, residences, offices, hospitals, childcare facilities, public buildings and historic structures.

The FTA provides guidance for assessment of transit noise vibration in the “Transit Noise and Vibration Impact Assessment Manual”.

Noise walls mitigate bus noise, but they can introduce negative aesthetic impacts. Other noise mitigation measures include acquisition of undeveloped property to use as buffer zones and noise insulation or soundproofing of residences.

4.4.5 Universal design/enhanced ADA

Incorporating elements of universal design (UD) improves accessibility of stations, both for disabled people and other transit patrons, such as travelers with luggage, strollers or other items. The goal of UD is to make environments, products and systems safer, healthier and more usable for everyone. Universal design addresses accessibility across the built environment and onto vehicles. Some BRT systems require the implementation of these elements at stations, either due to an extended platform length or to the need for platform boarding to accommodate BRT vehicles. Other items to consider for BRT stations to enhance ADA elements and improve accessibility include:

- Features that provide protection from weather extremes
- Adequate internal clearances within shelters and station areas for wheelchair users and others with assistive mobility equipment
- Real-time passenger information in audible and visual formats
- Increasing the number of elevators and/or escalators for additional options when equipment is not in service
- Multimodal stations, end-of-line stations or stations serving multiple routes designed to simplify transfers

For additional information on UD for transit, refer to the National Aging and Disability Transportation Center: https://www.nadtc.org/.

5. Design considerations

5.1 Foundations

Foundation requirements for all installations need to be identified and the locations evaluated to determine whether space and soil conditions are adequate. Areaways or underground utilities may limit the ability to install heavy signage or structures. Station platforms need to be designed with adequate strength and durability to support the weight and activity of all maintenance vehicles that will service the station. Local agencies may require special building code compliance and structural review during the design and permitting phases.

5.2 Concrete bus pads

If the BRT running way is constructed out of asphalt concrete pavement as opposed to Portland cement concrete, then it is recommended to construct Portland cement concrete bus pads at each BRT station to avoid the pavement rutting that occurs in asphalt concrete pavement from repeated deceleration of buses. The bus pad should be the entire length of the platform, as well as a suitable length preceding the platform, to account for the deceleration forces, typically 100 ft or to the limits of the marked crosswalk.

5.3 Utility considerations

5.3.1 Existing utilities

Project sponsors should develop an approach to existing utilities in the vicinity of station areas. Sponsors can relocate existing utilities from station areas, leave existing utilities in place or relocate only certain utilities. Consideration should be paid to the current condition of the utilities, existing agreements with utility companies and the project budget.

Relocating all existing utilities within a station area increases the construction cost of the project, depending on existing agreements with utility providers, but reduces disturbances to the BRT service once operational, should the utility require repair, maintenance or replacement. Leaving all existing utilities in place under the station and bus pad reduces initial construction costs but could result in a disruption to the BRT service at the station if portions of the station need to be removed for utility repair, maintenance or replacement, and could result in higher ongoing maintenance costs, depending on the existing or renegotiated agreements with utility providers.

In many situations, a blended approach is taken, relocating some utilities and leaving others in place. Factors that go into this determination include, but are not limited to, the condition of the existing utilities, the cost of the relocation and who bears that cost, and whether the utility can be encased to allow replacement without requiring removal or reconstruction of any station elements or disruption to the BRT service at the station.

5.3.2 Utility services

Many station amenities and systems will require access to utilities. It will be necessary to discuss the plan with local utility companies to determine whether existing utilities are present and the transit agency's ability to access them. Consider the different ways to calculate payments for utilities, such as a calculated flat fee based on consumption estimates or installation of a meter. It is helpful to know up-front whether a utility has minimum usage levels or charges.

The following sections discuss electrical, water and sewer, and communications. However, other utilities may need to be considered, depending upon the circumstances.

5.3.3 Electrical

Determine what power is needed to support the amenities at the location. Evaluate the utilities to determine whether existing power is compatible with the station's needs. If providing lighting, then consider opportunities to rely on existing street or area lighting rather than assuming all-new lighting be installed. If pursuing pavement snowmelt systems or heaters that may draw greater electrical loads, access to a transformer may be necessary. At the time of the initial station or stop construction, consider running conduit to various locations for future power needs, such as lit signage, security cameras, ticket vending machines, fare transaction processors and tree lighting not in the initial plans. Stations will also need to accommodate the space for electrical cabinets if required. If the station has high power draws, there may be the need for additional easements for utility access.

For BRT systems using battery electric buses, vehicle charging considerations should be included as part of utility considerations. Issues to be addressed would be the type of charging units, the amount of power needed to support the chosen charging solution and impacts to design. Structural, space and power needs will also need to be addressed.

5.3.4 Water and sewer

The need to have access to water and sewer will depend on the design decisions and the amenities provided. In some cases, a bathroom or other wash facility may be desirable. Access to water also may be desirable for landscaping and irrigation. Consider using drought-tolerant or native plants in landscaping. Using a truck-mounted, self-contained power washer for routine cleaning will eliminate the need for installing a water line. This could be less expensive than running water lines to smaller stops that do not have other needs for water.

5.3.5 Communications

Determine the requirements for the communications infrastructure needed to support the amenities at the location. These requirements include bandwidth, protocols, physical requirements and security measures. Wired communications include a fiber or copper network or telephone service, which generally requires conduit or overhead lines. Wireless communications include Wi-Fi, radio, modems and leased data service, which generally requires line of sight between transmission points. All communications equipment will need to be housed in an enclosure that protects it from weather, theft and vandalism.

5.4 Branding

Branding gives a service or product a distinct identity that results in clear and positive public recognition of the service. BRT stations are a key element in reinforcing the brand of the service and should be highly identifiable as a major component of the BRT identity. As the gateway into the BRT service, strong branding of the station presents the initial opportunity to emphasize the system. The continuation of the brand on all individual station elements should emphasize a clear and consistent message about the service.

The look of the stations must ensure that they are easily identified as different from the conventional bus shelters in the region. They should tie into all other aspects of the overall BRT brand, including the vehicle, colors, logos, signage and other service components. The BRT brand should remain prominent at the stations for customer recognition and understanding. Where a more standard bus shelter is used, the distinctive branding can come from a unique paint or graphic package, easily identifiable as different from the standard service.

The APTA recommended practice "Bus Rapid Transit Branding, Imaging and Marketing" contains a more in-depth discussion of BRT system branding practices.

6. Property needs

An important consideration in planning and designing stations is the amount of property required for the it and the supporting infrastructure, such as pedestrian linkages or park-and-ride lots.

Acquiring sufficient right-of-way for a BRT station can be a difficult task. Whenever possible, right-of-way should be acquired as soon as possible, ensuring that sufficient space is reserved for future needs. Depending on the project scope, this may require public consultation.

BRT stations and their support facilities may require displacement of existing residences and businesses. Moreover, where a BRT alignment is proposed adjacent to a railroad right-of-way, stations may require property in addition to what is needed for the running way.

The following sections contain further considerations for station placement.

6.1 Location

Stations and stops may be located on-street or off-street, depending on the running way configuration. Systems may employ more than one station location option.

6.1.1 Station spacing

The distance between stations along a BRT corridor is one of the most important considerations in the system design and operating plan. However, this topic is beyond the scope of this document. Please consult the APTA recommended practice "Bus Rapid Transit Service Design and Operations" for further information on station spacing.

6.1.2 Transition area

The transition area is the space that connects the station with the adjacent area. In general, the transition area should support the goal of treating passenger facilities as permanent community assets that reinforce the positive, defining qualities of the neighborhoods and contribute to the street-level environment. Among other things, the transition area should coordinate with and support street-level functions and elements, including intersections, building entrances, vehicular movement, adjacent pedestrian circulation patterns, and existing street furniture and landscape elements. It also should work within existing site conditions to provide strong visual and physical access while enabling the character of the surrounding area to be expressed in some way.

The transition area also should be welcoming and should provide passengers with system information before they enter the platform. If fare gates are used, then fare collection and ticket vending machines should be in the transition area.

A planned pedestrian and cycling network in the community can be used to encourage alternative and healthy transportation to the BRT service. To support these measures, the transition area should facilitate passenger access through clearly marked pedestrian pathways, curb cuts or ramps, and pedestrian-activated crossing signals where warranted by volume and crossing distance. Also, where practical, the transition area should provide facilities for bicycle parking. This could include bicycle lockers, secured bicycle areas and racks. Consideration should be given to installing way-finding indicators in a two- to three-block area around each station.

The transition area may include other passenger amenities, such as the following:

- Coffee or snack kiosk (this will depend on whether food and drink are allowed on the system; in addition, these may cause some maintenance or cleaning issues)
- Information on other transportation services and the surrounding community

6.1.3 On-street

Five location options may be considered with on-street stations. Two relate to the station position across the width of the running way, described in Section 6.1.3.1, while three relate to the station position in relation to intersections, described in Section 6.1.3.2.

6.1.3.1 Location across the running way

Curbside

A curbside station is located adjacent to the curb or parking lane of a street and is often integrated into a surrounding sidewalk. Curbside stations can be located far-side, near-side or midblock, as described in Section 6.1.3.2.

The advantages of curbside stations are that space is more likely to be available, and it is possible to avoid taking street space by using existing sidewalk area. A curbside station can be integrated with buildings and may complement other uses of the sidewalk. It will be possible to use a standard bus and share the facility with traditional bus service. This design also eliminates the need for some pedestrian street crossings.

A disadvantage of this option is that curbside real estate is quite valuable, particularly in dense urban locations. Buses must use the curbside lane to serve the station, potentially creating conflicts with right-turning vehicles, parked cars, bicycles, etc. The use of a curb extension helps to mitigate this issue. The curbside option generally requires two platforms (one in each direction) and may conflict with other uses of the sidewalk particularly in dense urban corridors. In these areas, coordination with adjacent property owners may be required. In commercial areas, it may be difficult to distinguish station signs from other signage. In cases where level boarding is desired, there may be grading issues, because the typical platform height (12 to 14 inches) is higher than the standard curb height (6 inches).

FIGURE 15
Curbside Stations

York Region Transit, Viva BRT
(York Region, ON, Canada)

Pace Suburban Bus, Pulse Milwaukee Line (Chicago, IL)

Median

A median station is located in the median of a divided street or roadway, associated with a median running way or bus lanes. In many cases, the option for a median station may not exist.

The advantages of median stations are that they can serve both directions simultaneously and feel more "rail-like." Such stations maximize speed by minimizing car conflicts and make transit signal priority (TSP) easier because of unique signals and signal phasing. They can take advantage of unused medians and may enable curbside parking. Median stations are easy to distinguish, enhancing system identity and visibility. These stations also do not create a visual obstruction for businesses and avoid having passengers waiting in front of nearby storefronts, which can be a concern for local establishments.

The disadvantages of median stations are that they may require taking of more right-of-way than curbside options; may conflict with other uses of the road, such as left turn lanes (far vs. near side); and may require unique signal timings. Also, such stations require all passengers to cross some street traffic at every location, and they increase the travel time for pedestrians if the crosswalk is lengthened. In addition, median space may be limited, and the station may be more difficult to maintain.

Median platforms may be located on side platforms on each side of the running way or in the center of the median:

- **Median side platform:** A side platform is located on each side of the median. The advantages are that conventional right-side boarding may be used, but this will require two station/stop units and more available space. Median side platforms can be located far side, side by side, near side or midblock, as described in Section 6.1.3.2.

FIGURE 16
Median Station with Side Platform for Right-Side Boarding

Cleveland RTA, HealthLine (Cleveland, OH)

- **Median center platform:** A center platform is located on the center island of the median running way. The advantages of this option are the ability to utilize shared passenger facilities serving both directions, reduced right-of-way requirements and costs. The disadvantages of this configuration are that it necessitates specialized vehicles with left-side doors, and it complicates left turn movements with general traffic crossing the running way.

FIGURE 17
Median Station with Center Platform

Lane Transit, Emerald Express (EmX) (Eugene, OR)

6.1.3.2 Location in relation to intersection

This analysis of location options applies to curbside and median stations with side platforms.

Near-side

A near-side station is located just before an intersection with another roadway.

The advantage of this location is that it can be utilized where limited property is available at a far-side location. For curbside stations, the near-side position can be used where the BRT route makes a right turn and provides an opportunity for a queue-jump lane. The vehicle arrival is independent of traffic signal timing. Where there is no signal priority, passenger service time may occur while the signal is clearing. For both curbside and median platform stations, this option reduces the distance customers need to walk between the intersection and the front door of the bus (an important feature if fares are collected onboard).

The disadvantages of near-side stations are that they minimize the benefits or use of transit signal priority; their platforms may conflict with right-turn lanes, especially where the bus stops at a green light (cars may try to pass the bus on the left); and departures may be delayed by the traffic-signal cycle. These disadvantages do not apply for median stations with side platforms. For both options, disadvantages include that bus drivers may have difficulty seeing pedestrians crossing in front of the bus; passengers may be inclined to jaywalk, especially where they alight at the rear of the bus; and the near-side stop is set back from the intersection. Sight distances related to the intersection or adjacent driveways must also be considered when siting stations. This consideration may compound location issues. For example, National Association of City Transportation Officials (NACTO) defines anything greater than 200 feet from the nearest cross street to be a mid-block crossing, which may encourage jaywalking. Sight distance considerations may also require stations to be set back further from the roadway, necessitating larger easements onto private property.

FIGURE 18
Near-Side Curbside Station

The Rapid, Silver Line (Grand Rapids, MI)

Far-side

A far-side station or stop is located just after an intersection with another roadway.

The advantages of far-side curbside stations are improved travel time if signal priority is available, easier ability to implement bus bulbs, and facilitation of right turns by other vehicles. For example, a near-side station with signal priority could activate the signal priority system while the bus is in the station, thus diminishing the system's effectiveness.

Another advantage is that a far-side station can be aligned with the left-turn lane. Making the most efficient use of the available right-of-way.

A disadvantage of far-side-curbside stations is that they may require buses to stop twice at an intersection—once for a red signal and a second time to board and alight riders. A disadvantage for both curbside and median platforms is that, with high-frequency BRT service, stations may serve multiple vehicles simultaneously which requires stations to be moved further from intersections to accommodate vehicle length.

FIGURE 19
Far-Side Median Stations

LA Metro, Orange Line (Los Angeles, CA)

Midblock

A midblock station is located between intersections.

The advantages of this location are that both arrivals and departures at the platform are independent of traffic signal timing and, for curbside stations, the possibilities are better for exclusive use of the lane at the platform. This option offers staging space to store buses between the preceding intersection and the platform, as well as between the platform and the subsequent intersection (important when service is frequent, such as headways equal to or less than traffic signal intervals).

In general, midblock stations apply in unique situations, such as a large trip generator located midblock. If there is a midblock station, consideration should be given to providing a designated crosswalk to enable passengers to access the station. Without such a crosswalk, customers may need to walk to one of the adjacent intersections to cross the street or may choose to jaywalk, especially where the block is particularly long

FIGURE 20
Midblock Stop Curbside Bus Stops

Lynx, Lymmo Grapefruit Line (Orlando, FL)

METRO Transit, A Line (Minneapolis, MN)

6.1.4 Off-street

Off-street stations generally are located on an exclusive guideway or transit right-of-way.

The advantages of an off-street location are that it eliminates potential conflicts between motor vehicles and transit riders; may lend a feeling of permanence; and may provide opportunities for additional amenities, such as park-and-ride. Overall, it may enhance the system brand. In addition, it can become a new amenity for the surrounding community and enhance TOD potential.

The disadvantages of off-street locations may include diminished brand if the station is located too far from the surrounding community or if it is hidden. Additional security measures might be needed if the station is in an area of limited activity. This option generally requires additional operating costs, because the station envelope becomes the responsibility of the transit agency, not the local municipality, and may require additional capital costs if the transit agency must purchase the right-of-way for the station.

A variation of an off-street station is an off-alignment station that is located some distance away from either the street or the dedicated running way. For example, if a BRT system is in a highway environment, such as a highway median, the station may be located on the side of the highway. In such cases, buses leave the main alignment to access the station, and then reenter the main alignment to continue the trip.

FIGURE 21
Off-Street Station Locations

OCTranspo, Dedicated transitway station (Ottawa, Canada)

Metrobus, South Dade Transitway (Miami, FL)

The advantages of an off-alignment location are that it provides additional services to an existing transit node or customer base; may provide opportunities for additional amenities, such as a park-and-ride; and may become a new amenity for the surrounding community or enhance TOD or joint development potential.

The disadvantages may include diminished brand if the station is located too far from surrounding community activity or is hidden; increased running time and operating costs to access the station; and the need for additional security measures if the station is located in an area of limited activity. This option may require additional operating costs if the station envelope is the responsibility of the transit agency, rather than the local municipality. In this case, additional capital costs may be required if the transit agency needs to purchase the land for the station.

Off-alignment station are recommended under the following circumstances:

- When a BRT system uses highway lanes, and stations are needed where the BRT route diverts to serve communities along the corridor (e.g., interchanges)
- When the available right-of-way is not present for the construction of a station on-street

FIGURE 22
Park-and-Ride Lot with Access to HOV/Bus Lane

San Diego MTS, Rancho Bernardo Transit Station (San Diego, CA)

BRT STATIONS DIMENSIONS AND LAYOUT

7. Station and platform dimensions

7.1 Platform layout

The station design will establish the placement of items on the platform, such as shelters, lighting, benches, electronic and static signage. In addition, there may be additional items, such as newspaper boxes and other vending machines, bicycles, and local way-finding signage, that are placed in the area by third parties. To control the placement of third-party items so that they do not interfere with pedestrian movement within the station or boarding or alighting areas, it can be helpful to create specific locations for those items. A bike rack or a corral with anchors for newspaper boxes are examples of what can be installed. Docking stations or designated areas for shared mobility equipment such as e-scooters or dock-less shared-bikes may also be considered.

7.2 Platform length

Length is the distance of the station running parallel to the flow of vehicles. Generally, length is easier to accommodate than width, especially with a median station.

- In general, station length should exceed the length of the longest vehicle multiplied by the maximum number of vehicles expected to serve the station and stop concurrently. Space also must be provided for infrastructure and the transition area.
- Where a passing or through-travel lane is included, the station length should be sufficient to allow vehicles to safely and efficiently merge into the traffic lane.
- If required by the service design, sufficient space should be provided to allow multiple vehicles to serve the station without interfering with one another.

7.3 Designated location for vehicle servicing of station

This is the place on the platform designated for specific vehicles to stop when servicing the station. For example, local service may board and alight in one location while express service uses another location. If only one such spot is used, it generally should be at the end of the platform.

If multiple vehicle berths are used, the following should be considered:

- The locations should be sufficiently far apart to ensure that passenger waiting areas are clear within the station and that vehicles do not interfere with one another when entering or departing the station. The distance between vehicle stopping locations also should allow buses to pass and reduce the likelihood of congestion within the station.
- For center platform stations in street medians or for station islands at transit centers, the stops on one side of the platform should be offset from stop locations on the opposite side if high passenger volumes are anticipated or if the station width is constrained.

For facilities served by high-frequency BRT systems, sufficient room should be available before entering the station to enable buses to wait for a stop location to open without blocking the through-travel lane. For example, in **Figure 23**, the two farthest canopies accommodate bus loading/unloading for two 60-foot articulated buses, while the nearest canopy is a non-paid area housing ticket vending machines that can accommodate a third 60-foot bus, clear of the adjacent intersection. Sufficient space also is provided for a bus to pull ahead to avoid vehicle stacking in the station.

FIGURE 23
Multiple Vehicle Stopping Locations

LA Metro, Orange Line (Los Angeles, CA)

7.4 Platform area

The platform area is the interface for the customer between the station and the BRT vehicle. Some of the factors that should be considered while designing a platform area include the following:

- Efficient flow of pedestrians
- Passenger amenities, including benches, weather protection, etc.
- Compatibility with BRT vehicle door configuration
- Accessibility for people with disabilities
- Station name visible from inside the vehicle
- Clear and simple way-finding signs
- Fare collection and control systems
- Safety and security
- Emergency evacuation procedures

The total area of the platform is largely a function of the anticipated passenger load. Stations that are too small can significantly increase dwell time and cause passengers to back up outside the station area.

In addition, consideration should be given to the area necessary for passenger circulation and passenger waiting areas. The passenger waiting area should be of sufficient size to accommodate the maximum number of passengers expected to wait for any service while providing sufficient room for alighting passengers and others to circulate.

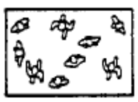
> **NOTE:** The overall station/stop area calculation excludes the tactile warning strips at the platform edge or the space for amenities and the access ramp.

The 2003 TCRP "Transit Capacity and Quality of Service Manual" developed the chart shown in **Figure 24**, which graphically depicts levels of service (LOS) regarding passenger circulation and estimates the area required for each level of service.

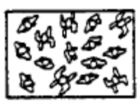
FIGURE 24
TCRP-Developed Levels of Service

LEVEL OF SERVICE A
Standing and free circulation through the queuing area possible without disturbing others within the queue.

LEVEL OF SERVICE B
Standing and partially restricted circulation to avoid disturbing others within the queue is possible.



LEVEL OF SERVICE C
Standing and restricted circulation through the queuing area by disturbing others is possible; this density is within the range of personal comfort.



LEVEL OF SERVICE D
Standing without touching is impossible; circulation is severely restricted within the queue and forward movement is only possible as a group; long-term waiting at this density is discomforting.

LEVEL OF SERVICE E
Standing in physical contact with others is unavoidable; circulation within the queue is not possible; queuing at this density can only be sustained for a short period without serious discomfort.

LEVEL OF SERVICE F
Virtually all persons within the queue are standing in direct physical contact with others; this density is extremely discomforting; no movement is possible within the queue; the potential for pushing and panic exists.

	Average Pedestrian Area		Average Inter-Person Spacing	
LOS	(ft^2/p)	(m^2/p)	(ft)	(m)
A	≥ 13	≥ 1.2	≥ 4.0	≥ 1.2
B	10-13	0.9-1.2	3.5-4.0	1.1-1.2
C	7-10	0.7-0.9	3.0-3.5	0.9-1.1
D	3-7	0.3-0.7	2.0-3.0	0.6-0.9
E	2-3	0.2-0.3	<2.0	<0.6
F	< 2	< 0.2	*Variable*	*Variable*

In general, the following formula can help determine the required area within the station or stop:

$$Area = P_{max} \times (\text{desired square footage per passenger}) + A_{inf}$$

where:
P_{max} is the maximum number of anticipated passengers in the station/stop at any given time
A_{inf} is the area required for station/stop infrastructure

7.5 Platform width

Platform width is the distance across the station perpendicular to the direction of travel. According to ADA regulations, a minimum width for a BRT station a platform is 8 feet. Width is generally a more challenging problem than length, because width is often the most limiting factor and can cause conflicts within the right-of-way. In some instances, lack of width can be compensated for by making stations longer where additional length is available, such as in underutilized medians.

Width generally is determined by right-of-way constraints. However, if right-of-way is not a constraint, then width generally is a function of the anticipated passenger load and the station's operational design. For example, width requirements can be reduced if vehicle berths are offset on either side of the station, reducing the depth needed to passenger waiting areas for those traveling in opposite directions. Station width requirements generally should account for the following:

- Width required for infrastructure (stairs, ramps, elevators, trash receptacles, ticket vending machines, signage, bike racks, etc.) within the station.
- Width required for passengers waiting for a vehicle to arrive.
- Width for passengers waiting for a vehicle to arrive in the opposite direction, particularly if the vehicle berths are directly across from each other.
- Width required for passengers to circulate within the station, particularly for purposes of entering or exiting the station.
- Width required to ensure access for passengers with disabilities (e.g., to accommodate wheelchair ramps and to permit maneuvering of wheelchairs). U.S. agencies should refer to federal guidelines or ADA requirements for transit stations.

Each jurisdiction should consider its unique requirements based upon many factors, such as the length of the bus ramp and wheelchair turning radius.

7.6 Platform height

Platform height refers to the vertical height of the station platform above the roadway or transitway:

- **Standard curb:** Platform heights match the typical surrounding roadway curb height.
- **Raised platform:** BRT platforms are built higher than a standard curb but below the floor height of a bus.
- **Level or near-level boarding:** BRT platforms match the vehicle floor height as closely as possible.

Generally, as platform height increases, project implementation risks increase and operational complexity is introduced. Implementing platforms that approximate the floor height of the bus can increase the ease of boarding BRT vehicles; however, each transit operator should carefully consider consistency, operability and constructability when deciding on a platform height.

A full range of platform heights have been implemented on BRT projects, from low curbs of 4 inches to 15 inches or even higher. Operationally, the greatest differences are introduced in how riders using mobility devices board the vehicle. Above a certain threshold (10 to 12 inches, depending on the vehicle configuration) traditional bus ramp deployment is not possible, and accessible boarding must be accommodated through platform and roadway design, docking technologies, and precise operations.

The designers and operators of BRT systems must weigh the trade-offs of increased boarding ease against the complexities of achieving this experience consistently. The requirements or maintenance considerations of partner roadway authorities are also critical to selecting a platform height. Most often, projects to date have implemented a raised platform. The next-most popular is a standard curb, with level boarding chosen less frequently.

Platform heights can also vary within a project, with heights varying between stations depending on constraints or operating conditions. Designers and operators must carefully balance the choice of consistency between stations or lines with the advantages of higher platforms.

7.6.1 Regulatory context

Federal regulations and definitions inform platform height definitions and requirements. 36 CFR 1192, modified Dec. 14, 2016, defines level boarding for non-rail vehicles (T404):

> Where the space between the floor of non-rail vehicles and a boarding platform is greater than 2 inches horizontally or 5/8 vertically when measured at 50 percent passenger load with the vehicle at rest, non-rail vehicles shall provide ramps or bridgeplates.

The design and function of ramps and bridgeplates is primarily a vehicle specification topic and is separately described in these standards. However, because of the relationship to platform design, the definitions and requirements from Section T402 are shared below:

> Ramps and bridgeplates provided on large non-rail vehicles shall be permanently installed and power operated. Exception: Ramps and bridgeplates on large non-rail vehicles that serve only designated stops with boarding platforms providing level boarding and alighting shall not be required to be permanently attached and power operated provided that portable ramps or bridgeplates capable of deployment to the roadway are carried aboard.

These requirements speak to the experiences and design approaches employed on BRT systems. To a certain point, traditional ramp deployment is achievable. Above this height, a level boarding system is used with a stowed manual bridgeplate that is available if necessary. Vehicles may be used across a range of lines and stations and may have both a traditional ramp (powered and permanently installed) and a detachable ramp used only at level platforms in rare cases.

7.6.2 Standard curb

Typical standard curb heights rise 6 inches above the roadway. This application generally requires no specialized infrastructure and most closely resembles local bus boarding. A standard curb also allows for a minimal horizontal gap between the platform and bus, requiring little or no step across a horizontal gap when entering the vehicle.

While additional costs and timelines are minimized, this option results in a larger vertical gap between the platform and vehicle. Even with low-floor coaches, a vertical step up to the vehicle is necessary. The vertical gap can be reduced at the front door through "kneeling" technology used on most buses; however, this is typically limited to a maximum of 4 inches. Repeated kneeling can also increase wear on bus components and takes several seconds to lower and raise the vehicle. Access into the coach for passengers with disabilities is achieved with standard ramp deployment, the use of which may increase dwell times.

While simpler from an operations and engineering standpoint, standard curbs offer less ability to distinguish BRT service from local bus service, and BRT platform space is less distinct from surrounding sidewalks. Still, other platform design choices can differentiate the BRT station platform.

Examples of BRT systems using standard curbs include Los Angeles Metro Rapid, AC Transit BRT, Columbus CMAX, Kansas City Main Street MAX, San Diego Broadway corridor, Orlando LYMMO, and the York Viva.

FIGURE 25
Standard Curb Boarding

LA Metro, Orange Line (Los Angeles, CA)

7.6.3 Raised platform or curb

The raised platform/curb option attains a platform height somewhere between a standard curb and a level platform. This option offers some of the benefits of a level platform but reduces the potential for vehicle damage and can also be employed in a wider range of roadway contexts and constrained operating environments. While there is no standard height employed for this approach, a raised platform typically refers to a height between 9 and 11 inches above the roadway and allows for standard mobility ramp deployment from the BRT vehicle.

A raised platform or curb reduces but does not eliminate the vertical gap in most cases. Even with bus kneeling technology, a small vertical step is required to enter the vehicle. Depending on the chosen height, a horizontal gap may be necessary to avoid fleet damage as vehicles approach the station.

The raised platform addresses the problem of potential vehicle damage, reducing risk concerns. As height increases, these concerns begin to be reintroduced and must be mitigated. At their lowest point, typical wheel lug nuts are about 10 in. above the roadway. The lowest point of a typical vehicle body is 9 to 10 in. above the ground, raising the prospect of platform strikes by approaching vehicles. Thus, platforms taller than 10 in. may need to employ docking assist systems such as a rub rail, stepped curb or other methods.

A raised platform surface can provide additional distinction of BRT service from typical local bus service, while providing a boarding height available to other transit vehicles. This can be an important consideration if a station is served by both BRT and other transit services.

As with level boarding, when contemplating a raised platform, consideration must be given to the additional cost, infrastructure and time needed for construction, as well as accessibility implications regarding the sloped access from the street level to the end of the platform.

7.6.4 Level or near-level boarding

This option attempts to most closely resemble rapid transit applications by almost eliminating the vertical gap between the vehicle and the platform. Level boarding suggests a seamless transition into the vehicle and a perception of reduced dwell times and faster boarding attributed to customer ease. Unlike rapid transit, however, a horizontal gap is omnipresent due to existing vehicle design limitations.

To eliminate the vertical gap, the curb is raised to the height of the vehicle floor at the doorway opening. Depending on the vehicle type, station platform heights are raised to 14 to 15 inches above the roadway. Level boarding seeks to consistently eliminate any vertical step up into the vehicle. In most cases, a traditional mobility ramp cannot be deployed from this platform height, so bridge plate-type systems are employed to ensure vehicle access. To ensure effective use of bridge plates, curb heights will need to be consistent and slightly lower than the bus, along with training for operators in raising and lowering the bus to effectively address variations in operating conditions.

As the vertical gap is minimized, the horizontal gap between the vehicle and platform may increase, resulting in a trade-off between vertical and horizontal dimensions. These vary depending on vehicle type and require docking assistance technologies for safe and consistent operation. In particular, articulated buses require horizontal separation from the boarding platform of 3 to 5 inches to allow for the inward swinging movement of the trailer section as vehicles pull away from the platform. This can be mitigated somewhat by having a long tangent pull-away zone if roadway configuration permits. A horizontal gap is also necessary to accommodate lug nuts on vehicle wheels.

Level boarding platforms are visually distinct from surrounding environments, providing an opportunity for a distinct brand and image. In many cases, local buses cannot or do not serve these platforms, creating an exclusive BRT-only environment as a premium service.

FIGURE 26
Level and Near-Level Boarding

RTC Transit, Metropolitan Area Express (MAX) (Las Vegas, NV)

Lane Transit, Emerald Express (EmX) (Eugene, OR)

The benefits of a level platform include increased customer perception of service; ease of boarding for all customers (anticipated to manifest as quicker boarding and reduced dwell times); potentially the elimination of the need for wheelchair access ramps or lifts; stronger brand identity; and greater similarity to rail-type services.

When contemplating a level or raised platform, there are many additional factors to consider. These may result in additional cost, infrastructure, or complexity in both the construction and operation of BRT systems. These are described in the following section.

Examples of cities where level or near-level boarding has been implemented include the EmX in Eugene, Oregon; the Prospect MAX BRT in Kansas City, Missouri; the CT Fastrak project in Hartford, Connecticut; the ART project in Albuquerque, New Mexico; Pulse Milwaukee Line in Chicago, Illinois and the HealthLine in Cleveland, Ohio.

7.6.5 Platform height decision factors

There is no singular practice recommended for BRT platform height. A range may be implemented with equal success depending on the constraints and priorities of a given system. Instead, a range of design factors should be considered when determining a platform height. Some of the primary factors are described in this section.

7.6.5.1 Vehicle variability

The floor height of BRT vehicles can vary significantly, including between doors of the same bus, with differential loading of the vehicle (total and depending on which side of the bus is more heavily loaded), within the same vehicle over time and condition, and between BRT buses within an operational fleet. These can vary by several inches, resulting in inconsistency when seeking to accomplish “level” boarding that meets requirements for both a < ⅝ inch vertical gap and < 2 inch horizontal gap. Most BRT vehicles can accommodate some adjustment in ride heights to help attain more consistency in level boarding. Vehicle doors vary and can limit platform design choices. Some door types swing out over the platform, have mounting brackets or weather stripping that interferes with door operation if the platform is built to the floor height of the bus. Raised platform or standard curb platforms avoid these complications. In general, “slide-glide” style door operation provides reduced conflict potential for taller platform curbs, as compared with swing-out or plug-style vehicle doors.

Finally, vehicle heights can change between generations of buses and over time. BRT platforms are long-term investments intended to last 50 years or more, whereas bus heights can change across a shorter time horizon as BRT vehicles are replaced every 12 to 14 years and are continuously improved as the transit industry evolves. Potential changes in bus floor heights may occur as vehicle electrification increases, with the potential for vehicle design to radically change if lower floor heights result. BRT vehicles are mechanically similar to standard buses, and future vehicles are likely to reflect the prevailing vehicle of their time.

7.6.5.2 Roadway variation

As bus floor heights vary, so can roadways. Level boarding is complicated by typical roadway slope and cross-slope design. Roadway cross-slope may cause a BRT vehicle to lean toward the platform, creating complications for boarding. Further variability and complication can result from settling, rutting or deterioration of the running way surface. To mitigate this condition, concrete pads in the roadway are recommended at stations.

Roadways can be designed to limit this variation, such as installing concrete pads in the roadway at stations. In order to enhance level boarding, the pads need to be constructed to closely match station vertical dimensions. In extreme cases this may entail changing roadway slopes. These considerations may result in greater costs as more exact construction tolerances, more robust station roadway designs, and storm water considerations increase project design and construction complexity.

7.6.5.3 Station approach

As platform height increases, additional space is required to achieve a consistent and acceptable horizontal gap. A straight approach to the station is necessary to bring vehicle doors to the boarding platform. With level boarding platforms, a minimum 100 ft straight approach (tangent) must be incorporated, in addition to the desired platform length. The approach tangent may need to be longer if the approach to the station immediately follows a turn by the BRT vehicle. In conditions where BRT buses pull off main roadway or transitway lanes, turn a corner or curve to reach the station, or navigate within dense urban environments with unpredictable disruptions (delivery vehicles, utility work or event detours, to name a few), large horizontal gaps may result at BRT stations. In these conditions, level platform boarding may not be consistently achievable, or platform access may be farther from desirable intersection locations. Alternatively, designing and implementing straight approaches to stations may increase the area impacted by construction and/or result in increased right-of-way needs and project impacts compared with a raised or standard platform.

7.6.5.4 Station access

Roadway intersections and crossings present complications for raised and level platform design. Intersection and station access ramps must be designed for accessible use. To reach a taller platform, access ramps must be either steeper, longer or both. Maximum slope pedestrian ramps (8 percent) require significant additional treatment beyond typical pedestrian ramp slopes (5 percent) to accommodate persons with mobility issues. Specifically, 5-foot by 5-foot landing pads are required between ramp segments; individual segments also cannot exceed a 30-inch rise; and handrails are required along the ramp where the slope is between 5 and 8 percent. In addition to greater difficulty for some users, this condition can result in higher platforms being located farther from intersections, or in different locations if driveways or block lengths do not enable requisite height and access.

7.6.5.5 Bike boarding and storage

Bicyclists are frequently allowed to bring a bicycle along a transit trip, either on a rack on the front of the vehicle or aboard the vehicle itself. As platform height increases, loading a bicycle on the exterior rack on the front of a bus becomes more complex due to the increased step down to the vehicle. Typically, platforms up to 10 to 11 inches high do not require special provisions to access the roadway to load a bicycle. Typical comfortable step height is 5 to 7 inches in architectural contexts, though cyclists may be comfortable with an increased step height. Above this height, steps and/or a railing may be provided to enable cyclists to reach the roadway. This can create additional maintenance, particularly in winter conditions, or require bicycle storage onboard BRT vehicles. Storing bicycles aboard the vehicle is generally popular and may be of interest to a wider range of abilities compared with the strength required to step down to the roadway and to lift, reach and operate external racks. But onboard storage can significantly reduce the seated or standing capacity of a BRT vehicle. Onboard racks vary in complexity, space required and displaced seats.

7.6.5.6 Winter conditions

In regions that experience snow and ice, BRT platform height presents special considerations of design, maintenance and features. As platform height increases, so does the importance of keeping snow and ice clear from both the platform and the roadway adjacent to the platform. Horizontal and vertical gaps can change due to snow and ice conditions at stations, to the point that consistent operations cannot be achieved, particularly with level boarding.

For BRT systems located along roadways (even with exclusive BRT lanes), a snow event may require several return trips to keep the platform and gutter area clear of snow and ice as roadway plowing operations iteratively clear the roadway surface. To improve customer experience under these conditions, refer to strategies outlines in Section 3.10.

7.6.5.7 Service design

Taller platforms may require specialized fleets. While typical for BRT operations, transfer opportunities to other services may be diminished if the platform allows for only some vehicle types. In addition, these operations could impair service reliability if regular buses cannot be used for BRT operations. If bus transfers are made via a separate stop location, then additional space must be secured for transit boarding, potentially requiring additional facilities. If this space is not available along the same block face or if customers must cross driveways to reach a transfer location, then reduced convenience and safety for transfers may offset the benefits of an elevated BRT platform.

7.6.5.8 Docking technology

A range of technologies and approaches have been used to help BRT vehicles minimize the horizontal gap and prevent curb strikes when approaching BRT stations. While station approach length and operator skills remain the primary factors in successful docking, assistance technologies have been employed on many systems.

The most common docking assistance technology is a stepped curb using a “rub rail” along the platform face. Typically a hard plastic resin bolted to the curb face, a rub rail allows BRT operators to guide the bus along the rail without damaging vehicle tires, wheels or body components. Rub rails are used in most systems using higher raised (10 inches or higher) or level (14 inches or higher) platforms.

Other approaches have been employed, including Kassel curbs, magnetic or other electronic docking technologies, or mechanical guide wheels on the vehicle. Still other systems have used gap-filling flexible plastic or rubber systems on the vehicle or platform space. Increased sensor-based technology systems are anticipated to become commercially available on buses in the future, similar to technology used in passenger vehicles. As of early 2020, few such systems are available. Component origin sourcing and liability considerations, combined with the small/specialized nature of the BRT market, may limit the pace or extent of product development.

7.6.5.9 Travel time

While the highest platform designs are intended to minimize dwell time at stations by increasing ease of boarding and avoiding ramp deployments, these features may come at a cost to overall travel time. To dock at a high platform, a slower approach speed is often necessary to avoid fleet damage. Compared with an occasional ramp deployment, a slower approach to every station on every trip may result in longer travel times and less attractive service. Driver skill can mitigate some of this delay over time, but higher platforms still come with added risk of platform strikes or inconsistent service delivery, especially if increased horizontal gaps result from faster station approaches.

7.6.5.10 Operations and training

Skilled operators remain the primary factor in attractive and reliable transit service. Currently, no amount of technology or infrastructure can substitute for a skilled operator focused on customer service. Practice, training and experience are necessary for successful operations at raised and level boarding platforms. Additional classroom and vehicle-based training are needed for taller platforms, especially when they approach level boarding. Maintaining this level of training and skill is an ongoing investment as turnover or extra board operations bring varied levels of driver experience to BRT systems. Level boarding presents the most challenging operations environment, because operators and customers must judge whether the vehicle is close enough to the platform to attempt roll-on boarding for a range of devices, or if a powered or manual bridgeplate must be deployed. This can present safety and liability concerns, or customer experience issues that undermine the goals of providing a level platform.

While no standard industry practices have yet emerged, attention to the curb height of a BRT station is a critical component of the overall planning for the system. While standard curbs may be easier and quicker to implement, raising the curb to a level or sub-level height may increase the benefits and improve perception of the BRT service. Generally, the raised platform at a BRT station provides a qualitative improvement in customer convenience and helps reinforce the brand and image of BRT as a premium product.

8. Support systems

Once the desired station and stop amenities are identified, they should be considered in context with one another and within the surrounding environment. It is critical to identify requirements up front and to inventory the existing support systems. The following support system needs should be addressed early in the design phase.

8.1 Safety and security

In planning BRT stations or stops, consideration should be given to Crime Prevention Through Environmental Design (CPTED) The basic tenet of CPTED is that "The proper design and effective use of the built environment can lead to the reduction in the incidence and fear of crime and thereby improve the quality of life. In other words, if a site is laid out well, the likelihood of it being targeted for a crime may be reduced." Key principles of CPTED include:

- Natural surveillance
- Territorial reinforcement
- Natural access control
- Maintenance

CPTED recommendations for BRT stations include the following:

- Having no entrapment areas
- Providing escape routes
- Creating clear and unobstructed sight lines and using convex mirrors where necessary
- Conducting regular inspections and maintenance to deal with hazards
- Ensuring that platforms and pedestrian pathways are well-lit and highly visible
- If the station is not attended, considering providing remote video monitoring and a call box that connects directly with the system operator and/or the police
- Creating signage, announcements, etc.
- Removing ice and snow
- Choosing plant species to prevent screening issues and ensure proper sight lines

Care must be exercised to balance the need for safety and security elements with the provision of an attractive, comfortable station. CPTED guidelines provide for a more aesthetically appealing approach to safety and security elements, focusing on the use of the natural environment to control antisocial behaviors and improve quality of life. Branding strategies support CPTED techniques by creating a sense of ownership and defining BRT stations. Additional information is available in the APTA recommended practice "Crime Prevention Through Environmental Design (CPTED) for Transit Facilities," APTA SS-SIS-RP-007-10.

In the U.S., transit projects eligible for FTA Section 5309 funding or other forms of federal assistance are required to implement a safety and security certification program as part of a project management plan. In addition, for all FTA New Starts projects, a safety and security management plan is required. Stations are one component of this plan and certification process. For more information, refer to 40 CFR Part 633.5, Chapter IV, of FTA Circular 5800.0.

More guidance can be found in TCRP Report 90: "Bus Rapid Transit, Volume 2: Implementation Guidelines." Some specific points to consider include:

- Implement proactive safety and security practices, and train staff and customers to recognize and act on potential threats.
- Develop procedures to deal with threats.
- Facility design should include a review by safety and security staff.
- Implement a preventive maintenance program that identifies standards, response times, inspections and a documentation trail.
- Consider installation of tactile strips.
- Develop an appropriate maintenance program to minimize and respond to equipment failures, such as lighting, video monitoring, alarms, call box, phones, etc.
- Conduct threat risk assessment on facilities based on an established schedule.
- Develop a program for regular patrols.
- Ensure that enforcement staff have adequate enforcement powers and a joint service agreement with the local police authority.
- Establish database and analysis tools to tabulate safety and security data to identify trends, areas of concern, and to implement corrective measures.
- Consider waste containers that avoid concealment of foreign objects and avoid materials that could become projectiles.
- Secure benches, bike racks and other accessories to avoid theft and damage.
- Determine civic addresses for all BRT facilities so emergency responders can locate them in their systems.
- Consider implementing a routine graffiti-removal program.

8.2 Maintenance

Determine how the station amenities will be cleaned, repaired and refurbished. Consider whether the work will be done on-site or will require that components be removed and replaced. Consider the impact on the riders and transit operations at the location, as well as other traffic operating near the facility during maintenance activities. These requirements will suggest what support systems are needed for maintenance, such as pressure-washer trucks, flatbed trucks or direct access to water and electricity.

8.2.1 Maintenance and life-cycle cost considerations

Decisions on station and platform configurations, location, and design should be influenced by operating and capital costs, and by the ongoing arrangements for life-cycle maintenance. This is the maintenance beyond day-to-day cleaning and repairs, when major reconstruction is required, or when important elements of the station require replacement.

Planning should consider how the station will operate during maintenance. For example, will vehicles continue to operate normally, and will customers be able to use the platforms normally? An agency may decide that the best approach is to build redundancy into the design, for example allowing two lanes in a station so buses can pass a work zone, or two stairways to a platform or two shelters on a platform so customers can use one while the other is repaired or rebuilt. An agency may also decide that immediate capital savings are worth more than future short-term inconvenience and when the major maintenance is performed, buses will detour off the normal route, or when a stairway is rebuilt customers will cross the busway at grade, or that the station will be temporarily closed.

Design should include elements that help reduce maintenance. For example, stainless steel railings can be self-polishing, and minimizing vertical surfaces can reduce graffiti, posters and other unwanted markings.

Space for maintenance activity, maintenance vehicles, materials and snow storage (where applicable) should be considered in the design. Consideration should be given to ensuring that service vehicles can access stations and park near them, if required. Also, standardized components, power and water needs, and other issues should be considered in the design.

Agencies should consider life-cycle maintenance procedures and costs along with construction costs and regular operating costs.

If the BRT alignment is built adjacent to an active right-of-way, such as a railroad, the operator of that facility may require access through the BRT right-of-way for maintenance activities.

Related APTA standards

APTA-BTS-BRT-RP-001-10, Rev. 1, "BRT Branding, Imaging and Marketing"
APTA-BTS-BRT-RP-003-10, Rev. 1, "Bus Rapid Transit Running Ways"
APTA BTS-BRT-RP-004-10, Rev. 1, "Bus Rapid Transit Service Design and Operations"
APTA-BTS-BRT-RP-005-10, "Implementing BRT Intelligent Transportation Systems"
APTA-SUDS-UD-RP-007-13, "Best Practices for Integrating Art into Capital Projects"

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Abbreviations and acronyms

ADA	Americans with Disabilities Act
BRT	bus rapid transit
CCTV	closed-circuit television
CPTED	Crime Prevention Through Environmental Design
FTA	U.S. Federal Transit Administration
LEED	Leadership in Energy and Environmental Design
LOS	level of service
NACTO	National Association of City Transportation Officials
NATSA	North American Transportation Services Association
NEPA	National Environmental Protection Act
TCRP	Transit Cooperative Research Program
TNC	transportation network company

TOD transit-oriented development
TSP transit signal priority
TVM ticket vending machine
UD universal design

Summary of document changes

- Focused recommendations on "stations" rather than "stops" and removed "stop" from the Recommended Practice title
- Removed "enhanced stops" section
- Changed station types to "basic" and "premium" to more closely align with FTA BRT definitions
- Added more on "freeway" stations
- Expanded discussion of "amenities"
- Expanded discussion of "design considerations"
- Removed outdated text, images and references
- Added more current BRT examples and images
- Re-organized document for improved logic and flow

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	CEO Approval	Policy & Planning Approval	Publish Date
First published	—	—	—	—	October 2010
First revision	Sept. 14, 2020	Oct. 31, 2020	Nov. 30, 2020	Dec. 10, 2020	Dec. 11, 2020
Second revision	—	—	—	—	—

Appendix A: Station layout diagrams

FIGURE 27
Enhanced BRT Station Layout (Everett, Washington)

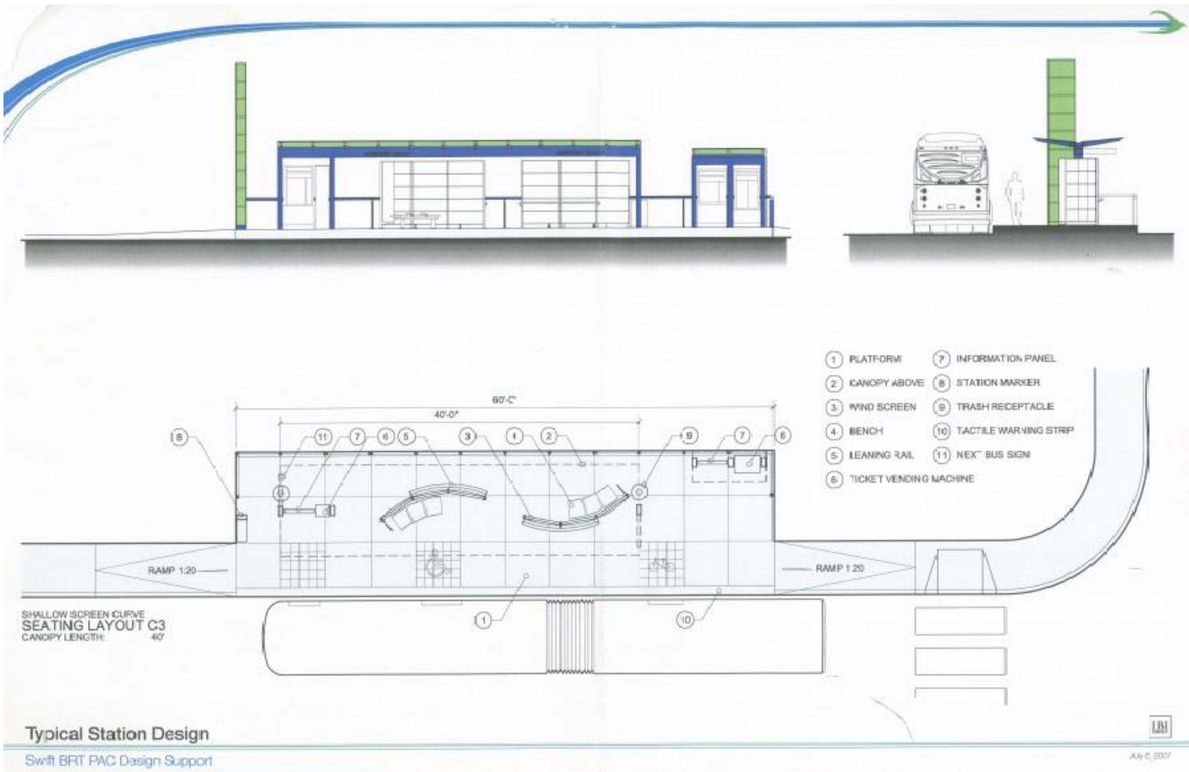

FIGURE 28
Enhanced Station Zone Layout (King County, Washington)

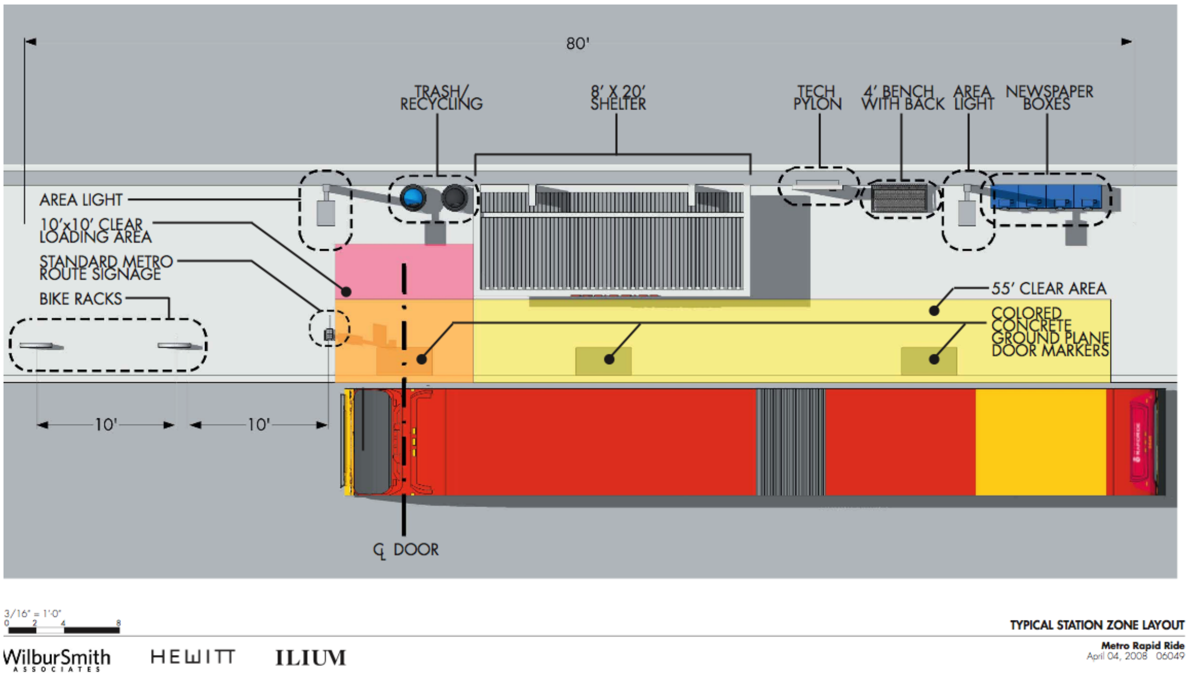

FIGURE 29

Off-Street Station with Curbside Platform Layout (Allegheny County)

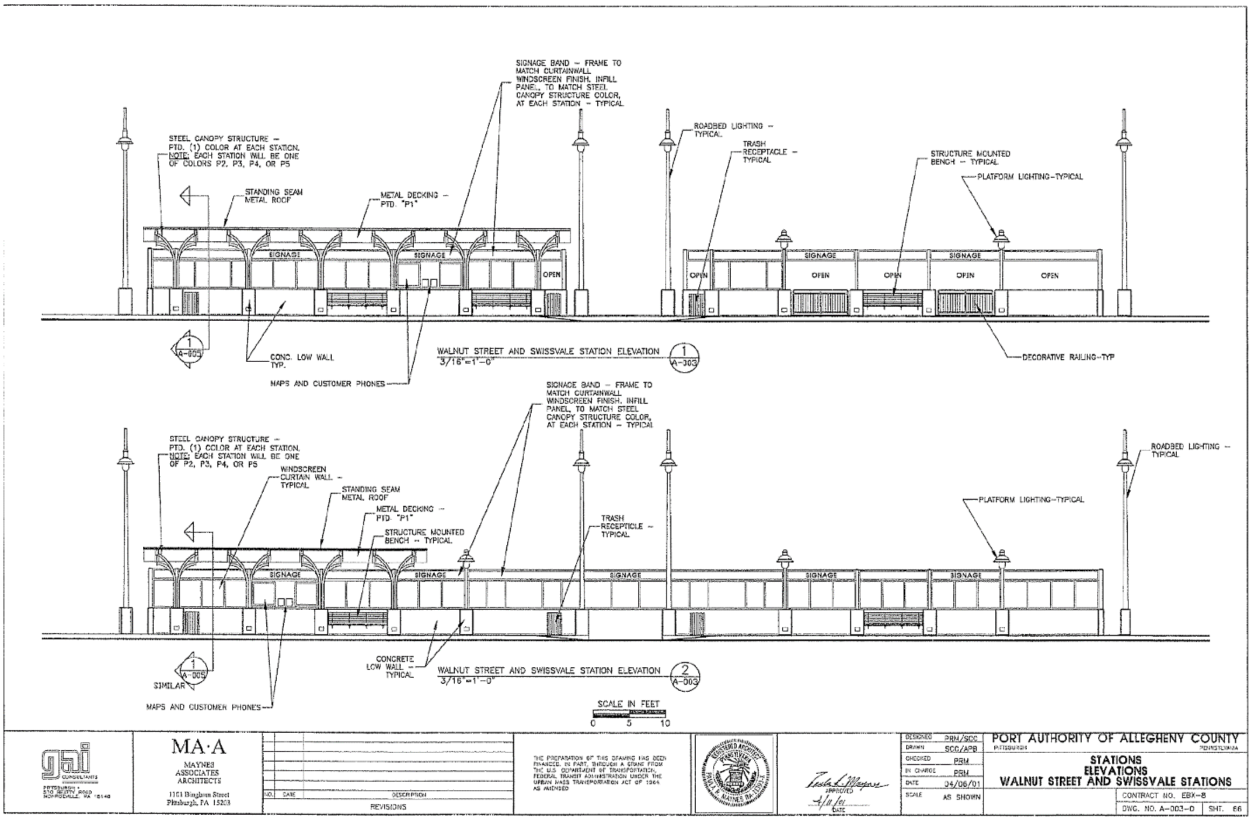

FIGURE 30
St. Barnabas Station Layout (Allegheny County)

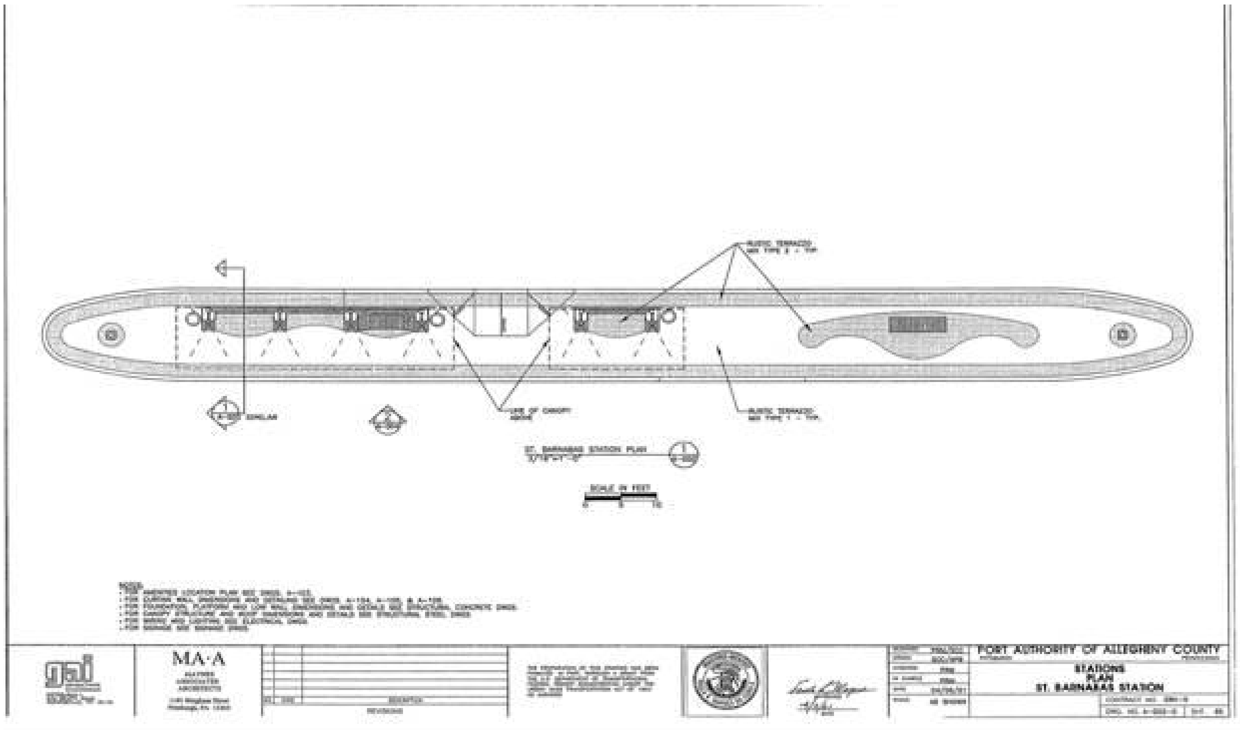

FIGURE 31
End-of-Line Station with Center Island Layout (Ottawa)