Technical Memorandum on Conceptual Design Standards

Introduction

The purpose of this document is to provide design standards for conceptual design of transit facilities and associated roadway modifications for the PdN HCTS short-listed alternatives. The document addresses Bus Rapid Transit (BRT) busways and lanes, BRT stations, and roadway and intersection modifications to accommodate BRT. Current standards of Rio Metro Regional Transit District (RMRTD), ABQ Ride, the City of Albuquerque, the City of Rio Rancho, and the New Mexico Department of Transportation are adopted for use where appropriate. In addition, nationally recognized BRT design guidelines have been used where local agency standards lack sufficient transit guidance. The design standards will provide a basis for developing conceptual designs of the alternative routes being considered.

Definitions

- **Bus Rapid Transit (BRT):** Frequent, faster and higher-capacity bus service that is designed as an integrated system of service, facilities and strategies that distinguish it from regular bus service. The elements of bus rapid transit can vary depending on the operating environment and may include priority through separate right-of-way, preferential treatments at intersections, intelligent transportation systems, as well as other actions that improve bus speed and reliability, including limited stops, vehicle design, fare collection systems and high-quality bus stations that allow for greater efficiency. Bus rapid transit is often branded to promote the service as unique from regular bus transit service.
- **Busway:** A section of a roadway reserved for buses only.
- **Bus Lane:** A roadway lane dedicated for bus transit vehicles.
- **Curb Lane:** The outer driving lane on a roadway adjacent to the curb or roadway edge, typically not used to describe the lane adjacent to a median curb and typically exclusive of any shoulder.
- **Business Access and Transit (BAT) Lane:** A roadway lane designated for use by vehicles accessing roadside businesses and for transit buses. Because of the roadside access function, BAT lanes are typically the outer lane, or curb lane, on a roadway. At intersections, BAT lanes may also serve as general purpose right-turn lanes.
- **Mixed-use Lane:** A roadway lane open for use by differing types of vehicles. Examples may include a lane shared by general traffic and bicyclists or a lane shared by general traffic and buses.
- **Guided Busway:** A busway physically separated from other roadway lanes and elements by barriers such as curb, metal or concrete railing, or other physical features. A guided busway can include a guidance system that uses the separating barriers or other means to guide bus vehicles.
- **Non-Guided Busway:** A busway that is not physically separated from other roadway lanes. Typically striping, rumble strips, pavement markings and/or unique pavement coloring are used to distinguish the busway from adjacent roadway lanes.
- **Median Busway:** A busway located in the median or middle part of a roadway where general traffic operates on each side of the busway.
- **Side-Running Busway:** A busway located along one side of a roadway and separated from the roadway by a physical barrier.

- **Queue Jump:** A form of transit signal priority where there is a separate signal phase for transit vehicles so they can advance ahead of other traffic. Queue jumps can be partnered with a queue bypass lane or may operate from a regular traffic lane.

Standards for BRT Busways, Bus Lanes, and Stations

For the purpose of this study, development of conceptual designs for BRT busways, bus lanes and stations should strive to balance achieving the highest level of service with the least cost and impact to existing roadway corridors. Where practical, desirable design criteria values should be used. Where use of desirable values would result in unreasonable costs or impacts, minimum values may be used, but only in the most constrained conditions.

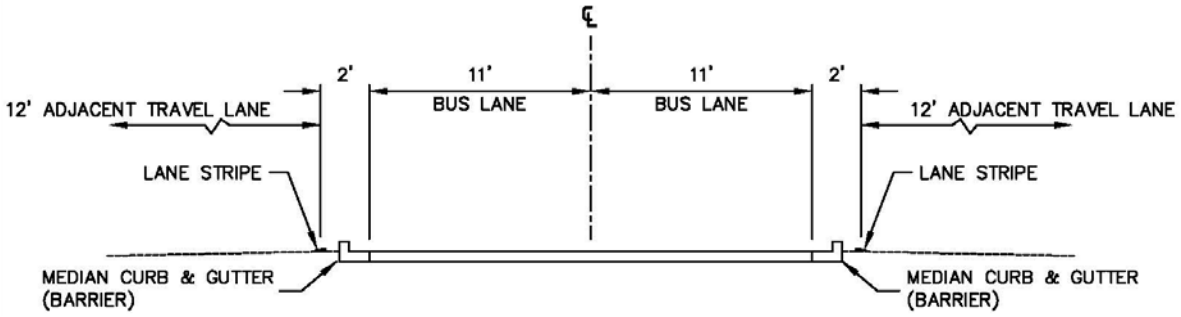
Cross-Section Design

BRT buses may operate in median or side-running busways dedicated to BRT vehicles, BRT curb lanes dedicated to BRT or other bus transit vehicles or mixed-use lanes that accommodate both general traffic and BRT vehicles in mixed flow. Busways and bus lanes dedicated to BRT vehicles are less affected by congestion than mixed-use lanes and therefore offer greater service reliability. Busways may be configured as either two-lane (two-way) or one-lane (bi-directional), and may be guided (separated from adjacent traffic), or non-guided (not separated from adjacent traffic). The various types of busways and lanes that may be implemented on this project are described below and depicted in the typical sections on the following pages.

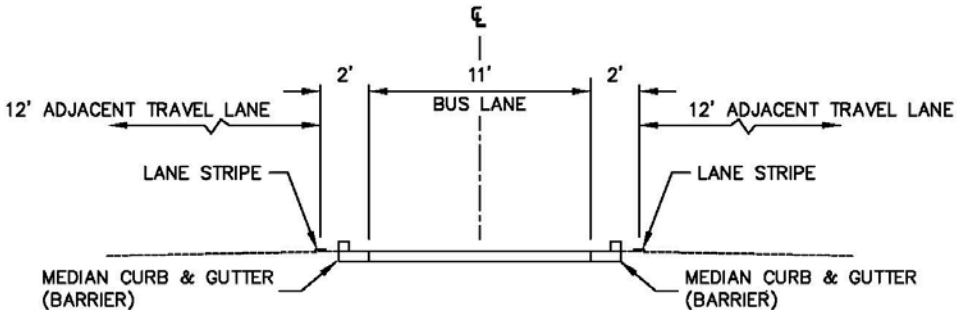
A **guided BRT busway** is separated from non-BRT traffic by a physical barrier such as a barrier curb or other physical feature. The use of a physical barrier prevents non-BRT traffic from entering the busway and thereby provides greater service reliability. Automated bus guidance systems that use the separating barriers or other means can be incorporated into guided busways but are not required. Guided busways can be located in the roadway median or offset to one side of the roadway. These are known as either a guided median busway or a guided side-running busway. American Public Transportation Association (APTA) Standards for Designing Bus Rapid Transit Running Ways (APTA-BTS-BRT-RP-003-10) recommends 11-foot wide bus lanes for separated busways in constrained areas. For separated busways that are guided by curbs or another type of barrier, APTA indicates that lane widths can be reduced to as narrow as 8 feet-10 inches. This should be considered an absolute minimum applicable only for short runs on tangent sections. On curved sections, 10 feet-6 inches should be considered the absolute minimum width and only applied for short runs. Figures 1 and 2 show typical sections for guided median and side-running BRT busways respectively.

A **non-guided BRT busway** is typically located within the roadway median. This design does not have a physical barrier between the bus lanes and outside traffic. Instead, a painted stripe and rumble strip is used to delineate the busway from adjacent traffic lanes. APTA Standards recommend 11-foot wide bus lanes and 1 foot-6 inch wide separator spaces on each side of non-guided busways. See Figure 3 for non-guided median BRT busway typical sections.

Figure 1: Guided Median BRT Busway Typical Sections

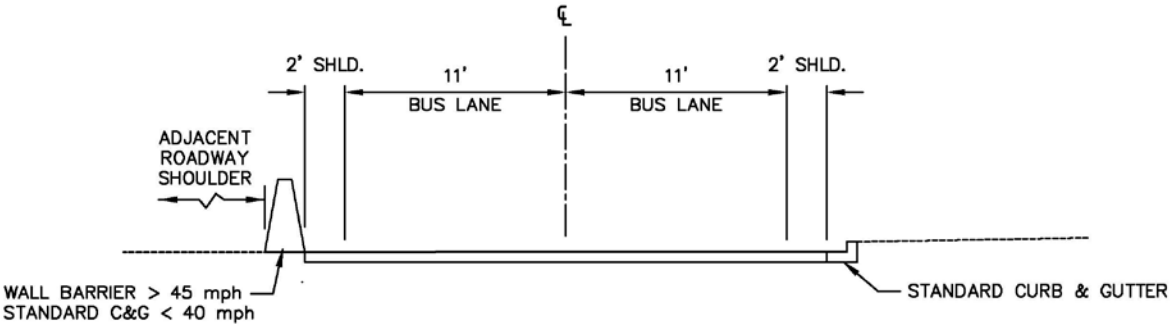


Two-lane (Two-way) Configuration

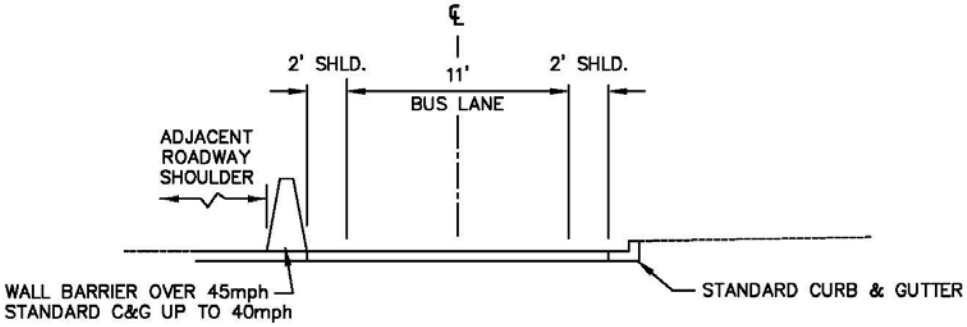


One-lane (Bi-directional) Configuration

Figure 2: Guided Side-Running (Separate) BRT Busway Typical Sections

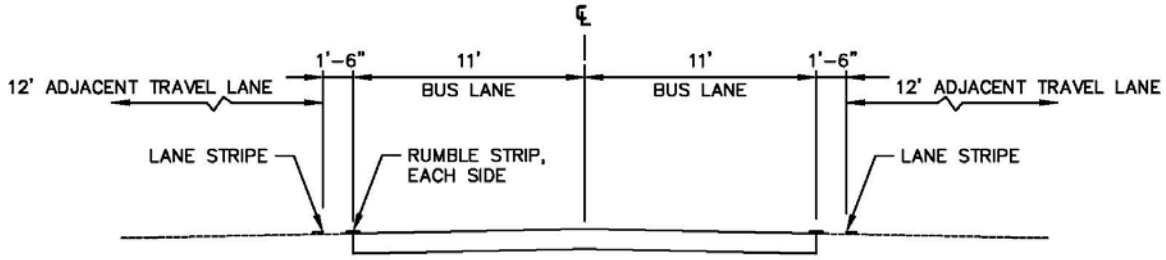


Two-lane (Two-way) Configuration

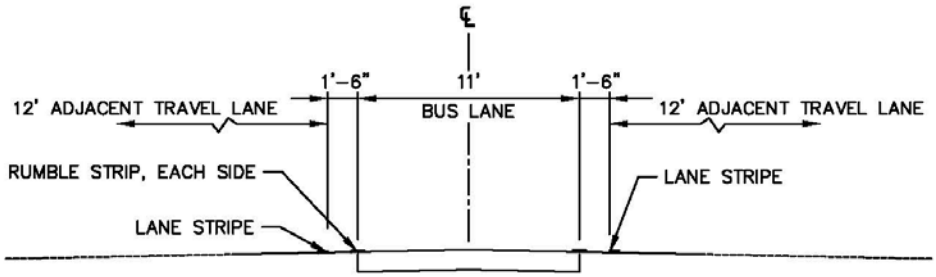


One-lane (Bi-directional) Configuration

Figure 3: Non-Guided Median BRT Busway Typical Section



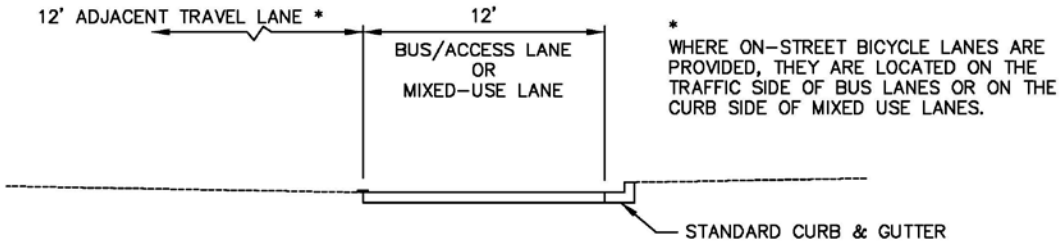
Two-lane (Two-way) Configuration



One-lane (Bi-directional) Configuration

A **BRT curb lane** is a dedicated lane adjacent to the outer curb of the street. This lane is not separated from other traffic by a physical barrier and may be used as an access lane for traffic exiting the roadway. When also used for access, this arrangement is commonly referred to as a Business Access and Transit (BAT) lane. BRT curb lanes and BAT lanes may also serve as a right-turn lane at intersections. Signing and pavement markings are used to delineate a BRT bus-only lane or BAT lane. The lane width of a BRT curb lane or BAT lane is the same as a mixed-use lane. For mixed-use lanes, signing and pavement markings may be used to identify the lane as a BRT bus lane. APTA recommends a minimum width of 12 feet for BRT curb lanes/BAT lanes and mixed-use lanes. Figure 4 shows a typical section of a BRT curb lane/BAT lane or mixed-use lane. Where on-street bicycle lanes are provided, the bicycle lane should be located between the BRT curb lane and general traffic lanes and should be a minimum of 6 feet in width. In mixed-use lane situations, on-street bicycle lanes should remain in the typical location adjacent to the outer curb and be the customary width defined by the standards of the local governing agency.

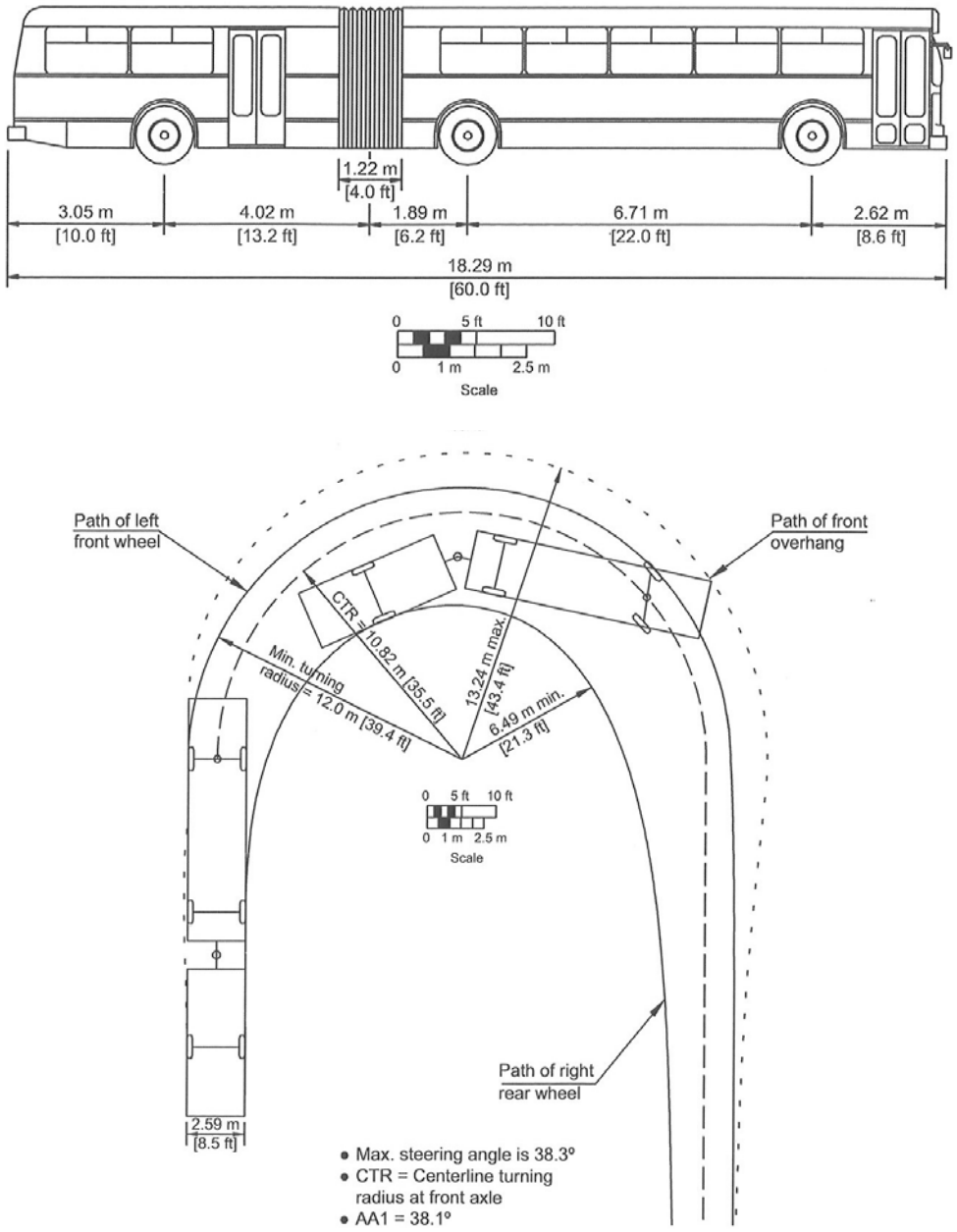
Figure 4: BRT Curb Lane/BAT Lane, or Mixed-Use Lane Typical Section



Design Vehicle

The design vehicle for BRT busways will be a 60-foot long articulated bus. AASHTO designates this vehicle as Articulated Bus (A-BUS). Busway alignments, intersection areas, and turning movements will be checked to ensure that this vehicle can be accomodated at all locations along the route. Figure 5 shows the minimum turning path for the design vehicle. Vehicles other than A-BUS may be selected where appropriate for design of specific elements of the BRT system or roadway areas along the study corridors.

Figure 5: Articulated Bus (A-BUS) Minimum Turning Path



Source:
AASHTO A Policy on Geometric Design, 6th Edition, 2011

Alignment Design

APTA has developed standard design criteria for BRT systems that are applicable to this project. Selected APTA criteria are included in Table 1 and will be used for conceptual design of the BRT running ways. Because the BRT running ways will be located on existing roadway corridors and constrained by the existing roadway features and rights-of-way, the criteria identified below will be followed where feasible but may vary due to existing conditions.

Table 1: Selected APTA Design Criteria for Separate BRT Busways

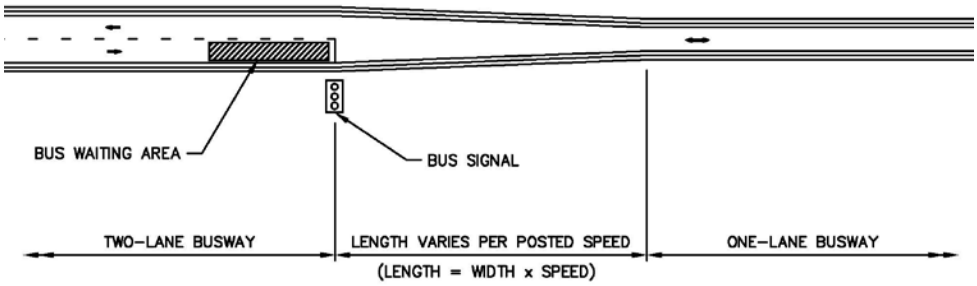
Design Parameter	Non-Guided Busway	Guided/ Separate Busway
Design Speed (MPH)	Match Existing Street	30-50
Alignment		
Stopping Sight Distance (ft.)	Per Design Speed/AASHTO Standards	Per Design Speed/AASHTO Standards
Desirable Min. Curve Radius (ft.)	Match Existing Street	500
Absolute Min. Curve Radius (ft.)	265	265
Max. Superelevation (Between Stations)	Match Existing Street	3%
Max. Superelevation (At Stations)	2%	2%
Min. Tangent at Station/Platform Ends (ft.)	65	65
Gradient		
Desirable Maximum	Match Existing Street	5%
Absolute Maximum	8% (run of 500' or less)	8% (run of 500' or less)
Range at Stations	0.5%-2%	0.5%-2%
Minimum	Match Existing Street	0.30%

Source: American Public Transportation Association (APTA) Standards for Designing Bus Rapid Transit Running Ways (APTA-BTS-BRT-RP-003-10) and the Transit Cooperative Research Program Report 118.

Where existing conditions require that a two-lane busway is reduced to a single lane, the following criteria will apply.

1. Transitions from two-lane to one-lane busways shall be signal controlled.
2. Transitions shall accommodate smooth flow at the posted speed limit (see Figure 6).
3. The length of one-lane busway shall be limited to one-half mile or less.

Figure 6: Transition from Two-lane to One-lane Busway



Station Design

For the conceptual design of alternatives, basic station footprints will be used to assess needs and impacts. Stations will be designed to accommodate simultaneous docking of two articulated buses at level or near-level boarding height. For median stations, it is assumed they can be served by vehicles that have left and right side doors and are not constrained by vehicles with only right side doors.

The types of stations that will be used for the conceptual design are a median station and a curb-side station. Basic station dimensions are shown in Table 2 below.

Table 2: BRT Station Standard Dimensions

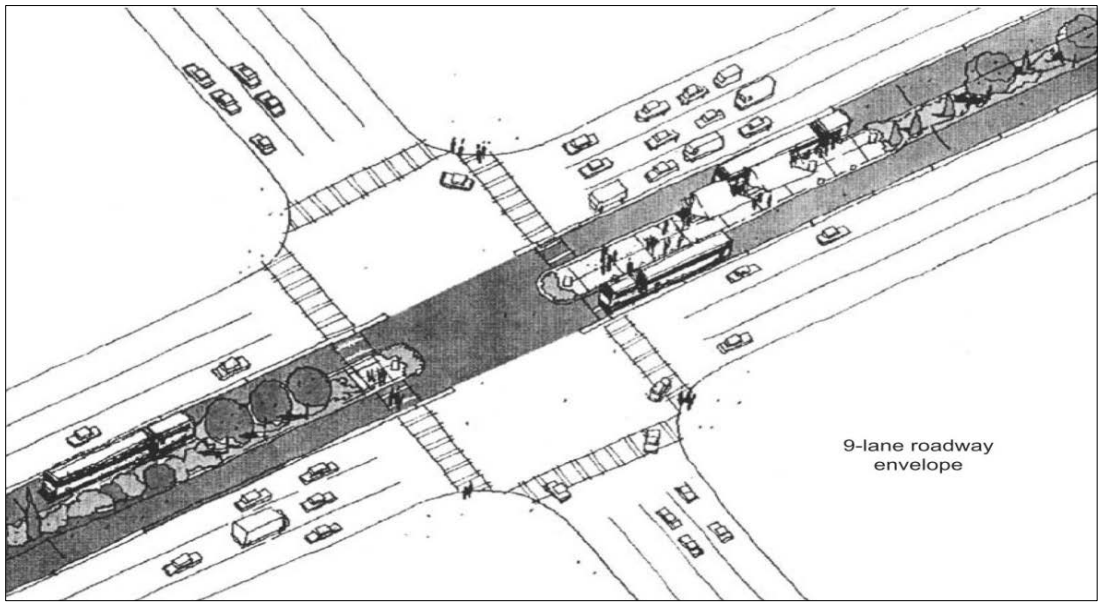
Design Parameter	Dimension
Median Station	
Station Width (Overall)	30’ max. to 26’ min.
Clear Platform Width (Each side)	12’ desirable, 10' min.
Curb-Side Station	
Station Width (Overall)	16’ max. to 10’ min.
Clear Platform Width	12’ desirable, 10' min.
Park & Ride Station	
Station Width (Overall)	20’ max. to 14’ min.
Clear Platform Width	12’ desirable, 10' min.
All Station Types	
Station Height	14.5" - 15.5"
Station Length	140'
Approach Taper Length	1.5x Bus Length
Departure Taper Length	1x Bus Length

Source: American Public Transportation Association (APTA) Standards for Designing Bus Rapid Transit Running Ways (APTA-BTS-BRT-RP-003-10) and the Transit Cooperative Research Program Report 118

A **median station** (see Figures 7 and 8) is located in the center of a median busway between bus lanes and simultaneously provides service for both directions of the BRT. An advantage of median stations is that a single station serves a given stop. However, a disadvantage of this type of station is that it either requires buses to have dual or left-side doors, or requires buses to cross to the opposite side at the stations and then cross back over once they leave the station. Median stations will typically require a wider than normal median to accommodate the station and busway.

A **curb-side station** (see Figures 9 and 10) is located along the side of a busway or lane and can be used in conjunction with a median busway, side-running busway, BRT curb lane/BAT lane or mixed-use lane. Curb-side stations provide service for one direction and therefore require separate stations for each direction of travel as well as additional roadside space above the normal sidewalk width. Curb-side stations are typically located on the far side of intersections (after passing through the intersection). This allows turn lanes to be placed on the near side and works well with signal prioritization.

Figure 7: Example of a Median Station



Source: Transit Cooperative Research Program (TCRP) Report 90, Bus Rapid Transit, Volume 2: Implementation

Figure 8: Median Station Dimensions

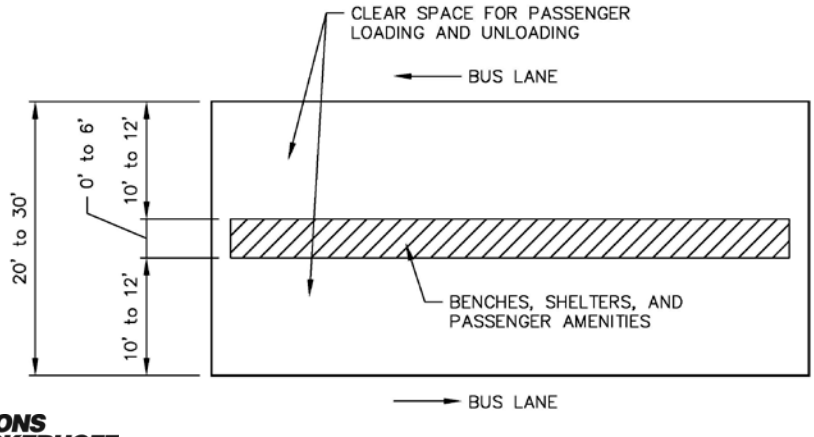
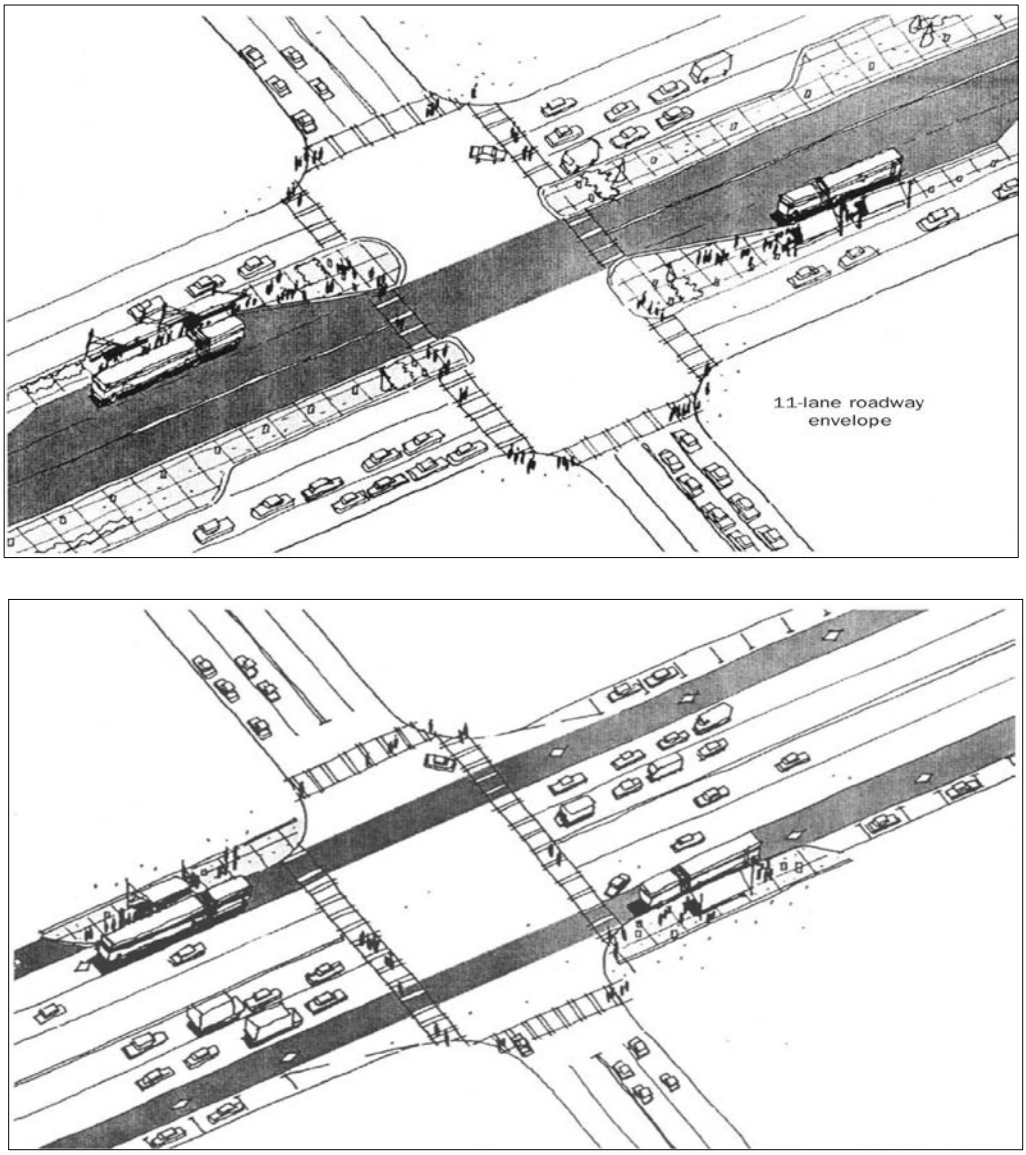
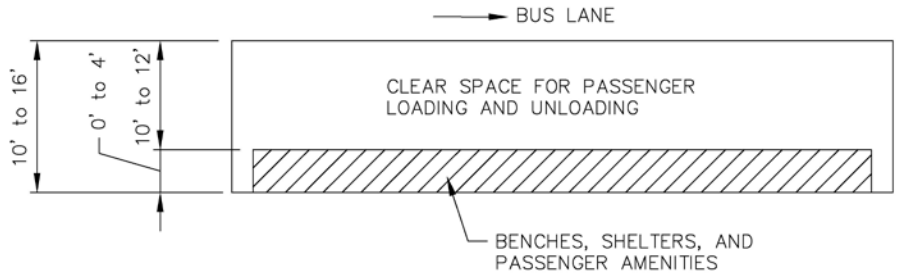


Figure 9: Examples of Curb-Side Stations



Source: TCRP Report 90, Bus Rapid Transit, Volume 2: Implementation

Figure 10: Curb-Side Station Dimensions

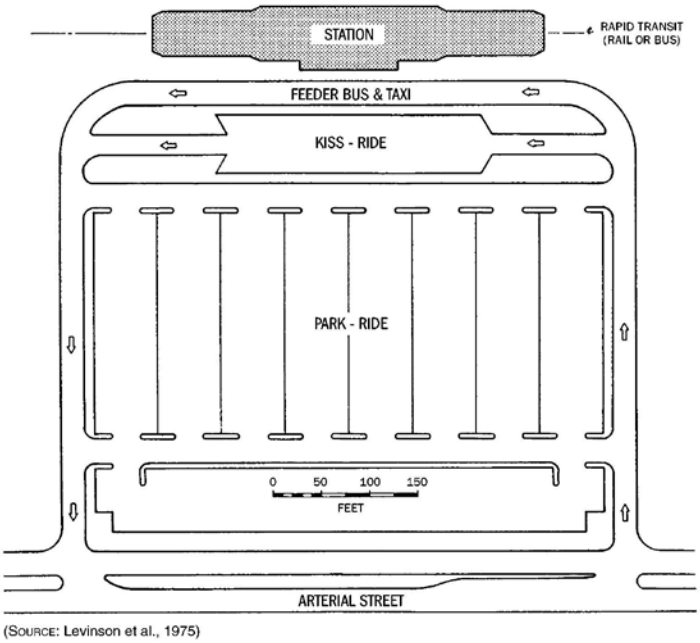


Park-and-Ride Lots

The design of park-and-ride lots will vary significantly depending on the shape and size of the site and location along the route. A general rule of thumb is that approximately 100 parking spaces can be provided for each acre of available land. The number of parking spaces will be maximized as required by demand and located as closely as possible to the adjacent station. A kiss-and-ride, or passenger drop-off/pick-up lane, will also be provided within the park-and-ride lot as near as practical to the station. Handicapped parking spaces will be provided in accordance with Americans with Disabilities Act (ADA) requirements.

Park-and-ride lots will fall into two categories: terminal park-and-ride lots and in-route park-and-ride lots. A terminal park-and-ride lot is located at the end of the BRT line; all others are considered in-route park-and-ride lots. Terminal park-and-ride lots will serve as turnarounds and layover locations for buses and will be designed for circulation of buses through the lot. In these cases, it is anticipated that stations will be located within the park-and-ride lot. Depending on the layout of the park-and-ride lot, the station could be either a median type or curb-side type. Stations at in-route park-and-ride lots are expected to be located adjacent to the roadway used by the BRT route. Therefore, bus circulation through these lots is not anticipated. An example layout of a park-and-ride lot is shown in Figure 11.

Figure 11: Example of a Park-and-Ride Lot



Source: TCRP Report 90, Bus Rapid Transit, Volume 2: Implementation

Standards for Roadway and Intersection Modifications

Roadway and intersection modifications will be required to accommodate the new BRT system. Roadways in the project area fall under the jurisdiction of the City of Albuquerque, New Mexico Department of Transportation (NMDOT) and the City of Rio Rancho. Each of these agencies has adopted roadway design criteria that will govern roadways within their jurisdiction.

Roadway and intersection modifications will consist of widening or reconfiguring lanes to incorporate BRT busways or bus lanes. Although some alignment shifts may occur, it is anticipated that the primary design effort will be in evaluating the existing roadway cross-section and determining appropriate measures to implement the BRT system within the available right-of-way with the least impact and cost.

For the segment of Paseo del Norte (PdN)adjacent to the Village of Los Ranchos, special restrictions limit roadway elevations at bridge crossings. Specifically, the roadway bridges that cross over PdN at Rio Grande Boulevard, 4th Street, and the Chamisal Lateral acequia pedestrian bridge cannot be raised above their current elevations. Roadway modifications to incorporate BRT busways or bus lanes in this area must remain consistent with the existing bridge elevations.

Pertinent criteria for the design of roadway and intersection modifications are described below.

Roadway Cross-Section Design

Modifications to the roadway cross-section will involve identifying the new busway or bus lane areas and shifting or reconfiguring traffic lanes to make way for busways and bus lanes. Table 3 shows the criteria for minimum and desirable widths of various cross-section elements for each agency involved.

Roadway Alignment Design

The alignment of the roadway corridors is established and major modifications are not expected. Alignment changes are anticipated to be limited to lane shifts and tapers to accommodate the introduction of busways into the roadway typical section. Table 4 shows pertinent design criteria for roadway alignment modifications.

Table 3: Roadway Cross-Section Elements

Type of Element	City of Albuquerque (COA) Width	NMDOT Width	City of Rio Rancho (CORR) Width
General Driving Lane*	11’ min., 12’ desirable	11’ min., 12 desirable	11’
Left or Right Turn Lane	10’ min.,	10’ min., 11’ desirable	11’
Bicycle Lane	6’ min.	5’ min.	6’ min.
Shoulders	No requirement	Per AASHTO Green Book	No requirement
Outer Curb & Gutter	2’-7 ½”	2’-6” typical Can match COA or CORR standard	2’-0”
Median Curb & Gutter	1’-6”	1’-6”	1’-6”
Sidewalk	10’ min. arterials adjacent to major activity centers, 6’ min. other arterials, 9’ min. collectors adjacent to major activity centers, 5’ min. all others	5’ min.	6’ min.
Sidewalk Buffer	Varies depending on right-of-way width, sidewalk typically set 1’ from right-of-way line	No specific requirement	5’ min.

** General driving lanes immediately adjacent to busways are recommended to be a minimum of 12 feet wide.*

Table 4: Roadway Alignment

Design Parameter	Design Value
Design Speed (MPH)	Posted Speed to 10 mph over Posted Speed
Alignment	
Lane Shifting Taper Length, L (ft.) (Where W = width and S= speed)	$L=(WS^2/60)/2$ (min. for speed up to 40 mph) L=WS/2 (min. for speed 45 mph or higher) L=WS (desirable for all speeds)
Lane Merging Taper Length, L (ft.) (Where W = width and S= speed)	$L=WS^2/60$ (min. for speed up to 40 mph) L=WS (min. for speed 45 mph or higher, desirable for all speeds)
Absolute Min. Curve Radius (ft.)	265
Gradient	
Desirable Maximum	Match Existing Street
Absolute Maximum	8%
Minimum	0.3%

Intersection Modifications

Intersection modifications will include reconfiguration and shifting of lanes to accommodate the new BRT system. Where median BRT busways are designed, all unsignalized intersection median openings will be closed. Table 5 below shows pertinent design criteria for intersection modifications.

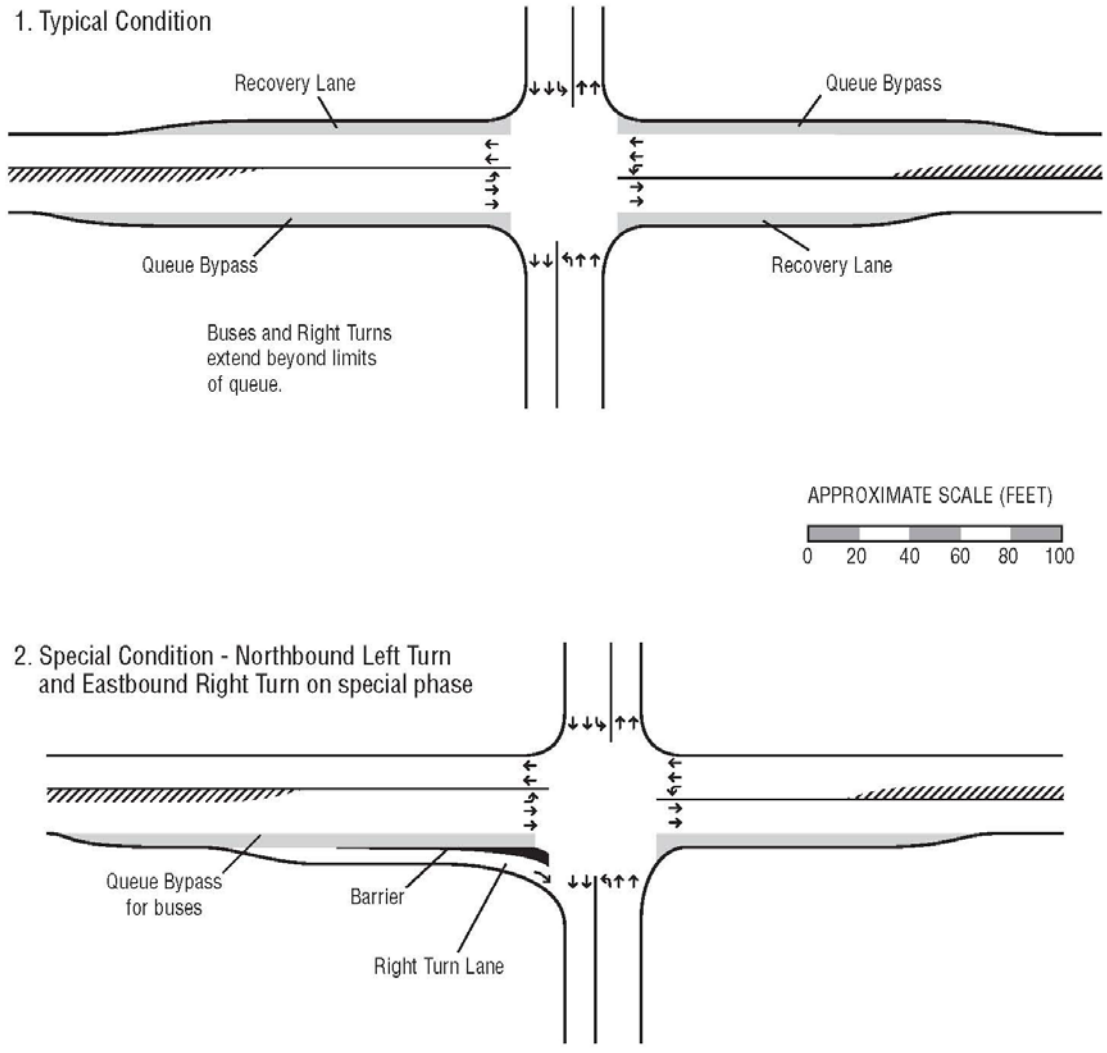
Table 5: Intersection Elements

Type of Element	City of Albuquerque Dimension	NMDOT Dimension	City of Rio Rancho Dimension
Min. Curb Return Radius (BRT Route)	25' Typical, Design for A-BUS vehicle	50' for Single Unit (SU) vehicle, Design for A-BUS vehicle	Design for A-BUS vehicle
Min. Left or Right Turn Lane Width	11' desirable, 10' absolute min.	11' desirable, 10' absolute min.	11'
Min. Left or Right Turn Lane Length	Determined by traffic analysis, but no less than 100' min.	Refer to Table 18.K.1 of State Access Management Manual	370' for Urban Principal Arterials posted 45mph or higher, all others determined by traffic analysis with 75' min.for unsignalized 160' min. for signalized
Min. Taper Length for Left or Right Turn lanes	84' Taper with 150' radius reverse curves	100' – 175' Depending on Design Speed. Refer to Table 18.K.1 of State Access Management Manual	Refer to Table 18.K.1 of State Access Management Manual

Queue Bypass Lanes

In locations where BRT curb lanes or mixed-use lanes are used, queue bypass lanes (i.e. queue jumps) may be warranted to facilitate preferential BRT operations at signalized intersections. Figure 12, obtained from TCRP Report 90, Bus Rapid Transit, Volume 2: Implementation, illustrates how queue jumps may be incorporated into intersections. Traffic analysis will determine where queue jumps are warranted and the required length of the queue jump lane. Queue jump lanes are typically a minimum of 10 feet wide and should be long enough to allow buses to avoid queues during peak hours. They may be combined with bicycle lanes under certain circumstances. They may also be combined with general purpose right-turn lanes. Queue jumps should be used sparingly as they require enforcement to restrict use from general traffic.

Figure 12: Schematic of Queue Jump Lanes at Intersections



Source: TCRP Report 90, Bus Rapid Transit, Volume 2: Implementation