INTRODUCTION

Presented in this third chapter are the criteria that were used to locate and design bus stops, prototypical bus stop designs that were used in laying out the proposed bus stops, examples of bus shelters from other locations, and specific bus/rail interface improvement plans for each of the six Pasadena to Azusa stations.

BUS STOP LOCATION AND DESIGN CRITERIA AND PROTOTYPES

Bus Stop Location and Design Criteria

As part of the Bus Interface Project, a technical memorandum was prepared that compiled criteria for locating bus stops and preparing concept designs for the safe and convenient interface between these bus stops and the Pasadena to Azusa Metro Gold Line Foothill Extension stations (Task 4.1 Design Criteria and Prototypical Bus Stop Treatments Technical Memorandum, prepared June 8, 2010). Since the Metro Gold Line Foothill Extension Construction Authority (Construction Authority) will not be the implementing agency for the bus stop improvements, the criteria, guidelines, and prototypes contained in the technical memorandum are intended to be sufficiently generic so that they can be further refined by each city and/or bus operator for detailed design under their supervision.

Combined in the Design Criteria Technical Memorandum are excerpts from the following documents:
- Los Angeles County Metropolitan Transportation Authority (Metro) Transit Service Policy Guidelines, November 2007
- Metro Rail Design Criteria, January 2010
- Omnitrans Bus Stop Design Guidelines, October 2006

Bus Stop Location Criteria

Identification of bus stop locations and the capacity of each bus stop are based on bus stop and layover space requirements identified in the technical memorandum. Positioning and sizing of bus stops are based on specific criteria developed or adopted by the appropriate public agencies and transit operators that will be servicing the bus stops. For the purposes of this project, bus stop location and design criteria are consistent with those adopted by Metro. These guidelines also incorporate by reference a report published by TCRP that includes specific details and recommendations regarding bus stop locations, spacing, and design guidelines. The TCRP guidelines have been adopted by the FTA. Standards and guidelines presented in these two documents are used as the basis for recommendations presented herein.

Bus Stop Location and Design Prototypes

Bus Stop Location and Design Prototypes

To ensure that various types of bus services operate as efficiently as possible, Metro and other bus operators have guidelines related to bus stop spacing for specific types of bus services. Table 3-1 summarizes the guidelines for bus stop spacing as adopted by Metro.

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Population Density (Persons per Square Mile)</th>
<th>Route Average Distance Between Stops (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Type</td>
<td>Population Density (Persons per Square Mile)</td>
<td>Route Average Distance Between Stops (miles)</td>
</tr>
<tr>
<td>Metro Liner</td>
<td>Over 20,000</td>
<td>1,500 to 4,000 ft</td>
</tr>
<tr>
<td>Express</td>
<td>Over 20,000</td>
<td>500 to 2,600 ft</td>
</tr>
<tr>
<td>Rapid Express</td>
<td>Over 20,000</td>
<td>800 to 1,500 ft</td>
</tr>
<tr>
<td>Rapid</td>
<td>Over 20,000</td>
<td>1,000 to 4,000 ft</td>
</tr>
<tr>
<td>Limited</td>
<td>Over 20,000</td>
<td>750 to 1,500 ft</td>
</tr>
<tr>
<td>Local</td>
<td>Over 20,000</td>
<td>500 to 800 ft</td>
</tr>
<tr>
<td>Shuttle</td>
<td>Over 20,000</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Source: Los Angeles County Metropolitan Transportation Authority, Transit Service Policy Guidelines, November 2007
The six Pasadena to Azusa light rail stations will primarily be served by local bus and shuttle services. However, stop spacing recommendations presented below would not preclude operation of other bus service types identified in Table 3-1.

**Bus Stop Bay Capacity**

The third criterion in determining bus stop locations and size addresses the appropriate capacity of bus stops to accommodate the anticipated number of buses that would be using the stop during peak-service time periods. Table 3-1 gave the total number of buses anticipated to service the stops located closest to the Pasadena to Azusa stations. There are two main categories into which these buses can be placed. The first category includes buses that are stopping adjacent to a light rail station only to board and disembark LRT passengers. These buses would be stopping for short periods of time (typically only as long as it takes to board and disembark passengers) before continuing their route. In these cases, several bus routes can typically share the same space within a single bus stop. Table 3-2 presents guidelines for the bus bay size requirements for an individual stop based on the frequency of service.

**TABLE 3-2: BUS STOP BAY SIZE RECOMMENDATIONS**

<table>
<thead>
<tr>
<th>No. of Buses Per Peak Hours</th>
<th>Capacity Required (Bays) When Service Time at Stop is</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>10 Seconds 1 1 1 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3</td>
</tr>
<tr>
<td>30</td>
<td>10 Seconds 1 1 1 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3</td>
</tr>
<tr>
<td>45</td>
<td>10 Seconds 1 1 1 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3</td>
</tr>
</tbody>
</table>


**Initial Bus Stop Needs**

The second category involves buses that will lay over adjacent to a particular light rail station. Buses stopping to lay over typically stop for durations of 10 to 15 minutes, allowing for short breaks for bus operators or shift changes between operators. Layovers typically occur at the terminus of an individual bus route. In these cases, a dedicated bus stop space or bay is usually required for each bus line, depending on the frequency of service for that individual bus line. Layover spaces are typically located completely outside of traffic lanes, either off-street in a bus bay or parallel to existing traffic lanes in a bus turnout or wide curb lane.

Using the recommendations presented in Table 3-2, bus stop capacity needs have been estimated for each of the Pasadena to Azusa stations by analyzing the bus frequency information presented in Chapter 2, Table 2-1. Table 3-3 summarizes the bus bay needs by station for the Gold Line opening year, based on existing bus service levels. The table identifies bus frequency at each bus stop at each Gold Line station, along with the corresponding bus stop capacity needs and layover space needs. The combined total of bus stops and layover positions is the need for each particular bus stop.

**Future Bus Stop Needs**

Estimating future bus stop capacity needs can be difficult as most transit agencies develop detailed service plans and route headway proposals only for short-term time periods (1-5 years). This short-term planning horizon allows agencies sufficient time for the acquisition of additional buses, if needed, and allows for flexibility to adjust service schedules to changing travel demand patterns. Even with these constraints, it is possible to make a conservative assumption regarding future bus service increases. Metro’s 2009 Long Range Transportation Plan (LRTP) calls for substantial investments in expanding local bus services, both by Metro and by municipal operators, as well as by Foothill Transit.
Chapter 3 | Proposed Bus/RAIL Interface Facility Improvements

### Table 3-4: Bus Stop Bay Needs by Station (Buildout Year)

<table>
<thead>
<tr>
<th>Station</th>
<th>Bus Stop Location</th>
<th>Stop Designation</th>
<th>Peak Hour Bus Flow AM</th>
<th>Stops Needed</th>
<th>Layover Spaces Needed</th>
<th>Peak Hour Bus Flow PM</th>
<th>Stops Needed</th>
<th>Layover Spaces Needed</th>
<th>Total Bus Bay Capacity Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arcadia</td>
<td>WB Santa Clara Street</td>
<td>A</td>
<td>11</td>
<td>0</td>
<td>3</td>
<td>11</td>
<td>0</td>
<td>3</td>
<td>3 layover</td>
</tr>
<tr>
<td></td>
<td>SB 1st Street (n/o Santa</td>
<td>B</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>Clara Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NB 1st Street (n/o Santa</td>
<td>C</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>Clara Street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SB 1st Street (n/o Huntington Drive)</td>
<td>D</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>SB Santa Anita Avenue</td>
<td>E</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td>Monrovia</td>
<td>SB Myrtle Avenue</td>
<td>F</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>WB Duarte Road</td>
<td>C</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>EB Duarte Road</td>
<td>D</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>NB Myrtle Avenue</td>
<td>E</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td>Duarte</td>
<td>SB Highland (n/o Duarte</td>
<td>A</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>Road)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NB Highland</td>
<td>B</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>(n/o Business Center Drive)</td>
<td>C</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>WB Duarte Road</td>
<td>D</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>EB Duarte Road</td>
<td>E</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>2 layover</td>
</tr>
<tr>
<td></td>
<td>EB Duarte Road</td>
<td>F</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td>Irwindale</td>
<td>WB Avenida Padilla</td>
<td>A</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>2 stops</td>
</tr>
<tr>
<td>Azusa-</td>
<td>EB Santa Fe Avenue</td>
<td>B</td>
<td>14</td>
<td>1</td>
<td>2</td>
<td>14</td>
<td>1</td>
<td>2</td>
<td>1 stop/2 layover</td>
</tr>
<tr>
<td>Alhambra</td>
<td>NB Azusa Avenue</td>
<td>C</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td>Azusa-Citrus</td>
<td>WB Foothill Boulevard</td>
<td>A</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
<tr>
<td></td>
<td>NB Citrus Boulevard</td>
<td>B</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>1 stop</td>
</tr>
</tbody>
</table>

Notes:
- Using the criteria identified above, recommended bus stop locations for each Pasadena to Azusa station are identified.
- n/o stands for north of.
- Does not consider M270 diverted to Primrose Avenue.

### Bus Stop Design

Figure 3-1 compiles elements and requirements that are either necessary or desirable features to include in the design of a typical bus stop. Clearances at the bus shelter and sidewalk are based on requirements in the California Building Code. Inclusion of the bus pad in the street is derived from Metro Design Criteria Civil Section 3.7.5 for bus stops adjacent to transit stations. The width is derived from the bus stop guidelines in the TCRP Report 19 – Guidelines for the Location and Design of Bus Stops. These standards are used by both FTA and Metro for their bus stop standards. The bus shelter features listed consist of items common in bus shelter and other features that could be included for sustainable design or advanced technology.

### Prototypical Bus Stop Configurations

Various bus stop configurations were developed as prototypes or templates for applying to the potential bus stop locations at each station site to ensure that the design criteria contained in the FTA TCRP Report 19 would be met. There are four conditions that apply: a bus stop on the near side of an intersection (before crossing it) (see Figure 3-2), the far side (after crossing it) (see Figure 3-3), mid-block (Figure 3-4), and mid-block in a turnout to be out of the traffic lanes (Figure 3-5). The location of the bus stop relative to the corner for the “far side” case when the bus has made a left or right turn needs to be further away from the intersection than if the bus is traveling in a straight path.

A sawtooth arrangement is not shown since there are none proposed for the bus stops at the Pasadena to Azusa stations. A bus stop located on the opposite side of the street will not be considered. Most of the proposed stations are located on relatively low-speed streets, requiring curb extensions to provide bus stops.

A bus stop with a segment against the curb with the bus on the other side of the street was selected to be shown in Figure 3-6. These include the standard bus stop arrangements that are typical at stops and layover spaces, as well as the extended bus stop arrangements that are typically available at the station locations. Street traffic, the need for on-street parking, and access to adjacent property would make their inclusion impractical and not always necessary because of the relatively slow traffic speeds.

Examples of some existing bus shelters in the corridor cities are shown in Figure 3-6. Examples of some innovative bus shelter designs include the use of solar power, recycled materials, and touch screen displays are shown in Figure 3-7. Additional sustainable features that could be incorporated into the design of the bus stops and walkways connecting the stops to the LRT stations are shown in Figure 3-8. These include sustainable approaches to lighting, benches, and other street furniture typically found at bus stops, as well as landscaping and drainage.

As depicted in Figure 3-6, another approach to bus shelter design is to mimic the Gold Line station canopies. A bus shelter design that mimics the Gold Line station canopies is one way to extend the station “branding” Bus stop continuity with the stations could also be achieved by extending pavement materials, colors, detailing of fixtures such as rail receptacles and lighting, etc. Extending the station materials and/or detailing would provide for visual association and recognition of the bus stop as the one where the passenger transfers to the LRT.
Figure 3-1: Typical Bus Stop Design

Note:
Dimensions shown are desired, but may need to be modified to fit actual conditions at each bus stop location.

CHAPTER 3 | PROPOSED BUS/RAIL INTERFACE FACILITY IMPROVEMENTS

Foothill Extension Bus Interface Plan
Figure 3-2: Typical Near-Side Bus Stop

- **Increase Bus Stop Zone**: 50’ for each additional standard 40-foot bus, 30’ for ADA van, or 70’ for each additional 60-foot bus.

- **No Parking Zone**: (bus approach to stop)

- **60’ for articulated bus**: From end of curb radius or edge of crosswalk.

- **5’**: Dimensions shown are desired, but may need to be modified to fit actual conditions at each bus stop location.

**Note:**
Dimensions shown are desired, but may need to be modified to fit actual conditions at each bus stop location.
**Figure 3-3: Typical Far-Side Bus Stop**

*Note:*
Dimensions shown are desired, but may need to be modified to fit actual conditions at each bus stop location.
Increase Bus Stop Zone
50’ for each additional standard
40-foot bus, 100’ for each additional 60-foot bus,
or 30’ for ADA van

No Parking Zone
(bus approach to traffic)

50’

100’
(bus stop and bus approach to stop)

Note:
Dimensions shown are desired, but may need to be modified to fit actual conditions at each bus stop location.

Figure 3-4: Typical Mid-Block Bus Stop
Increase Bus Stop Zone
- 50’ for each additional standard 40-foot bus,
- 100’ for each additional 60-foot bus,
- or 30’ for ADA van

Notes:
- TCRP Report 19 acceleration and deceleration lanes per traffic through speed not provided.
- Dimensions shown are desired, but may need to be modified to fit actual conditions at each bus stop location.

Figure 3-5: Typical Mid-Block Turnout Bus Stop
Examples at the left are samples of bus shelters found in the cities served. Passenger volumes may be larger due to train capacity than for a typical bus stop and a more substantial shelter may be appropriate. In addition, the stop may give a first impression of the community to transit riders.
Through public and academic design competitions and agency and municipality design contracts, innovative and unusual approaches to bus stop design have been developed worldwide. Many reflect thinking about how to incorporate sustainable design, alternative energy, and the newest communication and lighting technologies into the stops and shelters. Others address passenger comfort and providing relevant information.

**Figure 3-7: Examples of Innovative Prototypes**
SUSTAINABILITY

Weaving sustainable design components into the public realm when planning station areas will ensure not only resource conservation, but also provide another set of place-making opportunities. Opportunities exist within station areas to employ bioswales, biofiltration planters, and permeable paving to infiltrate or cleanse storm water in the public realm before it reaches storm drains. Planting concepts can incorporate drought-tolerant and native plant species to minimize water use and maintenance. Energy savings can be achieved through the use of solar-powered and high-efficiency lighting and furnishings. Impacts of furnishings manufacturing and transportation can be mitigated by choosing locally made furnishings and materials with locally sourced, recycled, or sustainable harvested content. Furthermore, incorporating street trees and paving materials with high reflectivity can create shade and reduce the heat island effect of paved areas.

Cleanse/Infiltrate Storm water

Bioswale
- Capture, cleanse and infiltrate storm water runoff from street or building downsputs
- Water percolates into soil below

Biofiltration Planter
- Capture and cleanse storm water runoff as it flows through planter
- Cleansed water returns to storm drain

Permeable Paving
- Allows storm water to filter into the ground instead of carrying pollutants to the storm drain

Incorporate Drought-Tolerant and Native Planting
- To conserve water, provide urban habitat for local wildlife, visual appeal and shade, incorporate drought-tolerant and native planting

Use Solar-Powered and High-Efficiency Lighting and Furnishings

Solar Powered Recycling and Trash Receptacles
- Harness sun's energy to compact items, reducing trips needed to empty bins.

Solar Powered Lighting
- Off-the-grid; reduce reliance on energy; cost savings

LED High Efficiency Lighting
- Reduced energy needs and cost savings

Choose Locally Made Furnishings & Materials With Locally Sourced, Recycled, and Sustainably Harvested Content

- Locally manufactured furnishings reduce the distance items must be shipped, which contributes to the local economy
- Locally sourced, recycled, and sustainably harvested content reduce impacts on the environment

Reduce Heat Island Effect

- Sufficient tree canopy provides shade that also contributes to reducing the heat island effect
- Lighter-colored paving materials reflect the sun's rays more than darker materials, reducing the heat island effect

Products that incorporate recycled materials, such as this bench made from recycled plastics, reduce impacts resulting from extraction and processing of virgin resources.

- To conserve water, provide urban habitat for local wildlife, visual appeal and shade, incorporate drought-tolerant and native planting

Figure 3-8: Sustainability Considerations