APPENDIX E

CURB-SIDE STUDIES

This appendix presents a review of the curb-side studies findings and observations. The information has been integrated and organized to reflect the experiences and amenities that might be encountered at a bus stop by patrons.

The objective of the curb-side studies was to determine how placement and design of curb-side amenities impact patron and pedestrian utilization of bus stops. To accomplish this objective, the following tasks were completed:

- Collect information on a wide variety of bus stop designs, configurations, and placements.
- Collect field data on pedestrian and patron behavior at bus stops at a number of different locations with high bus patron volumes.
- Observe actual utilization of bus stop sites for extended periods to determine site utilization patterns and external influences on site utilization.
- Analyze the environmental characteristics of an individual site and how they may impact site utilization and adaptive use of the nearby land use.
- Analyze the placement of the bus stop and how it influences pedestrian- and bus-patron-related activities (conflicts with boardings/alightings and waiting areas and changes in general pedestrian traffic).
- Summarize and integrate the observations from both the regional and field study locations.

STUDY DESIGN

The data collected for the curb-side field studies were categorized into two general areas: (1) site-specific information and (2) behavior of bus patrons and general pedestrian traffic. Table E-1 shows the type of information gathered within these two broad categories.

Table E-1. Field Study Data Collected.

Patron and Pedestrian Behavior	Site-Specific Information
• Popular Congregating Areas	• Existing Amenities and Location
• Integration with Neighboring Pedestrian Traffic	• Sun/Shade Patterns
• Boarding/Alighting Patterns	• Orientation of Stop (E, W, N, S)
• Adaptive Use of Site and Off-Site Elements (Ledges, Curbs, and Store Fronts)	• Placement of Stop with Respect to Land Use, Sidewalk, and Curb
• Queuing Areas/Informal Staging Areas	• Evidence of Use - Mud or Worn Areas
• Jaywalking	• Landscaping
• Unintended Use of Bus Facilities by Non-Bus Riders	
• Seating/Standing Patterns as a Result of Crowding and Environmental Conditions	

Pedestrian information was collected using video cameras, field notes, sketches, checklists, and still photography. The video camera was useful for recording congregation areas, pedestrian movement information, sun/shade patterns, and seating patterns. Still photography was utilized to record individual characteristics of a site, adaptive behavior, and pedestrian movement patterns. While using still and video photography at these sites, researchers were very careful not to influence the behavior of individuals sensitive to having their pictures taken.

Site-specific information was recorded on checklists and by measuring each site. Field notes and sketches were useful for recording behavioral observations and physical elements found at the site. Table E-2 describes each bus stop site studied in greater detail and which data collection methods were utilized. Following are discussions on the findings from the field studies.

Table E-2. Description of Field Study Sites.

State	Location & (City)	Shelter Location	Method of Data Collection					
			Video	Site Measurements	Notes	Sketches	Still Photo	Check-lists
AZ	Speedway @ Campbell (Tucson)	On Sidewalk	✓	✓	✓	✓	✓	✓
	Campbell @ Speedway (Tucson)	Behind Sidewalk	✓	✓		✓	✓	✓
	Speedway @ Mountain/Cherry (Tucson)	Behind Sidewalk	✓	✓	✓	✓	✓	✓
	Mill @ University (Tempe)	Behind Sidewalk	✓	✓		✓	✓	✓
	Washington @ N. First/Central (Phoenix)	On Sidewalk	✓	✓	✓	✓	✓	✓
CA	Polk @ Clay/Sacramento (San Francisco)	On Nub		✓	✓	✓	✓	✓
	Polk @ Jackson/Pacific (San Francisco)	On Nub		✓	✓	✓	✓	✓
	Polk @ Sutter (San Francisco)	On Nub		✓	✓	✓	✓	✓
	Polk @ Pine (San Francisco)	On Nub		✓	✓	✓	✓	✓
	Santa Clara @ First (San Jose)	On Sidewalk		✓	✓	✓	✓	✓

APPROACH TO BUS STOP

The walk to the bus stop affects the comfort, convenience, and safety of the bus patron. This section documents common treatments used to enhance patron access.

Integration of Bus Stop with Streetscape and Adjacent Land Use

The best pedestrian access to bus stops are locations with sidewalks that are direct and comprehensive in approach (see Figure E-1). The waiting area is a concrete pad and access from the curb to the sidewalk or waiting area is concrete or another impervious material. In Phoenix, the transit agency (RPTA) coordinates bus stop installation or improvements with street reconstruction activities. Waiting pads are defined with brick pavers, and additional space is provided at the waiting pad to install a bench or shelter depending on need. Landscaping is also installed during construction to provide shade trees for waiting pedestrians. The Phoenix example illustrates the need to coordinate bus stop locations and improvements with other street projects. By coordinating with other street projects, RPTA has the opportunity to update and improve an existing bus stop or install a new bus stop at developing locations. The bus stop is considered an important element of the overall "streetscape."

Figure E-1. Example of Good Pedestrian Access.

Sidewalk Location

In rural or developing suburban areas, sidewalks may or may not be installed along major roadways due to continuing development in the area or lack of justification for them. Sidewalks along the roadways may or may not exist. Typically, the only passenger amenity at the bus stops is a transit agency sign. The bus stop sign is located on the soft shoulder or placed in the dirt, which makes reaching the stop inconvenient during inclement weather (see Figure E-2). Patrons either stand on the undeveloped right-of-way (ROW) or seek relief from the elements by standing beneath nearby trees. Depending upon familiarity with the schedule, the patron may or may not have a long wait at these unsophisticated bus stops.

As areas become more developed, sidewalks become more commonplace. ADA compliance can be an impetus for installing sidewalks. At some locations, a discontinuous sidewalk has been installed to give bus patrons greater access to the bus stop from the intersection. The sidewalk begins at the intersection and ends at the bus stop (see Figure E-3). Although the sidewalk may not continue toward the next land use or along the roadway, this is the first step toward providing complete access to the stop.

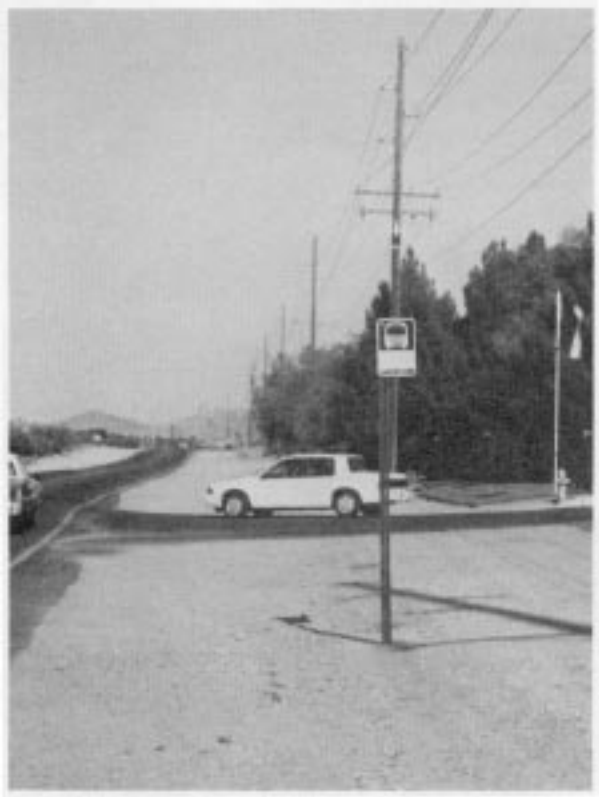


Figure E-2. Bus Stop on Soft Shoulder.

Figure E-3. Discontinous Sidewalk to Bus Stop

Sidewalks located far away from the curb can create large distances between the edge of the curb, sidewalk and bus stop. Suburban bus stops with wide right-of-ways are characteristically developed in this manner to permit further roadway expansion. The sidewalk is parallel to the curb but several feet from it. The sidewalk, bus stop, and curb may or may not be connected by impervious material. The bus stop is often located directly on the grass and is marked with a bus stop sign. A bench or bus shelter may or may not be present, depending upon demand. Over time, the site where the shelter or stop is placed becomes worn (see Figure E-4). Footpaths also develop in these areas showing common circulation paths. During inclement weather, the worn areas become muddy, creating the need for patrons to reach the bus from another location, such as a nearby driveway.

Commonly, bus stops are positioned between the sidewalk and the curb (see Figure E-5) or behind the sidewalk away from the curb (see Figure E-6). In both scenarios, the bus stop or bus shelter is away from the general pedestrian traffic on the nearby sidewalk. Some transit agencies prefer to have the sidewalk in front of the bus stop so bus patrons can see the general vehicular traffic and the surrounding pedestrian activity. The additional space also provides waiting patrons a zone of comfort away from the nearby traffic flow. At some suburban sites observed, speeds were over 45 mph near the bus stops, which further justifies the need to separate waiting passengers from high-speed vehicles.

Figure E-4. Bus Stop on Grass.

Figure E-5. Bus Stop Positioned Between Sidewalk and Curb.

Figure E-6. Bus Stop Positioned Behind Sidewalk.

Different bus stop configurations can also impact the relationship of the sidewalk to the bus stop. For example, in Phoenix, the shelters are located at the taper of either the acceleration or deceleration lanes of the bus bay. The shelters are parallel to the sidewalk and the taper. By angling the shelters in a linear area, additional room is created for the amenity. Depending upon where the bus ultimately stops, patrons may or may not have a long walk from the shelter to the vehicle when the shelter is sited in this manner (see Figure E-7).

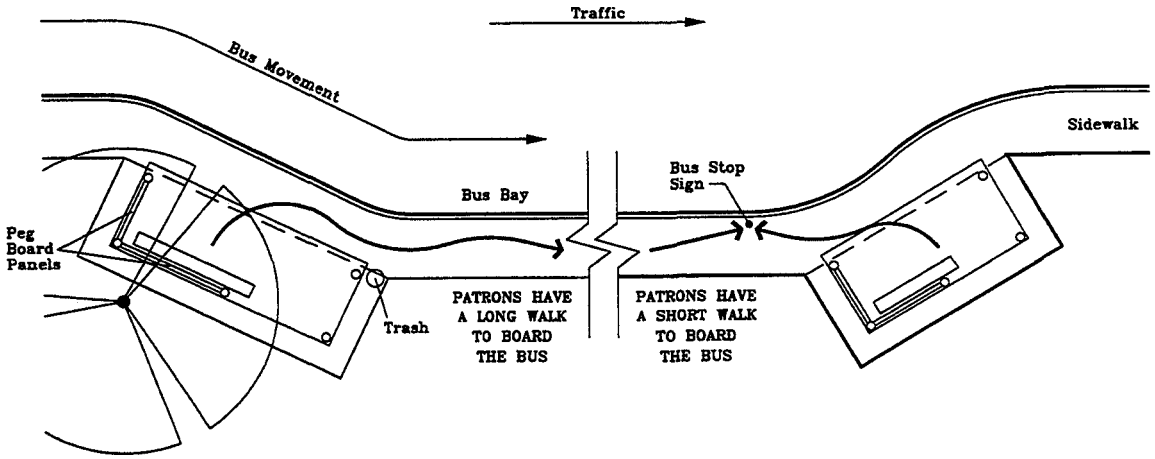


Figure E-7. Examples of Angled Shelters at a Bus Bay.

Access Between the Curb, Bus Stop, Sidewalk, and Land Use

Indirect or inconvenient access between the land use and the bus stop can detract from the experience of using transit by increasing walking time. Items such as walls, landscaping berms, fences, and circuitous sidewalks can limit direct access from the land use to the stop. Walls and fences are common along the perimeter of housing and apartment complexes. Smaller walls also exist along commercial developments in suburban settings. The walls are used to define and separate the edge of the parking lot from the nearby roadway and sidewalk (see Figure E-8).

Pedestrians can have direct access to and from the land use and the bus stop by providing an opening through the wall. An additional pedestrian improvement is defined or designated walkways through parking lots. Walkways can be as elaborate as a landscaped sidewalk through the parking lot or as subtle as painted walkways that warn vehicles and direct pedestrians (see Figure E-9).

Figure E-8. Wall Separating Parking Lot from Sidewalk.

Figure E-9. Painted Walkway.

Another land use interaction issue is circuitous sidewalks and landscaping berms. These elements are commonly associated with business parks and along suburban roadway systems. The circuitous sidewalks can create difficulties for transit agencies when determining the final stop location. The curvilinear sidewalks may not align with the final stop destination and can create access problems through grass and landscaping (see Figure E-10). Transit agencies will often request that sidewalks run parallel with the curb until the sidewalk meets the stop. By doing so, patrons will have direct access from the bus onto impervious cover when boarding and alighting the vehicle. Early involvement in the development approval process can help insure coordination between bus stop placement and sidewalk location. As evident in these examples, the location of the sidewalk and access to the curb can significantly influence the comfort and convenience of patrons.

Figure E-10. Curvilinear Sidewalk at Stop.

ADA ACCESS

The influence of ADA access mandates was clearly visible in the field. A direct and impervious path should be installed between the curb, sidewalk, and stop for both general bus patrons and for the physically impaired. Mobility impediments include cluttered sites that have an abundance of vending machines, bike stalls, trash receptacles and undeveloped ROW that lack sidewalks. Figure E-11 is an example of ADA improvements observed at many sites.

Figure E-11. Sidewalks for ADA Mandates.

PLACEMENT WITHIN RIGHT-OF-WAY (ROW)

Available ROW can significantly influence the location and number of pedestrian amenities that can be constructed at a site. Items commonly found in the ROW, such as the edge of the curb, sidewalk, landscaping, and utility poles can influence the size and positioning of a bus stop and the number of amenities that can be placed at the site for patrons. Different street-side stop designs, such as bus bays, can also place additional constraints on space availability. Many of the sites observed are compromises between needed amenities and the space available in the right-of-way.

Bus Stops Located Directly on Sidewalk

Where right-of-way is limited, bus stop shelters are sometimes placed directly on the sidewalk or overhang the sidewalk. Several examples of shelters located directly on the sidewalk or impinging on the sidewalk were observed on the regional visits (see Figure E-12). One benefit of having the shelter or stop located directly on the sidewalk is that it ensures that patrons will have a paved surface to await the next bus. However, locating the stop or shelter on or close to the sidewalk can affect the flow of general pedestrian traffic.

To gain a better understanding of the influence of shelter placement on pedestrian movement, video and still photography were used at the field study site in Tucson on Speedway at Campbell. The site has two shelters that slightly overhang the sidewalk (see Figure E-13). Pedestrians and bus patrons must share this space between the curb and the overhanging shelters.

Figure E-12. Shelter Located on the Sidewalk.

Figure E-13. Shelters Overhanging Sidewalk.

From the video and observations made at the site, a majority of pedestrians chose to walk around the shelter into the nearby parking lot rather than share the sidewalk in front of the bus shelters. Of the 189 pedestrians observed in a 12-hour period, 143 pedestrians walked around the shelters (see Figures E-14 and E-15). This behavior could be due to a number of different elements associated with the site:

- People may have previous experiences of walking through the site when a bus was boarding or alighting and the area became too crowded.
- The width of the sidewalk with respect to the shelter overhang may "infringe" on the personal comfort zone of people causing them to choose another route.
- Ample space to walk around the shelters is available in the hotel parking lot.

A potentially hazardous situation exists when pedestrians walk behind a structure rather than on the sidewalk in front of the shelter. The bus shelter blocks the view of pedestrians walking behind the shelter from the traffic turning into the hotel. The proximity of the driveway to the shelter could create conflicts between pedestrians and turning vehicles. Although this situation was not directly observed, the opportunity exists because of the large numbers of bus patrons and general pedestrian traffic using the sidewalk.

Site observations made at other locations during the regional visits reinforce this observation. Worn paths in grass and dirt suggest that general pedestrian traffic prefers to walk behind the shelters instead of through the shelter. Based on these observations, shelters located directly on the sidewalk should be avoided because of their impact on general pedestrian traffic.

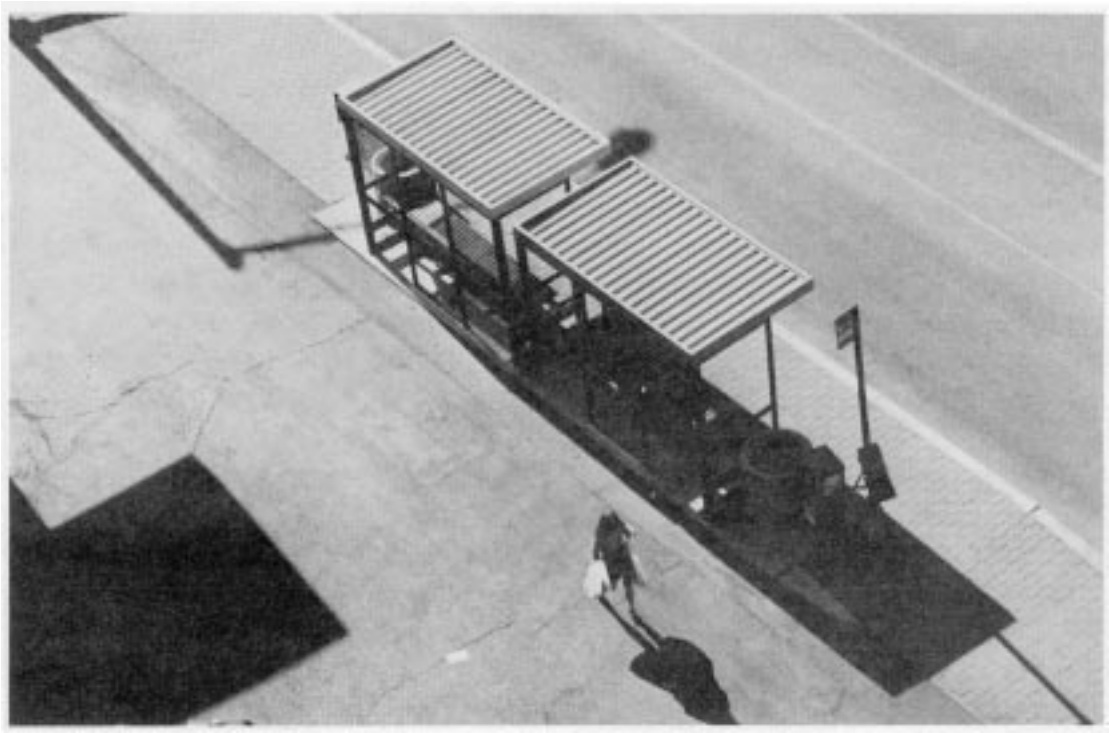
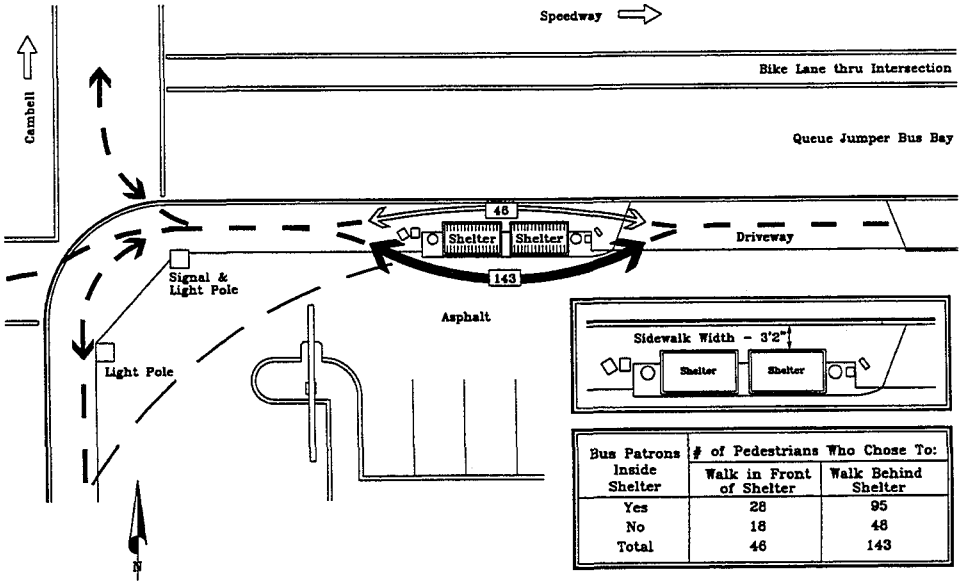


Figure E-14. Pedestrian Walking around Shelter.



Bus Patrons Inside Shelter	# of Pedestrians Who Chose To:	
	Walk in Front of Shelter	Walk Behind Shelter
Yes	28	95
No	18	48
Total	46	143

Figure E-15. Pedestrian Movement Study (Speedway at Cambell Street).

Nubs

In San Francisco, limitations on sidewalk space near bus stops have been overcome with the addition of bus nubs. Bus nubs create additional space for shelters, benches, and phones in dense urban settings. Nubs are also known as bus bulbs and curb extensions. The nubs provide enough space for bus patrons to comfortably board and alight the bus with little or no conflict with nearby general pedestrian traffic.

As part of the field studies, four nub sites in San Francisco were studied in greater detail to determine the advantages of this type of configuration. A far-side, near-side, and two midblock stops were studied. Three of the sites are along Polk Street, which is an established shopping and residential neighborhood. The Polk Street sites experience higher bus patron volumes on the weekend because of shopping opportunities in the area. Each site includes a standard agency design shelter, while only one site, Polk Street between Sacramento and Clay Streets, has additional seating outside the shelter (see Figures E-16 through E-19).

The fourth study site is located in the Chinatown district along Stockton Street between Jackson and Pacific Streets. The site is a midblock stop in a thriving shopping area punctuated by neighborhood grocery stores and restaurants. The sidewalks experience high general pedestrian volumes throughout the week. The midblock nub does not have any pedestrian or bus patron amenities to note. It is essentially a concrete curb extension which could be due to the high bus patron volumes at this site during the weekend. The Stockton Street site, similar to the Polk Street sites, has a dramatic increase in bus patron volumes on the weekend.

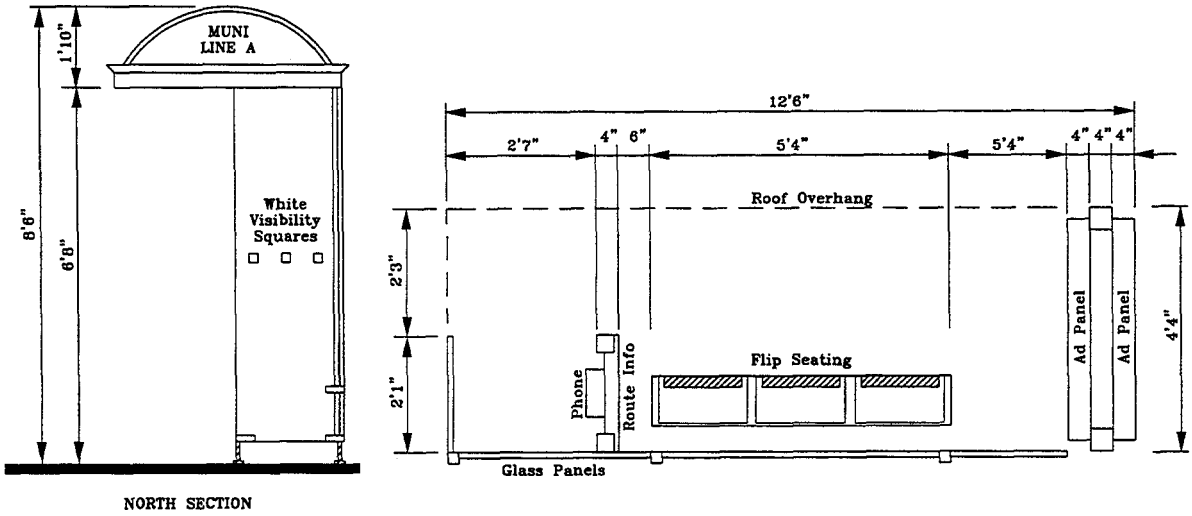


Figure E-16. Example of Shelter Detail at Polk Street Bus Stops.

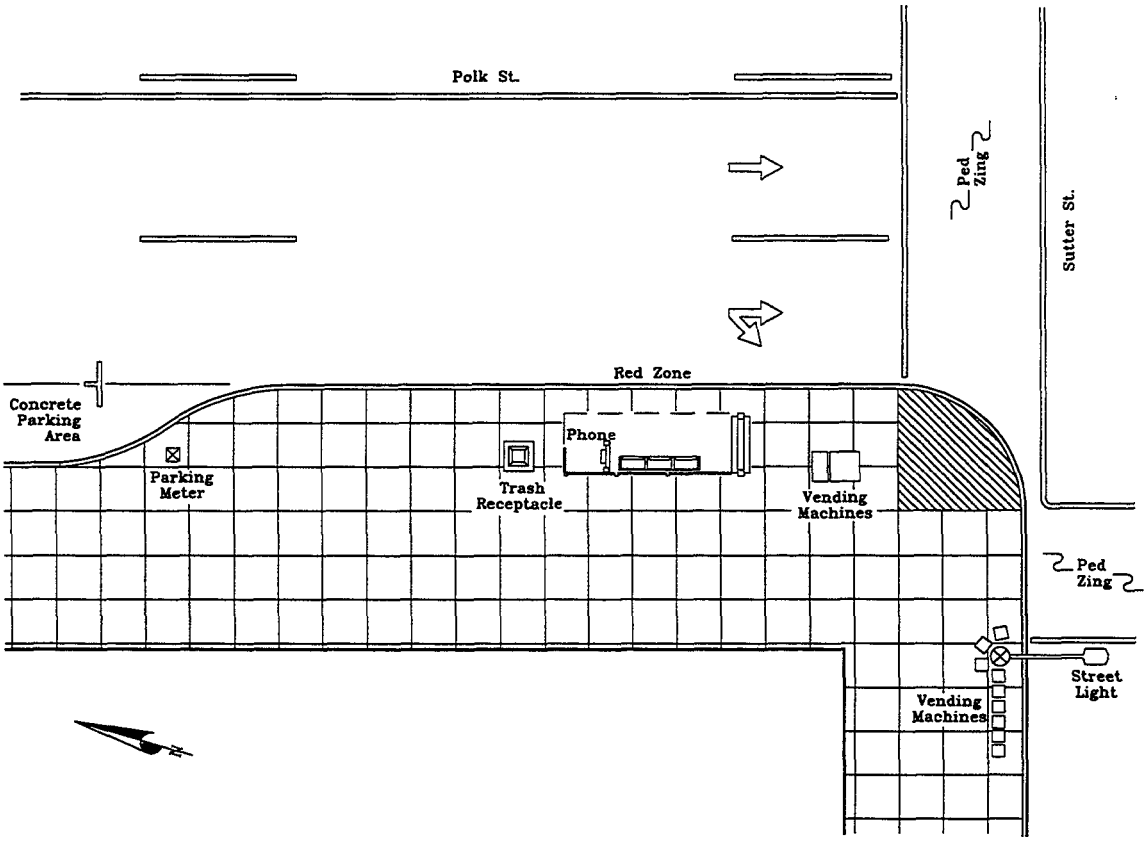


Figure E-17. Near-Side Nub (Polk Street at Sutter Street).

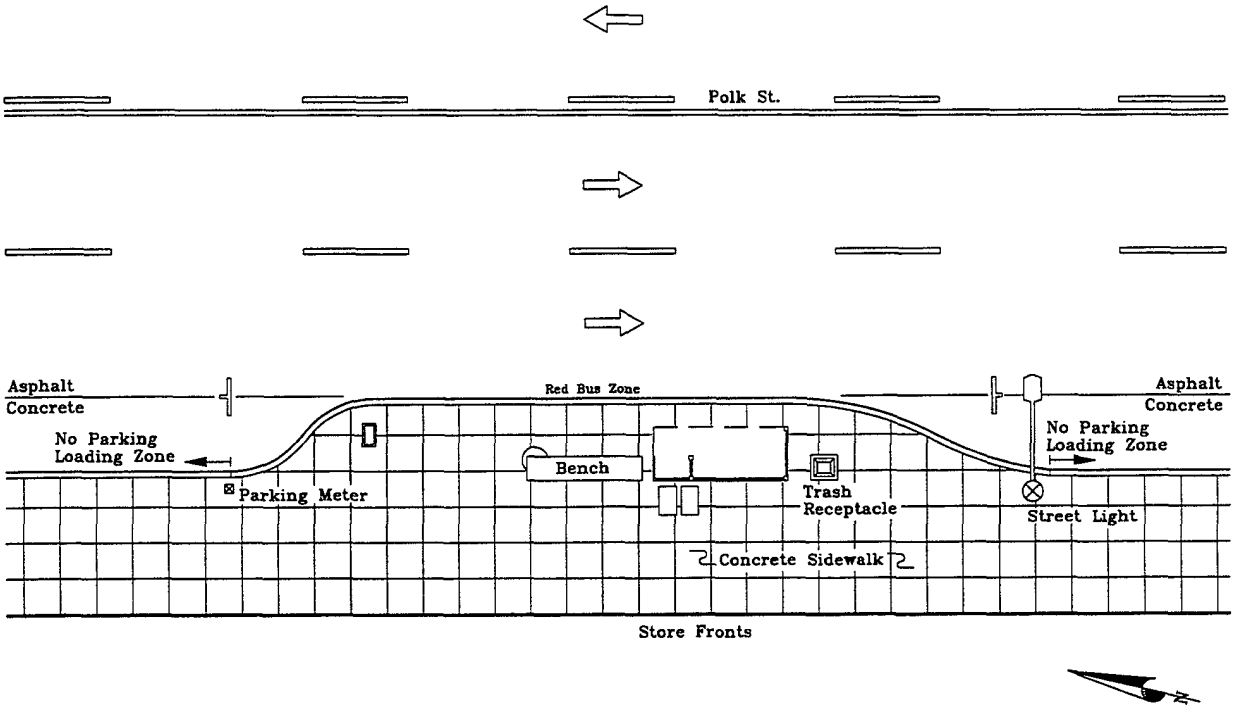


Figure E-18. Midblock Nub (Between Sacramento and Clay Street).

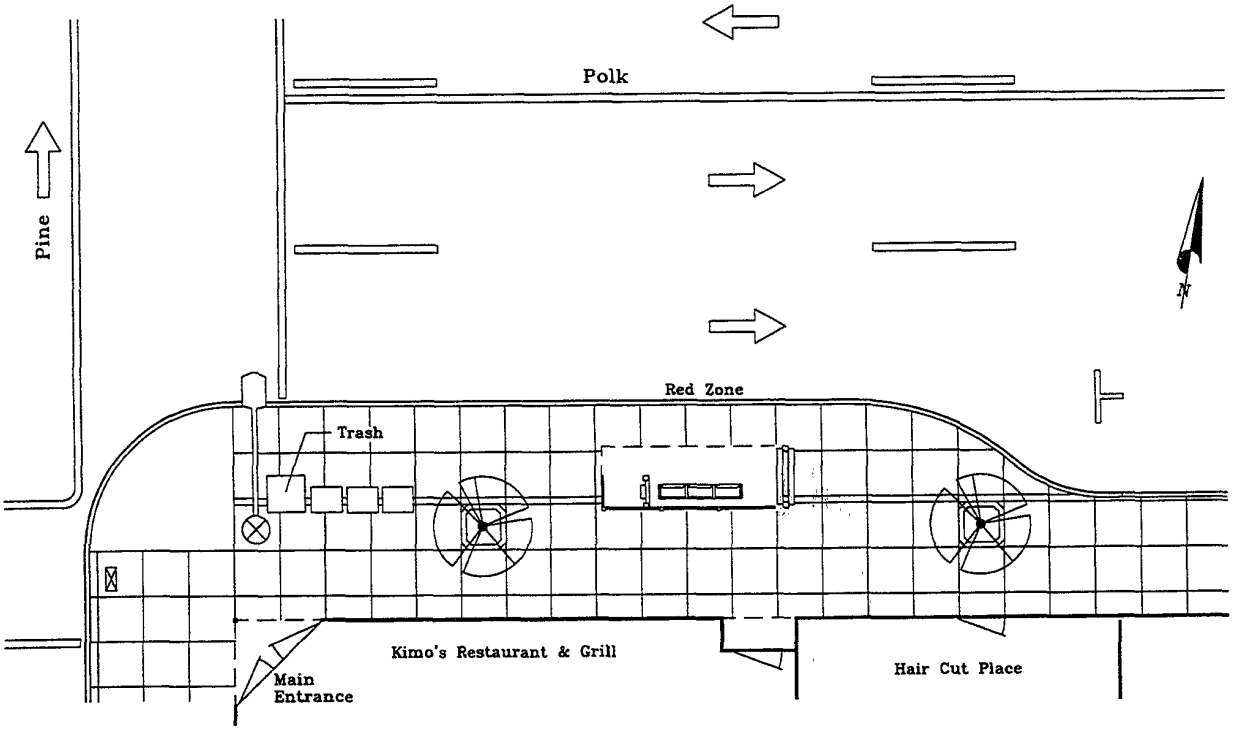


Figure E-19. Far-Side Nub (Polk Street at Pine Street).

The following general observations were made about nubs:

- The general pedestrian and bus patron conflicts are reduced when nubs are used.
- The number of amenities that can be included at a dense downtown setting can be increased.
- The amount of adaptive use of store ledges or awnings because of the separation between the bus stop and the store fronts and the increased waiting area is reduced. Bus patrons, with the exception of the Chinatown site, were observed to be using only those amenities located at the site.
- Without the additional space provided by the nub, the site and adjacent sidewalk would probably reach an uncomfortable level of saturation. Figure E-20 is an example of bus patrons standing on the nub at the Stockton Street field study site away from the pedestrians using the nearby sidewalk.
- The amount of jaywalking may increase. Although no bus patrons were seen illegally crossing the street, several pedestrians were seen taking advantage of the reduced width between opposing curbs. Midblock nubs appear to have the greatest impact on encouraging jaywalking. The near-side and far-side nubs do not appear to encourage any type of jaywalking because of the proximity to the intersection. With near-side and far-side nubs, pedestrians "shortcut" the walk through the intersection when approaching the curb (see Figure E-21).
- The telephone provided inside the shelter was never used by people waiting for the bus. The additional pedestrian traffic caused by the telephone created minor conflicts between bus patrons and pedestrians, especially during bus boardings and alightings.
- From a pedestrian and bus patron point of view, nub configurations enhance the comfort and convenience of transit in dense urban settings.

Figure E-20. Bus Patrons Standing on Nub Design.

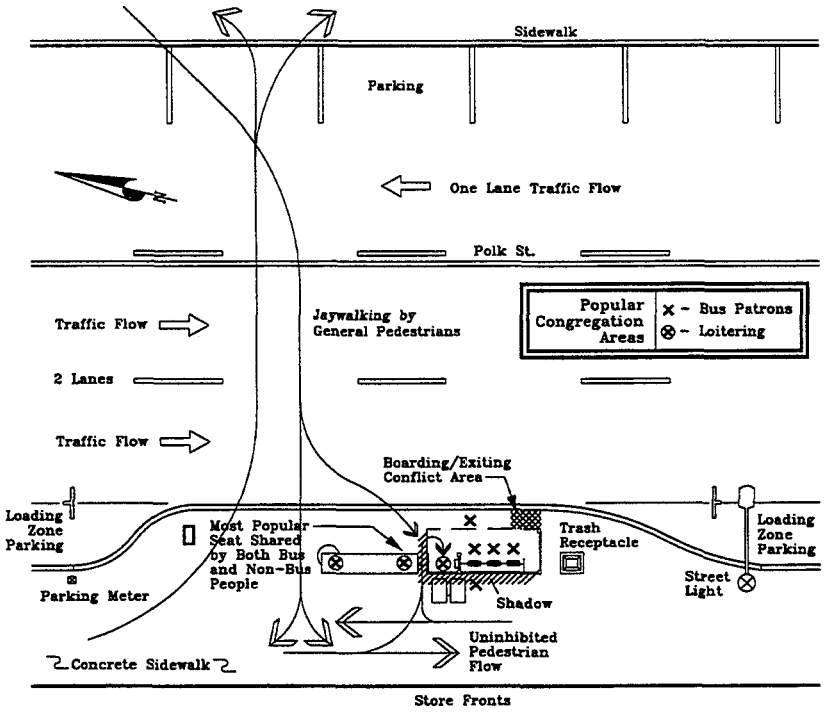


Figure E-21. Pedestrian Movement Study (Midblock: Polk Street).

AMENITIES

Amenities are considered to be those elements at a bus stop that enhance the comfort and convenience of using transit. Amenities can also influence a patron's real or perceived sense of security at a bus stop. It is unclear which amenities attract new riders and which amenities, when removed, may cause reductions in existing riders because of reductions in security, comfort, and convenience.

Amenities found at most bus stops are placed at the site in response to a human need or a need to address an environmental condition association with that specific site or region. This section summarizes the observations of bus stop amenities made during the regional visits and includes detailed findings from the field study sites.

Shelter

A number of bus shelter configurations and designs were observed during the project. Multiple conditions, constraints, and opportunities exist on a site-by-site basis, which can determine the final placement, configuration, and appearance of a shelter. With some exceptions, such as developer-constructed and -installed or artist-designed shelters, there was little variation in size, shape, and color of shelters observed by the research team.

The primary site-specific factor affecting shelter placement is available right-of-way. In virtually every case where there was adequate right-of-way, shelters were set away from vehicle traffic and out of the flow of pedestrian traffic. Many of the shelter installations observed were visible compromises in response to unique site-specific conditions.

An important issue for transit agencies regarding bus shelters is maintenance and safety. Several transit agencies visited during the regional visits noted the importance of proper bus shelter maintenance and providing safe, secure bus shelters.

Shelter Configurations

Panel placement and type is the most common treatment used to make the bus shelter as comfortable as possible. In southern climates with mild winter temperatures and extreme summer temperatures, shelters can be designed to be completely open to air circulation from all four sides. At sites with wind, rain, or glare problems, standardized shelters can be retrofitted with panels to provide protection and shade. The panels can be solid pieces of glass, metal, or plastic. The panels observed in southern climates typically have openings to permit air movement through the shelter. On some occasions, panels are properly placed to diffuse direct sunlight and glare. Figure E-22 is an example of a shelter in Tucson, Arizona, that uses a perforated panel to protect waiting patrons from the heat and glare of the setting sun.

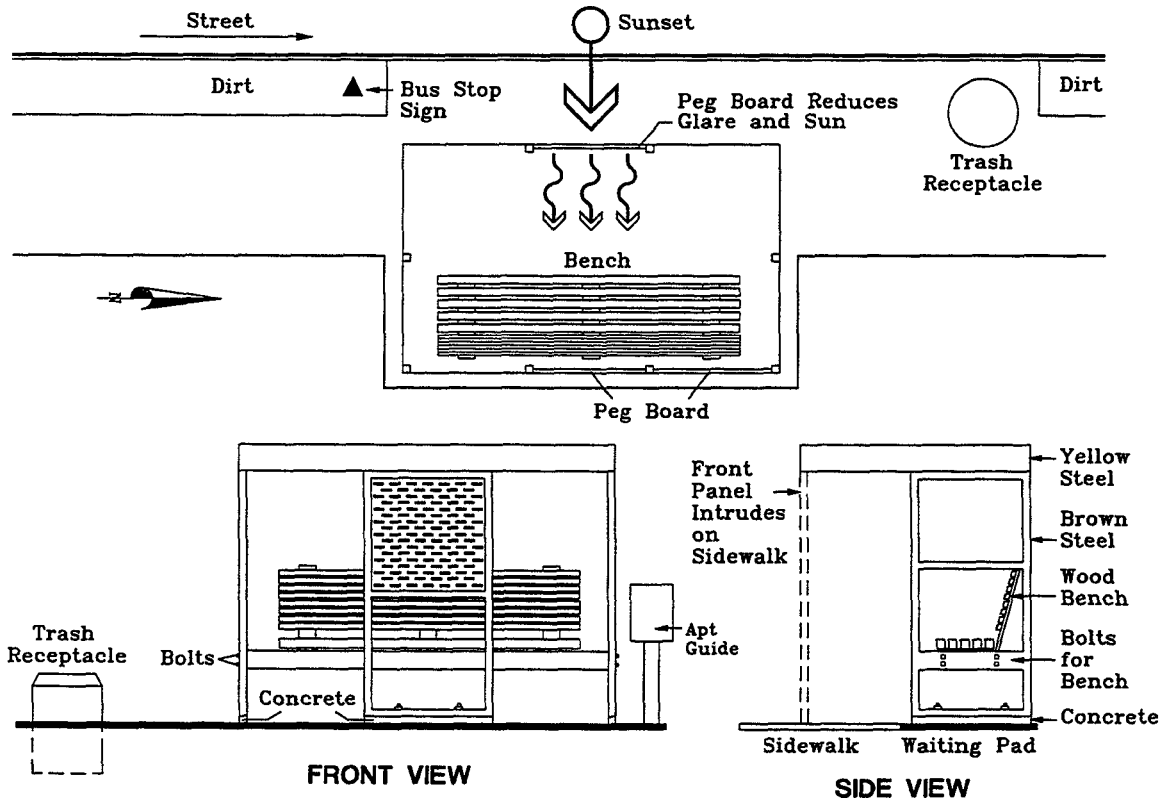


Figure E-22. Bus Stop Treatment in a Southern Climate.

In northern climates, four-sided shelters with solid paneling is common. The panels help reduce exposure to wind and precipitation. Four-sided shelters usually have two openings for entry and exiting (see Figure E-23). One opening for entry and exiting is avoided because of safety concerns rather than enhancing ventilation conditions.

Figure E-23. Shelter in Northern Climate with Two Openings for Entering and Exiting.

Orientation of Bus Shelter

An important consideration when determining the final location of a stop or shelter is the orientation of the stop or shelter with respect to the environmental conditions of a site. Proper orientation of the stop or shelter can offer patrons protection from the elements. Bus stops that are improperly placed can accentuate the negative environmental factors at a site and make transit an uncomfortable and inconvenient experience. Improper bus shelter orientation may also encourage waiting bus patrons to seek relief at locations other than inside the bus shelter (see Figure 24).

In southern climates, shelters should be oriented to take advantage of cross ventilation or to reduce the amount of afternoon sun entering the shelter. In northern climates, shelters are typically oriented to block cold winter winds and to protect patrons from snow and rain. A unique feature associated with northern climates is that some shelters are oriented with the rear of the shelter facing the street instead of the entrance and exit facing the street. By having the rear of the shelter adjacent to the street, it protects patrons from snow that can be moved or blown by snow removal machines on the street (see Figure E-25).

In urban areas, shade and glare can be created by adjacent buildings and materials. Attention to the climate created by adjacent structures should be made when determining the location and orientation of a bus stop.

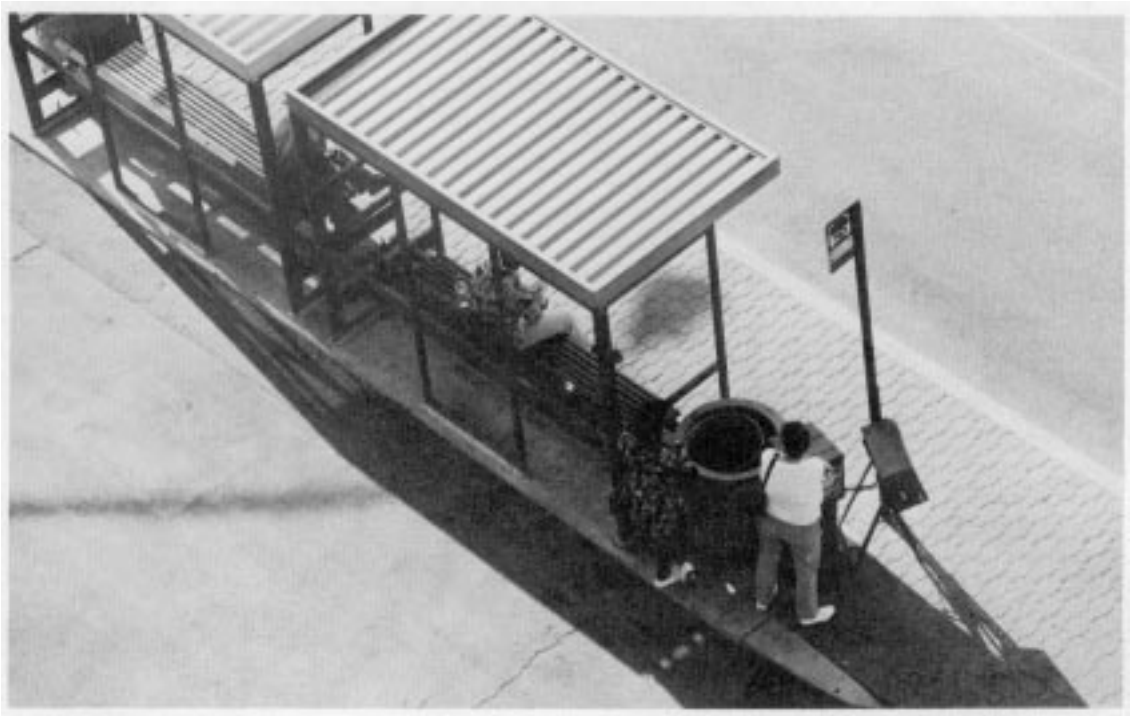


Figure E-24. Patrons Using Shadows Cast by Shelter as Shade.

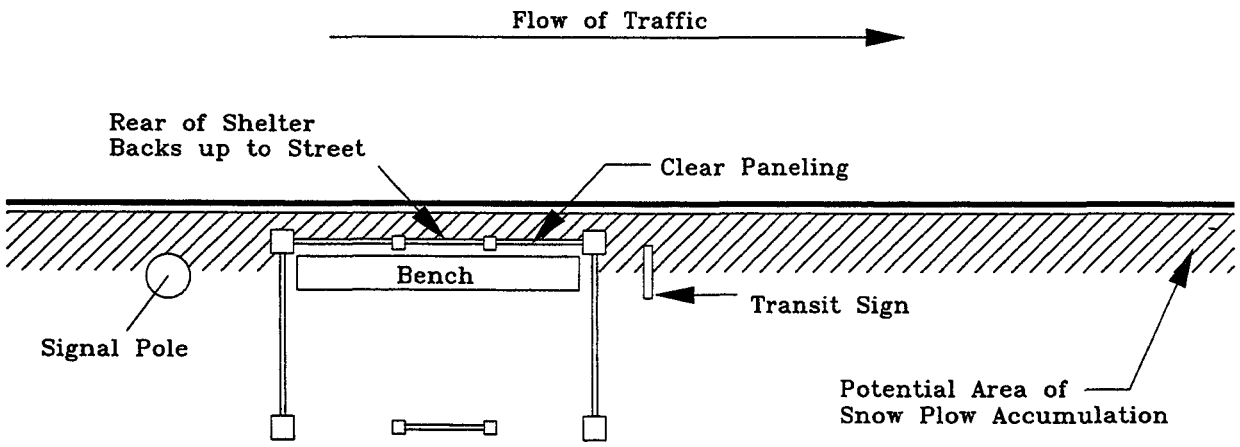


Figure E-25. Example of Rotated Shelter in Northern Climate.

The climatic conditions of a bus stop site can influence the utilization of the shelter. The shelter in Figure 26 is an example of a poorly oriented bus stop. During the morning hours, the site is in complete shade because of an adjacent building. In the afternoon hours, the site is in full sun. Patrons are generally comfortable in the morning hours because of the mild climate and shade. However, in the afternoon, the site would become quite warm and the shelter will be unused. Because the front of the shelter is completely exposed to the setting sun, patrons will stand behind the shelter for shade or linger in adjacent store fronts. Re-orienting the shelter with the back toward the street could overcome this situation. As the example currently exists, the waiting passengers standing behind the shelter would block the sidewalk during the afternoon hours.

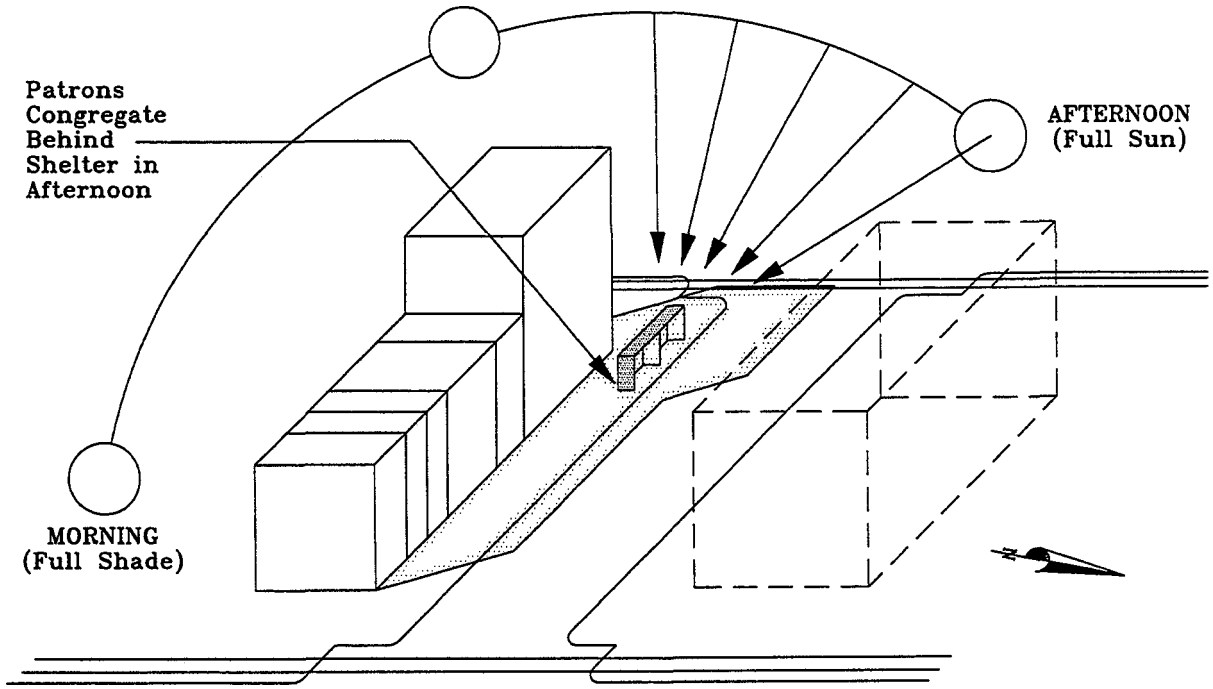


Figure E-26. Morning Shade Patterns and Afternoon Sun Angles.

Unique Shelter Designs to Compensate for Environmental Extremes

To overcome extremes in local weather conditions, a few select sites throughout the United States have been outfitted with features to give waiting patrons climatic comfort within the shelter. In the Southwestern region of the United States, air temperatures can reach above 110 degrees Fahrenheit on a regular basis during the summer. Asphalt and concrete increase the air temperature by several degrees because of the heat the materials retain and reflect. Because of the proximity of the shelter to roadways, temperatures at a bus stop can exceed the air temperature by several degrees. The areas where bus stops are typically located can be an extremely uncomfortable microclimate. Unique designs observed included a cool air mister and evaporation cooling towers.

In Tempe, Arizona, a misting system has been installed along the edges of the roof at one bus stop along a major arterial (see Figure E-27). Patrons activate the system by pushing a red button inside the shelter. Small particles of water are then sprayed around the edges of the roof of the shelter and the interior environment is cooled. While in Tempe, the mister worked as designed.

In Phoenix and Tucson, Arizona, cooling tower technology is being tested at a few designated transit malls (see Figure E-28). At the top of the tower, approximately 25 feet high, water is evaporated by wind. As the air cools, it sinks to the lower portions of the shelter and exits the shelter as a cool breeze.

No special cold weather treatment were observed during the regional visits. Any type of technological treatment applied to bus shelters to improve environmental comfort appears to be maintenance-intensive and costly.

Figure E-27. Bus Stop Misting System.

Figure E-28. Bus Stop with Cooling Tower.

Developer-Built Shelters

Developers will often differentiate their development from surrounding developments by using themes, color schemes, and repetition of forms and materials. By doing so, the developer can establish an identity that can be easily marketed. A number of outstanding examples of developer-designed shelters were observed during the regional visits. Three examples (an apartment complex in Concord, California; a residential community [Orindawoods] near Concord, California; and a commercial shopping center in Phoenix, Arizona) each coordinated the bus stop design with elements from the development.

In all three examples, the developer repeated common forms, colors, and materials from the development into the design of the shelter to create unity and similarity between the shelters and elements in the development. The shelter at the apartment complex in Concord, California, is the same form, shape, material, and color of the entry awning (see Figure E-29). In Orindawoods, the neighborhood association constructed shelters throughout the community that are similar to the design form of the entry sign (see Figure E-30). The landscaping in and around the shelters is also similar to the plant material used around the entry sign. At the commercial shopping site in Phoenix, Arizona, the developer-constructed shelter repeats the forms of the adjacent entry sign and buildings in the development (see Figures E-31 and E-32). The shelter is essentially a smaller scale representation of the buildings in the commercial center. Aesthetically, the shelters are significant changes from the standard prefabricated shelter.

Developer-designed shelters should be recognized for their merits in achieving aesthetic coordination with nearby land uses. This highlights the need and potential for coordinating transit with future development. Developer-designed and -constructed shelters can be a cost-effective way of providing an aesthetically unique shelter at a development.

Figure E-29. Shelter in Concord.

Figure E-30. Shelter in Orindawoods.

Figure E-31. Entry Sign at Commercial Center.

Figure E-32. Shelter at Commercial Center.

Artist-Designed Bus Stop Shelters

Under flexible funding provisions available from the Federal Transit Administration, funds can be allocated for designing and installing non-traditional shelters and related amenities. Artist-designed bus stops add festivity, color, and beauty. Four bus stops in Tempe, Arizona, have been designed by local artists (see Figure E-33). The sites are close to the Arizona State University campus and downtown Tempe. The sites experience high volumes of bus patrons and are located at highly visible intersections. Each design is uniquely identifiable. In addition to creating new shelters, the local artists have created new benches, trash receptacles, and bike racks at each site (see Figure E-34).

The functionality of the bus stop should not be sacrificed for aesthetics. An artist-designed bus stop should adequately provide protection from the elements. In one such case, it was obvious that the artist-designed bus shelter did not protect waiting patrons from the sun. Consequently, the patrons looked uncomfortable at this stop.

Figure E-33. Artistic Bus Stops in Tempe, Arizona.

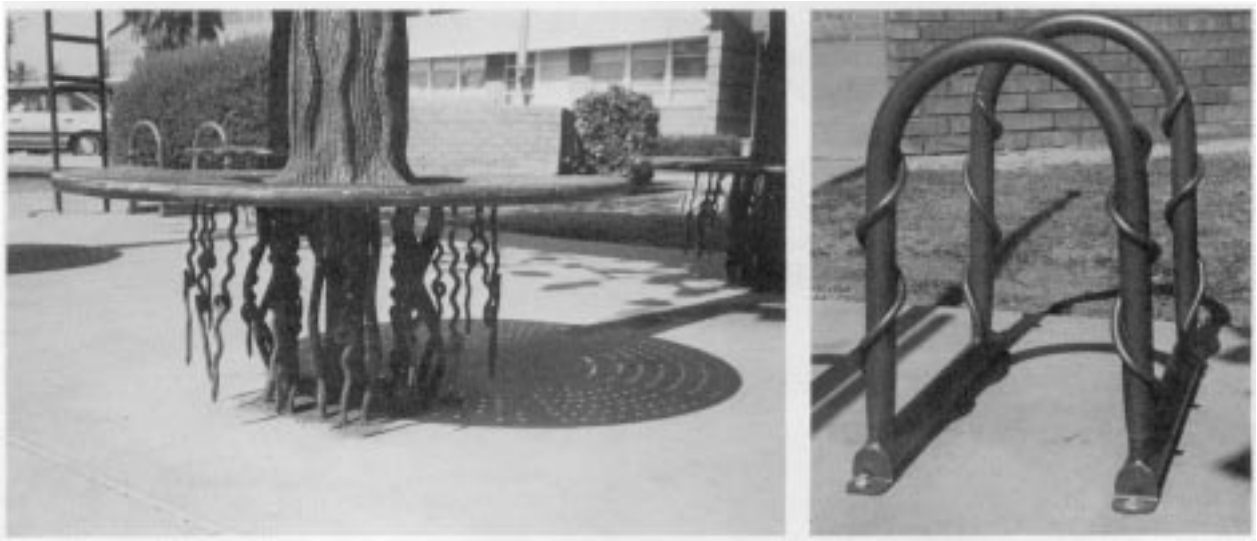


Figure E-34. Bench and Bike Rack Created by Local Artists in Tempe, Arizona.

Advertising Bus Shelters.

Advertising bus shelters are bus shelters installed by advertising companies in exchange for the right to place advertising panels on the bus shelter. For more information regarding advertising bus shelter design and placement, please refer to Chapter 4 of the *Guidelines.*

Advertising Kiosks. An alternative to advertising panels placed directly on bus shelters is advertising kiosks in close proximity to the shelter. Advertising kiosks were observed in Phoenix, Arizona, at some stops in downtown. The form, color, and material are similar to the adjacent shelter (see Figure E-35). An advantage of kiosks is that the advertising is located elsewhere, which permits greater surveillance of the shelter interior. The kiosks also create additional shade during the morning and evening hours (see Figure E-36). In Phoenix, the advertising kiosks are located downstream of the traffic flow to permit full view of the bus stop from passing traffic and bus drivers (see Figure E-37).

Figure 35. Advertising Kiosks.

Figure 36. Using Shade Created by Kiosks.

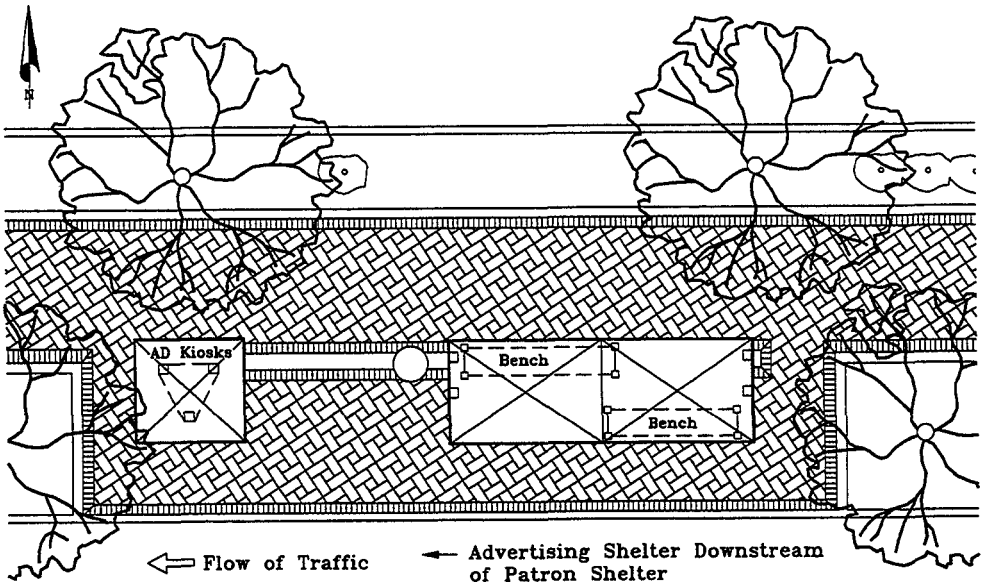


Figure E-37. Example of Locating Advertising Kiosk Downstream of Bus Stop.

Seating/Benches

As part of the field studies, benches were studied to determine what items (e.g. placement, crowding, and comfort) might impact their utilization. Benches at bus stops can be a stand-alone amenity inside a bus shelter or additional seating outside a bus shelter. The following paragraphs are a review of the observations and findings from the field studies of benches.

Interior Seating. Interior seating is standard among many manufactured shelter designs. The seats or benches are typically linear and are parallel and adjacent with the rear of the shelter. In some instances, the bench did not extend along the entire length of the shelter. The additional space may accommodate standing patrons inside the bus shelter or passengers in wheelchairs (see Figure E-38).

In some instances, multiple benches are used inside a bus shelter to accommodate large numbers of waiting bus patrons. Based on observations, when benches are staggered, patrons moved easily through the shelter (see Figure E-39). The bus stopped directly in front of the shelter and the "walk through" space helped relieve any potential congestion in front of the shelter. Other shelters have variations of the two-bench configuration. Depending on placement of the benches, movement through the shelter was either simple or challenging.

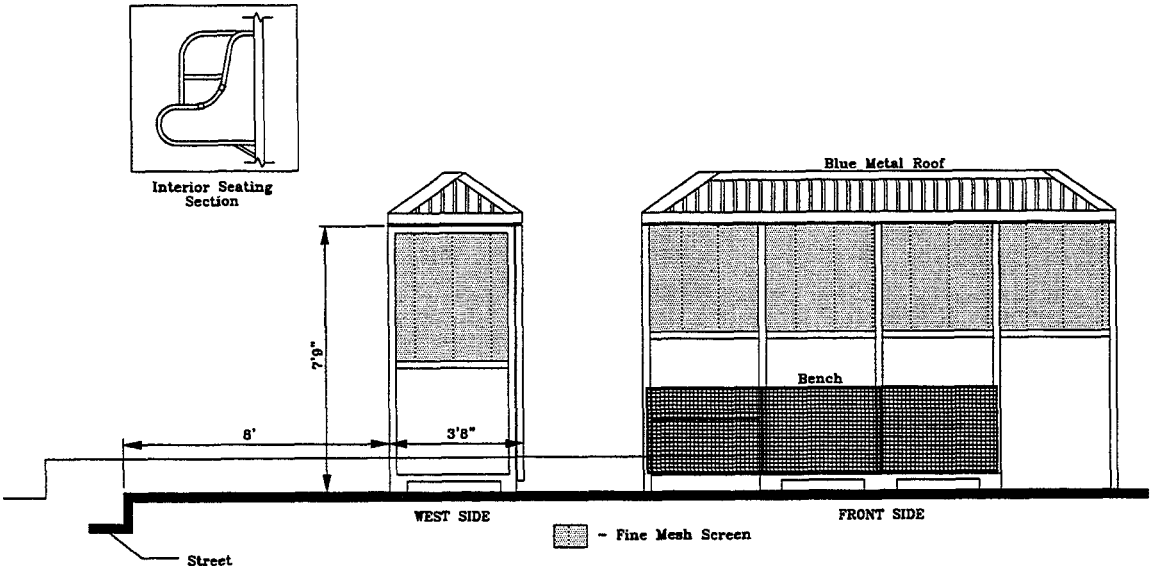


Figure E-38. Bus Shelter Section With Bench That Does Not Extend Along the Entire Length.

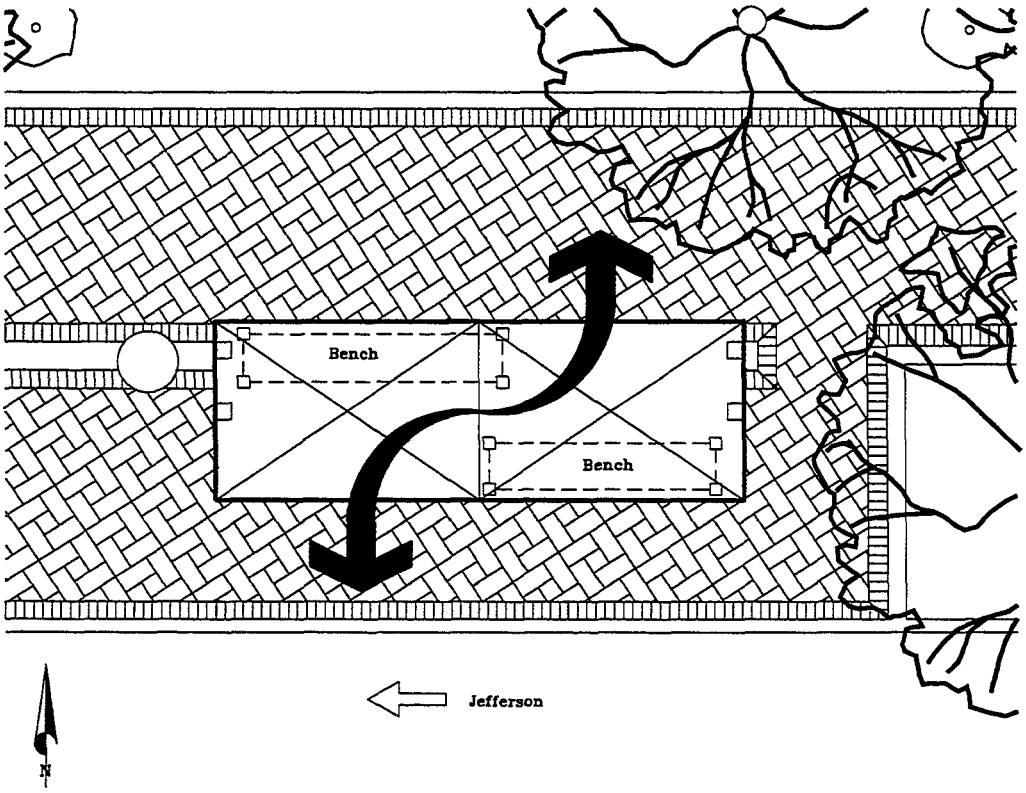


Figure E-39. Offset Linear Seating in Phoenix.

Other unique seating configurations exist in San Francisco where the bus shelters are equipped with three chairs that pivot on a common rod. The chairs are somewhat uncomfortable and awkward to use. According to local transit agencies, the chairs are designed to discourage unintended use of the bus shelters after operating hours. A benefit of the pivoting chairs is that additional standing space is created inside the bus shelter when the chairs are unused (see Figure E-40).

One factor that can greatly influence utilization of interior benches is crowding at the site. Crowding can limit the amount of available choices to sit or wait and creates situations where patrons must wait elsewhere than in intended areas in and around the shelter. Discouraging all amenities that may encourage non-bus riders to loiter in and around a bus stop can assist in preventing overcrowding at a bus stop.

Figure E-40. Pivoting Chairs in San Francisco.

As noted in the sections on bus shelter configurations and orientation, interior bus shelter comfort can influence how the shelters are used by bus patrons. Despite the availability of seating within the shelter, patrons will seek relief elsewhere if the climate of the bus shelter is harsh (see Figure E-41). A detailed evaluation of seating patterns with respect to sun/shade patterns was conducted at the Speedway at Campbell site in Tucson, Arizona. Figure E-42 details theses findings. As previously believed, the preferred seats are those in the shade and those seats in the sun were left largely unused throughout the day.

Figure E-41. Seating Patterns at Speedway at Campbell.

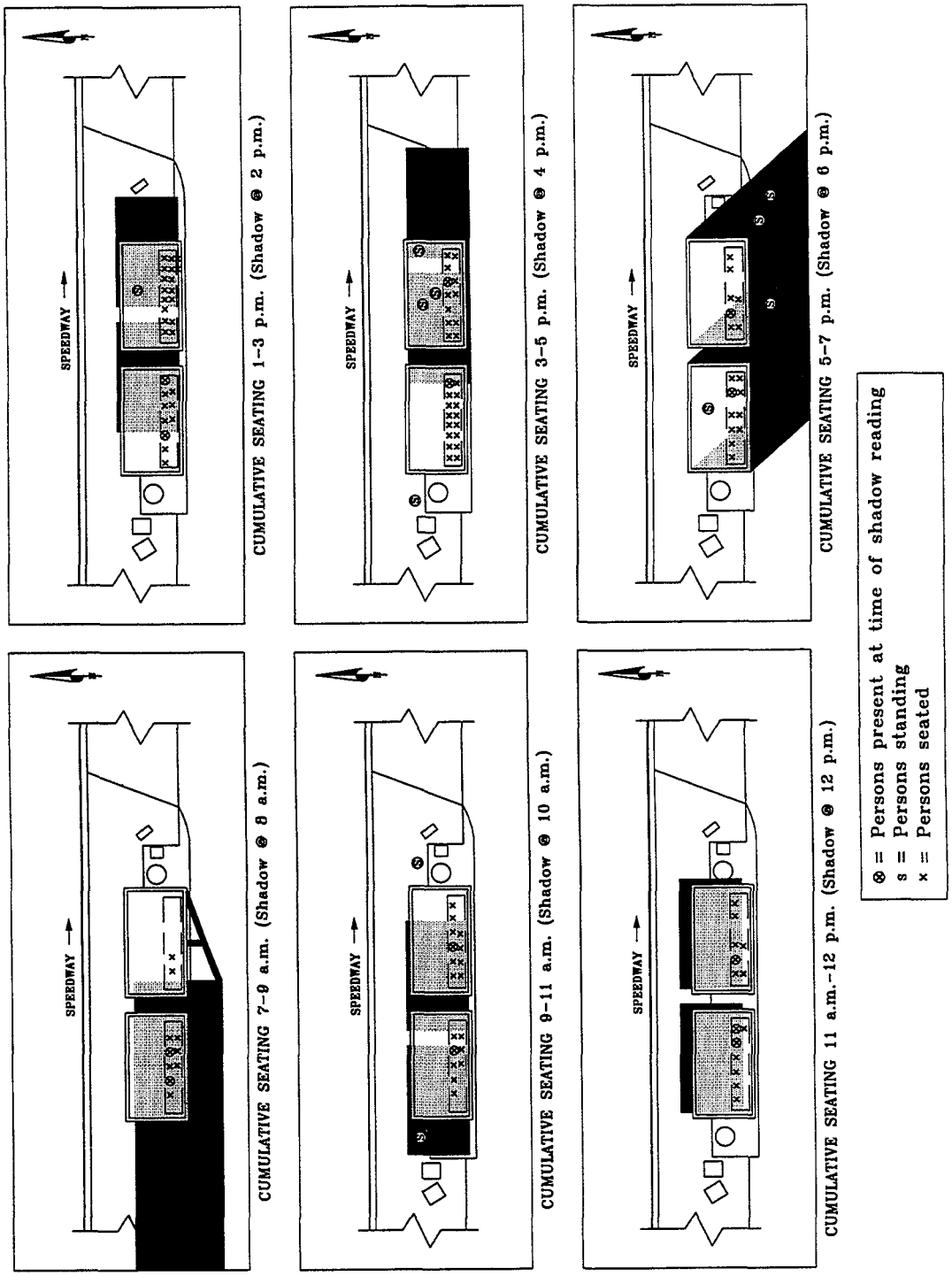


Figure E-42. Seating Pattern Study (Speedway at Campbell).

Exterior Seating with Shelter. Additional seating outside a shelter is necessary at sites with large passenger volumes or to accommodate increased demand during peak periods. Typically, the additional seating is placed to either side of the shelter and may vary in length, depending upon space availability, demand, or system policy. Crowding, environmental conditions, and claims to personal space affect utilization of benches and surrounding features.

Three study sites (San Francisco, San Jose, and Phoenix) yielded interesting information concerning exterior bench utilization. In San Francisco, the exterior bench is only 9 inches from the shelter, but is a comfortable 4.5 feet from the curb. The distance between the shelter and the bench is too small for most patrons to move through. However, the placement of the bench with respect to the curb allows for unobstructed movement between the bench and the curb (this is especially important when a bus is boarding and alighting) and the space provides patrons with an acceptable zone of comfort from the nearby traffic.

The bus stop in San Jose, California, has two shelters and four additional benches. The closest bench is only 4 feet away from a shelter. The other three benches are more than 30 feet away from the shelter (see Figure E-43). Each bench is 4 feet away from the curb and approximately 9.5 feet away from the edge of the building, providing a large area for general pedestrian traffic between the stop and the building. The additional sidewalk space is useful during peak periods of the day to limit pedestrian congestion in and around the bus stop. Similar to the San Francisco bus stop, the 4 feet of space between the benches and the curb provides a much-needed circulation space when the buses are boarding and alighting at this bus stop. Observations at this site are illustrated on Figure E-43.

The downtown Phoenix, Arizona, field study site reinforced previous observations about the influence of crowding and environment on bench utilization (see Figure E-44). The site has a large shelter with two interior benches. An advertising kiosk is downstream of the shelter and two exterior benches are upstream of the shelter. The sidewalk is landscaped with several shade trees. The landscaping is utilized well at this bus stop. The additional shade provided by the trees served as informal waiting areas for bus patrons when the shelter or exterior benches were exposed to the sun.

From the field study sites, observations include:

- The distance between the shelter and the exterior bench needs to be large enough to permit unobstructed movement.
- Minimal conflict between general pedestrian traffic and bus patrons waiting on the bench occurs at nub sites because the bench and the bus shelter are separated from the sidewalk.
- Crowding and environmental extremes encourage patrons to seek cover other than the bus stop.
- Rarely will people sit next to each other during non-congested periods. People would rather lean against the wall of a nearby building or sit on a ledge.
- The exterior benches are more popular than the seating inside a shelter (see Figure E-45). People may feel safer waiting on an exterior bench than on benches in a semienclosed space (bus shelter), when weather permits.

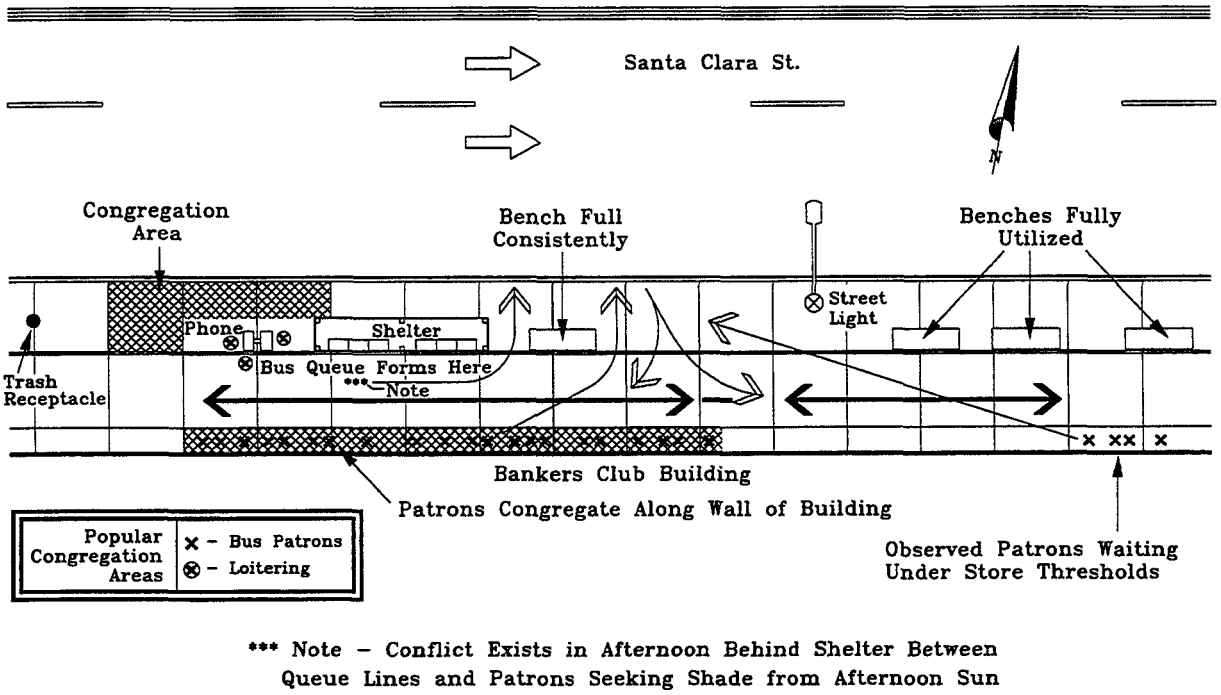


Figure E-43. Pedestrian Observations (San Jose).

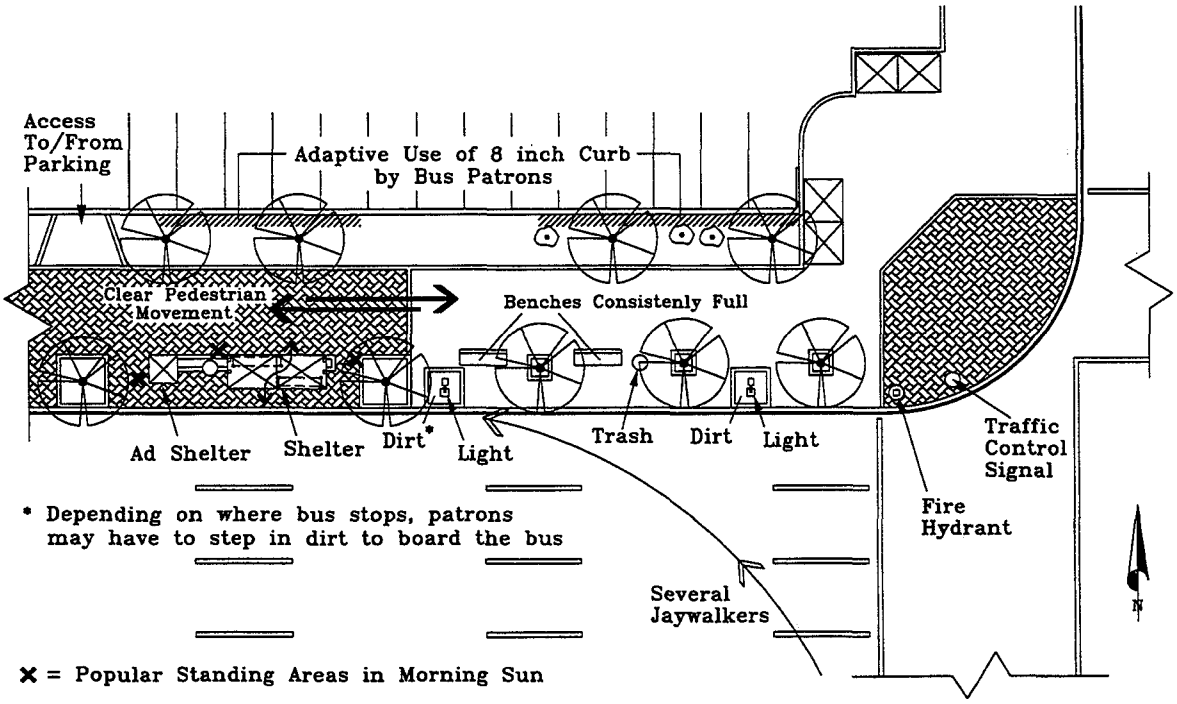


Figure E-44. Pedestrian Observations (Phoenix).

Figure E-45. Exterior Bench Close to Shelter.

Each of these factors can be addressed with proper site evaluation by the transit agency. One factor that the transit agency has little control over, though, is the patron's zone of public domain or personal space. When patrons place objects to separate or claim space on the bench, other patrons may be forced to stand or look elsewhere for seating. The need to produce or protect individual space may be a result of perceptions of security.

Bench-Only Sites. Benches are a means of providing a convenient and comfortable amenity at bus stops that do not warrant a bus shelter. A bench and a sign post can be the sole amenities provided at a stop that has few riders or infrequent service. During the regional visits, a number of benches were observed in various conditions and locations.

The location of a bus stop bench can influence a bus patron's comfort and convenience. Figures E-46 and E-47 show two different examples of bench placement. In northern climates, snow can create significant access problems for bus stops with benches. Snow plowed from the adjacent street can be pushed onto the bench or onto the space between the sidewalk and the bench, creating hazardous conditions for patrons. Because of liability problems, transit agencies sometimes do not clear foot paths for patrons at bench-only sites. Bus drivers, out of courtesy, will typically board and alight the vehicle at cleared driveways to avoid having patrons walk through slush or snow.

Figure E-46. Benches Close to Sidewalk.

Figure E-47. Bench Near Street.

In Phoenix, Arizona, benches for bus patrons are coordinated with streetscaping projects that are currently taking place on many arterial streets. Benches are automatically installed at sites that have less than 10 feet of right-of-way on a 40-foot-by-10-foot brick-paver waiting pad. At a minimum, a 4-foot-wide sidewalk is installed to either side of the waiting pad, which is contiguous with the street. Furthermore, the benches are placed on the backside of the waiting pad and are coordinated with landscaping to provide shade for waiting passengers (see Figures E-48 and E-49).

Figure E-48. Bus Stop Coordinated with Streetscaping Project.

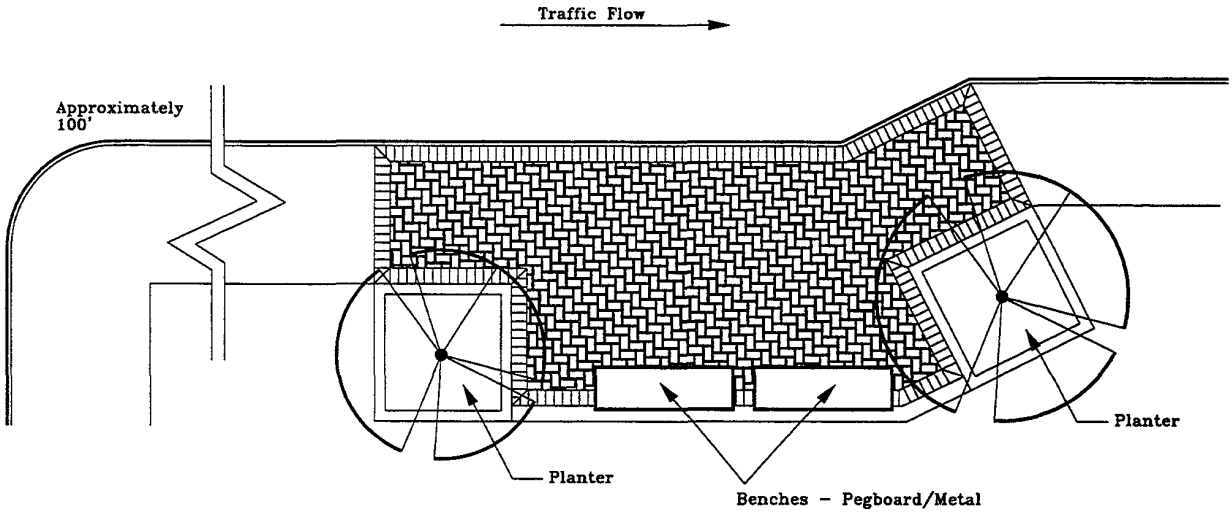


Figure E-49. Example of Integrating Bus Stop with Sidewalk and Landscaping.

Advertising Benches. Another element of benches is the prevalence of privately provided benches with advertising (see Figure E-50). This has allowed more benches to be provided than might otherwise be the case. Advertisers are primarily concerned with drive-by visibility, rather than transit ridership. In situations where good coordination exists between the private bench providers and the transit agency, this does not appear to be a problem. While in other situations, transit agencies noted a loss of control and influence. Finally, some agencies have decided not to allow advertising benches at all.

Figure E-50. Example of Advertising.

Lighting

Lighting is an important amenity at bus stops, in particular during the winter when daylight is limited. Lighting significantly influences the passenger's perception of safety and security at a bus stop. Lighting at a bus stop can provide a waiting passenger comfort because of the increased surveillance afforded by the light. It can also discourage loitering or unintended uses of transit facilities by non-bus riders.

Only a few of the transit agencies visited maintained lighting within a shelter or at a bus stop. For some transit agencies, service ceases at dusk or shortly afterwards. Therefore, interior lighting is considered an unnecessary expenditure. The transit agencies, though, did acknowledge the need for interior lighting when daylight-savings time is in effect since passengers may arrive and return in the dark. Cost, availability of power, and vandalism usually influence the decision to install lighting at a site.

Direct lighting is expensive and can be difficult to achieve with limited access to a power source. In San Francisco, interior bus shelter lighting is provided at most urban stops. Figure E-51 details the design and location of the lighting elements in the San Francisco bus shelters. In Tucson, Arizona, SunTran has installed lighting at some sheltered stops using solar power (see Figure E-52). The energy collected from the sun during the day is stored in power cells and is used after sunset. All new shelters in Phoenix, Arizona, will be equipped with lighting powered by solar panel electricity.

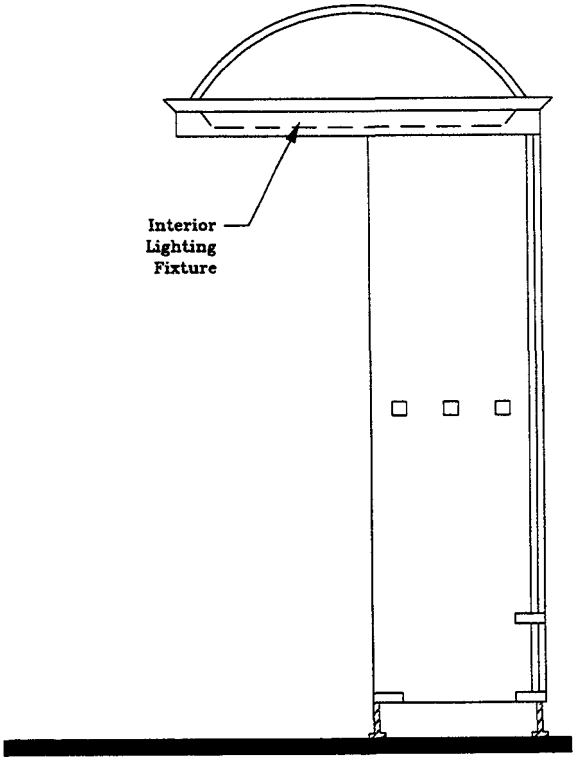


Figure E-51. Location of Interior Lighting.

Figure E-52. Lighted Shelter Using Solar Power.

An option that is being implemented by some transit agencies is to include installation of lighting as a part of the agreement with advertising shelter companies. This is viewed as a costeffective approach to providing lighting at sites that would otherwise be uneconomical for the transit agency to install. The advertising company maintains the lighting as well.

A cost-effective approach to providing indirect lighting is coordinating stops with existing street lights. Among the transit agencies visited, coordinating the bus stop locations with a street light is a system policy when interior lighting cannot be provided. It is an inexpensive method of achieving lighting at a bus stop. A majority of shelters and stops observed during the regional visits were located within 30 feet of an existing street light.

Vending Machines

Some transit agencies encourage the installation of vending machines (primarily newspaper) at or near their stops, typically on the grounds that they are convenient for the passengers. Others actively discourage such installations on the grounds that they clutter the area and contribute to the trash problem (see Figure E-53).

Figure E-53. Vending Machines at Stop.

Trash Receptacles

Trash receptacles are common at bus stops, especially at stops with benches or shelters. The decision whether to install trash receptacles or not seems to be a general policy matter, though not a very high-profile one. Experience with trash receptacles is varied. Some find wide public acceptance and appreciation with limited vandalism or abuse. Others find maintenance difficult and expensive, abuse and clutter high, and public acceptance correspondingly poor. This is especially evident at sites near convenience stores, fast food restaurants, or gas stations. General pedestrian traffic generated by the convenience stores also uses receptacles that are conveniently located along sidewalks near bus stops. Companies installing advertising shelters or benches, though, offer a solution to this problem. As part of the agreement to install shelters or benches at a site, the company must maintain and clean the sites regularly, thereby relieving the transit agency of this duty.

Trash receptacle designs may be artistic (see Figure E-54) but should be functional. Bus patrons are concerned with the appearance, placement, and smell of the receptacle. Trash receptacles that are overflowing and in full sun are unpleasant in a number of ways. The negative impacts of uncontained trash can be unintentionally enhanced with some receptacle designs. For example, trash receptacles with ledges create spaces for liquids to remain, rather than be contained inside the trash receptacle or drain away. Designs that allow the contents of the container to be exposed also attract insects, which can be hazardous to some bus patrons. In Arizona, some of the trash receptacles are partially installed below grade; whether it is to reduce exposure to sun or permanently affix the receptacle to the site is unclear.

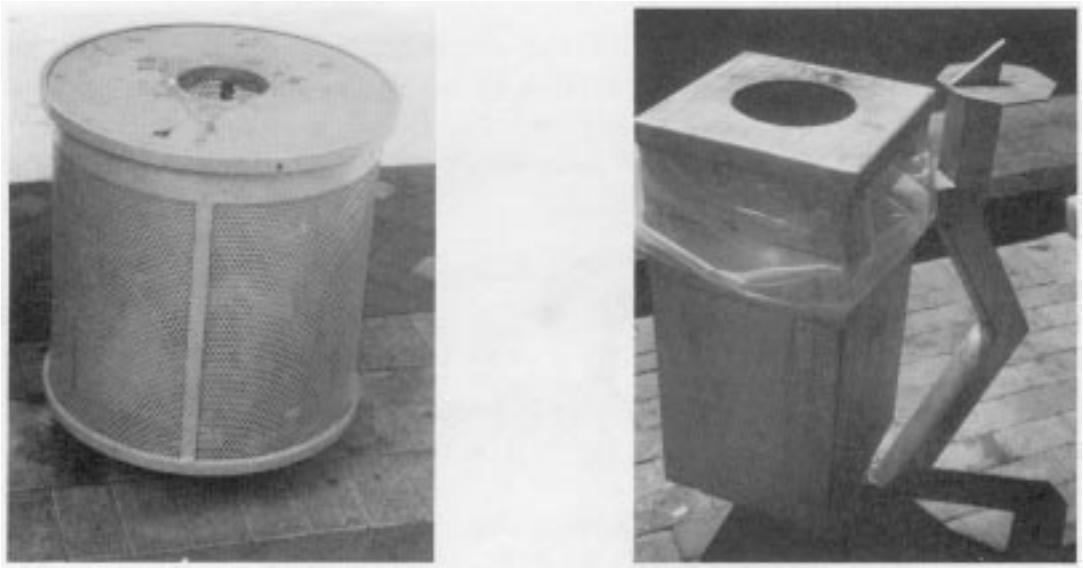


Figure E-54. Trash Receptacle Designs.

Phones

Phones at bus stops, like trash receptacles, are a result of a systemwide policy, rather than random placement. Some transit agencies have explicit policies regarding the installation of phones—such as that phones offer patrons the potential convenience of receiving real-time bus arrival information (if available) and quick access to emergency services and allow patrons to make personal calls (see Figure E-55). Conversely, some agencies strongly feel phones at bus stops create opportunities for illegal or unintended activities.

Figure E-55. Exterior Phone at Bus Stop.

In San Francisco, phones are included at several bus stops because of a city ordinance restricting the amount of phones on a per block basis. At the Polk Street study sites in San Francisco, phones are installed in each shelter (see Figure E-56). The phones added to the number of people at the bus stops, which increased congestion levels during boardings and alightings.

Figure E-56. Interior Phone at Bus Stop.

Route Information

Route information, such as system maps and schedules, is an amenity that is quite valuable to transit customers. Including route or schedule information at a bus stop is a system policy at many transit agencies. Most shelters and stops visited have the mechanism for including route schedules and maps. Mechanisms include panels specifically designed to hold this type of information, frames inside the shelter, and panels on signposts (see Figure E-57).

Several transit agencies, though, ceased updating the route and schedule information at the stop because of the number of changes that occur during the year. Instead of replacing old schedules with updated schedules, the information is removed from the shelter completely or is quickly taped to the side of the shelter (see Figure E-58).

Figure E-57. Panel on Post.

Figure E-58. Schedules Taped to Shelter.

Bicycle Storage Facilities

Bicycle storage facilities, such as bike racks, are provided at bus stops as a matter of convenience for bike riders using transit. The storage facilities also discourage bicycle riders from locking their bikes on the shelter or bench or on an adjacent piece of property. Proper storage of bicycles can reduce the amount of visual clutter at a stop by confining the bikes to one area. Several designs were observed on the regional visits (see Figure E-59).

To encourage greater multimodalism, transit agencies are pursuing greater numbers of bicycle riders on buses. Bicycle riders can, in some cities, either take the bike on the bus or store the bike on a bike rack installed on the front of the bus. From conversations with transit agencies, it is believed that bicycle riders would rather take the bike with them on the bus rather then store the bike at a bus stop for extended periods. The increased purchasing costs and popularity of bicycles probably play a significant role in the preference of bicycle riders to take the bikes with them on the bus. On-vehicle bicycle programs are extremely successful in university towns, such as Tempe, Arizona.

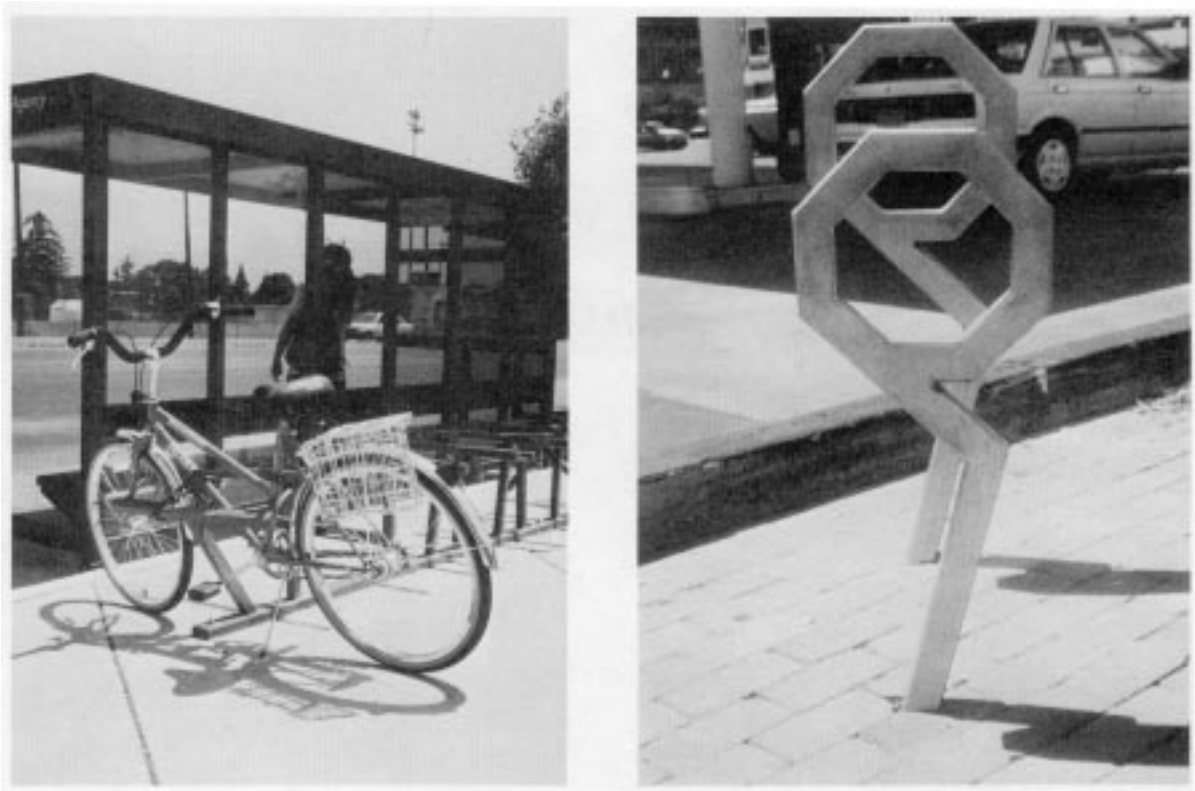


Figure E-59. Bicycle Rack Designs.

Shopping Cart Storage Areas

A phenomenon observed on a frequent basis that does not receive attention in the literature is the presence of shopping carts at bus stops. Shopping carts were observed at multiple bus stops. The carts are haphazardly stored in and around the bus stop, creating an eyesore and blocking the sidewalk (see Figure E-60). Typically, sites with shopping carts are suburban strip commercial centers where patrons have long distances to walk between the store entrance and the bus stop. The bus stop is too far from the store to return the carts and the bus stop lacks a place to store the carts. A need exists to install a storage facility near the stop to accommodate shopping carts and to prevent random storage in and around the stop.

Figure E-60. Shopping Cart Left at Bus Stop.

Landscaping

Installation of trees at a bus stop can enhance environmental comfort regardless of region. The shade is welcome in southern climates and trees provide wind protection in northern climates. In Phoenix, Arizona, a number of bench-only and bus shelter sites are coordinated with "streetscaping" projects. The landscaping provides additional aesthetic value and the shade provided by the trees serves a necessary function in a warm climate (see Figure E-61). Sites with limited natural protection from the elements, as evident in Figure E-62, should be avoided or improved to enhance patron comfort. Landscaping (trees and shrubs) that block visual access to/from a bus stop should also be avoided. The location of trees and the height of shrubs are important to preserving visual access.

Figure E-61. Bus Stop Shaded by Trees.

Figure E-62. Bus Stop with Little Vegetation.

MATERIALS

Several materials are used at bus stops. The primary determinants for selecting materials are resistance to weather, continual use, vandalism, and how easily the materials are maintained. A balance must be made between aesthetics and functionality when selecting materials.

Resistance to weather is highly variable among the regions visited. In Arizona, the materials are subjected to extreme heat and sun, while in Michigan, materials must withstand rain and snow. The San Francisco Bay area remains mild throughout the year except in San Jose where summer temperatures can be very warm.

Vandalism is increasingly becoming a major problem at bus stops and greatly influences materials chosen. Graffiti "artists" select bus stops because of the visibility the stop receives from drive-by traffic. Depending on the material selected, evidence of vandalism or graffiti may or may not remain after removal. Graffiti removal is costly and time-consuming.

A review of materials used at bus stops, including advantages and disadvantages, is provided in Chapter 4 of the *Guidelines.*

THE TRANSPORTATION RESEARCH BOARD is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. It evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate the information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 400 committees, task forces, and panels composed of more than 4,000 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is interim president of the National Academy of Engineering.

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transit Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation