Southeastern Michigan
Transportation Authority


# Designing for Transit:

# A Transit Design Criteria & Standards Manual

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Southeastern Michigan
Transportation Authority

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# Table of Contents


| | |
|---|---|
| List of Illustrations | v |
| Preface | vii |
| Introduction: The Economics of Transit Design | 1 |
| Part One: Transit and the Community | 3 |
| Part Two: Technical Design Standards and Criteria | 13 |
| Chapter I Bus Specifications | 14 |
| Chapter II Roadway Design and Transit | 28 |
| Chapter III Bus Stops: Access to Transit | 50 |
| Glossary of Transit Terms | 63 |
| Bibliography | 65 |
| Index | 67 |

**Photographs**

1. Access to Transit — Macomb County I 5
2. Access to Transit — Macomb County II 6
3. Access to Transit — Oakland County I 7
4. Access to Transit — Oakland County II 8
5. Access to Transit — Wayne County I 9
6. Access to Transit — Wayne County II 10
7. Front View of a Bus Shelter 61
8. Side View of a Bus Shelter 62

**Figures**

1. Linehaul Design Vehicle 15
2. Small Bus Design Vehicle 16
3a. Linehaul Turning Template — Scale 1″ = 20′ 17
3b. Linehaul Turning Template — Scale 1″ = 30′ 19
4a. Small Bus Turning Template — Scale 1″ = 20′ 21
4b. Small Bus Turning Template — Scale 1″ = 30′ 23
5. Line Haul Service Area 25
6. Intercity Bus 26
7. Articulated Bus 27
8. Simple Curve Radius — No On-Street Parking — Preferred Minimum 29
9. Simple Curve Radius — No On-Street Parking — Absolute Minimum 30
10. Simple Curve Radius — On-Street Parking Before Turn — Preferred Minimum 31
11. Simple Curve Radius — On-Street Parking Before Turn — Absolute Minimum 32
12. Simple Curve Radius — On-Street Parking After Turn — Preferred Minimum 33
13. Simple Curve Radius — On-Street Parking After Turn — Absolute Minimum 34
14. Simple Curve Radius — On-Street Parking — Preferred Minimum 35
15. Simple Curve Radius — On-Street Parking — Absolute Minimum 36
16. Driveway Design — 40 Foot Wide Entrance With On-Street Parking 37
17. Driveway Design — 40 Foot Wide Entrance With No On-Street Parking 39
18. Driveway Design — 44 Foot Wide Entrance With On-Street Parking 41

19. Driveway Design — 44 Foot Wide Entrance With No Parking 43

20. Cul de Sac 45

21. Curb Side Bus Stops 47

22. Far Side Bus Stop After Right Turn 48

23. Near Side and Far Side Flared Lanes 51

24. Mid-Block Bus Turnouts 53

25. Flared Lanes at the Entrance of a Development 55

26. Alternative Park and Ride Design — Macomb County 57

27. Alternative Park and Ride Design — Oakland County 58

28. Alternative Park and Ride Design — Wayne County 59

29. Bus Shelter Space Requirements 60

The Southeastern Michigan Transportation Authority (SEMTA) is an agency created by the State of Michigan in 1967. SEMTA is responsible for public transportation in Wayne, Oakland, Macomb, St. Clair, Livingston, Washtenaw, and Monroe counties. SEMTA operates over five hundred linehaul and small buses. SEMTA also contracts for services with the Detroit Department of Transportation (D-DOT) which runs more than five hundred linehaul vehicles. Together, SEMTA and D-DOT carry over 100 million passengers per year.

SEMTA wishes to acknowledge the invaluable assistance of the following agencies that reviewed this manual. First, the State of Michigan's Department of Transportation, through the Traffic and Safety Division, as well as the Development and Demonstration staff, provided many useful comments. The cooperation of the road commissions of Oakland and Macomb counties is also gratefully acknowledged. Further, the Wayne County Road Commission and the Traffic Engineering section of D-DOT performed incisive and detailed reviews of this manual.

SEMTA believes that with the comments and suggestions of these agencies augmenting its extensive research and experience, this document will prove vital to the region as a tool in meshing transit service needs with road and development projects.

This part of the manual is intended to inform both the layman and the technician of the marketing and operating nature of public bus service. The following attempts to illustrate the appropriate relationship among the region's roadways, developments, and transit services. This section then sets the stage for projects which have an impact upon transit and upon which transit will likewise affect.

Roadway and land developers, when determining the compatibility between a project and transit service, need to look at two different sets of criteria: the requirements of the system from the operator's standpoint and from the passengers' standpoint. The factors that the system operator will weigh when deciding whether to provide service can differ greatly from the factors weighed by potential passengers when deciding whether to use the service. The operator will ask such questions as: Is there enough road space for the vehicles? Does the market justify the cost of serving this area? Is the route direct and easily accessible, or must buses twist and turn through residential streets to reach riders? Passengers will ask such questions as: Is the bus stop far from my home? Is it far from my destination? Can I wait in comfort for the bus if it's raining or snowing?

SEMTA and other bus system operators use two major criteria when addressing the question of whether to provide service to a particular area. First, does a sufficient transit market exist to justify providing service to this locality? Second, is the market physically accessible to the vehicles? Three factors indicate the existence of a market sufficient to justify transit service:

- a **common origin** of a significant number of people who are likely to use transit;
- a **common destination,** such as a downtown business district or a shopping center; and
- a **common travel time** to and from that destination.

An ideal transit market, for example, would be an apartment complex in which most of the residents have similar work hours and work within one block of each other in the city's downtown. This clustering virtually guarantees good utilization of buses, and therefore creates an ideal transit market.

The ideal rarely occurs, if at all. More usual are different combinations of the elements necessary for a market. Perhaps, for instance, many people live close together in a high-rise apartment building, but they work at many different places, resulting in many different work-trip patterns. Working with a given level of buses, time and operators, a system operator must weigh the market's strength against the system's capacity to serve it. Basically, transit operators try to serve the greatest number of people with the most efficient use of drivers and buses.

Once the value and scope of a market has been determined, the operator then must examine the physical accessiblity of that market. Two factors must be considered: The physical make-up of the market itself, and the type of vehicles the operator has available to serve it.

In judging the physical accessibility of a market, a transit operator evaluates road widths, their weight-bearing strength, their intersection dimensions, and the number and length of trips a bus must make off main roads.

The type of vehicles available relates directly to the operator's capacity to serve a market. This factor is generally considered in tandem with the market's physical characteristics. In southeastern Michigan, two vehicles are basic: the small bus, a van-like vehicle carrying 15-20 people; and the linehaul bus, the standard 35- or 40-foot bus seating 40-50 people.

Small buses are used to provide special transportation services to people who cannot readily use linehaul vehicles (the handicaped, for example) or in areas where operation of linehaul buses is not feasible. Linehaul vehicles serve larger transit markets with commuter service during morning and afternoon rush hours and all-day service covering both rush hours and the time between them.

Commuter service can operate as either local service or express service. On local service routes, passengers board the bus at many different points along the route. On express routes, passengers board at a limited number of pre-determined stops. One example of express service is a Park and Ride, where riders drive to the bus stop, park (usually free) and return to their cars after work.

The use of either linehaul or small buses is dictated by the physical characteristics of a market and by the size and type of market itself. Given limited resources, the system operator must make social and economic trade-offs in selecting the level of service for a community.

The primary concern of the bus patron (for the purposes of this manual) is the accessibility of the system. Can he or she get to the bus comfortably? The issue is important because a major goal of transit is to provide convenient bus service. There are three basic measurements of passenger accessibility.

(When the term "bus" is used here in relation to passenger accessibility, it refers to the linehaul vehicles. This is because linehaul service relies mostly on the passenger's getting to the system. Small bus systems usually provide curb-to-curb service.)

One of the first measurements of passenger accessibility is the patron's distance from the bus stop. Most people will usually prefer to walk no more than about a quarter of a mile to a bus stop; many elderly persons will not walk more than one eighth of a mile to catch a bus.

A second measurement of passenger accessibility is the quality of the path to the stop. To provide accessibility, a path must be **direct** and **clear.** There should be no snow or other weather-induced obstacles. The path should be paved, preferably with a non-slippery material such as concrete; and it should be fairly straight, not winding. As important as sidewalks are in providing these clear and direct paths, many apartment complexes and housing developments do not have them. Photos 1 and 6 clearly illustrate some prime examples where sidewalks emanate from the development to the main road.

A third element in passenger accessiblity is bus stop appearance. Amenities such as benches or clear, paved surfaces are important to passengers; a shelter is also a positive factor if passenger demand warrants. There are various types of stops: the curb side or street-corner stop; the flared lane, where the bus can pull off a busy road at an intersection to pick up passengers; and the recessed bus bay, similar to the flared lane but located between intersections.

Other kinds of bus stops are the Park & Ride and Kiss & Ride Lots. People usually drive to these stops. While Park & Ride users drive themselves, picking up their car at the end of the day, Kiss & Ride patrons are dropped off by someone else. Both of these bus stops have special design consideration discussed in Part II of this manual.

Park & Rides and Kiss & Rides are generally used in areas of low population density that are on the threshold of linehaul service. Close to more densely populated areas, all-day linehaul service becomes feasible, although significant demand for Park and Ride lots can still exist.

Commercial developers usually provide Park & Ride sections in parking lots because Park & Ride passengers often become customers after work. Also, based on their experience as Park & Ride passengers, these potential customers may return to shop at other times. Lots designated for Park & Ride service are usually part of excess parking reserves, remote from normal traffic yet near enough to major lot entrances and exits to provide easy bus entry and exit.

The sidewalks pictured accent this Macomb apartment complex while providing a clear and direct path from its buildings to the road. Even without bus service, this development at Kings Gate and Canal Road in Sterling Heights, is still a good example of transit access.

This single family subdivision is located at Biscayne and Schoenherr Roads in Sterling Heights. This development makes good use of sidewalks. Note the sidewalk setback from the road. If there was bus service and if the main road was not to be widened, a bus shelter pad could be placed between the sidewalk and the road. Of course, there would be pathways connecting the pad with the road and sidewalk.

Though this is a minor entrance to an apartment complex, its sidewalk system links the development with the main sidewalk along the road. Not far from this point is a SEMTA bus pad, which is also linked to the sidewalk. This site is located on 10 Mile Road, just east of Southfield Road in Southfield.

**Photograph 4**

**Access to Transit—
Oakland County II**

There is good pedestrian access from the pictured subdivision to Mount Vernon Road. Sidewalks along the road lead to Greenfield Road and SEMTA bus service. This example is located in Southfield.

These apartments have a well designed sidewalk system, connecting the development interior with Cherry Hill Road in Dearborn Heights. This complex is west of Gulley Road and is served by two SEMTA bus lines.

At Melba Jean Road and Pennsylvania Road in Southgate, sidewalks enable the residents of this development to easily get to the main road. If a bus line served the development, the patrons would have little difficulty in getting to the stop.

Now that the reader is familiar with the characteristics of good transit design, he or she can put them into practice with the aid of the checklist below. Stated as questions to be answered by the reader, the points contained in the checklist can, if met, bring together the developer, the engineer, the concerned citizen, and the bus operator. The best way to use the checklist is for the reader to examine a planned development or roadway project in light of the questions below. If these criteria are met, a development is being designed with transit access in mind. If a particular design criterion is missing from the plan, then consult Part Two of this manual for guidance in meeting the criterion.

1. Is there all day linehaul service in your locale (Refer to the map on page 25)?
☐ Yes
☐ No
2. Is there only small bus service in your locale (Refer to the map on page 25)?
☐ Yes
☐ No
If you answered "yes" to question 1, then use the standards and criteria for linehaul buses. Otherwise use the small bus as the design vehicle unless your project expects to receive intercity buses. In which case use the linehaul standards.
3. Is your project/development directly accessible to the main road (i.e., the bus does not have to travel on to a street connecting your development with the main road)?
☐ Yes
☐ No
4. Does the road along which your development is located:
a. Have eleven foot wide travel lanes?
☐ Yes
☐ No
b. Have intersection curves with radii within the turning capability of your service vehicle (See turning templates, Part Two, pages 17, 19, 21, and 23)?
☐ Yes
☐ No
c. Capable of supporting the weight of your service vehicle (36,000 pounds for linehaul; 11,400 pounds for small bus)?
☐ Yes
☐ No
5. Is the farthest point within your development one quarter mile from the main road (If elderly people are to be residing in your development reduce to one eighth mile)?
☐ Yes
☐ No
6. Is there a fairly direct (not winding, circuitous) path to the main road? And is the path surfaced with non-slippery material such as concrete?
☐ Yes
☐ No
7. Is there good snow and water removal from path?
☐ Yes
☐ No
8. Is there a paved surface at the point where the development meets the road? (Make sure that these places are wheelchair accessible, for they will be used as either a landing pad or shelter base)
☐ Yes
☐ No
9. Is the bus stop area cleared of snow and water?
☐ Yes
☐ No
10. Is there a place near the bus stop:
a. Where people can be under cover during rain?
☐ Yes
☐ No
b. Where there is good visibility of the street to see an on-coming bus?
☐ Yes
☐ No
11. At the point where there is a bus stop, is there a zone clear of parking (ninety feet along curb for corner stops and 150 feet along curb for midblock stops)?
☐ Yes
☐ No
12. Is the main road heavily travelled with speeds of thirty-five m.p.h. or more? If the main road is heavily travelled and with speeds of more than thirty-five m.p.h. consider the placement of flared lanes (at intersections) or bus bays (between intersections)—See Part Two, Chapter II for specifications.
☐ Yes
☐ No
13. Can the bus serve the development without directly entering the development? Note: SEMTA generally discourages service where the bus must leave the main road.

## Summary

Part One has presented, both in narrative and checklist forms, the general requirements for transit services in a locality. These requirements:

- That a sufficient transit market exists in the locale.
- That the market can be physically reached by the bus.
- That bus patrons are within one quarter mile of a bus line.
- That sidewalks exist which give the patron a clear and direct path to the bus stop.
- That bus stop space be provided, surfaced, and drained of rain and snow.

Part Two discusses most of these points in detail. Refer to it when formulating or evaluating project plans. SEMTA's Planning Department is at your service to answer any questions which arise as you analyze your development.

Following are what may be considered "blueprints" of transit design. Road geometrics, bus stop dimensions and similar data useful in transit design are discussed and illustrated in this part. The manual reader will find here ready examples and standards (based on local empirical work and on national standards) to be used in formulating road and development plans which are compatible with transit.

Although this manual advocates thorough consideration of transit operations in roadway and development plans, significant constraints may exist is some communities in meeting some of the preferred minimums standards. SEMTA recognizes the important differences in land availability, costs, and traffic volumes between heavily urban areas and suburban areas. Consequently, standards for road geometrics have been presented with both "preferred minimum" dimensions as well as "absolute minimum" dimensions. In most cases, SEMTA believes and strongly recommends that the "preferred standards" prevail. In the few cases where there are **severe** restrictions "absolute minimum" dimensions will, depending on the circumstances, be acceptable. In such instances, SEMTA's Planning Department should be consulted.

Drawings in Part Two will be the primary medium used to convey design standards. Considerable effort has gone into making the drawings "stand alone." Despite their independent quality, the reader is urged to read the appropriate text to give depth to the two dimensional drawings.

In order to present technical material important to designing for transit, this section is divided into chapters. Each chapter deals with a specific aspect of transit design. The first chapter presents bus data including vehicle dimension and weight information. The second chapter reviews minimum road standards for the safe operation of buses. The third and final chapter contains design criteria for curb side bus stops, bus shelters, flared lanes and other transit access points. Following the last chapter is a glossary of transit terms which may be of use in further understanding transit operations.

The purpose of this chapter is to acquaint the reader with the vehicles which provide transportation to and from project areas.

Two types of transit vehicles are used in southeastern Michigan. One is the linehaul bus, the vehicle ridden by most transit users. The second type is the small bus, a van-like vehicle used for special trips.

SEMTA has many vehicles in either the small bus or linehaul bus category. However, only one linehaul bus and one small bus are used to illustrate standards and criteria. The reason for selecting design vehicles is to have on hand those standards which apply to the most common and, sometimes, the most extreme design cases. For these reasons, the linehaul General Motors (GM) RTS bus and the small C&E Fortibus vehicle will be the design vehicles used in this manual.

The physical configurations of the RTS and the C&E Fortibus are displayed in figures 1 and 2, respectively. The illustrations are accompanied by each bus' specifications. These figures will be useful in acquainting the reader with the most common vehicles used in southeastern Michigan. They also provide necessary operational data to supplement the standards discussed in later chapters of this manual.

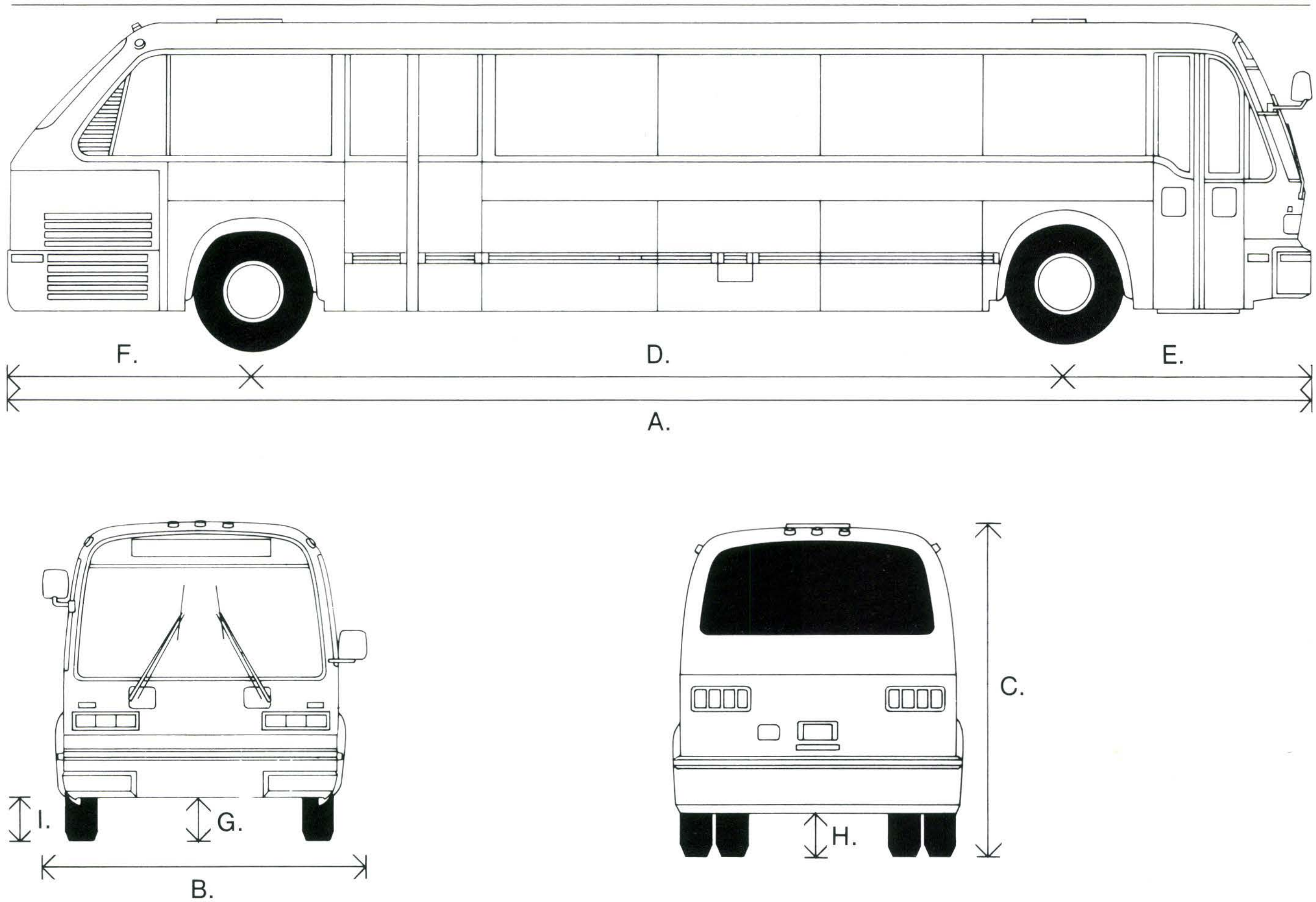
Figures 3a, 3b, 4a, and 4b are 90° and 180° turning templates for the design vehicle's turning radius. The scale drawn figures may be used to check road widths as well as curb and curve radii to determine if the design vehicle can negotiate a project's roadways. These templates are based on actual test work done by SEMTA personnel. Selecting the appropriate turning template depends on the type of vehicle being used. There are two sets of templates; one set is in a 20 feet to the inch scale, the other 30 feet to the inch. Two sets are provided for convenience. The figure on page 25 presents the general linehaul vehicle design area, where the RTS vehicle normally operates.

The linehaul vehicle design area map on page 25 is intended to be only a general guide in the selection of an appropriate design vehicle for a project locale. Projects falling within the linehaul design area should use the RTS as the design vehicle. Conversely, projects occuring beyond the linehaul design area should use the C & E Fortibus as the design vehicle. Since the design area map is a general guide, some areas designated linehaul may not have such service now. However, given the long term effects of roadway and development efforts, and given the reasonable possibility of new linehaul service in developing areas, it seems wise to anticipate regular transit service by having roadways and developments accessible to linehaul vehicles. The level of service in a specific area may be estimated by examining SEMTA bus volume maps, obtainable from SEMTA. The maps illustrate both graphically and numerically the average number of buses travelling on a given road link in an hour. The volumes reflect bus service during weekday morning rush hours (7 AM to 9AM) and midday (9AM to 4PM).

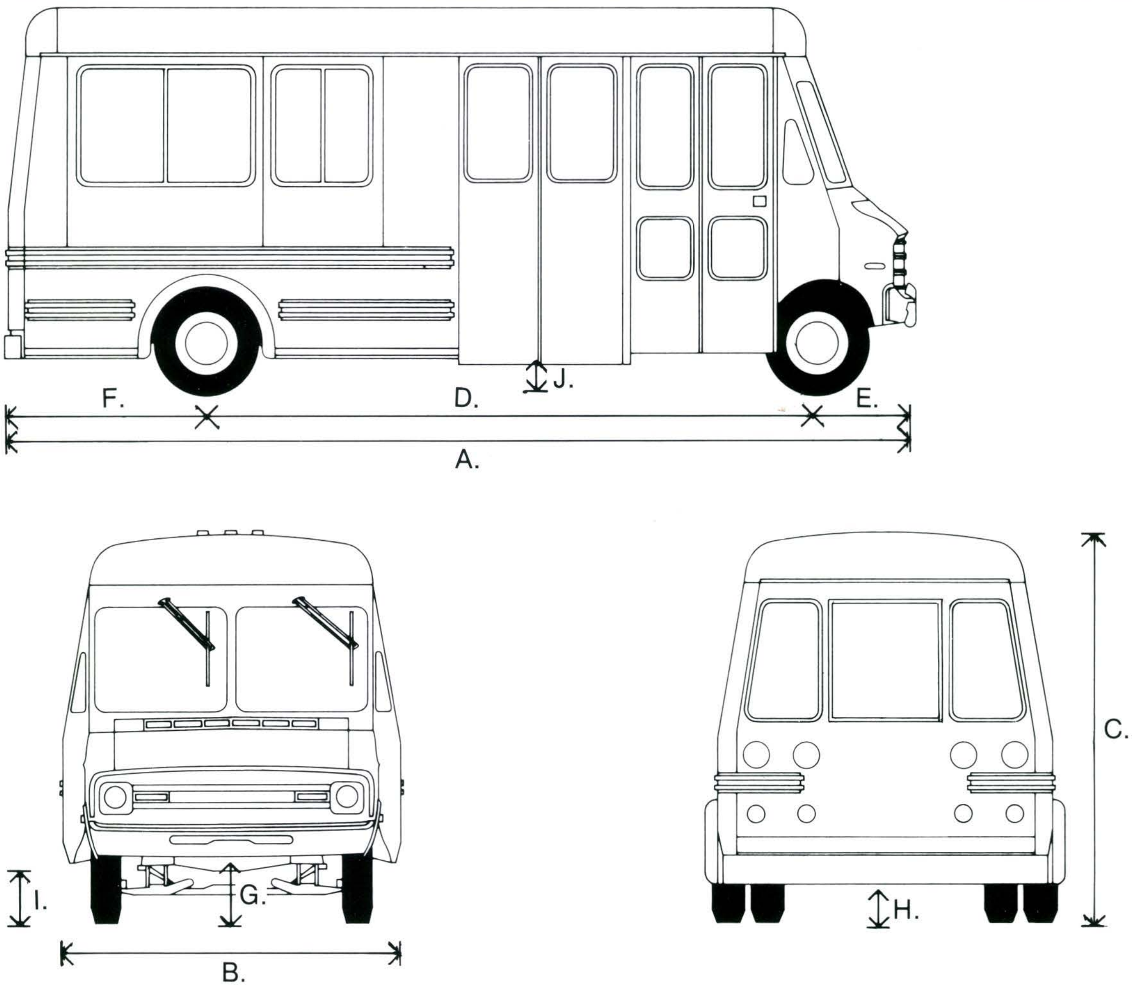
Some developments, such as hotels, restaurants or sporting facilities once completed, may expect charter buses to use the site. Charter buses are often the "intercity" or "Greyhound" type vehicles. In such cases, the information contained in Figure 6 may be of importance. It should be emphasized that inter-city bus specifications are for special design situations, not normally encountered in everyday transit service. If a developer has some question as to the applicability of the intercity bus specifications to a project, then the developer or engineer should call SEMTA's Planning Department.

The specifications of one additional transit vehicle have been included in Figure 7. In the near future, SEMTA may introduce this articulated bus in some of its most heavily travelled corridors. Developers and engineers may wish to consult with the SEMTA Planning Department regarding the timing of this new bus service.

**Figure 1** **Linehaul Design Vehicle—GM RTS**




| Item | Dimension (Feet) | (Meters) |
|---|---|---|
| A. Overall Length | 40.0 | 12.2 |
| B. Overall Width (including mirrors) | 10.5 | 3.2 |
| C. Overall Height (including antenna) | 9.5 | 2.9 |
| D. Wheelbase Length | 24.9 | 7.6 |
| E. Front Overhang | 7.85 | 2.3 |
| F. Rear Overhang | 7.5 | 2.2 |
| G. Front Bumper Distance to Ground | 1.4 | 0.4 |
| H. Rear Bumper Distance to Ground | 1.3 | 0.4 |
| I. First Step Distance to Ground | 1.3 | 0.4 |
| **Turning Radii** | **Dimension (Feet)** | **(Meters)** |
| Maximum Left Front Body Corner | 54.5 | 16.5 |
| Minimum Right Rear Wheel | 32.0 | 9.7 |
| **Gross Vehicle Weight** | **Dimensions (Pounds)** | **(Kilograms)** |
| Front Axle | 12,500 | 5,681.8 |
| Rear Axle | 22,500 | 10,227.3 |
| Total | 35,000 | 15,909.1 |
| Seating Capacity | 47 | |




| | Item | Dimension (Feet) | (Meters) |
|---|---|---|---|
| A. | Overall Length | 21.8 | 6.6 |
| B. | Overall Width | 7.5 | 2.3 |
| C. | Overall Height | 9.8 | 3.0 |
| D. | Wheelbase Length | 12.1 | 3.7 |
| E. | Front Overhang | 3.3 | 1.0 |
| F. | Rear Overhang | 6.4 | 1.96 |
| G. | Front Bumper Distance to Ground | 1.1 | 0.3 |
| H. | Rear Bumper Distance to Ground | 1.3 | 0.4 |
| I. | First Step Distance to Ground | 0.8 | 0.3 |
| J. | Lowest Distance to Ground | 0.8 | 0.3 |

| Turning Radii | Dimension (Feet) | (Meters) |
|---|---|---|
| Maximum Left Front Body Corner | 25.5 | 7.8 |
| Minimum Right Rear Wheel | 12.5 | 3.8 |

| Gross Vehicle Weight | Dimensions (Pounds) | (Kilograms) |
|---|---|---|
| Front Axle | 3,900 | 1,772.7 |
| Rear Axle | 7,500 | 3,409.1 |
| Total | 11,400 | 5,181.8 |

| Seating Capacity | 15 | |
|---|---|---|

Linehaul Turning Template—
Scale 1" = 20'

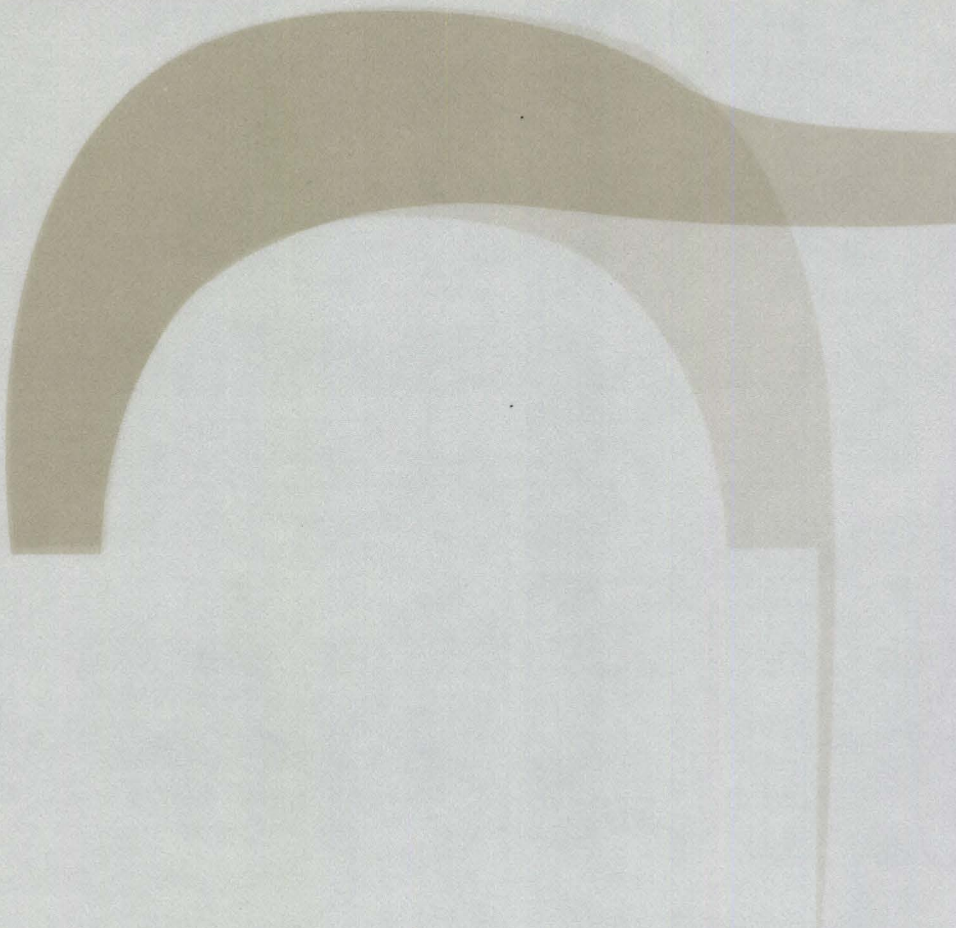
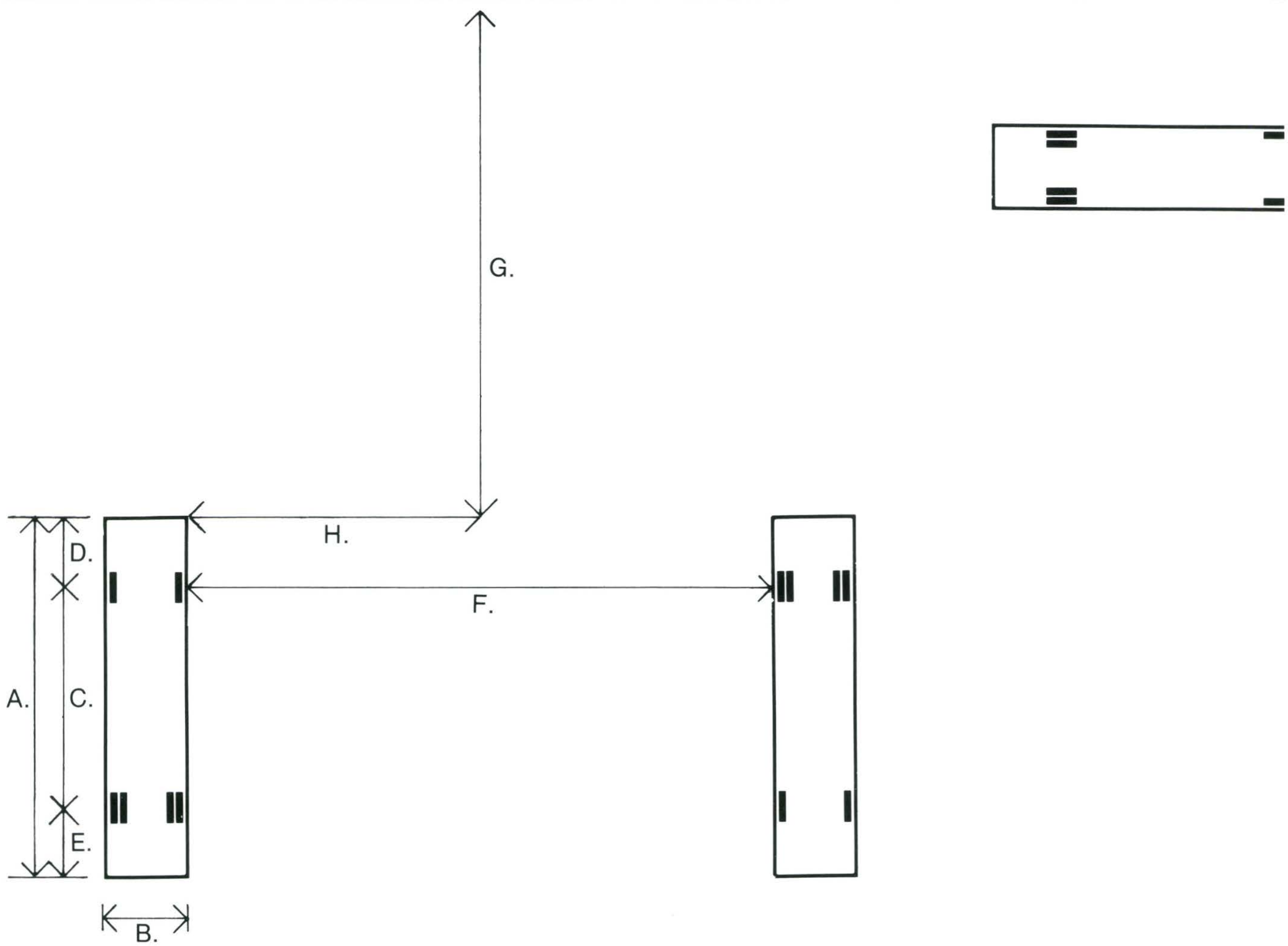


Figure 3a

**Linehaul Turning Template — Scale 1″ = 20′**




| | Item | Dimension (Feet) |
|---|---|---|
| A. | Overall Length | 40.0 |
| B. | Overall Width (excluding mirrors) | 8.5 |
| C. | Wheelbase Length | 24.9 |
| D. | Front Overhang | 7.85 |
| E. | Rear Overhang | 7.5 |
| F. | Diameter of Turn | 63.0 |

| | Turning Radii | Dimension (Feet) |
|---|---|---|
| G. | Maximum Left Front Body Corner | 54.5 |
| H. | Minimum Right Rear Wheel | 32.0 |

Linehaul Turning
Template —
Scale 1″ = 30′

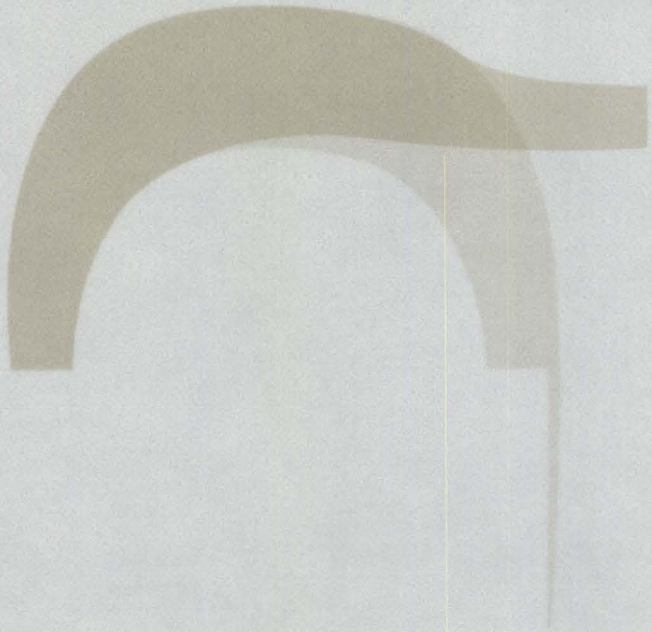
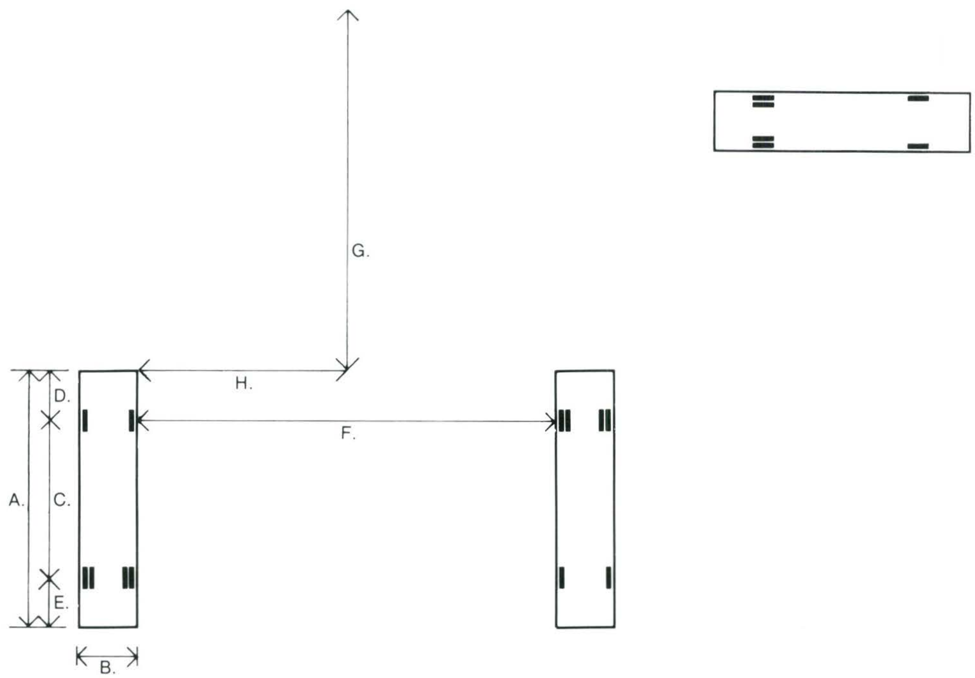


**Figure 3b**

**Linehaul Turning Template — Scale 1″ = 30′**




| Item | Dimension (Feet) |
|---|---|
| A. Overall Length | 40.0 |
| B. Overall Width (excluding mirrors) | 8.5 |
| C. Wheelbase Length | 24.9 |
| D. Front Overhang | 7.85 |
| E. Rear Overhang | 7.5 |
| F. Diameter of Turn | 63.0 |

| Turning Radii | Dimension (Feet) |
|---|---|
| G. Maximum Left Front Body Corner | 54.5 |
| H. Minimum Right Rear Wheel | 32.0 |

Small Bus Turning Template —
Scale 1" = 20'

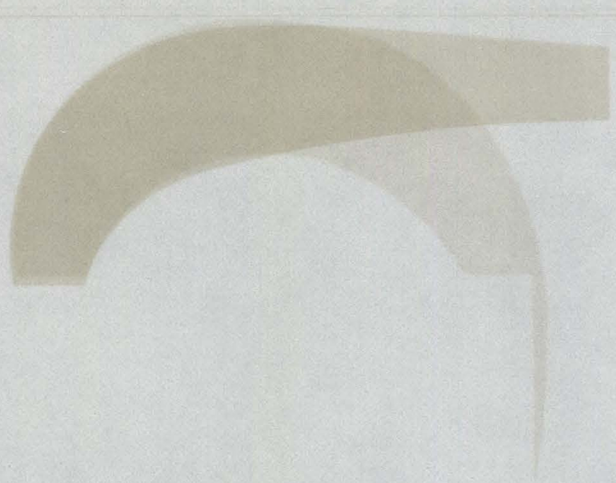
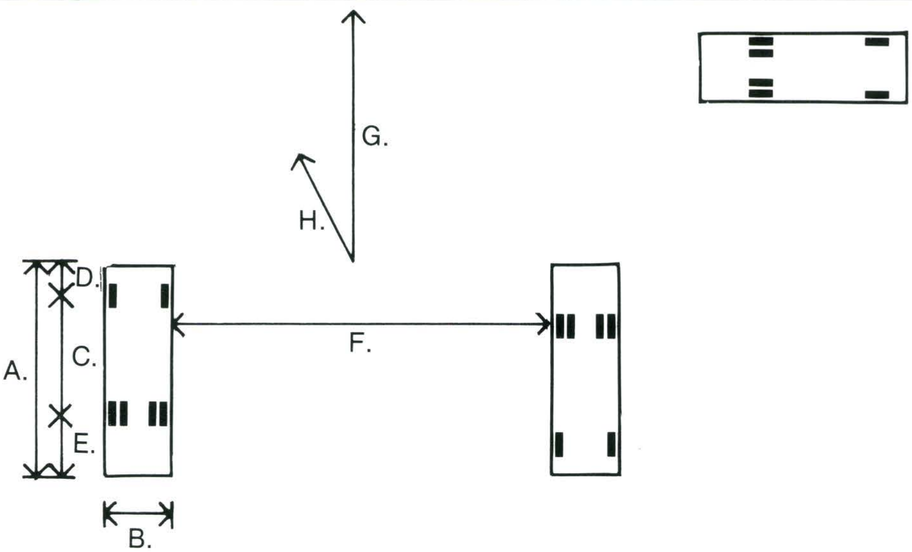


Figure 4a

**Small Bus Turning Template—Scale 1″ = 20′**




| Item | Dimension (Feet) |
|---|---|
| A. Overall Length | 21.8 |
| B. Overall Width | 7.5 |
| C. Wheelbase Length | 12.1 |
| D. Front Overhang | 3.3 |
| E. Rear Overhang | 6.4 |
| F. Diameter of Turn | 39.0 |

| Turning Radii | Dimension (Feet) |
|---|---|
| G. Maximum Left Front Body Corner | 25.5 |
| H. Minimum Right Rear Wheel | 12.5 |

Small Bus Turning Template—
Scale 1" = 30'

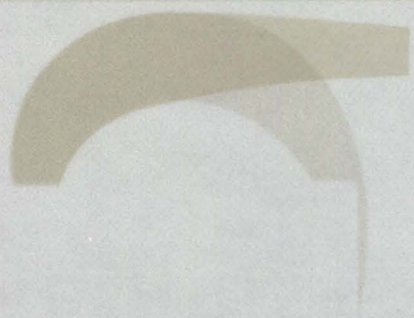
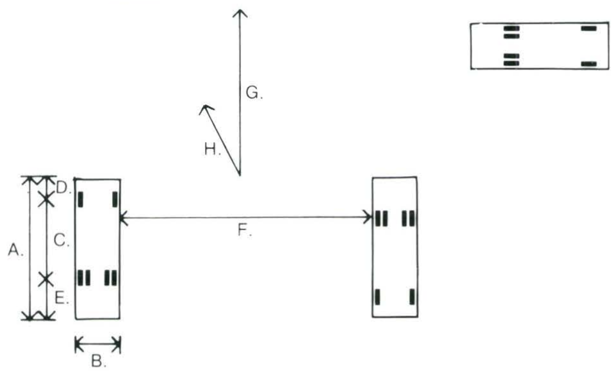


Figure 4b

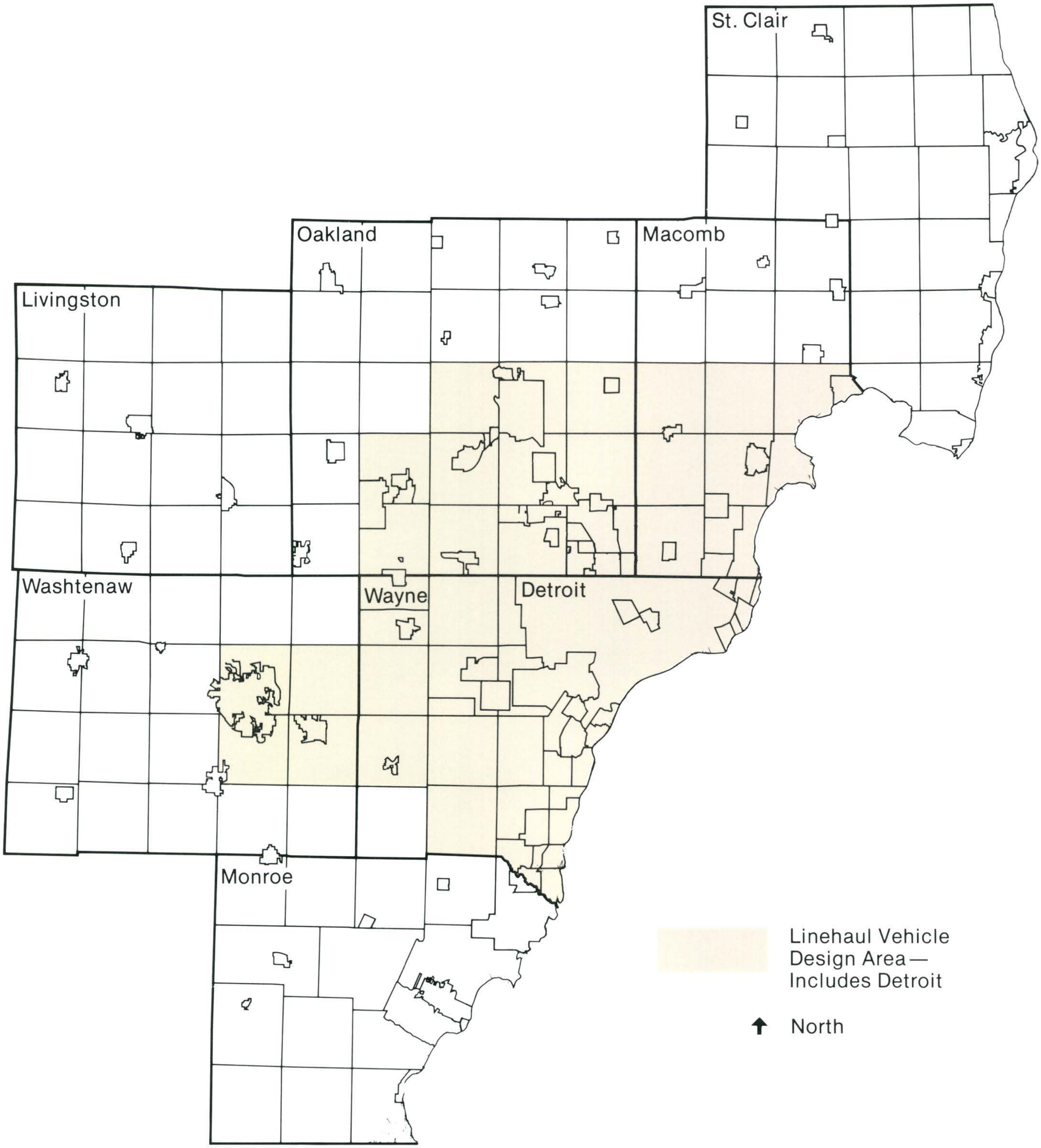
**Small Bus Turning Template — Scale 1″ = 30′**

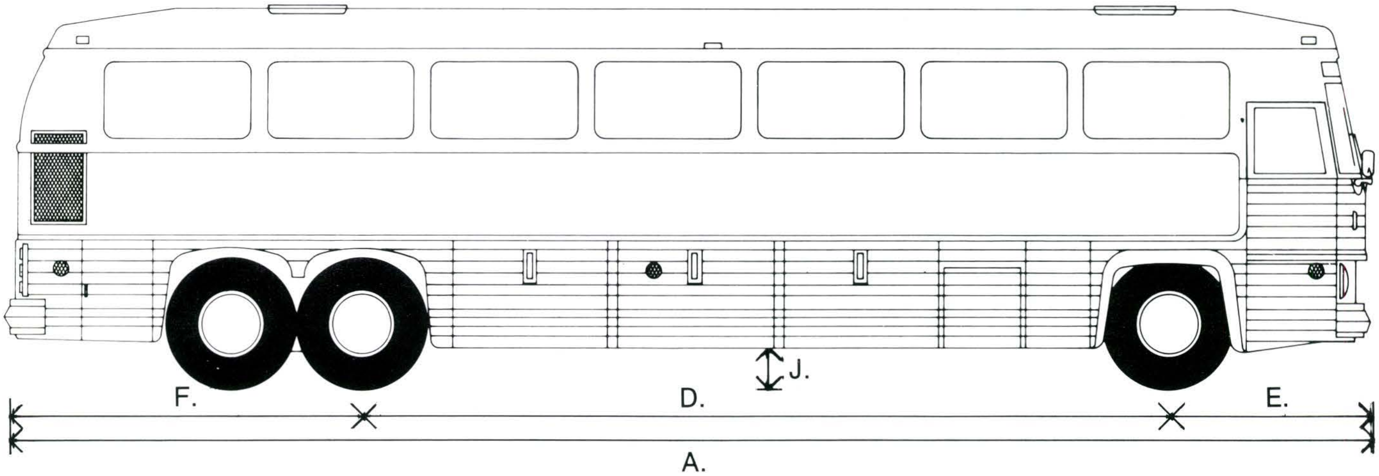


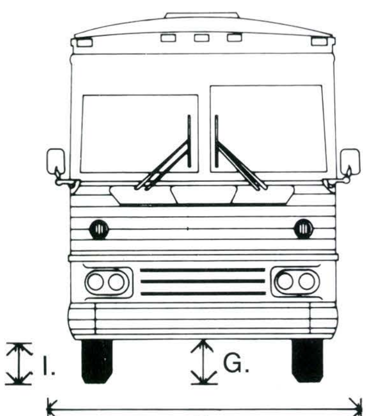

| | Item | Dimension (Feet) |
|---|---|---|
| A. | Overall Length | 21.8 |
| B. | Overall Width | 7.5 |
| C. | Wheelbase Length | 12.1 |
| D. | Front Overhang | 3.3 |
| E. | Rear Overhang | 6.4 |
| F. | Diameter of Turn | 39.0 |

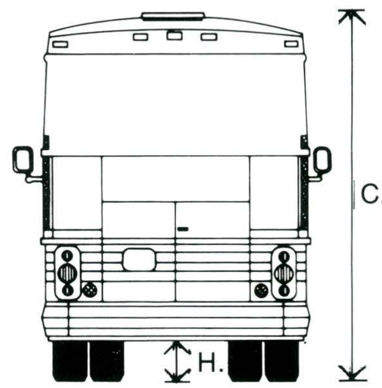
| | Turning Radii | Dimension (Feet) |
|---|---|---|
| G. | Maximum Left Front Body Corner | 25.5 |
| H. | Minimum Right Rear Wheel | 12.5 |

## Linehaul Vehicle Design Area






| Item | Dimension (Feet) | (Meters) |
|---|---|---|
| A. Overall Length | 40.0 | 12.2 |
| B. Overall Width (including mirrors) | 10.5 | 2.4 |
| C. Overall Height | 10.8 | 3.3 |
| D. Wheelbase Length | 23.8 | 7.2 |
| E. Front Body Overhang | 5.9 | 1.8 |
| F. Rear Body Overhang | 10.4 | 3.2 |
| G. Front Bumper Clearance | 1.8 | 0.5 |
| H. Rear Bumper Clearance | 1.9 | 0.6 |
| I. First Step Height | 1.3 | 0.4 |
| J. Center Clearance | 1.0 | 0.3 |

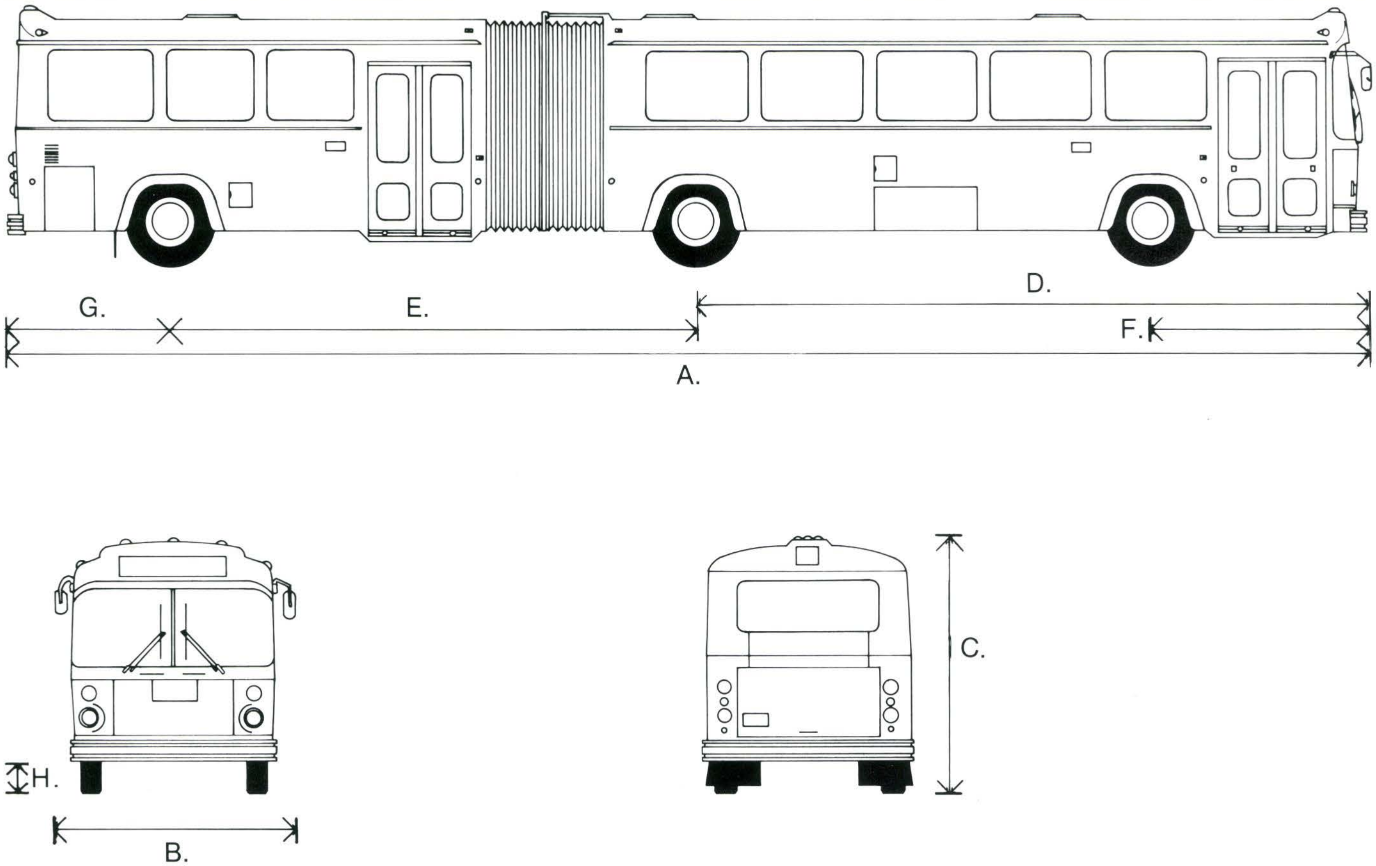
| Turning Radius | Dimension (Feet) | (Meters) |
|---|---|---|
| Maximum Left Front Body Corner | 50.6 | 15.4 |

| Gross Vehicle Weight | Dimensions (Pounds) | (Kilograms) |
|---|---|---|
| Front Axle | 12,500 | 5,681.8 |
| Drive Axle | 18,000 | 8,181.8 |
| Tag Axle | 6,000 | 2,727.3 |
| Total | 36,500 | 16,590.9 |

| | | |
|---|---|---|
| Baggage Compartment Space | 300 cubic feet | 8.5 cubic meters |
| Seating Capacity | 43 | |

Figure 7

**Articulated Bus**
**M.A.N. (Machinen Fabrik Augsburg Nurnberg)**




| Item | Dimension (Feet) | (Meters) |
|---|---|---|
| A. Overall Length | 59.64 | 18.2 |
| B. Overall Width (including mirrors) | 10.5 | 3.2 |
| C. Overall Height | 10.3 | 3.2 |
| D. Wheelbase Length—Drive Axle to Front | 18.5 | 5.7 |
| E. Wheelbase Length—Rear to Drive Axle | 24.0 | 7.3 |
| F. Front Overhang | 8.7 | 2.7 |
| G. Rear Overhang | 8.6 | 2.6 |
| H. First Step Distance to Ground | 1.25 | 0.4 |
| **Turning Radii** | **Dimension (Feet)** | **(Meters)** |
| Maximum Left Front Body Corner | 43.35 | 13.0 |
| Minimum Right Rear Wheel | 23.54 | 7.9 |
| **Gross Vehicle Weight** | **Dimensions (Pounds)** | **(Kilograms)** |
| Total | 55,000 | 24,795 |
| Seating Capacity | 67 | |

Safe and efficient transit operations depend on, in part, roadways which can accommodate the region's buses. This chapter provides a range of roadway design situations—from intersections and driveways to cul de sacs. Depending on the nature of the project, whether it involves putting in a driveway or widening a road, the specifications illustrated below will help planners, architects, and engineers formulate their designs.

There are two broad aspects of roadway design which are of concern to transit operators. The first concern is the geometric design of a road. Second, is the construction of the road's surface.

The roadway design standards are based on the operation of the 40-foot RTS bus. The travel lane should be at least 11 feet wide. The road construction material should adequately support an 18 ton vehicle. The exact material and construction for a given project are left open to the individual engineer. In pavement construction, however, emphasis is given to these four considerations:

a. Bus axle weight
b. Bus volumes*
c. Pavement material strength
d. Subground soil characteristics[1]

Figures 8 through 15 present geometric design standards for roadway intersections. The figures also show the turning path of the 40-foot RTS bus. Each figure represents a design situation determined by whether there is on-street parking. Each design example has two travel lanes meeting at the intersection. Each lane is, for these illustrations, eleven feet wide (minimum recommended width for bus travel). There are two curve radii given as standards. One is the "preferred minimum," the standard recommended by SEMTA for the vast majority of design configurations. The second radius is the "absolute minimum." The absolute minimum should be used **only** when local physical constraints do not permit the larger radius.

The illustrated design situations may be used by the reader to formulate plans for roadway intersection design. Further, since the figures show a linehaul vehicle's turning path through two travel lanes, the drawings will have equal implications in accurately showing vehicle encroachment whether both lanes handle traffic in the same or in opposite direction. As can be seen from the drawings, there is significant encroachment by the right front corner in the travel lane farthest from the roadside. Encroachment can be controlled by adjusting the curve radius, the road widths, or a combination of the radius and road width. Figures 16 through 19 illustrate driveway radii and road widths. These illustrations, along with figures 8 through 15, depict the relationships among curve radius, road width, and encroachment. The turning templates in Chapter I can be used to determine the degree of encroachment that would result given a radius and road width. The only provision, of course, is that the roadway plan be at the same scale as the turning template.

Figure 20 shows specifications for a cul de sac that would allow a bus to make a complete turn around. The design does not permit parking in either the center or along the perimeter. A cul de sac would be used where circulation space for buses is limited. A cul de sac would permit a focus of bus movement and loading activity. One good example of a cul de sac used in this manner is at the Northland Shopping Center in Southfield, Michigan.

It should be noted that cul de sacs do not represent the best bus circulation area. Despite their apparent advantages in solving some circulation problems for buses, they also have significant disadvantages. First, bus cul de sacs must be limited to bus traffic only, raising policing problems. Conflicting vehicles would cause further difficulties for the bus driver in steering out of the bowl of the cul de sac (a difficult maneuver by itself). Difficulty in steering out of a cul de sac becomes even more onerous if a vehicle is broken down in the bowl. A developer considering such a road for use by buses should consult SEMTA's Planning Department.

Since the above standards are based on the RTS design vehicle, they would certainly be inappropriate for those areas with only small bus service. In situations where development is sparse and not within the linehaul service area, roadway and entrance standards can reflect typical engineering standards. If a development or roadway project of significant dimension, however, is contemplated beyond the linehaul service area, the reader is urged to contact SEMTA for future linehaul service possibilities.

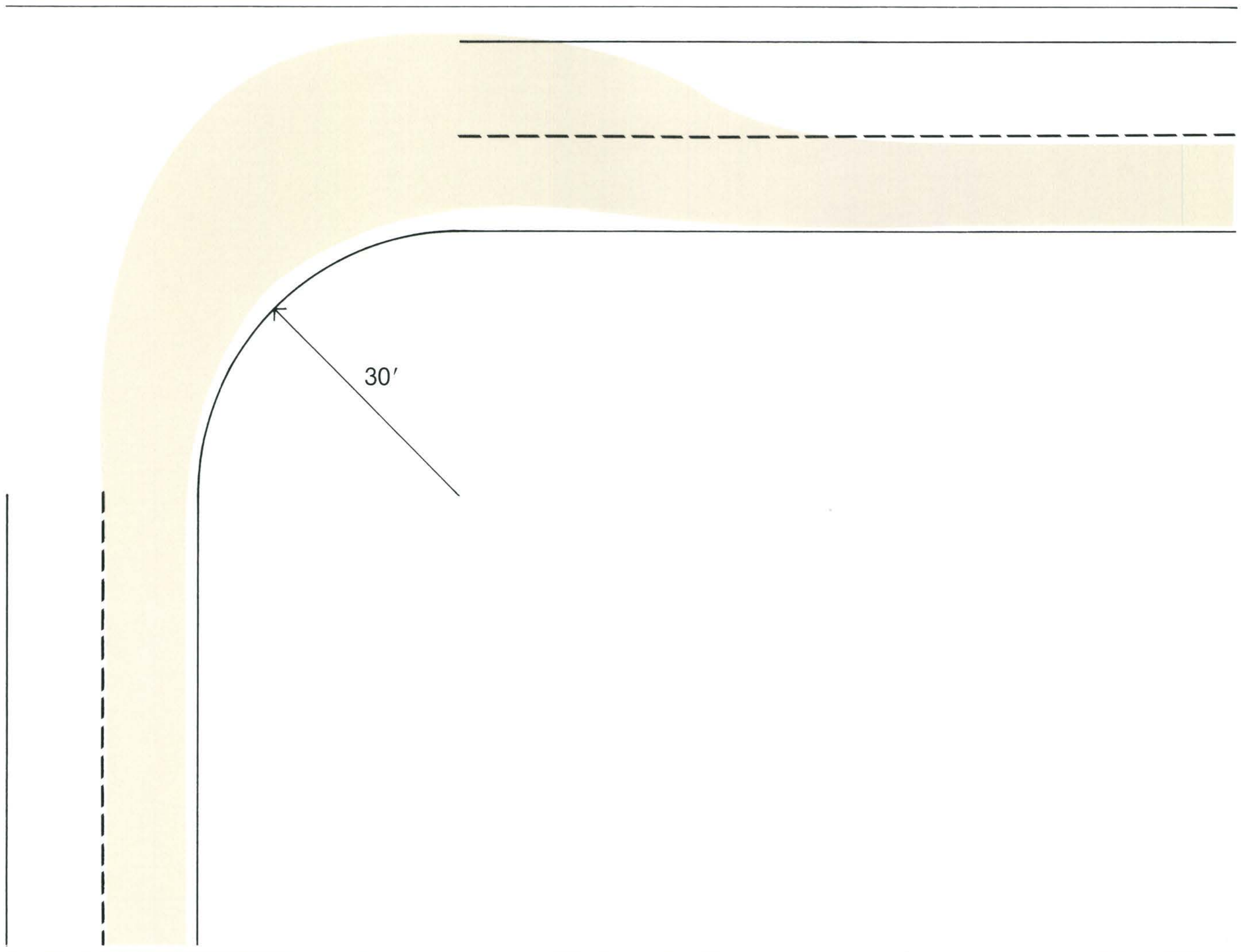
**Footnote**

[1] R. Higbee, "Transit Facilities Design and Maintenance Standards," in **Planning With Transit** (Portland, Ore.: Tri-Met Planning and Development Division, Npd.) p. 62.

* Bus volume maps are available from SEMTA. See page 14 for explanation of the maps.

Figure 8

**Simple Curve Radius — No On Street Parking — Preferred Minimum**




**Preferred Minimum**

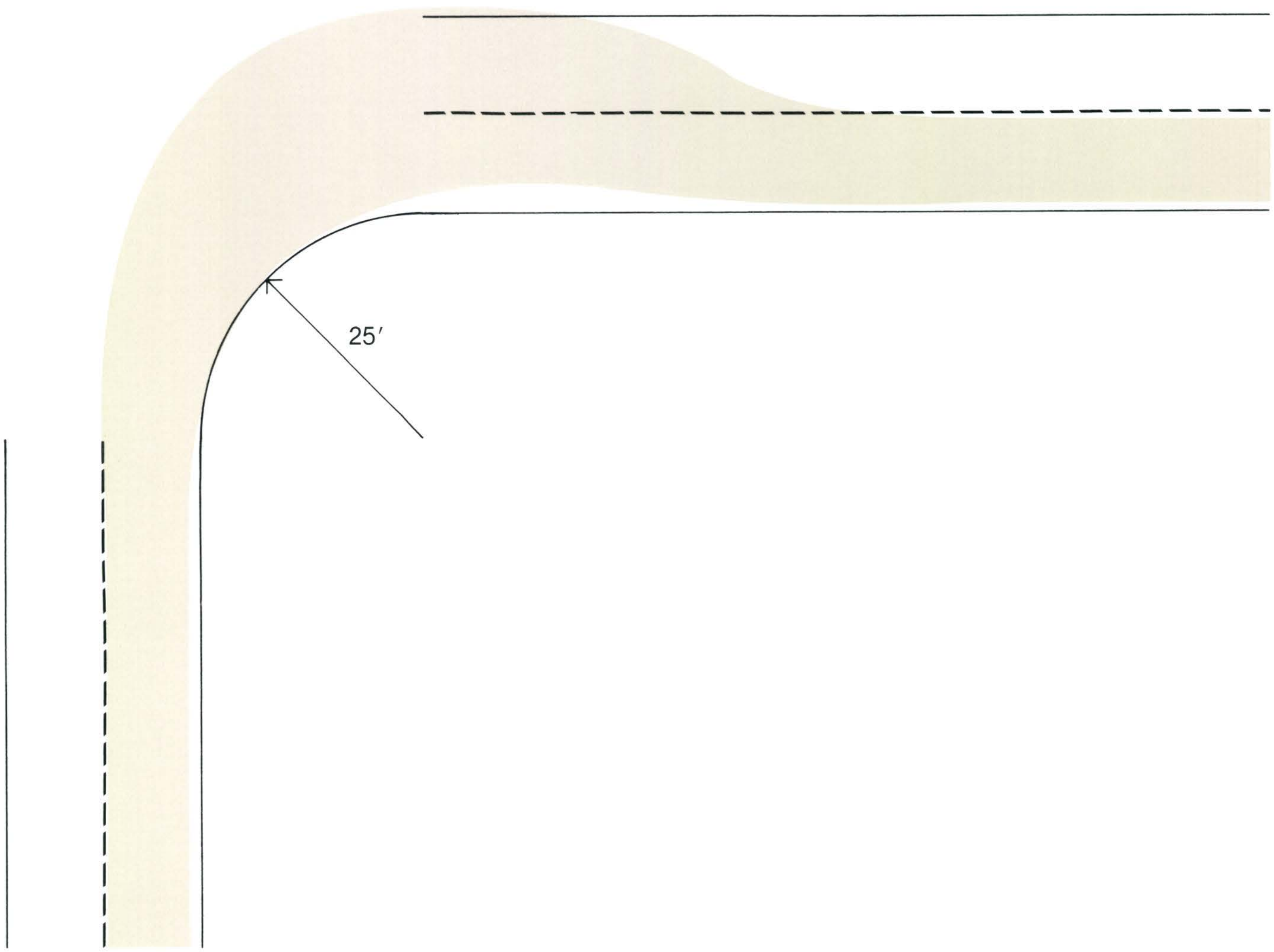
Recommended for most design cases.

Assuming no parking on street and eleven foot travel lanes. Path of forty foot RTS making a right turn.

Scale 1″ = 20′

Figure 9

**Simple Curve Radius— No On Street Parking— Absolute Minimum**




**Absolute Minimum**

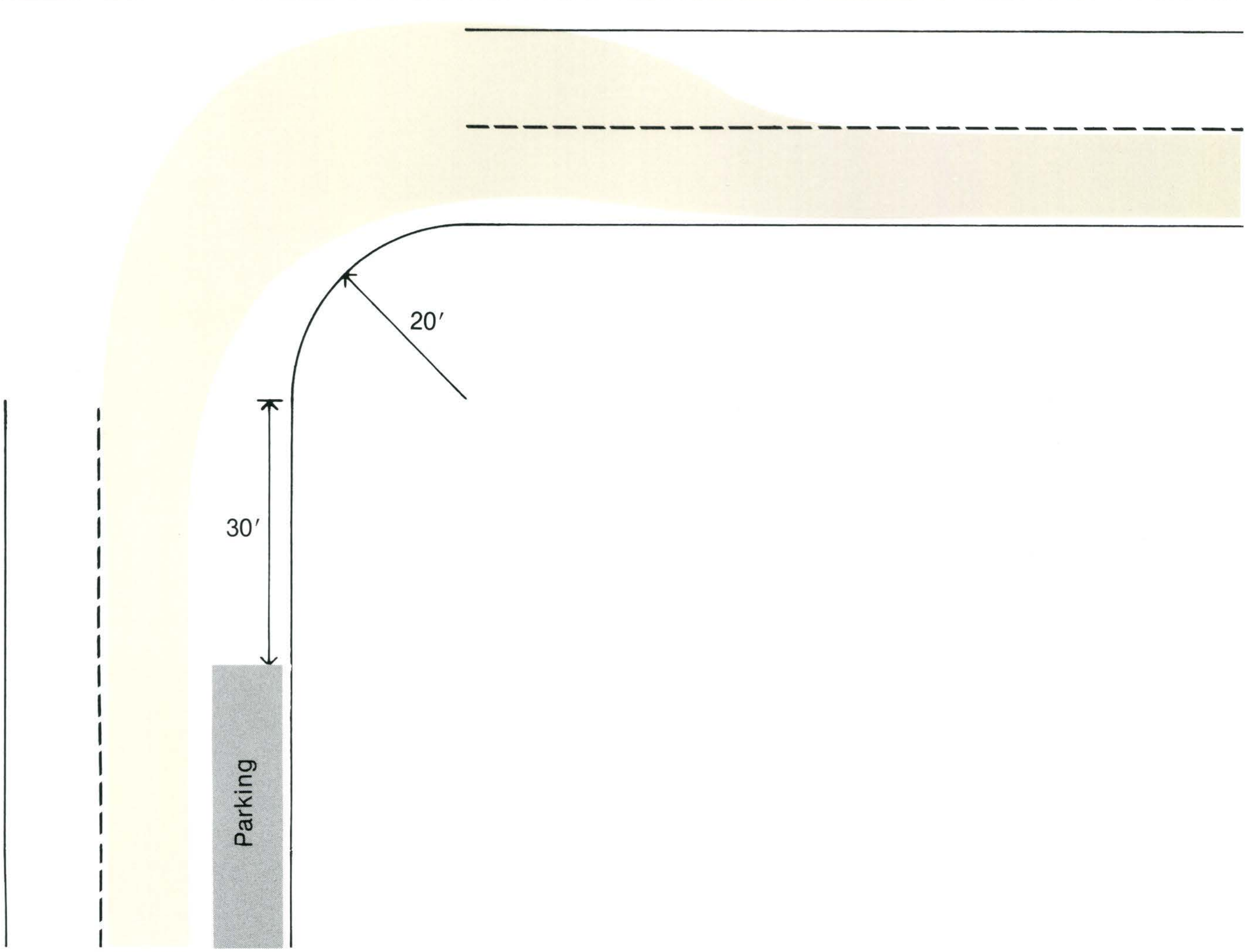
For severe design constraints only.

Assuming no parking on street and eleven foot travel lanes. Path of forty foot RTS making a right turn.

Scale 1″ = 20′

Figure 10

**Simple Curve Radius — On Street Parking Before Turn — Preferred Minimum**




**Preferred Minimum**

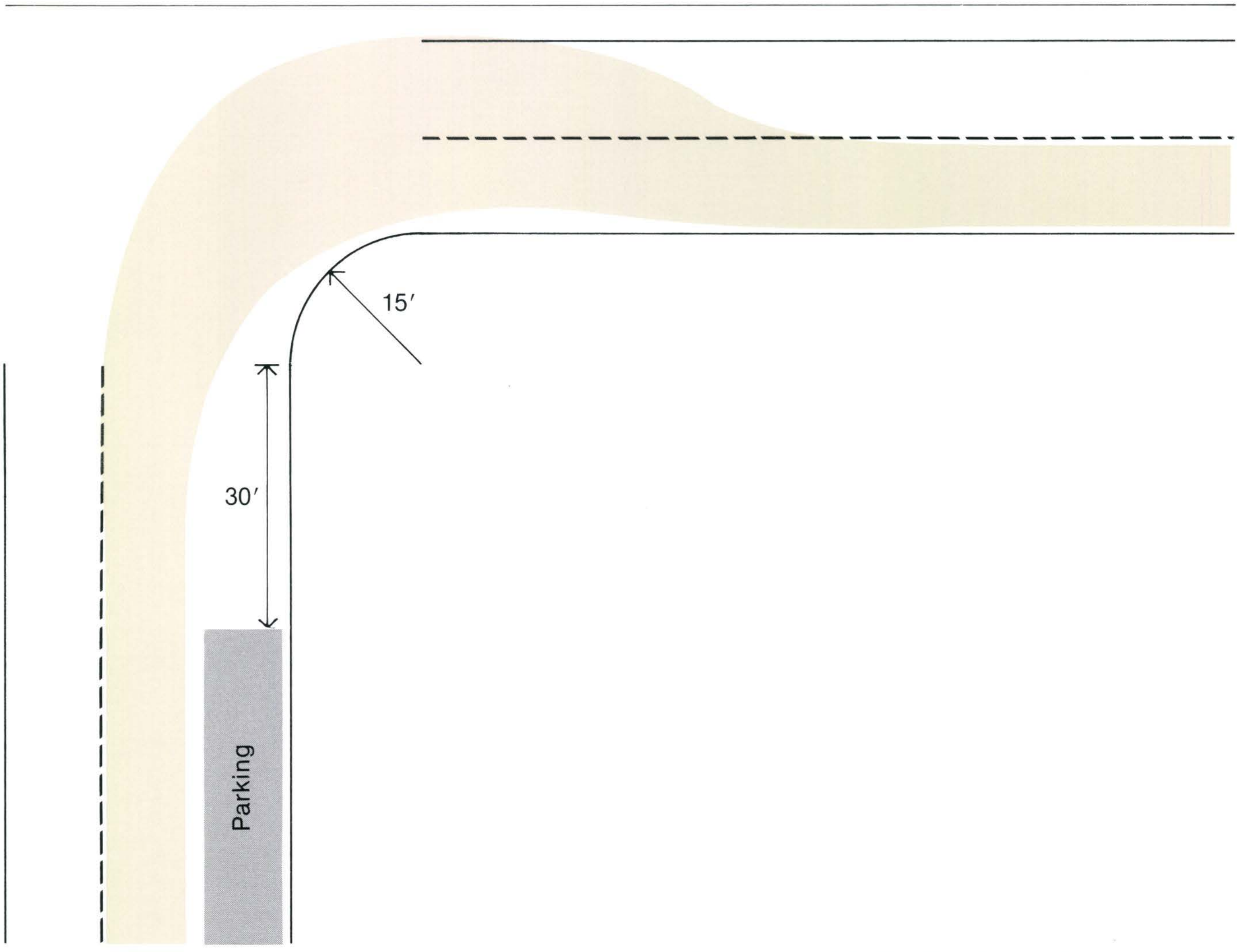
Recommended for most design cases.

Assuming parking before turn, none after turn. Parking assumed to be thirty feet from curve tangent. Travel lanes are eleven feet wide. Turning path of forty foot RTS bus making a right turn.

Scale 1″ = 20′

Figure 11

**Simple Curve Radius — On Street Parking Before Turn — Absolute Minimum**




**Absolute Minimum**

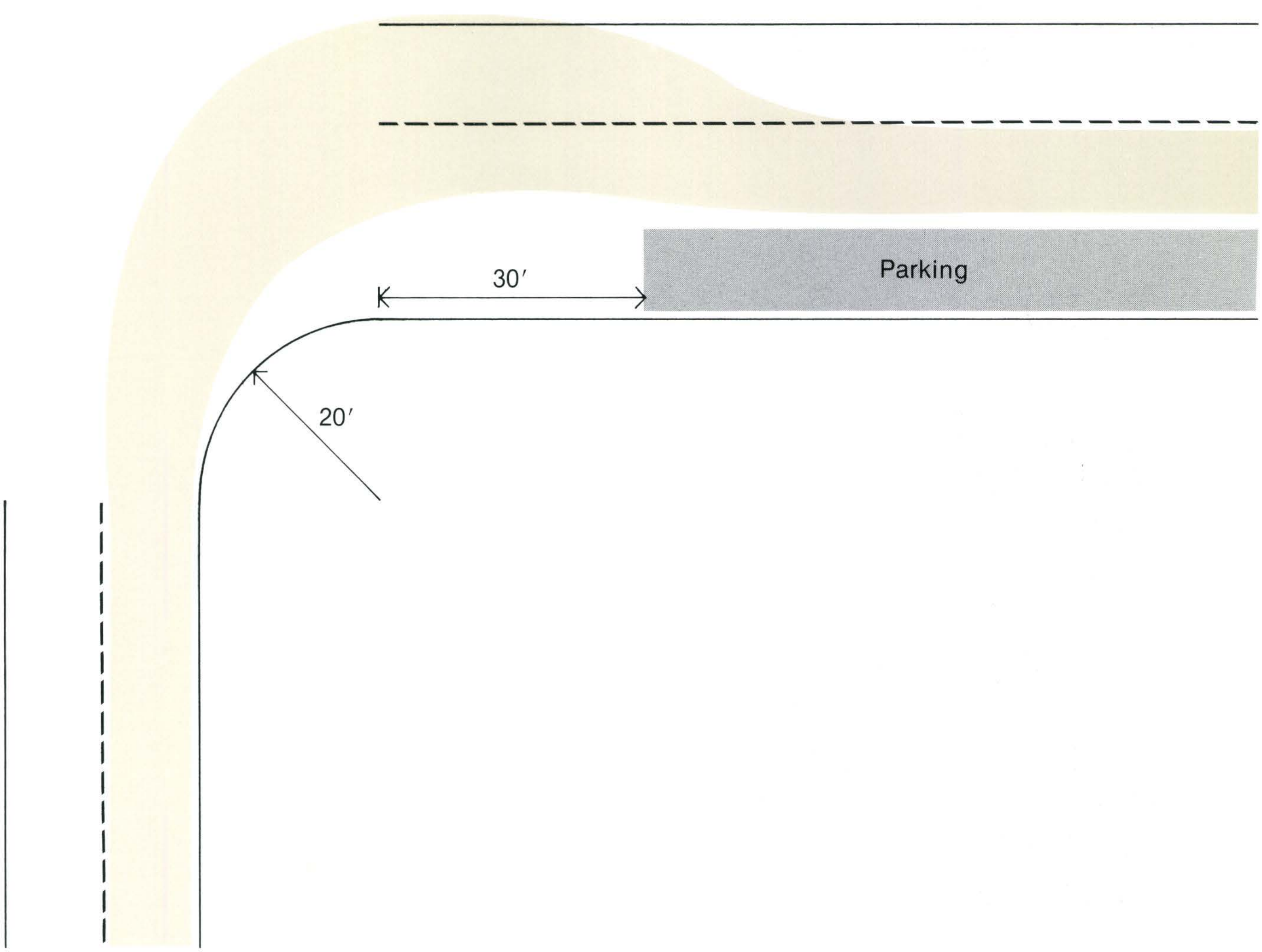
For severe design constraints only.

Assuming parking before turn, none after turn. Parking assumed to be thirty feet from curve target. Travel lanes are eleven feet wide. Turning path of forty foot RTS bus making a right turn.

Scale 1″ = 20′

Figure 12

**Simple Curve Radius — On Street Parking After Turn — Preferred Minimum**




**Preferred Minimum**

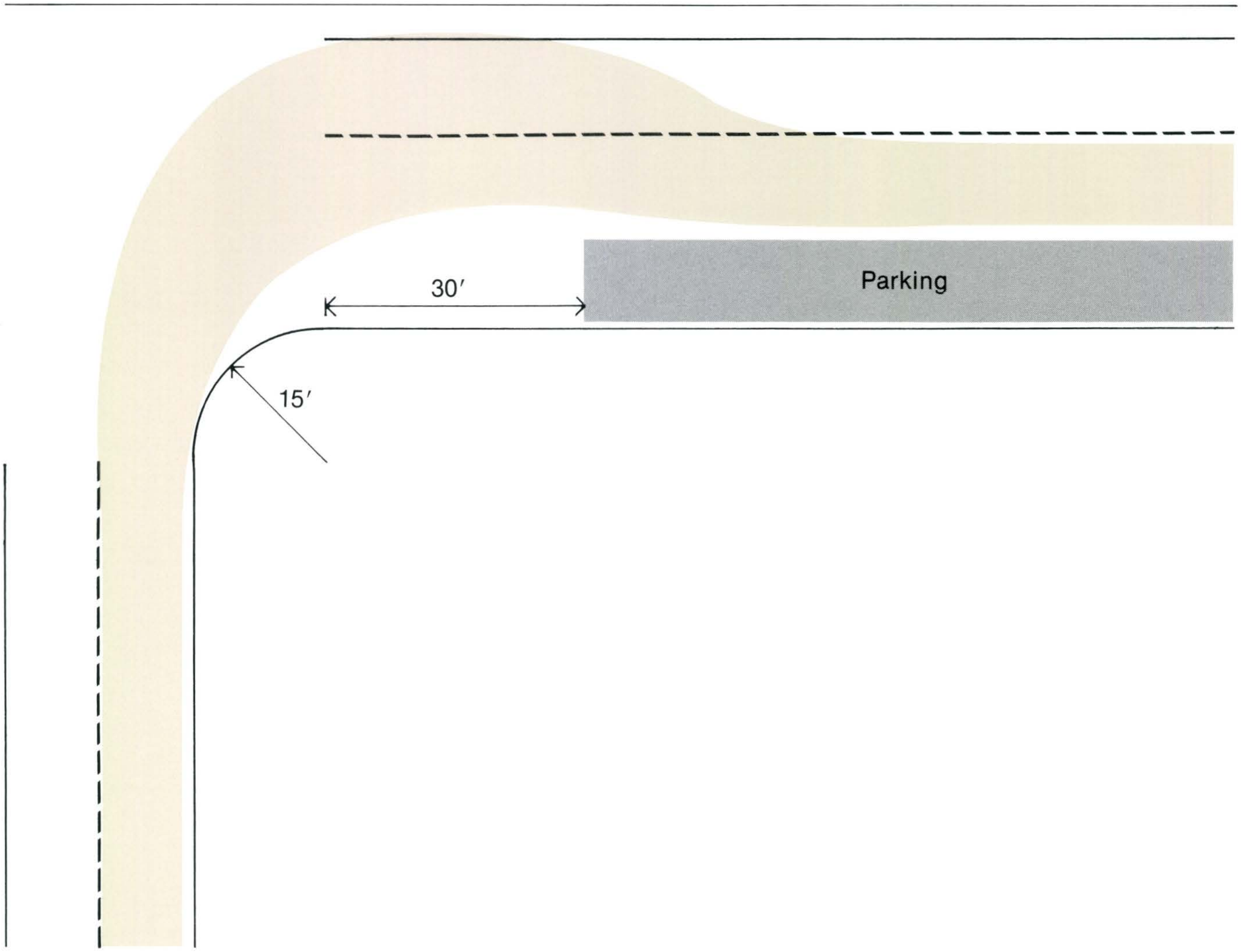
Recommended for most design cases.

Assuming parking after turn, none before turn. Parking assumed to be thirty feet from tangent. Travel lanes are eleven feet wide. Turning path of forty foot RTS bus making a right turn.

Scale 1″ = 20′

## Figure 13

## Simple Curve Radius — On Street Parking After Turn — Absolute Minimum




**Absolute Minimum**

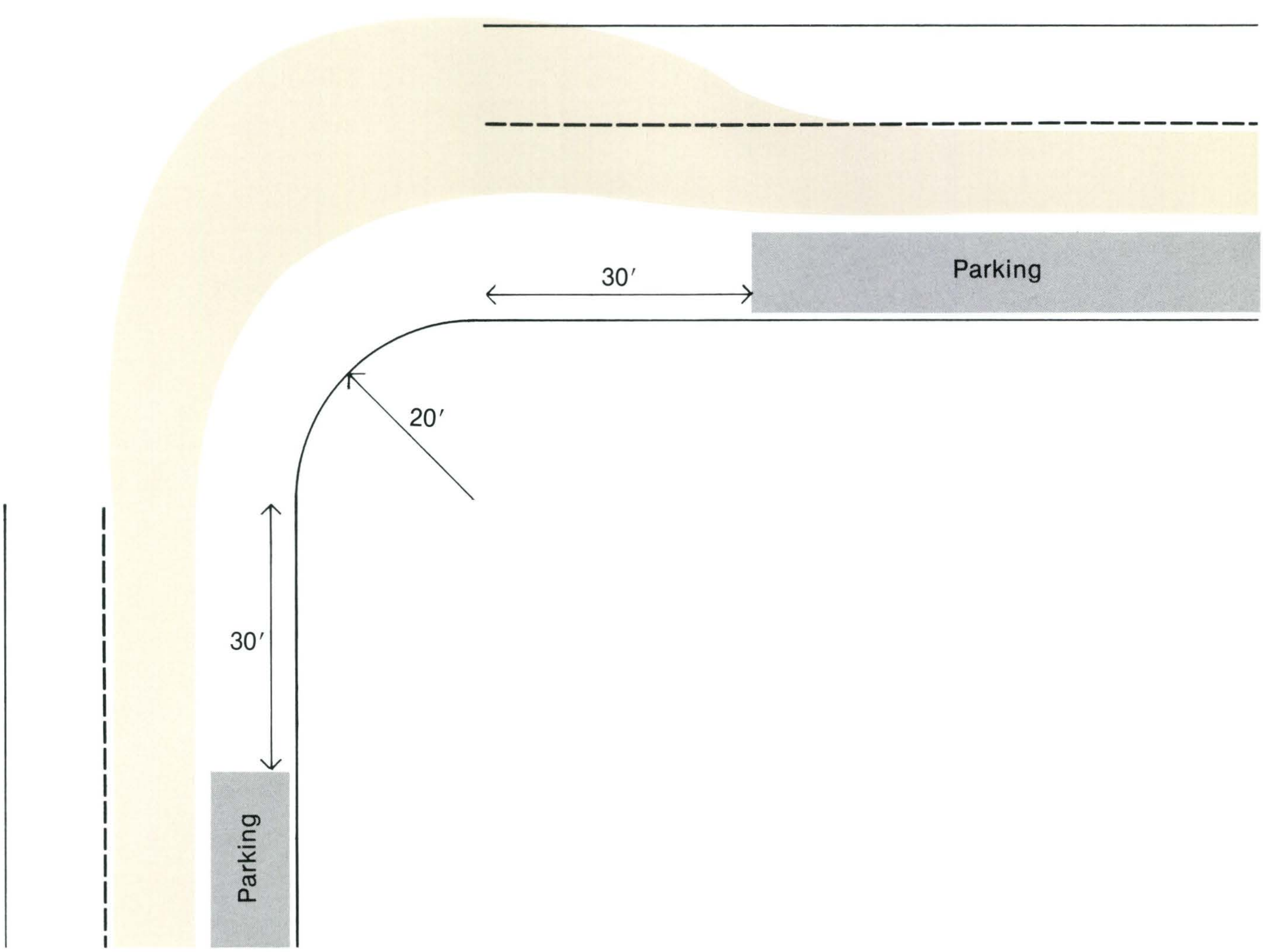
For severe design constraints only.

Assuming parking after turn, none before turn. Parking assumed to be thirty feet from tangent. Travel lanes are eleven feet wide. Turning path of forty foot RTS bus making a right turn.

Scale 1″ = 20′

Figure 14

## Simple Curve Radius—On Street Parking—Preferred Minimum

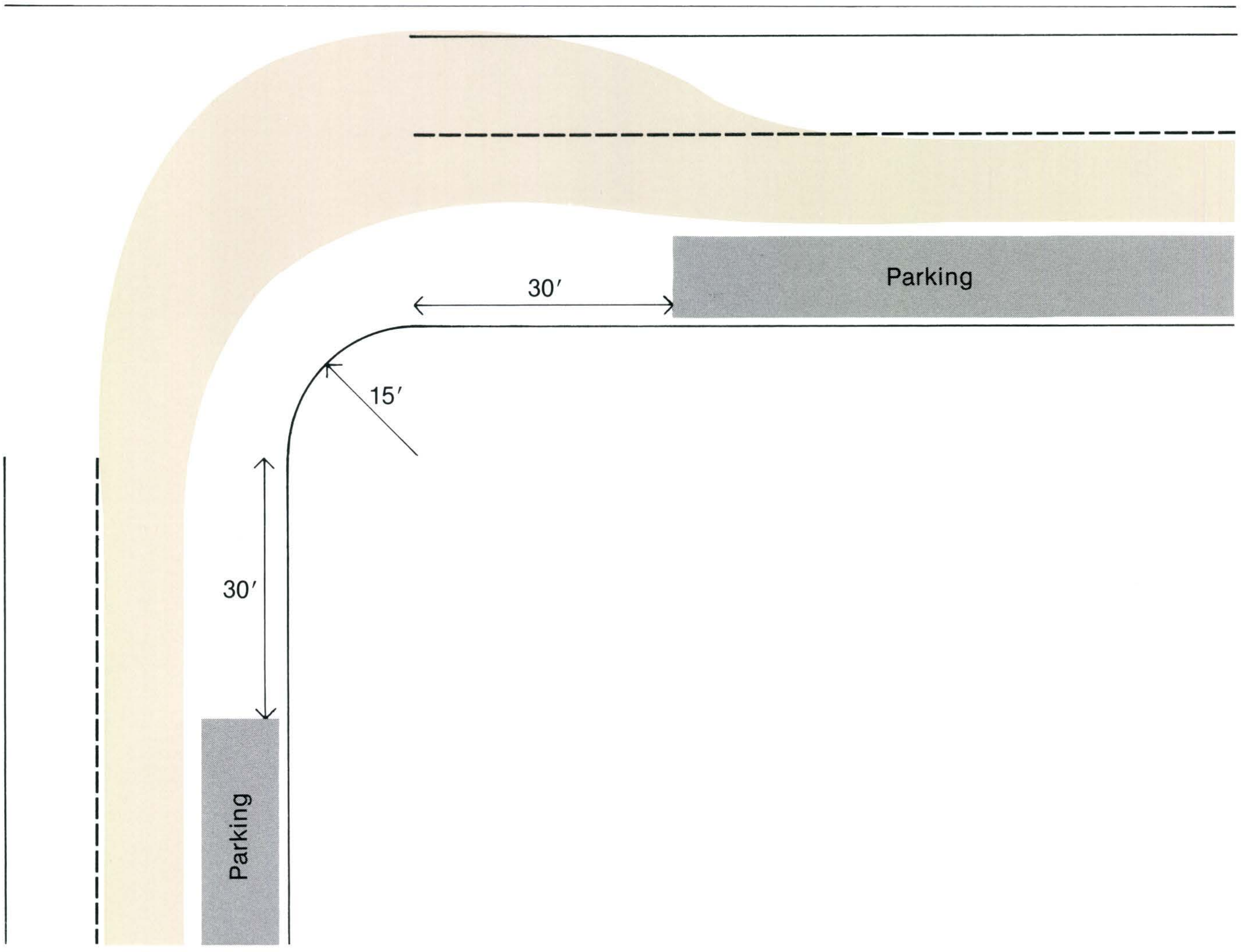



**Preferred Minimum**

Recommended for most design cases.

Assuming parking before and after turn—thirty feet from tangents. Travel lanes are eleven feet wide. Path of forty foot RTS bus making a right turn.

Scale 1″ = 20′



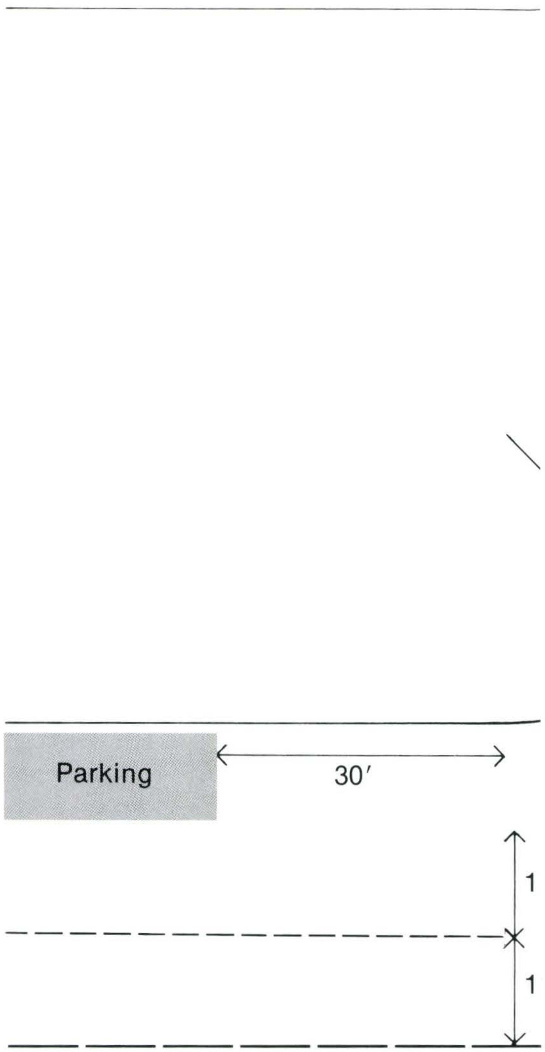

**Absolute Minimum**

For severe design constraints only.

Assuming parking before and after turn—thirty feet from tangency points. Travel lanes are eleven feet wide. Path of forty foot RTS bus making a right turn.

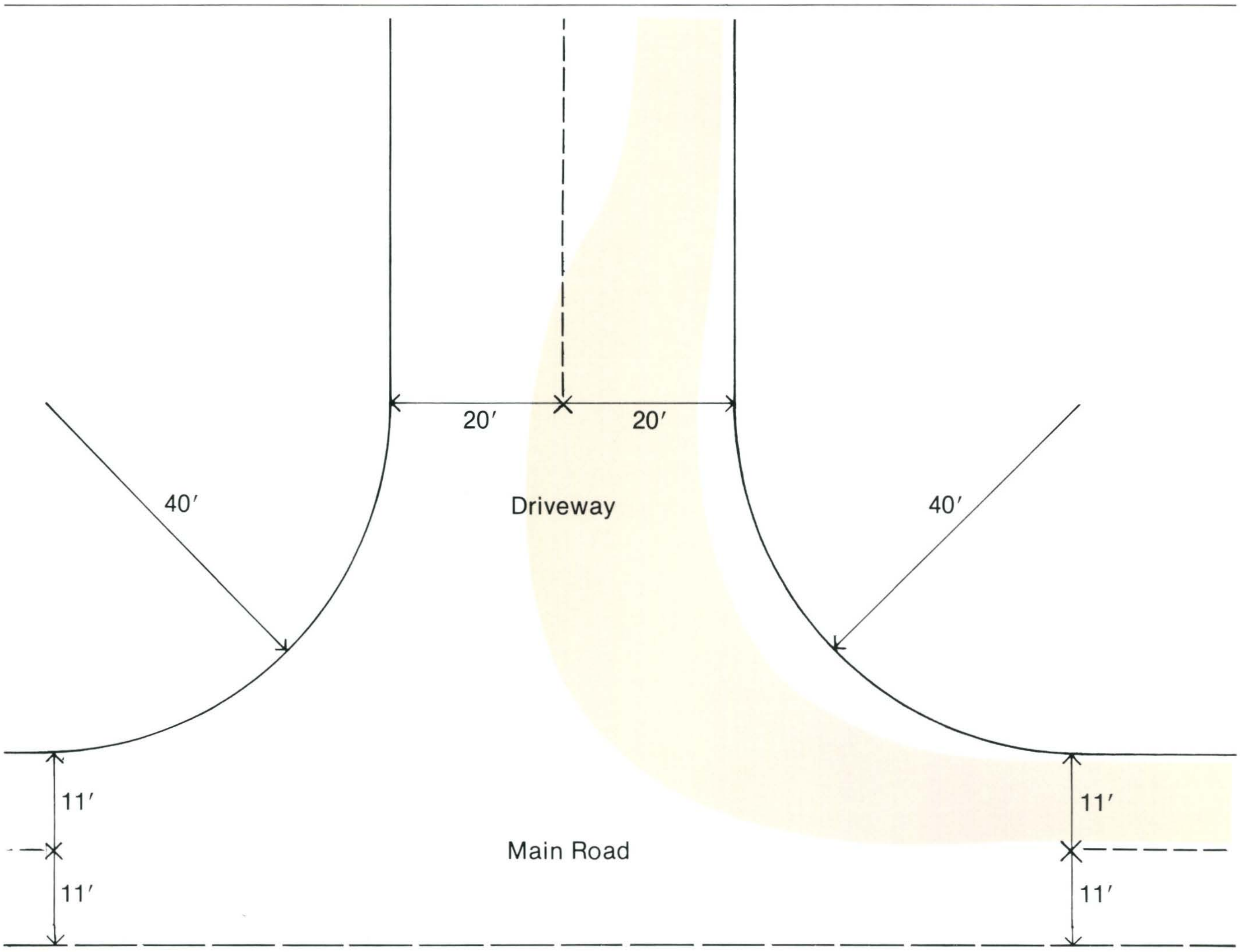
Scale 1″ = 20′

**Figure 16** **Driveway Design**



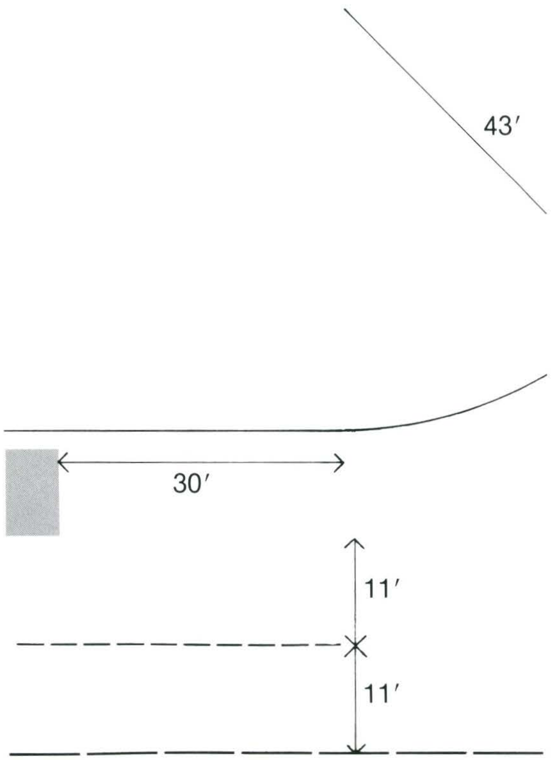

Assuming forty foot RTS. Radius thirty fee
parking lane on approach (beginning thirty
tangent). Driveway lanes are twenty feet w
road lanes are eleven feet wide. Main road
viewed as either carrying traffic in the sam
opposite direction.

Scale 1″ = 20′



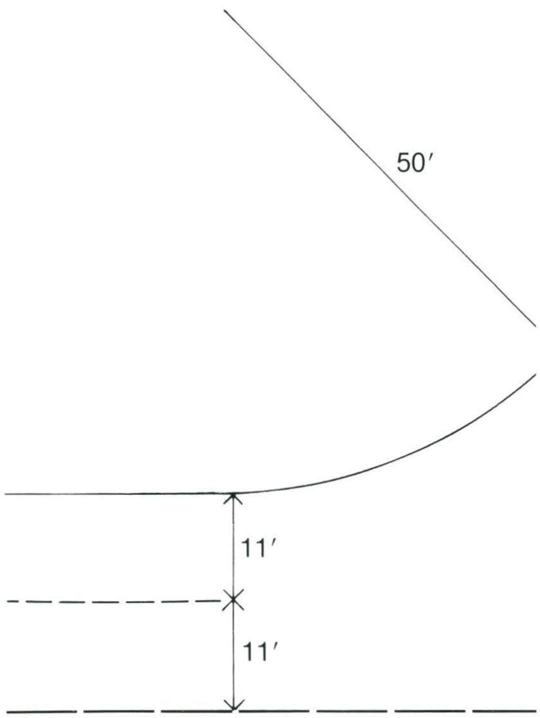

Assuming forty foot RTS. Radius forty feet with no parking before entrance. Driveway lanes are twenty feet wide. Main road lanes are eleven feet wide. Main road can be viewed as either carrying traffic in the same or opposite direction.

Scale 1″ = 20′



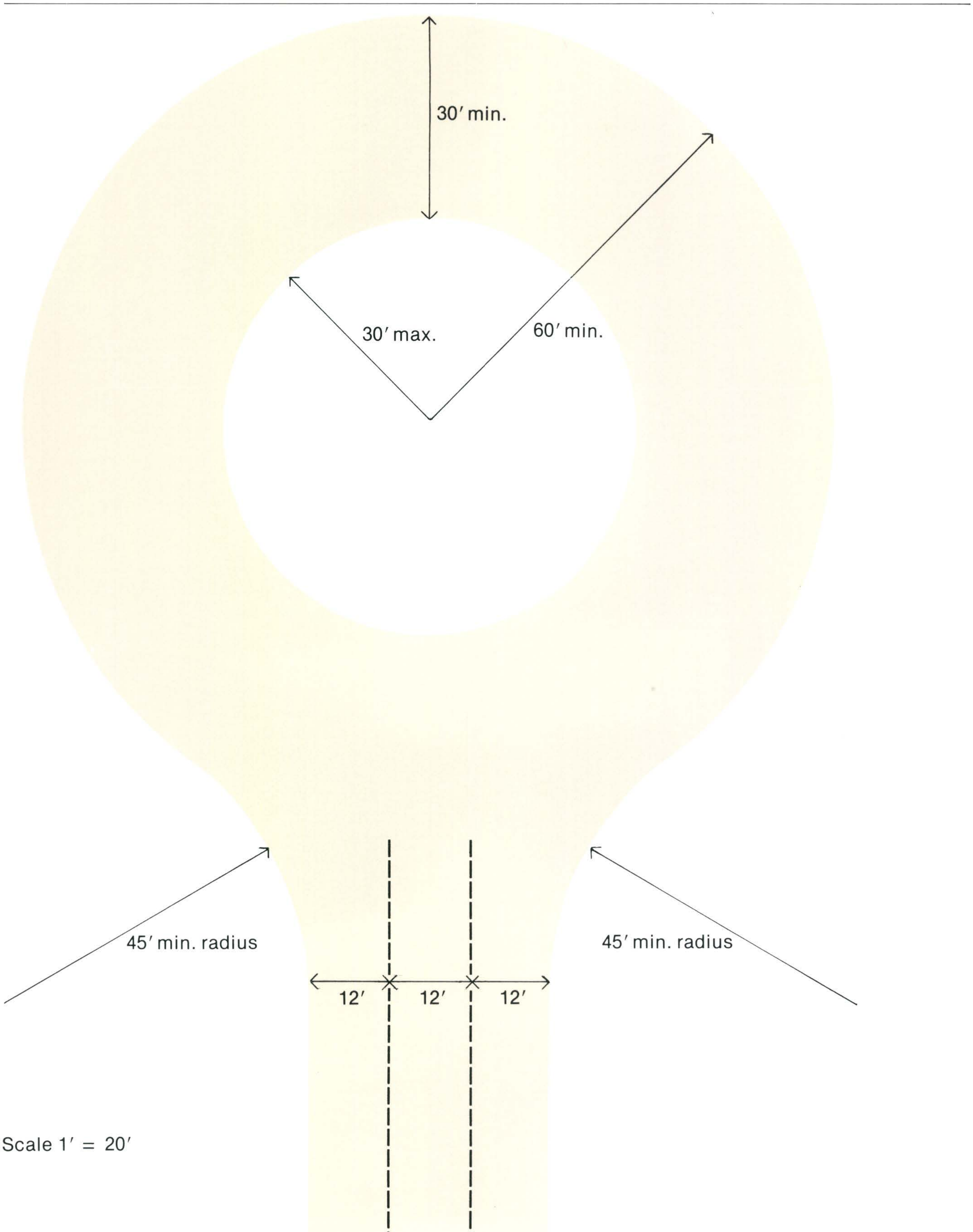

Assuming forty foot RTS. Minimum radius i
three feet with some lane encroachment. A
roads are eleven feet wide. Parking is thirty
from tangent. Main road can be viewed as ε
carrying traffic in the same or opposite dirε

Scale 1″ = 20′




Assuming forty foot RTS. Minimum radius feet with one lane encroachment. All trave are eleven feet wide. Main road can be vie either carrying traffic in the same or oppo direction.

Scale 1″ = 20′




Scale 1′ = 20′

This chapter may be of special interest to local government officials and traffic engineers since the provision of bus stop space usually requires concurrent parking regulations. The bus stop specifications supply data regarding the advantages, disadvantages and required street space for the various stops.

From the bus passenger's point of view, the bus stop is the most important element of transit design. Four types of stops are described below:

a. Curb Side Stops
b. Flared or Recessed Turnout
c. Park (Kiss) and Ride Lots
d. Sheltered and Paved Stops

**Curb Side**

There are three major curb side bus stops: far side, near side, and mid-block. These stops are named with regard to their location at or between intersections. See Figures 21 and 22.

Far side bus stops are located beyond a street intersection relative to a bus travelling through the intersection. A far side stop can be either on the same road or on a different road. The latter type of far side stop may be located after either a right or left turn. Near side stops are found before the intersection, relative to a bus travelling through the intersection. Midblock stops are located between intersections.

Figures 21 and 22 also show the nationally recommended dimensions of the curb side stops. The standards, which have been adopted by SEMTA, allow the bus to pull close to the curb, out of the way of traffic and with enough approach, dwell, and exit space. The dimensions assume a 40-foot long bus. Where additional buses are expected to dwell at these stops at the same time, 45-feet per bus should be added to the requirements. Further, local regulations for crosswalks should be considered along with the bus stop space requirements. As can be seen in the figures, the measurements begin at the point of tangency (where the curve ends and the straight curb starts). Where crosswalks either precede or follow the bus stop, local regulations may require additional space between the point of tangency and where the crosswalk ends at its farthest point from the intersection. The selection of the kind of curb side stop depends on a number of circumstances. Far side stops are generally preferred by SEMTA primarily for safety reasons, and are usually placed every two city blocks. The minimum length of a far side stop is 80-feet. Signs at all stops are located 80-feet from the intersection and one to three feet from the curb. In all cases, parking should be prohibited from bus stops.

In addition to safety, far side stops have other advantages:

1. They reduce conflicts between right turning vehicles and stopped buses.
2. They provide additional intersection capacity by making the curb lane available for traffic.
3. They eliminate sight-distance deficiencies on approaches to intersections.
4. They encourage pedestrian crossings at the rear of the bus.
5. They require shorter maneuvering distances for the buses to enter and leave moving traffic. (This is not relevant where curb parking is prohibited.)
6. At signalized intersections, buses can find gaps for re-entry into the traffic stream. (This is not relevant where curb parking is prohibited.)
7. Waiting passengers can assemble along less crowded sections of sidewalk[1].

In some situations, far side stops are not recommended. One example would be where transit routes intersect, making passenger transfers difficult if there are far side stops at an intersection. Having a combination of far side and near side stops could reduce passenger street crossings for transfers. In such cases, near side stops may be used. However, near side stops should be used with care. The disadvantages of near side stops are important to note:

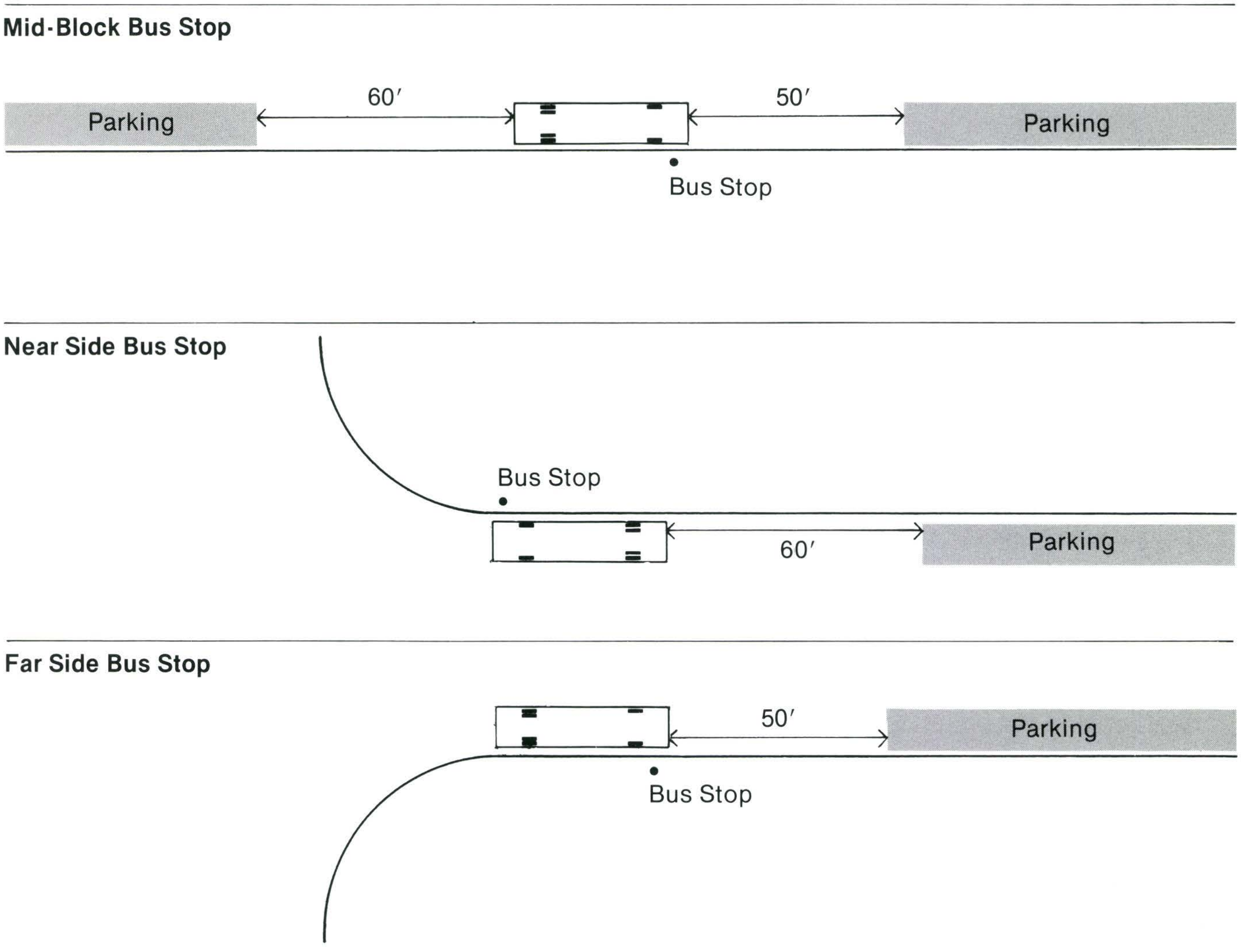
1. Heavy vehicular right turns can cause conflicts, especially where a vehicle makes a right turn from the left of a stopped bus.
2. Buses often obscure STOP signs, traffic signals, or other control devices, as well as pedestrians crossing in front of the bus.
3. A bus standing at a near-side stop obscures the sight distance of a driver entering the bus' street from the right.
4. Where the bus stop is too short for occasional heavy demand, the overflow will obstruct the traffic lane.[2]

Midblock stops are used when an intersection is far from a major trip generator. As with near side stops, there are some significant disadvantages to midblock stops:

1. The removal of considerable curb parking may be required.
2. Patrons from cross streets must walk farther to board the bus.
3. Pedestrian jaywalking is more prevalent, thereby increasing vehicular friction, congestion, and accident potential. (A mid-block stop should be located at the far side of mid-block pedestrian crosswalk so standing buses will not block a motorist's view of pedestrians in the crosswalk.)[3]

Figure 21

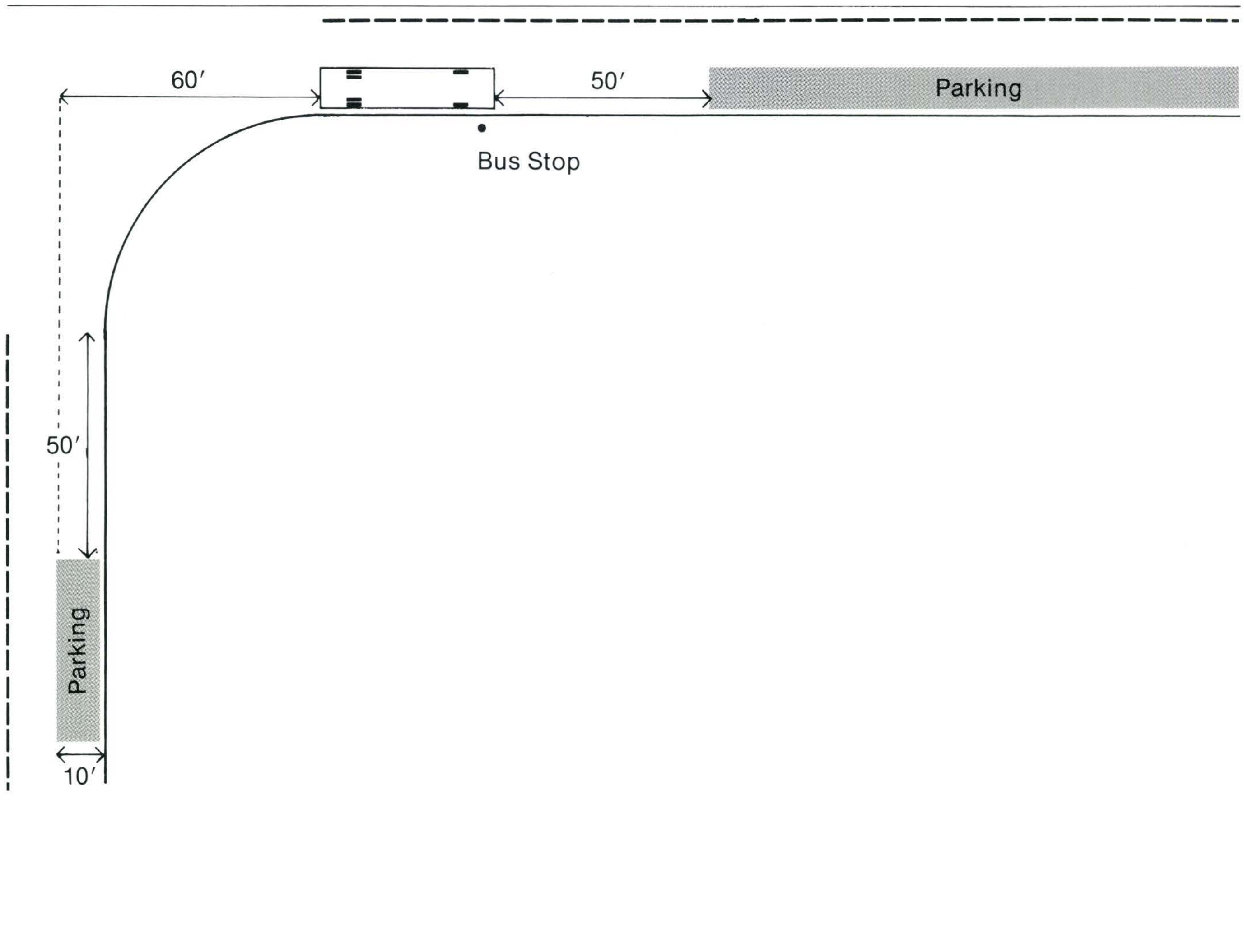
Curb Side
Bus Stops




Scale 1″ = 40′

Figure 22

**Far Side Bus Stop After Right Turn**




Scale 1″ = 40′

**Bus Bays**
As there are three kinds of curb side stops, there are three types of recessed bus bays: far side; near side; and midblock. Bus bays are used to provide a place where a bus can pull out of traffic. Figures 23 and 24 show the dimensions of these turnouts.

Bus bays are appropriate along roadways where there are heavy and high speed traffic and long bus stop dwells[4].

And where:

1. Curb parking is prohibited, at least during the peak hours.
2. There are at least 500 vehicles in the curb lane during the peak hour.
3. Bus volumes are inadequate to justify an exclusive bus lane. At least 100 buses per day and 10 to 15 buses carrying 400 to 600 passengers in the peak hour traverse the street.
4. The average bus dwell time generally exceeds 10 seconds per stop.
5. Right-of-way width is adequate to allow constructing the lane without adversely affecting sidewalk pedestrian flow.[5]

The same considerations given to the placement of curb side bus stops need to be given to the location of bus bays.[6] When more than one bus is expected to dwell in a bay, seventy feet per bus of dwell space should be allowed.

Flared lanes, which serve the same purpose as bus bays, can also be used at the entrances of developments, where a bus does not actually go into the area. Figure 25 shows a possible configuration. Also note that a recessed lane opposite the entrance is required. In this case, use the standards for midblock bus turnouts.

**Park & Rides**
Park & Ride service is often the beginning of line-haul service to an urban fringe area. By its nature, Park & Ride lots draw their ridership from a surrounding, low density area. The passengers generally drive to the Park & Ride site. Commercial developers may wish to reserve part of their parking spaces for the commuter market that will use Park & Ride facilities.

Usually, the spaces reserved for Park & Rides are excess parking space during typical weekday work hours. Since commuter parking occurs only between 6:30 AM and 6:00 PM on work days, customers should have full use of the parking lots during the peak evening and weekend shopping times.

The design criteria for Park & Ride lots are somewhat incomplete. Though some aspects of the physical requirements for Park & Rides can be definitively stated, other requirements cannot. It can be safely said that Park & Ride lots follow the same physical standards as any other parking lot with the additional provision that a reinforced drive path be a part of the pavement where the bus is to travel. A second standard is the location of a Park & Ride within a lot used for other purposes. The Park & Ride should be relatively remote from every day shopper traffic. Further it should be near to major vehicular entrances and exits to permit easy and fast access by the transit bus. It is also preferred that some part of the designated lot area for Park & Ride have a shelter or at least a landing pad. Shelter and pad standards are discussed later in this chapter. See figures 26, 27 and 28 for examples of various Park & Ride layouts.

The number of spaces needed for Park & Ride lots cannot be stated with certainty. Numerous marketing considerations as well as demand potential enter into the question of reserving spaces for Park & Ride. The reader should call or contact SEMTA's Planning Department for an estimate of the number of spaces needed in a specific project.

**Bus Shelters and Landing Pads**
Bus shelters and landing pads are a modification of bus stops rather than a wholly separate category. The provision of bus shelter space is the only consideration with regard to shelters that engineers and developers can make since the actual placement of a shelter by SEMTA depends on several criteria contained in a somewhat involved allocation formula[7]. This assumes, of course, that the developers or engineers will not build their own sheltered stop. However, the provision of space for a shelter as well as providing connecting walkways, enhances the possibility that SEMTA will place a shelter in that area.

The installation of a shelter requires a concrete base ten feet by twenty feet. Landing pads, which provide a concrete surface for a bus patron to stand on, have the same dimensions as shelter bases. So, while a developer or engineer is providing a decent waiting area for transit passengers, in the form of a landing pad, they are also enhancing the chances of a shelter being erected. If sidewalks already abut the curb where a bus stop is to be located, and the sidewalk is sufficiently wide to permit a ten by twenty foot shelter area without hindering pedestrian traffic, then, obviously, no base need be provided—for the sidewalk itself will be the base of the shelter. The bases of shelters, landing pads, and access paths to these places, should be accessible to wheelchairs. Further, where necessary, walkways from a shelter/pad base to the sidewalk and to the curb should be installed. These areas should, of course, be plowed in winter. See Figure 29.

The typical SEMTA bus shelter is twelve feet by six feet three inches, and about eight feet high. The suburban shelters are generally constructed of aluminum and plexiglass. The downtown Detroit structures are made of bronze colored aluminum and tempered glass. Shelters usually have a seating bench inside. See photos 7 and 8 for illustrations of SEMTA shelter.

**Footnotes**

[1]Herbert S. Levinson , et al, **Bus Use of Highways: Planning and Design Guidelines,** Washington D.C.: Transportation Research Board, 1975, p. 126.

[2]Ibid, p. 127.

[3]Ibid.

[4]Ibid, p. 130.

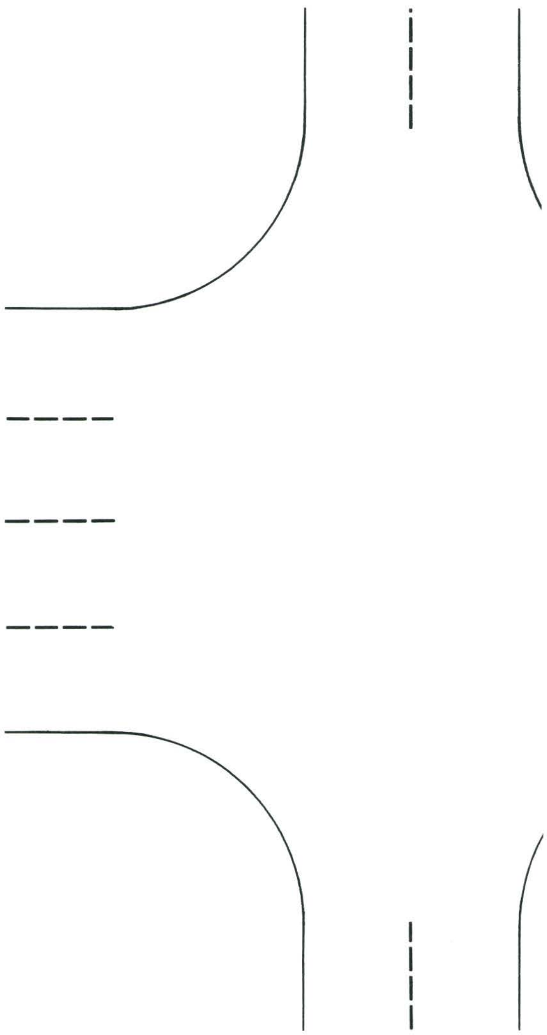
[5]Ibid.

[6]Ibid.

[7]SEMTA, **Fixed Facility Improvement Recommendations 1980-1985,** Chapter VII.

Figure 23

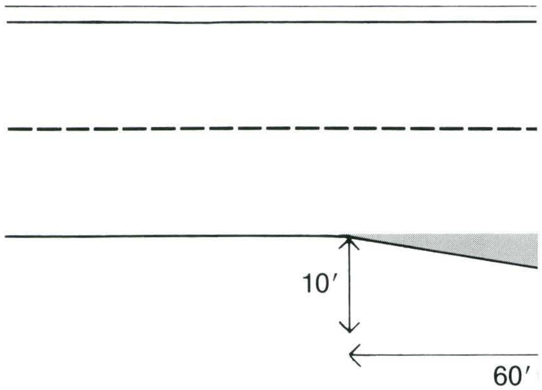
**Near Side and Far Side Flared Lanes**



Scale 1″ = 20′

Source: Herbert Levinson, Crosby L. Adam
William Hoey, **Bus Use of Highways: Plann
Design Guidelines.** (Washington D.C.:
Transportation Research Board 1975) p. 13

**Figure 24** **Mid-Block Bus Turnouts**



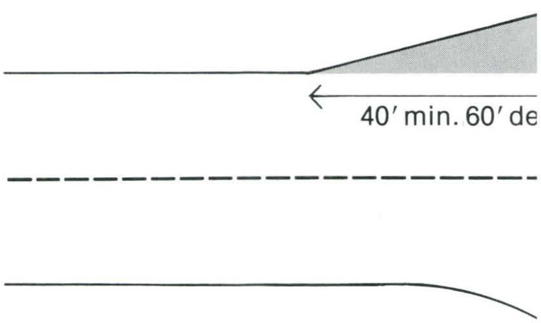

If more than one bus is expected to dwell a
70 feet per bus should be allowed. Tapers
the same.

Scale 1″ = 20′

Source: Herbert Levinson, Crosby L. Adam
William Hoey, **Bus Use of Highways: Plann
Design Guidelines.** (Washington D.C.:
Transportation Research Board 1975) p. 13

Figure 25

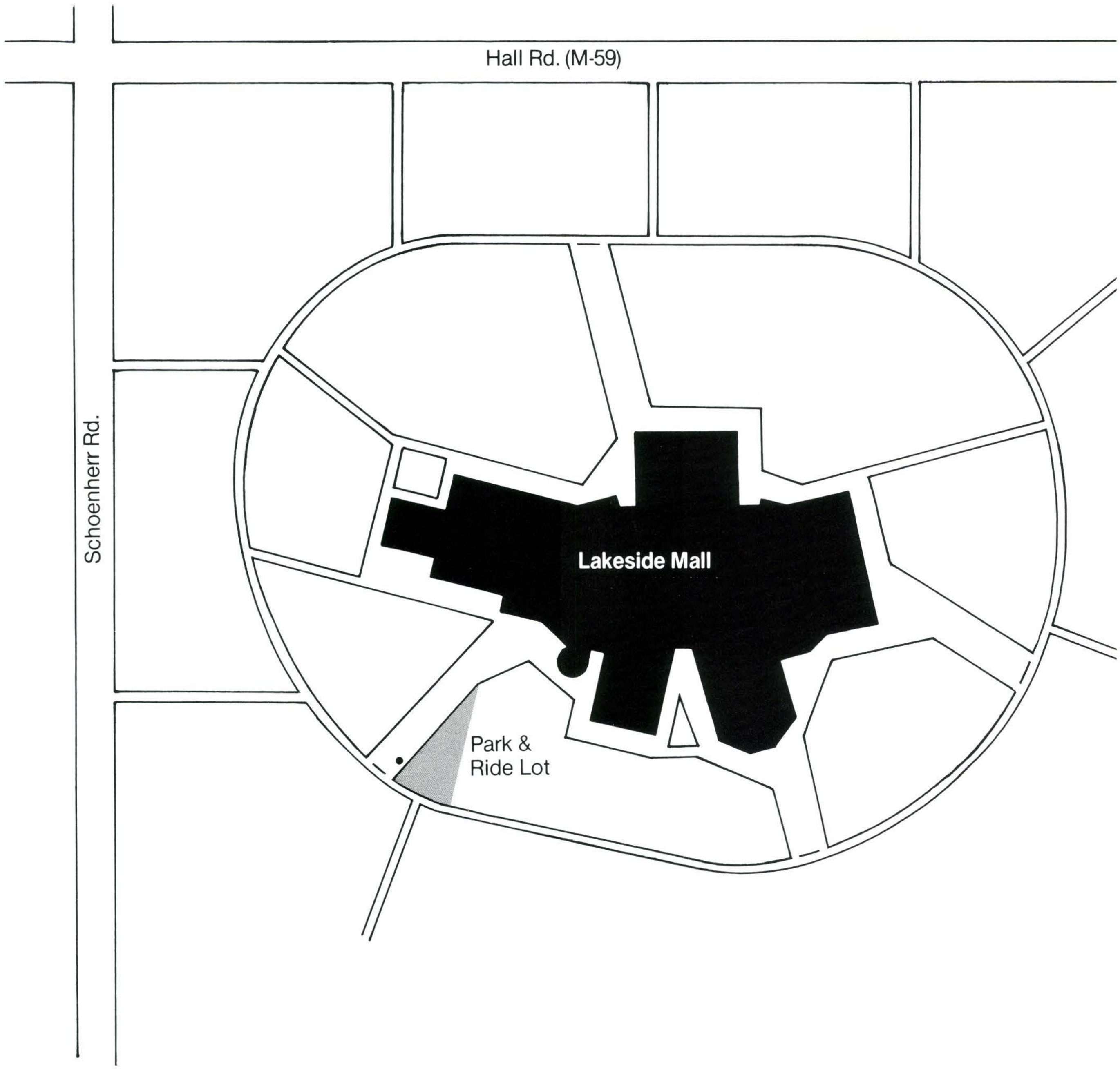
**Flared Lanes at the Entrance of a Development**




Scale 1″ = 20′

Source: Herbert Levinson, Crosby L. Adam William Hoey, **Bus Use of Highways: Plan Design Guidelines.** (Washington D.C.: Transportation Research Board 1975) p. 1

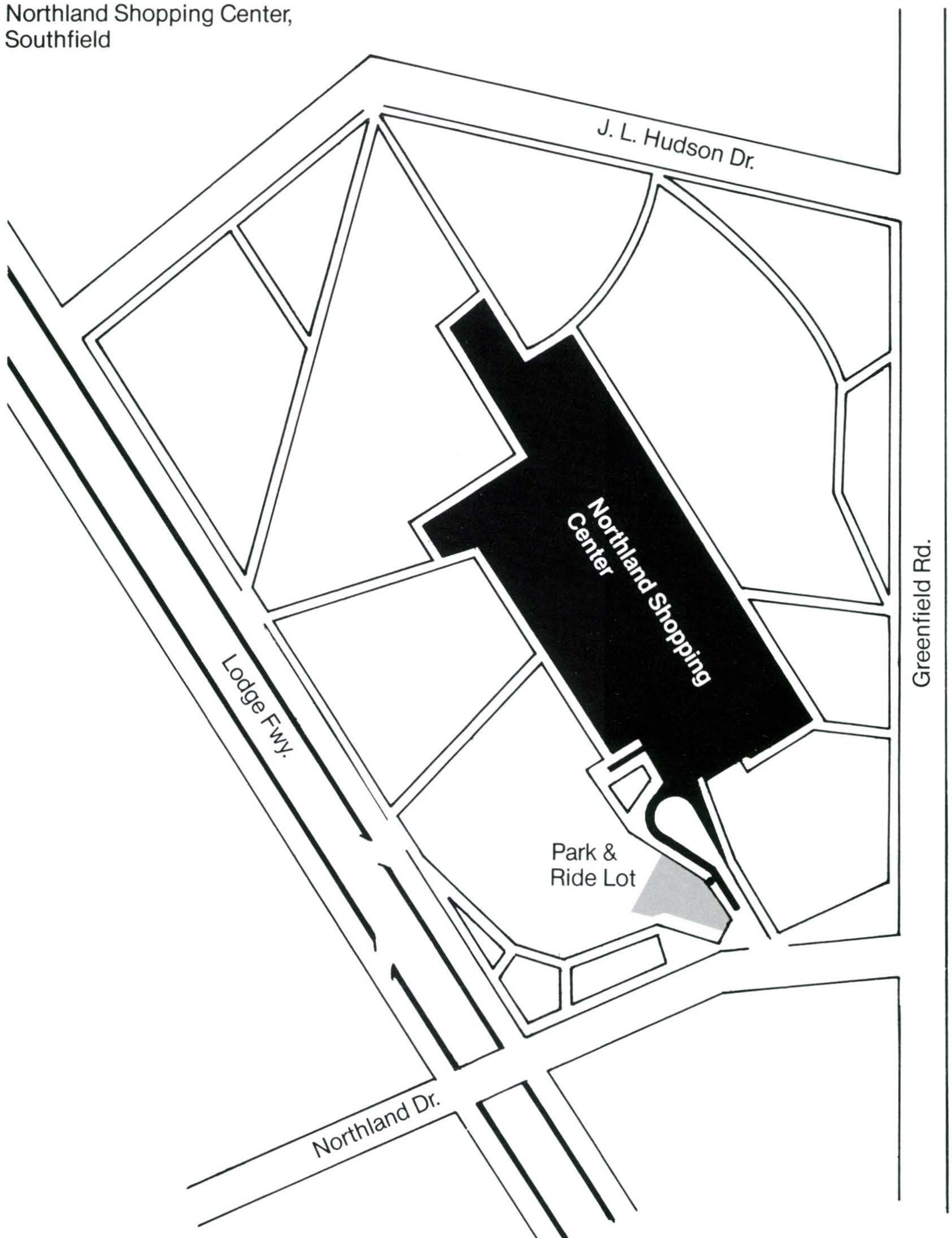
Lakeside Mall, Sterling Heights




Not to Scale

↑ North
• Park and Ride Bus Stop

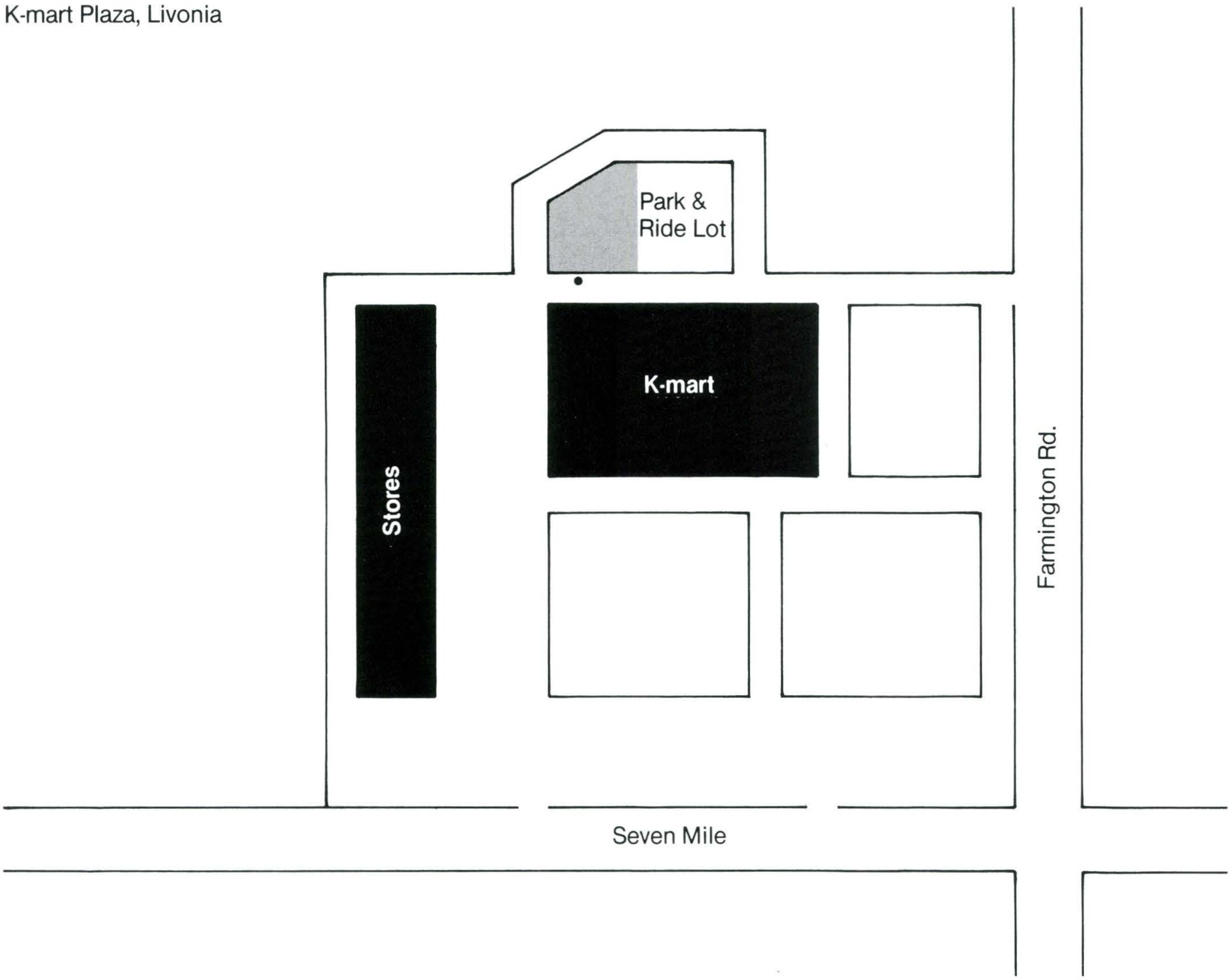
Northland Shopping Center,
Southfield




Not to Scale

↑ North
• Park and Ride
Bus Stop

K-mart Plaza, Livonia

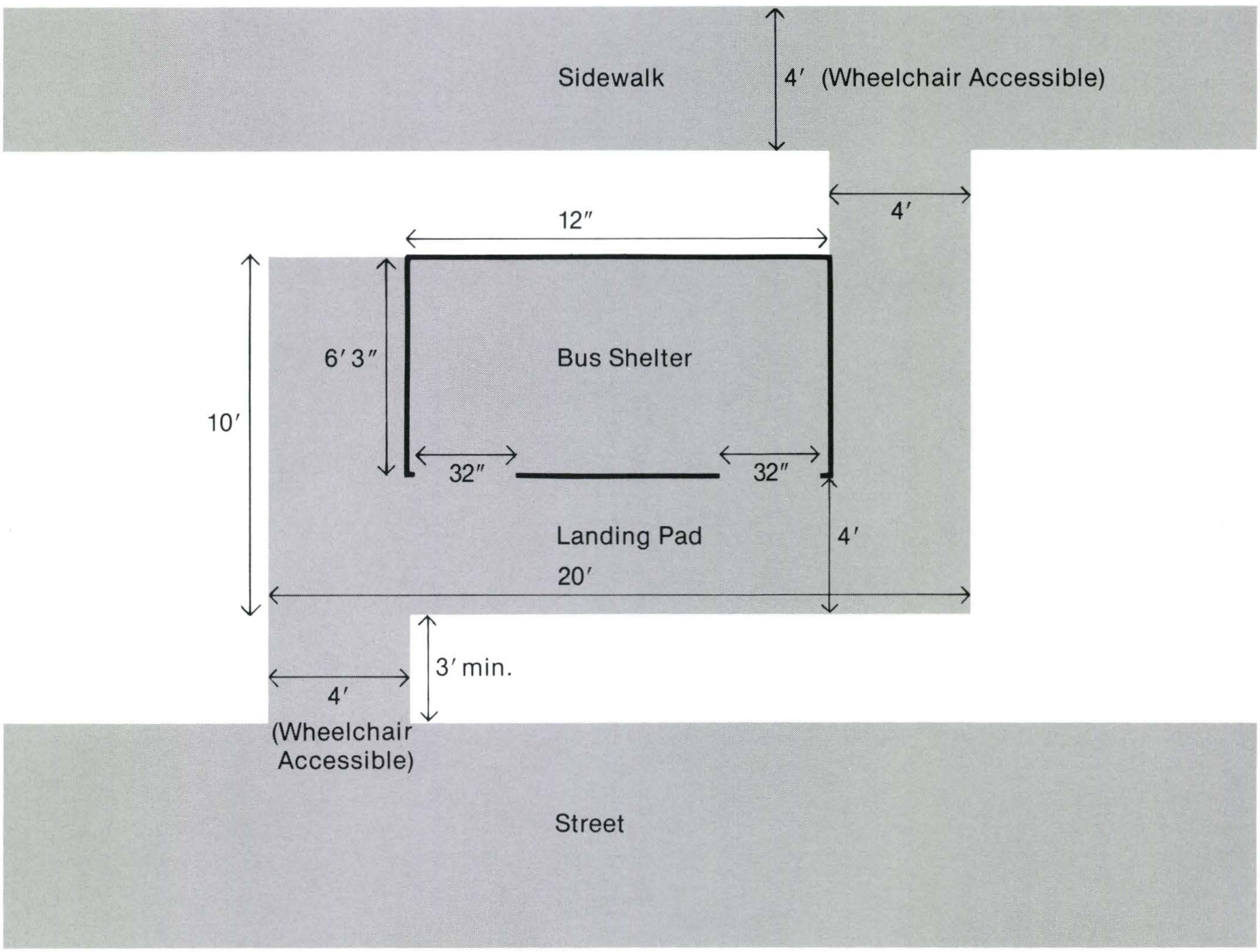



Not to Scale

↑ North
• Park and Ride Bus Stop

Figure 29

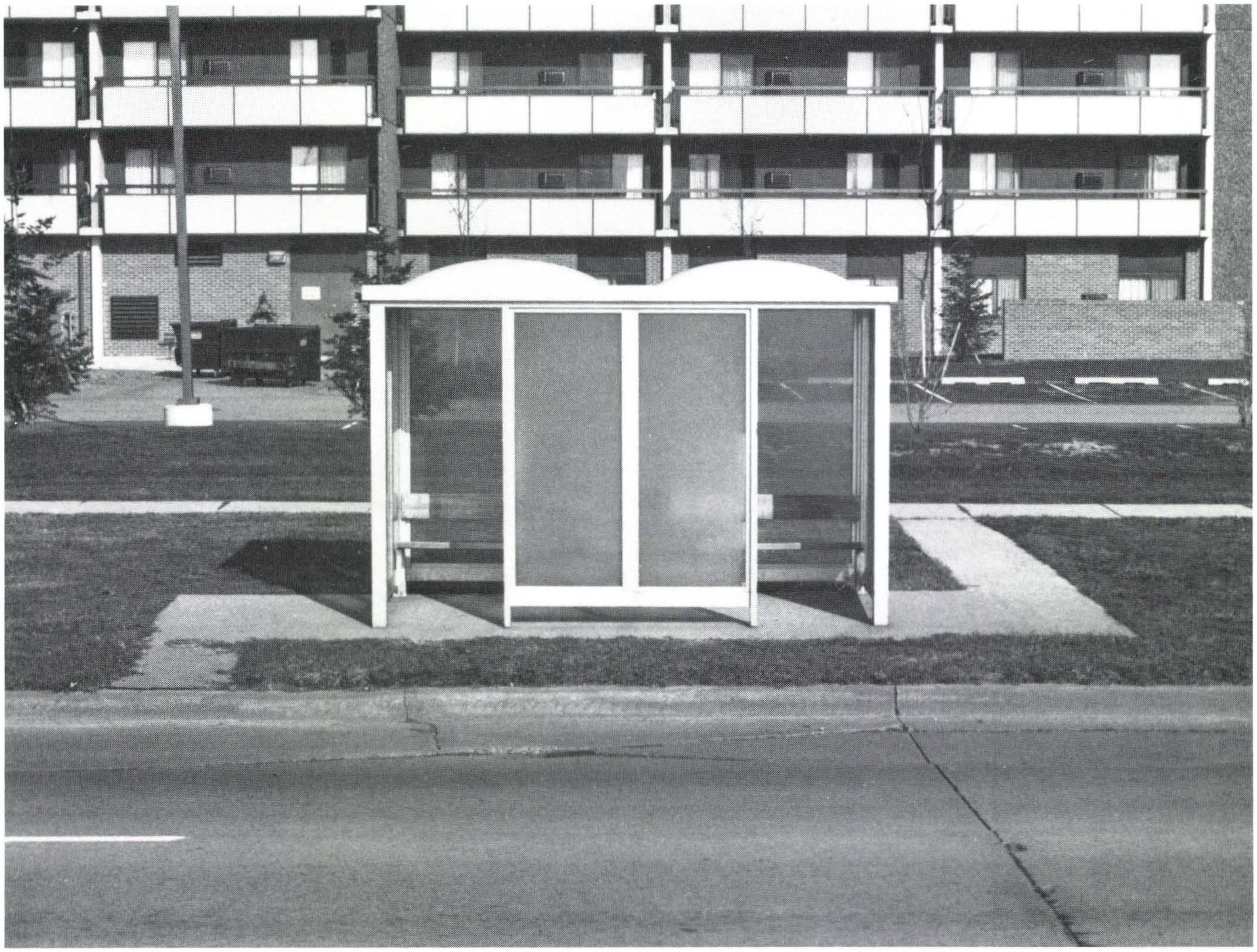
**Bus Shelter Space Requirements**




Scale 1″ = 5′

Photograph 7

## Front View of a Bus Shelter



Note the placement of the shelter pad in relation to the sidewalk and road. It is important to leave sufficient space for a shelter since a shelter greatly enhances a bus stop. Shelter placement is, of course, SEMTA's responsibility.

Photograph 8

## Side View of a Bus Shelter

This photo clearly shows the bench inside the shelter and how the pad is connected to the sidewalk and road curbing with concrete paths. See Figure 29 for shelter space requirements.

**Articulated Bus** — A high capacity (60 to 70 seated passengers) linehaul vehicle consisting of two sections hinged to each other, permitting the vehicle to turn within a relatively short turning radius.

**Bus Bays** — (Also Recessed Bays and Bus Turnouts.) Indentations in road side to permit a vehicle to dwell at roadside while minimizing conflicts with general traffic.

**Central Business District (CBD)** — That downtown portion of a municipality in which the dominant land use is characterized by intense business activity. In Detroit, this area corresponds approximately to the area that is bounded by Sixth Street to the west, the Chrysler Freeway to the east, the Fisher Freeway to the north, and the Detroit River to the south.

**CBD Route** — A bus route extending from the downtown area.

**Commuter Service** — Bus service where most passengers ride for the purpose of travelling to and from work.

**Corridor** — An area distinguished by certain physical or travel characteristics that set it apart from its surrounding area. The Woodward corridor, for example, is bounded by the Lodge Freeway and I-75. The travel patterns and the physical conditions of the Woodward corridor are distinctive enough to warrant study as a unit.

**Cul De Sac** — A road in which there is only one outlet onto another road in which there is a place, usually circular, permitting a vehicle to turn around.

**Curb Side Bus Stop** — A transit pick up/discharge point located adjacent to a transit route.

**Curb Radii** — The distance from a point on the arc of a curve in a street to some central point, if such an arc was drawn as to complete a circle.

**Crosstown** — A bus route which does not enter the Detroit CBD.

**Deadhead** — A bus "deadheads" when it operates without carrying passengers. This usually occurs between terminals and the beginning or end of the route; between the end or beginning of two different routes; or between the end or beginning of the same route.

**Dwell Time** — The time a vehicle spends waiting to pick up or drop off passengers.

**Entrance Radii** — Dimensions for curves which form the intersection of an access point to a development and an abutting street.

**Express** — A bus which makes restricted local stops in outlying areas and operates non-stop to its destination area.

**Far Side Bus Stop** — Transit pick up/discharge point located across an intersection, relative to a bus travelling through the intersection.

**Feeder** — A bus route which collects passengers to take them to another route to complete their trips to their destination.

**Flared lanes** — Indentations along a roadway located at a street intersection.

**Headway** — Refers to the frequency of bus or train trips and is the scheduled time, in minutes, between vehicles at a given point on the route.

**Intercity Bus** — A linehaul vehicle that is designed expressly for carrying passengers on long trips.

**Landing Pad** — A paved, usually concrete, surface upon which a passenger can wait for a bus at a bus stop.

**Limited Bus** — A high speed transit route which makes only selected stops.

**Linehaul Bus** A type of transit vehicle marked by its size (minimum length of about thirty five feet), passenger capacity (about 40 to 50 seated people, minimum), and regular, fixed route service.

**Mid-Block Bus Stop** A transit pick up/discharge point located between road intersections.

**Modal Split** The proportioning of trips between travel modes. For example, if a company employs ten people, of whom eight arrive by automobile and two by bus, the transit-to-automobile modal split would be twenty percent.

**Mode** A particular form of travel: bus, commuter rail, or automobile, for example.

**Near Side Bus Stop** A transit pick up/discharge point located just before an intersection, relative to a bus travelling through the intersection.

**Off-Peak** Those periods of the day when demand for transit service is not at its maximum, i.e., not during rush hours. SEMTA's established weekday off-peak hours are 9:00 a.m.-4:00 p.m. and 6:00 p.m.-6:00 a.m.

**Owl Service** On bus routes which have 24-hour service, this refers to trips between 10:30 p.m.-7:00 a.m.

**Park & Ride** A route on which a bus picks up people at a number of parking lots and delivers them to a major destination.

**Peak Hour** The specific hour(s) of the day when the largest number of people travel and the major flow of traffic to/from work is encountered (e.g., 7:30 a.m.-8:30 a.m.)

**Radial Route** Bus routes from the Detroit CBD which travel on the major arterial roads which radiate from the CBD to the rest of the region.

**Recessed Bays** See **Bus Bays.**

**Reverse Haul** A travel pattern which occurs on a route which has a substantial flow of people in the reverse direction to the normal flow. The reverse haul occurs in the morning rush hour in the outbound direction, and in the afternoon rush hour in the inbound direction with relation to the Detroit CBD.

**Route (line)** Specified path taken by a bus along which it picks up and discharges passengers. The route is normally designated by a number or name.

**Running Time** The amount of time it takes a bus to traverse the route, usually broken up into segments between time-points.

**Service Area** A geographic locale or region where transit is provided.

**Shelter** A structure used by bus passengers while waiting for a bus.

**Small Bus** A transit vehicle smaller than a linehaul bus. Typically used for specialized transit services. Seats 15 to 20 people.

**Transit Market** A locale where people are likely to use a bus service in sufficient volume as to warrant the provision of such service.

**Trip** A bus makes one trip when it goes from its beginning to its end along a specific route.

**Trip Generator** A cluster of activities or residences which attract a large group of current or potential transit users.

**Turnouts** See **Bus Bays.**

Higbee, Ron. "Transit Facilities Design and Maintenance Standards." In **Planning with Transit** . Portland, Ore.: Tri-Met Planning and Development Division, NPD.

Levinson, Herbert S.; Crosby L. Adams; and William F. Hoey. **Bus Use of Highways: Planning and Design Guidelines.** Washington, D.C.: Transportation Research Board. 1975.

Metropolitan Transit Commission. **Standards for the Design and Maintenance of Bus Related Road Improvements.** St. Paul, MN: MTC. 1975.

**Articulated Bus,** 14, 27

**Bus Bays,** 4
(see also Flared Lanes) 49
at development entrances,
dimensions, 51, 53
general requirements, 49

**Bus Shelters,** 49, 50, 60, 61, 62

**Bus Stops,**
closeness to activity areas, 4
dimensions, 47, 48
examples of
accessibility, 5, 6, 7, 8, 9, 10
far side, 46, 47, 48
local officials and, 46
midblock, 46, 47
near side, 46, 47
parking regulations and, 46
path to, 4, 5-10
signs at, 46
types, 4, 46

**Bus Volumes,** 14, 28
SEMTA, 14

**Commuter Service,** 3, 49

**Cul De Sacs,** 28, 45

**Developments, Land**
access to by transit, 3, 11
bus bay at entrances to, 49, 55
developers, 4, 14, 49
flared lanes at
entrances to, 49, 55
influence on and
by transit, 1, 3

**Flared Lanes,**
at development entrances, 49
dimensions, 55

**Handicapped,**

**Highways,**
see Roads and Roadway Projects.

**Intercity Bus,** 14, 26

**Kiss & Ride,** 4

**Land Developments,** 1
access by transit, 1, 3
bus bays and, 49
developers of, 4, 14, 49
entrance design standards, 37-43
flared lanes and, 49, 55
influence on and by
transit, 1, 3

**Landing Pads,** 49, 60

**Linehaul Bus,** 3
articulated, 14, 27
cul de sacs and, 28
design area, 11
design vehicle, 14
GM RTS, 14, 15, 28
M.A.N. articulated bus, 14, 27
specifications, 15, 26, 27
turning template, 19, 21

**Northland Shopping Center,** 1, 28, 58

**Park & Ride,** 1, 3, 4, 49
lot designs, 49, 57, 58, 59

**Passenger, Transit**
access requirements, 3, 4, 11, 12
maximum distance to stop, 4, 11

**Roads,**
geometric standards, 28-43
construction material, 28

**Roadway Projects,**
design standards for
construction material, 28
cul de sacs, 28, 45
general specifications, 28, 29-43
intersection design, 29-43
width of roads, 28

**Sidewalks,** 4, 5-10, 11, 49, 50

**Small Bus,** 3
C & E Fortibus, 14, 16
design area, 11
design vehicle, 14
general specifications, 16
turning template, 21, 23

**Transit Market,** 3, 12

**Transit Operator,**
general, 1, 3, 28
markets and, 3, 12
physical requirements, 3, 12
vehicle utilization, 3

**Transit Service,** 1

**Transit Service, (continued)**

all day, 3
commuter, 3
kiss & ride, 4
linehaul bus, 3, 4
market requirements, 3
park & ride, 1, 3, 4, 49
small bus, 3

**Transit Vehicles,**

see Linehaul bus and Small bus.