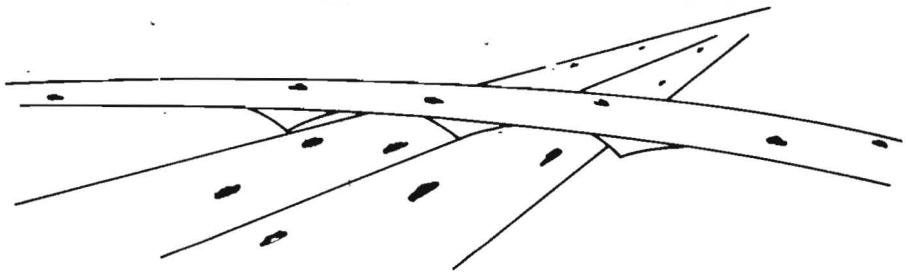

DEPARTMENTAL RESEARCH

Report Number : S S-10.1

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A STUDY OF ON-STREET PARKING ARRANGEMENTS

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A STUDY OF ON-STREET PARKING ARRANGEMENTS

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Texas Highway Department
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A STUDY OF ON-STREET PARKING ARRANGEMENTS

ABSTRACT

Part I

In many cases, particularly in smaller cities, an urban highway facility must be designed to provide for on-street parking. This study consists of an analysis of the operating characteristics of parallel parking and parking at an angle of $22\frac{1}{2}^{o}$ with the curb. The analysis was made using graphical methods and by using vehicles in parking situations.

The conclusions of this study are that the flat angle parking arrangement offers some definite advantages over parallel parking and should be considered for use under certain conditions.

Part II

The results of the general analysis of parking were applied to a specific situation in Huntsville, Walker County. A proposed parking arrangement to be used in connection with a street improvement project in Huntsville is presented. The accident records on the existing facility are reported and calculations of estimated street capacity are shown.

A STUDY OF ON-STREET PARKING ARRANGEMENTS

Part I - Investigation of Types of Parking

Discussion of Need for On-Street Parking

Except for controlled access expressways, most highways in urban areas are routed along portions of the city street system. The design problems for an urban highway facility are much more complex than for usual rural conditions. The primary consideration in the design of a rural highway is the safe and efficient movement of traffic between points which are usually well defined, and the designer is not confronted with providing for high volumes of traffic entering and leaving the travel lanes at frequent intervals. Also, the designer of a rural facility usually has some degree of control over roadside features and can eliminate or greatly improve conditions which might have an adverse effect on the movement of traffic. In contrast to this, the designer of an urban facility must not only consider the movement of a stream of traffic, but he must give consideration to frequently spaced intersections and roadside conditions over which he has little control. For an urban highway, the designer is generally faced with a fixed right of way width, as the cost of additional right of way would be prohibitive due to development on abutting property.

These problems in an urban area originate from the nature of city streets. In most cities, the street system in the central business district was established before automobiles were commonplace. Originally, the streets provided adequate space for traffic movement, on-street parking, and pedestrian travel with a minimum of regulation and control. As the number of vehicles using the streets increased, it became necessary to install

pavement markings, signals, and signs to regulate and direct traffic. Also, parking regulations became a necessity in order to eliminate undue interference with traffic movement. Generally, the width of street right of way in the central business district is comparable for cities of all sizes and has little relation to the volume of traffic to be carried. In the larger metropolitan areas, the demand for a facility to move high volumes of traffic has led, in many instances, to the elimination of on-street parking. In this case, the primary function of traffic movement has precedence over other considerations, and secondary uses of available street areas have been sacrificed. Merchants, property owners, and businessmen in the central business district have recognized that off-street parking space must be provided for their customers and employees. This provision of off-street parking, however, has been an evolutionary process developed over many years. In small cities, most streets in the central business district presently provide on-street parking as traffic demands have not forced the development of adequate off-street facilities.

Streets within the central business district of small cities fill an important role in the social and economic life of the community. They provide for movement of traffic through the downtown area, access to offices and stores, and provide for pedestrian travel. Also, the appearance and character of streets in the downtown area are a part of the city's culture. In many instances, citizens of a city prefer to retain historical and cultural buildings and landmarks, even at the expense of increased traffic congestion. Where on-street parking exists in the central business district, businessmen and property owners generally consider this to be a definite asset and

strongly resist any proposal that would reduce the areas available for parking. They feel that on-street parking is a convenience to their customers and that its elimination would adversely affect their businesses. Where the traffic congestion reaches the point that convenient utilization of on-street parking space becomes a real problem for most drivers, the attitude of downtown merchants changes to some degree. The usual solutions are to provide off-street parking spaces or relocate some of the businesses to outlying areas where parking space is available. Usually, this transition must be gradual and any effort by highway authorities to force the elimination of on-street parking is met with strong local resistance. The designer of an urban highway must recognize these community values and plan a facility that will best serve both the traveling public and the local community as a whole.

From the standpoint of providing for the movement of traffic, the most efficient scheme is one that makes the entire width of a street available to moving traffic. This is not always acceptable on the local level and a generally accepted compromise is to require parallel parking for all on-street parking facilities. Most of the literature in the field of traffic engineering contains statements to the effect that prohibition of all parking is desirable, but parallel parking may be allowed where the street width is sufficient. These sources also generally contain statements that, based upon safety aspects and effect upon travel lane capacity, all angle parking should be prohibited.

The generally accepted reference for highway capacity is the Highway Capacity Manual of 1965, published by the Highway Research Board. This Manual furnishes data useful in estimating the capacity of a highway

facility. The guidelines for capacity of urban streets cover only cases where parking is prohibited or where parallel parking is permitted. No information is given in the Manual concerning the effect of angle parking. Roadway capacities in small urban areas computed from guidelines in the Manual are subject to considerable question. This is due, in part, to the fact that street capacity data included in the Manual are taken from observed conditions in large metropolitan areas. Also, two statements contained in the Manual are worthy of note.

> "Wide ranges of observed volumes under heavy flow conditions were reported for apparently similar physical conditions during the 1955-6 studies".
>
> "It should be clearly understood that these figures do not provide final answers, even when the adjustments contained in the associated tables are applied".

The first statement indicates that some factors which affect street capacity have not been fully evaluated. The second statement is made in reference to the curves in the Manual used for computation of estimated street capacity. The Manual also states, in effect, that the true measure of capacity of a given facility must be based on actual field experience. While the Capacity Manual does have a wealth of usable data, interpretation and application for a particular situation must be made based upon good engineering judgement.

Types of Parking Arrangements Considered

Although parallel parking on city streets has been generally accepted by most traffic engineers for many years, certain features of this parking arrangement have been criticized by drivers and local authorities. Experience has indicated that some of the advantages usually claimed for parallel parking in comparison to angle parking, such as increased safety and minimal dis-

ruption to traffic movement, may be open to question. Most parking studies treat varying arrangements of angle parking as being comparable and conclusions of these studies have been generally considered as applying equally to all angle parking arrangements. It appears that this is in error and there is a significant difference in operating characteristics of varying arrangements of angle parking.

An angle parking arrangement is currently in operation on US 190 and SH 19 in Huntsville, Walker County. The layout differs from that in general use in that the parking spaces make an angle of $22\frac{1}{2}^{o}$ with the curb line. This flat angle parking has been received well by the local community. The operating experience with this parking layout indicates that it offers some advantages over both the more usual types of angle parking and parallel parking.

To gain further insight into the operational characteristics of flat angle parking as compared to parallel parking, these parking arrangements were analyzed graphically and by using vehicles in parking situations. The analysis using vehicles was somewhat limited in scope but adequately illustrates the type of operation that can be expected in actual on-street parking situations.

The full scale analysis of vehicle parking operations was made on a parking area at the District 17 Headquarters. Plastic tape was used to delineate the parking spaces and lane lines. No attempt was made to duplicate standard lane markings, rather the markings were only to clearly indicate the position of the travel lane. Only the travel lane adjacent to the

parking area was delineated. Each side of this lane was marked by a solid line adjacent to the parking spaces and by short dashes in the remainder of the area. For this study, a four lane street with two 11 foot lanes in each direction and on-street parking along the curb line was assumed.

Analysis of Parallel Parking

Figures 1 and 2 show the pavement markings used for the parallel parking arrangement. The individual parking spaces are 10 feet by 22 feet which is a generally accepted standard. Usually the parallel parking lane is marked as 8 feet wide, with an additional 2 feet of lateral clearance being allowed in the travel lane. In this study, the edge of the 11 foot travel lane was marked for illustrative purposes.

Figure 1. Pavement markings for parallel parking study.

Figure 2. Pavement markings for parallel parking study.

The geometry of the parallel parking maneuver is shown in Diagram 1. The photographs in Figures 3, 4, 5, and 6 correspond to the positions 1, 2, 3, and 4, respectively, in Diagram 1. Figure 7 illustrates the completion of the parking maneuver. It should be noted that in positions 2 and 3 (Fig. 4 and 5) the backing vehicle is occupying the entire width of the outside travel lane and the left front fender is on the edge of the inside lane. It is obvious that a vehicle in this position will have some effect on traffic in the inside lane. Although the magnitude of this effect may be difficult to determine, it can be assumed that the effective width of the inside lane is decreased with a corresponding decrease in capacity.

Figure 3. Parallel parking maneuver, position 1.

Figure 4. Parallel parking maneuver, position 2.

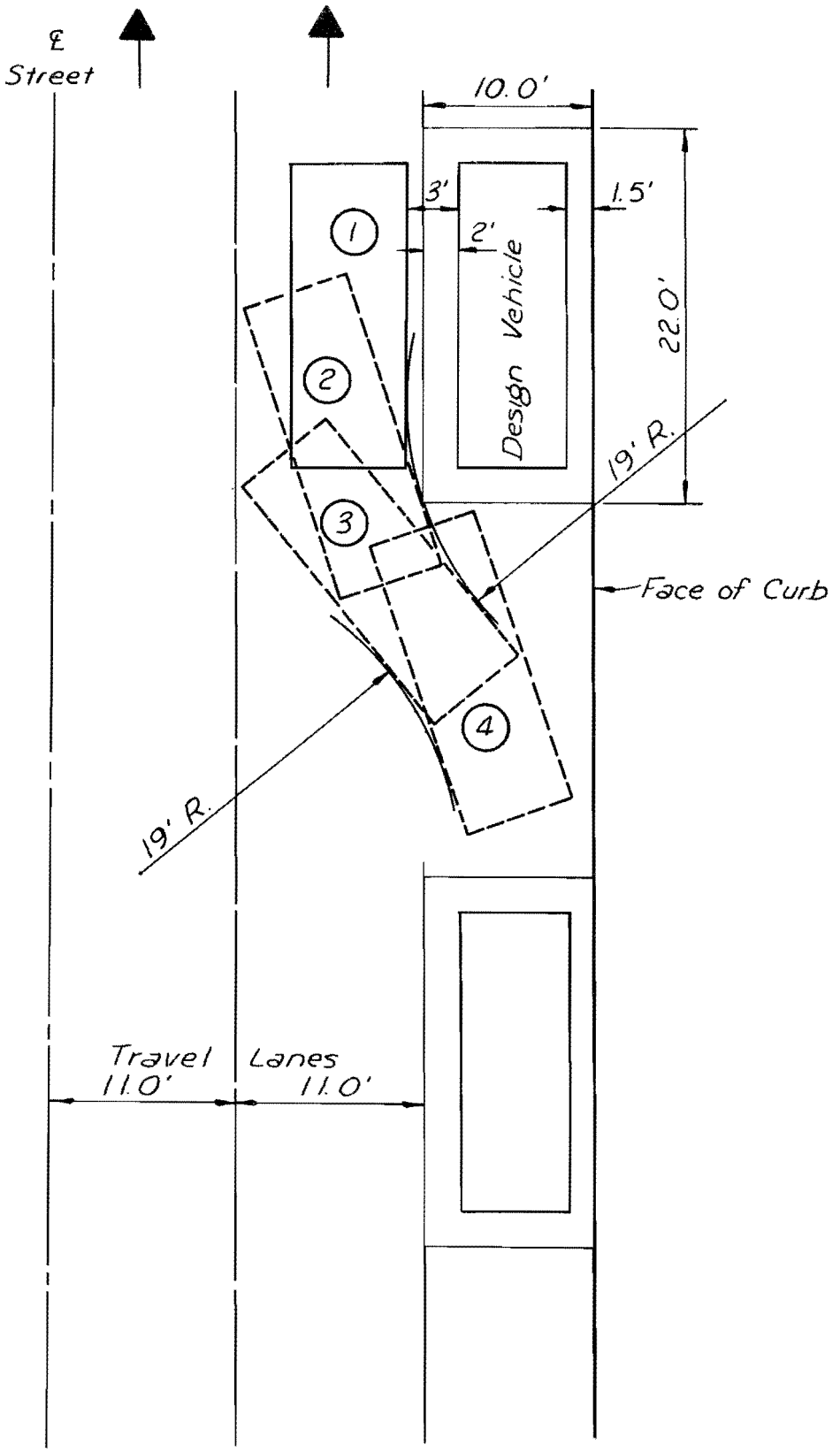

Diagram 1
MANEUVERS FOR PARALLEL PARKING
Scale : 1"=10'

Figure 5. Parallel parking maneuver, position 3.

Figure 6. Parallel parking maneuver, position 4.

Figure 7. Completing parallel parking maneuver.

The parallel parking maneuver illustrated is based upon parking between two properly positioned vehicles. This provides an actual clear space of approximately 26 feet between parked vehicles. If the vehicles are already parked so that the available space is reduced to 24 feet or less, the parking maneuver becomes more difficult and time consuming, resulting in more encroachment in the travel lanes and greater disruption of traffic. If the available clearance is as little as 22 feet, the parking maneuver is extremely difficult and many drivers would be hesitant to attempt to park in this space.

Figure 8 illustrates a situation that is all too frequent in a heavy traffic situation. A vehicle is stopped in the travel lane to start a parking maneuver but cannot be backed into the space because another vehicle is positioned immediately behind. The driver of the second vehicle will not back up because of discourtesy or cannot back up or change lanes because of the presence of other vehicles. If both drivers involved are stubborn, a significant delay in traffic movement may result.

Figure 8. Front vehicle is blocked from making parallel parking maneuver.

Figure 9. Vehicles properly positioned in parallel parking spaces.

When vehicles are properly parked, parallel to the curb line, (Fig. 9 and 10), the travel lanes are unobstructed and any apparent interference with the orderly movement of traffic is negligible. This is true only as long as the parked vehicles are unattended. One hazard for which the driver of an approaching vehicle must be alert is drivers or passengers entering and leaving parked vehicles with little advance warning.

Figure 10. Vehicles properly positioned in parallel parking spaces.

Figure 11. Encroachment of parallel parked vehicle and pedestrian on travel lane.

Figure 12. Encroachment of parallel parked vehicle and pedestrian on travel lane.

Any opened door on the street side of a vehicle encroaches on the adjacent travel lane (Fig. 11 and 12). This encroachment is, of course, the greatest for the wider doors on two door automobiles. The individual standing at the edge of the travel lane to enter or leave a vehicle is in an extremely precarious position. He is standing within arm's reach of moving traffic and an error of judgement on his part or on the part of a driver would likely result in a very serious injury. The presence of a pedestrian adjacent to a parked vehicle will tend to make a driver in the adjacent lane drive to the left (Fig. 13) and thereby influence traffic in the inside lane.

Figure 13. Position of traffic in outside lane passing a driver leaving parallel parked vehicle.

This hazard could be avoided, of course, if all drivers and passengers left and entered a parked vehicle from the curb side. This is only rarely seen in an actual situation, particularly as seat belts, bucket seats, and floor mounted consoles installed in vehicles have made it very inconvenient to slide across a seat to use the doors adjacent to the curb,

In preparing to leave a parallel parking space, the driver has a somewhat limited view of traffic approaching from his rear (Fig. 14 and 15).

Figure 14. View to the rear from a parallel parked vehicle. Approaching vehicle is 140 feet behind driver.

Figure 15. View to the rear from a parallel parked vehicle. Approaching vehicle is 100 feet behind driver.

An outside rear view mirror gives a better view, but many vehicles do not have this accessory and some drivers do not make use of it when it is available. A wider field of vision could be realized by the driver leaning out an opened window, but most modern automobiles are equipped with year-round air conditioning and few drivers follow this practice.

Usually, the maneuver of leaving a parallel parking space and entering the travel lane is fairly simple and requires a minimum amount of time. This is not true, however, if the parked vehicle is in a cramped space. If adjacent vehicles are parked at the extreme limits of the marked spaces (Fig. 16) there is only 22 feet for the unparking maneuver as shown in Diagram 2. Backing to the maximum extent (position 2) and moving forward (position 3) does not allow the driver of the moving vehicle to leave the parking space. He must again back up (position 4) before moving into the travel lane (positions 5 and 6). Positions 2, 3, and 4 are shown in photographs by Figures 17, 18, and 19, respectively.

Figure 16. Vehicle in minimum parking space due to crowding by adjacent vehicles.

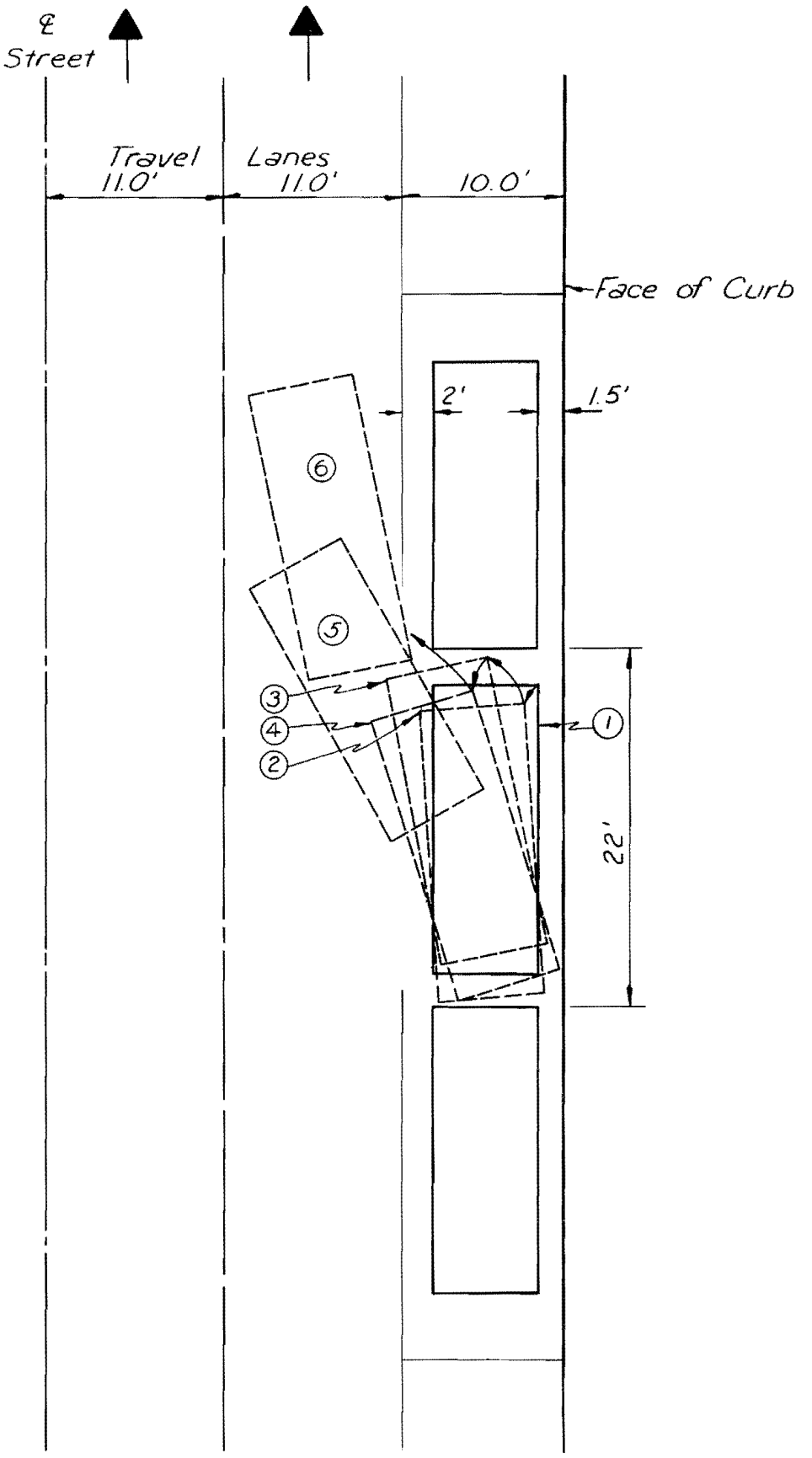

Diagram 2
MANEUVERS FOR LEAVING A
MINIMUM PARKING SPACE
Scale : 1"= 10'

Figure 17. Position 2 from Diagram 2.

Figure 18. Position 3 from Diagram 2.

Figure 19. Position 4 from Diagram 2.

Figure 20. Encroachment on the travel lane during unparking maneuver, positions 3 and 4.

It should be noted that at the time the vehicle is making the second backing movement, from position 3 to position 4, it is encroaching on the travel lane as shown in Figure 20. This would definitely have an adverse influence on the free movement of traffic.

Upon leaving a cramped parking position, the vehicle enters the travel lane at a sharp angle (Fig. 21). If the driver does not make a sharp turn to the right, there is a possibility of encroaching on the inside travel lane. This brief study indicates that the unparking maneuver can take a considerable amount of time and significantly interfere with traffic if adjacent vehicles are parked in such a manner to limit the maneuver space. The elimination of this problem would require a considerable amount of policing and control of parallel parking and this degree of control could be justified in only extremely rare situations.

Figure 21. Vehicle leaving cramped parking space.

These rather limited studies and observations of actual parallel parking situations indicate that there are problems involved with this parking arrangement. One other factor that is difficult to evaluate is the degree of skill in parallel parking possessed by the average driver. It is probable that many drivers have very little practice in this maneuver. It is possible to drive regularly in both large and small cities without being required to make a parallel parking maneuver due to the availability of angle parking spaces on some streets, in off-street parking lots, and in parking areas at shopping centers.

One conclusion gained from an overall evaluation of parallel parking on city streets is that there can be considerable interference with traffic. There are situations in which a vehicle will encroach upon two travel lanes. Also, pedestrians entering and leaving parked vehicles are subject to an extreme degree of exposure to moving traffic. These factors lead to the conclusion that the parallel parking arrangement has some serious disadvantages and that alternate solutions for on-street parking should be fully investigated.

Analysis of Flat Angle Parking

As noted previously, most reference material on the subject of parking discourages the use of angle parking based upon safety considerations and reduction in street capacity. When applied to what might be considered the more common arrangement, approximately 45° angle parking, these arguments have some merit. It is obvious that the driver of a vehicle parked at a 45° angle has limited vision to the rear at the start of the unparking movement. Also, it is difficult to back from such a parking space without encroachment on the inside travel lane.

Many of the disadvantages of angle parking are eliminated when flat angle marking is used. There is little published data concerning flat angle ($22\frac{1}{2}^{\circ}$) parking; but, from observations of an existing situation, this arrangement appears to offer many distinct advantages over alternate schemes. Flat angle parking merits further study and consideration as a desirable alternate to parallel parking.

A suggested layout for flat angle parking spaces is shown in Diagram 3. This requires a total width of 14 feet between edge of travel lane and face of curb. In extreme situations, it might be possible to reduce this width, but this would probably reduce the effective width of the travel lane.

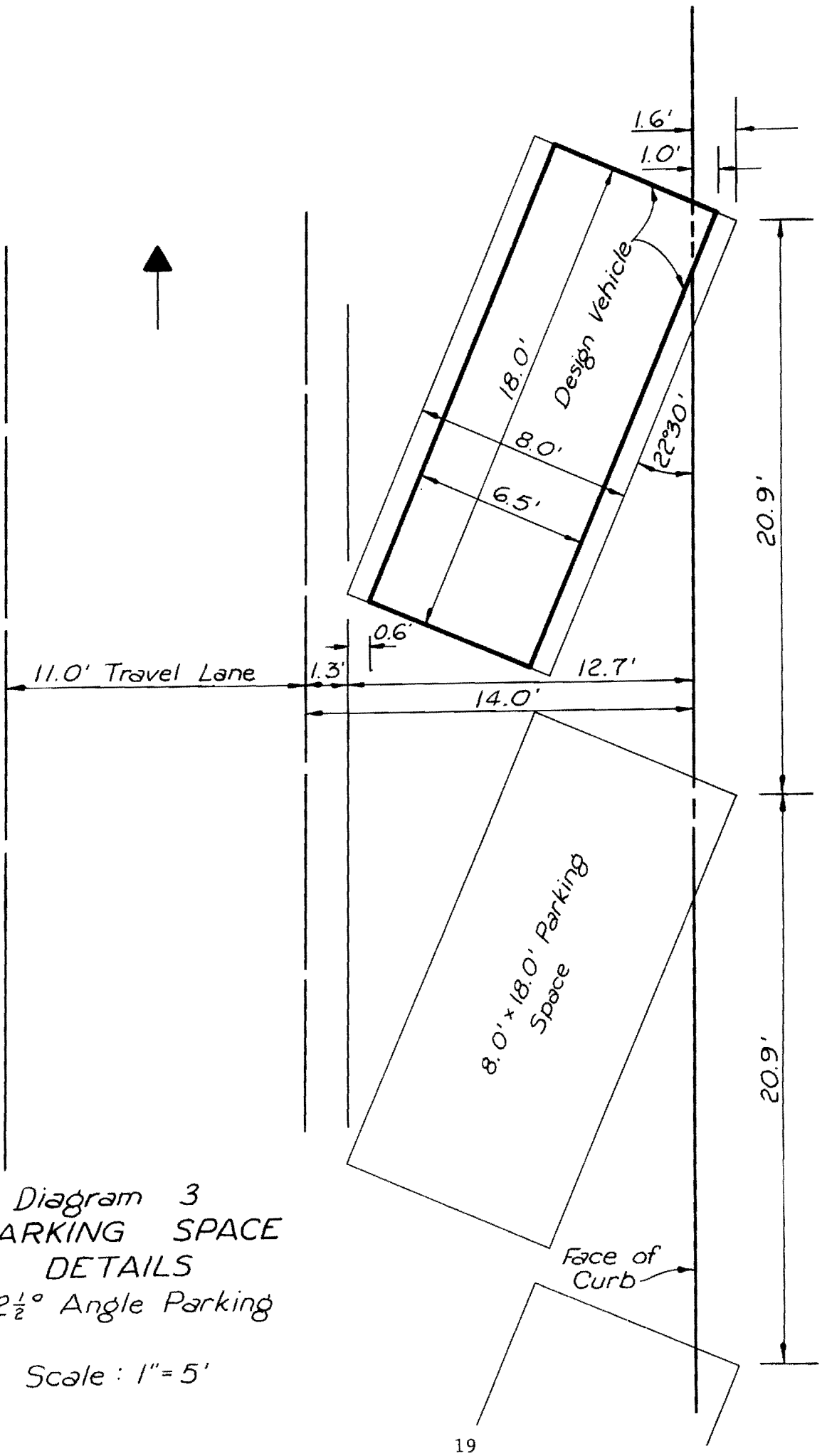

Diagram 3
PARKING SPACE DETAILS
22½° Angle Parking

Scale : 1" = 5'

Parking in a flat angle space (Fig. 23) is extremely convenient. A vehicle may leave the travel lane and enter a parking space (Fig. 24) with a negligible effect upon other moving vehicles. One reason for this is that the approaching driver has a good view of the parking space from a considerable distance. A problem with some angle parking arrangements is that a small vehicle may be occupying a parking space but is hidden by other vehicles until a driver has started a parking movement. As shown in Figure 25, even a small vehicle in a flat angle parking space is visible for a reasonable distance.

Figure 22. Pavement markings for flat angle parking study.

Figure 23. Two vehicles in flat angle parking spaces.

Figure 24. View of third vehicle position in angle parking space.

Figure 25. Compact vehicle in flat angle parking space.

Flat angle parking provides a high degree of safety to pedestrians entering or leaving parked vehicles. The adjacent vehicles serve as a barrier between the pedestrian and traffic in the outer travel lane. The opened doors of a parked vehicle do not encroach on a traffic lane and a person entering or leaving the vehicle is well away from moving traffic (Fig. 26).

Figure 26. Driver leaving parked vehicle.

Even if a moving vehicle is at the outer limit of the travel lane, there is no interference from doors on parked vehicles (Fig. 27). Also, as illustrated in Figure 28, the trunk of a parked vehicle is fully accessible with no interference to moving traffic or adjacent vehicles. All doors of a parked vehicle may be fully opened (Fig. 29 and 30). This is particularly convenient for persons with physical handicaps. The fact that the opened doors do not strike adjacent vehicles is appreciated by drivers, as the scratches and dents usually associated with angle parking are avoided.

Figure 27. Traffic passing parked vehicle with opened doors.

Figure 28. Access to trunk of vehicle in flat angle parking space.

Figure 29. Parked vehicle with all doors opened.

Figure 30. Angle parked vehicle with doors opened adjacent to curb.

The driver of a vehicle in a flat angle parking space has a reasonably good view to his rear. This is illustrated by Diagram 4 and by photographs (Figures 31, 32, and 33).

Figure 31. View to the rear from vehicle in parked position. The man indicated by arrow is in center of outside travel lane, 190 feet behind driver.

Figure 32. View from vehicle in parked position. Approaching vehicle in outside lane is 140 feet behind driver.

Figure 33. View from vehicle in parked position. Approaching vehicle in outside lane is 100 feet behind driver.

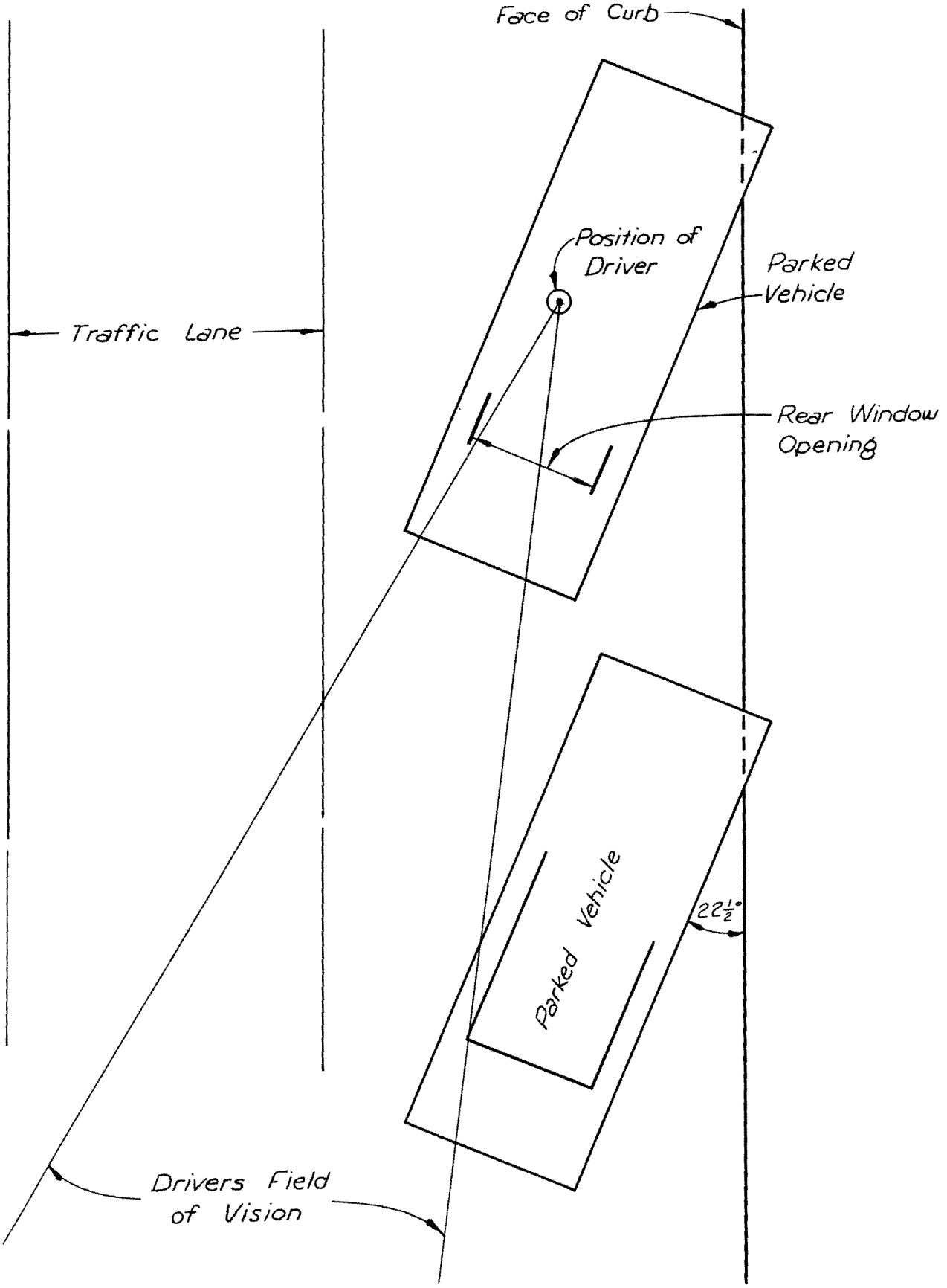

Diagram 4
VIEW TO REAR FROM PARKED VEHICLE

As the vehicle is backed from the parked position, the driver's field of vision is greatly increased. When the vehicle reaches the position as shown in Diagram 5, the driver's view of the adjacent travel lane is as indicated by Figures 34 and 35. It should be noted that in this position the unparking vehicle has not actually encroached on the travel lane.

Figure 34. View from vehicle positioned as shown in Diagram 5. Man indicated by the arrow is in center of outside travel lane, 310 feet behind driver.

Figure 35. View from vehicle positioned as shown in Diagram 5. The approaching vehicle in outside travel lane is 100 feet behind driver.

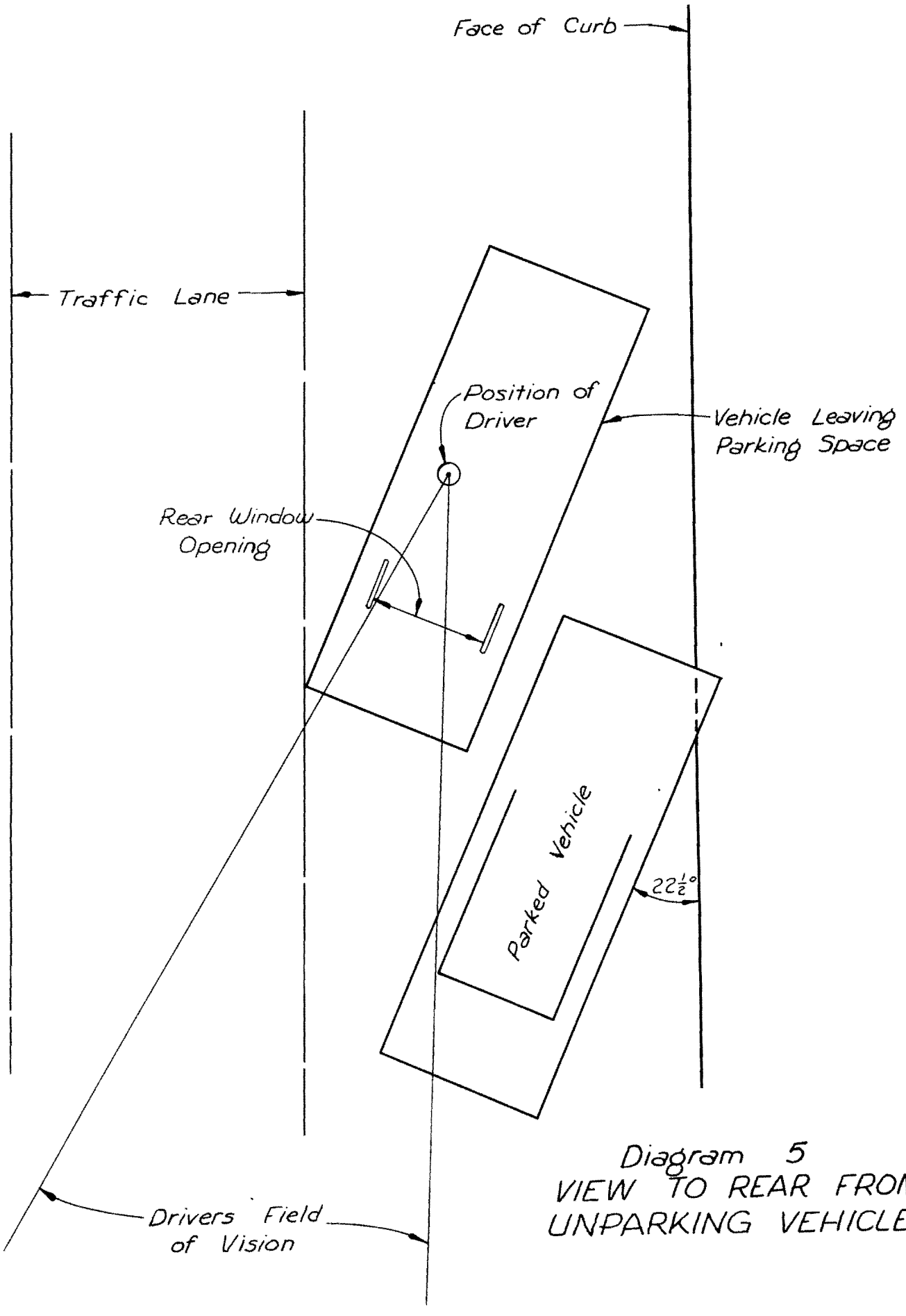

Diagram 5
VIEW TO REAR FROM UNPARKING VEHICLE

The maneuver of leaving a flat angle parking space and entering a stream of traffic obviously takes more time than for parking, but it can be made with safety and convenience. As the unparking maneuver is simple and convenient, the driver is not required to follow a precise pattern of movement. The movement of the vehicle may be classified into three basic patterns, each of which avoids all interference with traffic in the inside lane.

The Type I movement (Diagram 6) is simply a reversal of the parking maneuver. The vehicle is backed from the parking space until it is centered in the outside travel lane, from which position it is driven directly forward.

Figure 36. Position 3 of Diagram 6.

Figure 37. Side view of vehicle in position 3 from Diagram 6.

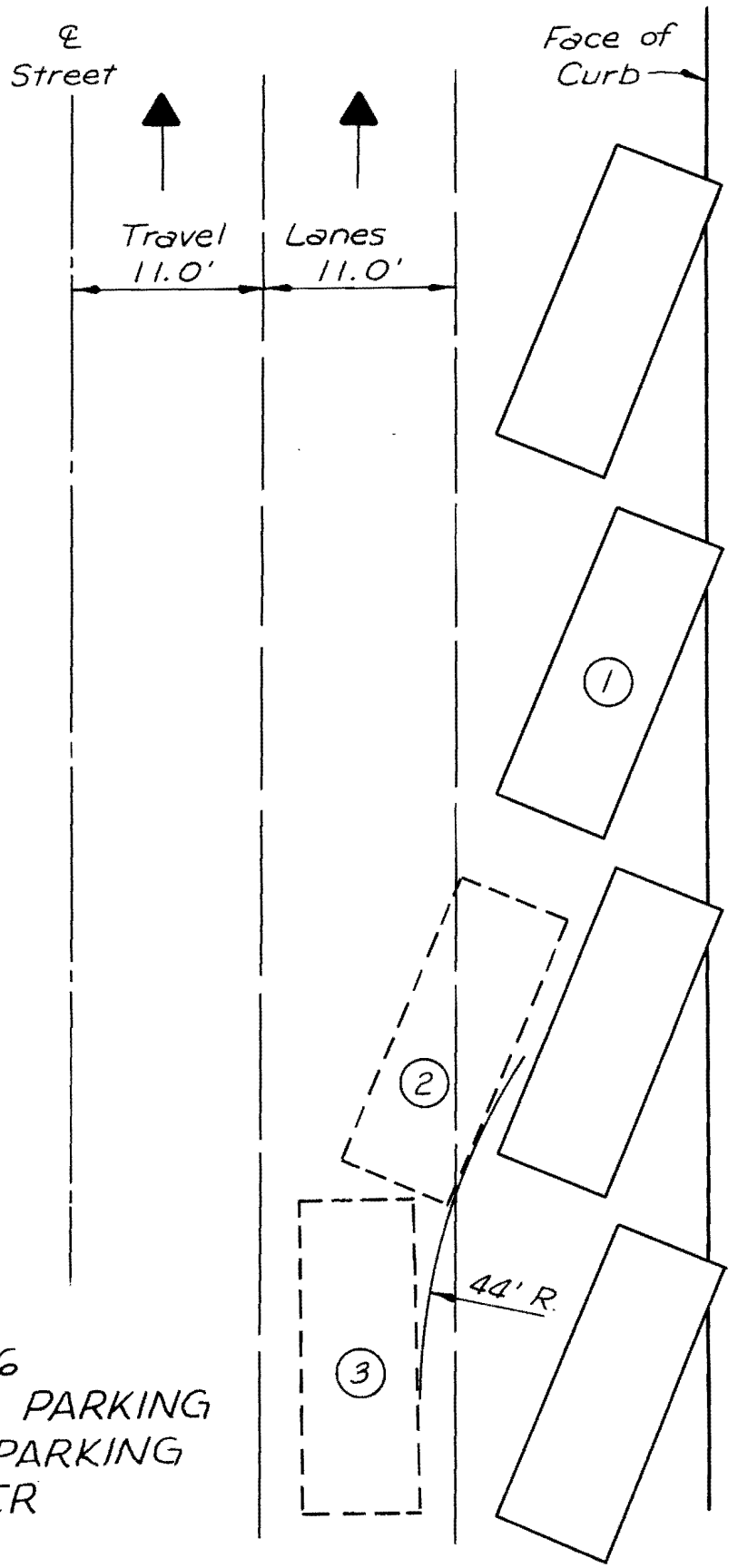

Diagram 6
FLAT ANGLE PARKING
TYPE I UNPARKING
MANEUVER

Scale : 1" = 10'

Diagram 7 is a sketch illustrating a Type II maneuver. In this case, the vehicle is backed in a straight line until the left rear fender is about two feet from the inside travel lane. The vehicle can then be driven forward from this position with all directional changes being made while the vehicle is moving forward. When the vehicle is in position 2 (Fig. 38), the ample space in front of the vehicle made possible by the flat angle parking arrangement tends to encourage the driver to move forward. This greatly reduces the possibility of any encroachment on the inside travel lane.

Figure 38. Vehicle in position 2 of Diagram 7.

Figure 39. Vehicle in position 3 of Diagram 7.

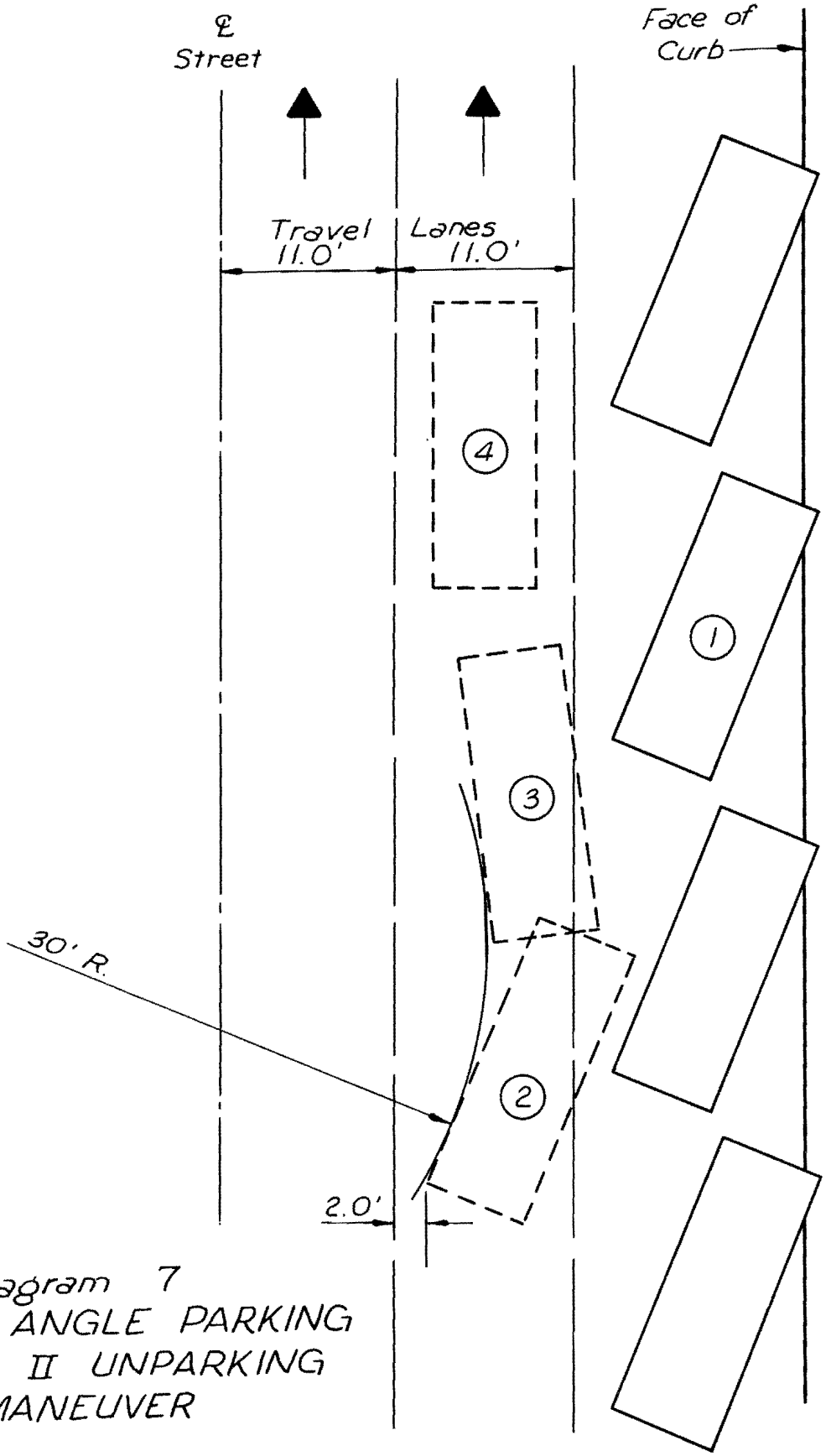

Diagram 7
FLAT ANGLE PARKING
TYPE II UNPARKING
MANEUVER

Scale : 1" = 10'

The Type III unparking maneuver requires a minimum amount of space as shown in Diagram 8. When the vehicle has moved forward to position 3 (Fig. 41), it is occupying only about one foot of the travel lane width. If the unparking vehicle is stopped in this position, a sufficient width of travel lane is available for slow moving traffic to proceed. In heavy traffic situations, some drivers will take advantage of two short gaps in approaching traffic to complete the unparking movement. The driver will move from the parked position to position 3 in the first available gap and then enter the traffic stream in the second gap.

Figure 40. Vehicle in position 2 of Diagram 8.

Figure 41. Vehicle in position 3 of Diagram 8.

Figure 42. Vehicle in position 4 of Diagram 8.

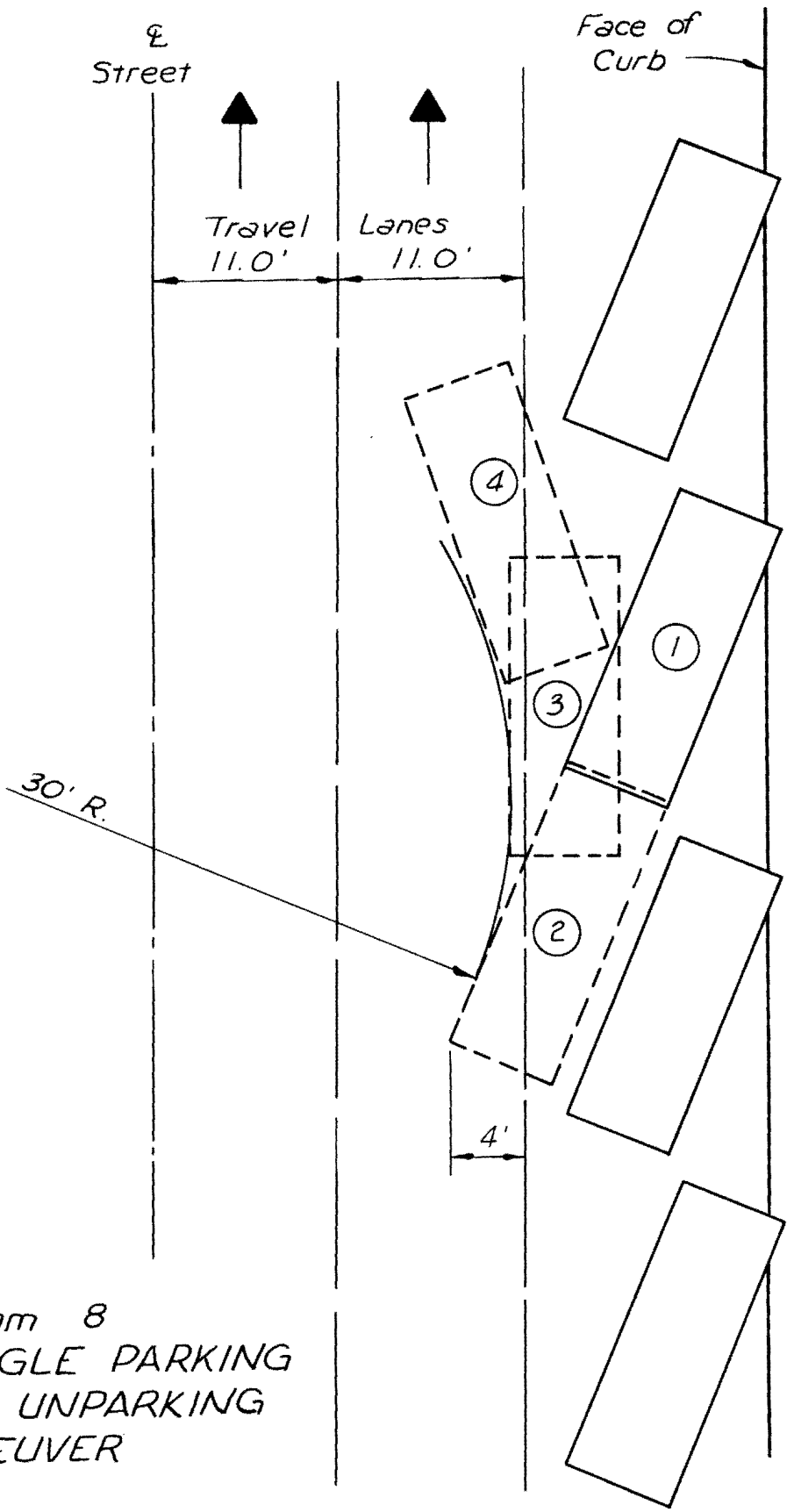

Diagram 8
FLAT ANGLE PARKING
TYPE III UNPARKING
MANEUVER

Scale : 1" = 10'

In actual practice, it can be expected that some maneuvers other than the three illustrated will be used. Probably, any single unparking maneuver will involve elements of all three types. A fact meriting attention is that in any unparking situation from a flat angle space, the driver can turn his vehicle on a generous radius. Even the shortest radius turn required does not approach the limits of the design vehicle and is considerably greater than the turning radius required for other parking arrangements.

Comparison of Operating Characteristics

One factor common to all traffic operation is the tendency for several vehicles to travel in relatively closely spaced groupings or platoons separated by wider gaps. This is particularly evident on city streets where some intersections are signalized. This characteristic of traffic operation should be considered in any study of the effect of parking on traffic movement.

For the purpose of this study, it was assumed that the total time required for a complete parking cycle (a parking maneuver and an unparking maneuver) might be approximately the same for parallel parking and flat angle parking. The difference in these two situations is the proportion of time required for each part of the cycle. For parallel parking, the parking maneuver requires the major portion of the cycle time and the unparking maneuver can be made in a considerably shorter time. The relative amount of time for each part of a cycle is reversed for flat angle parking.

Both parking arrangements involve backing of the vehicle in a travel lane, but the difference in characteristics of parking cycles has a definite bearing on the extent of traffic disruption caused by on-street parking. For parallel parking, a vehicle must be stopped in a travel lane and backed into a parking space. If the parking vehicle is one of a platoon, all vehicles to the rear are stopped until the parking maneuver is completed unless traffic in the inside lane is light enough to allow lane changes. The driver of the parking vehicle has no real choice; he must stop immediately upon passing the parking space or he will not be able to take advantage of the parking opportunity. When leaving a parallel parking space, the driver can wait for a gap in traffic and enter the travel lane with a minimum of disruption unless he is in a cramped space as discussed earlier.

An entirely different situation exists for flat angle parking. The driver can enter a parking space and cause little delay or inconvenience to vehicles immediately to the rear. This is true even in those cases where the parking vehicle is one of a closely spaced platoon. The unparking maneuver takes a greater amount of time, but the driver has an opportunity to observe approaching traffic and wait for a gap of sufficient length.

From the standpoint of time that traffic in a travel lane is blocked due to a vehicle entering or leaving a parking space, the flat angle parking would interfere with traffic movement for the shorter time. It follows that parallel parking has a greater adverse effect on the capacity of travel lanes than does flat angle parking.

The curb length for a single parallel or flat angle parking space is approximately the same. In rare cases, a given curb length might accommodate one extra space if flat angle parking were used rather than parallel parking. This is of minor importance in most instances. The suggested layout for a flat angle parking space requires 293 square feet of street area while the standard parallel parking space requires 220 square feet. The apparent advantage of parallel parking in space requirements is open to serious question when it is recognized that this advantage is gained by requiring drivers and passengers to step into the travel lane when entering and leaving a vehicle. If an extra width of parking lane to provide pedestrian protection is considered, the overall space requirements become more nearly comparable.

Conclusions

From this study and comparison of parking arrangements, several conclusions may be made. Of course, there are many factors other than parking to be considered in the design of an urban highway facility, but the application of suggested guidelines developed by this study allows the designer to select a parking arrangement most desirable for a particular situation.

It is recommended that the following guidelines be used in planning an urban highway facility:

. . . On-street parking must be provided on many highway improvement projects in order to receive support for the proposed work from the local community.

. . . Flat angle parking does not adversely affect the safety or capacity of travel lanes when compared with the generally accepted arrangement of parallel parking. This is true, provided that adequate widths for travel lanes are available.

. . . Flat angle parking results in improved safety for pedestrians entering or leaving parked vehicles.

. . . Flat angle parking results in less disruption of traffic flow than does parallel parking.

. . . Where sufficient street width is available, flat angle parking should be provided in preference to angle parking.

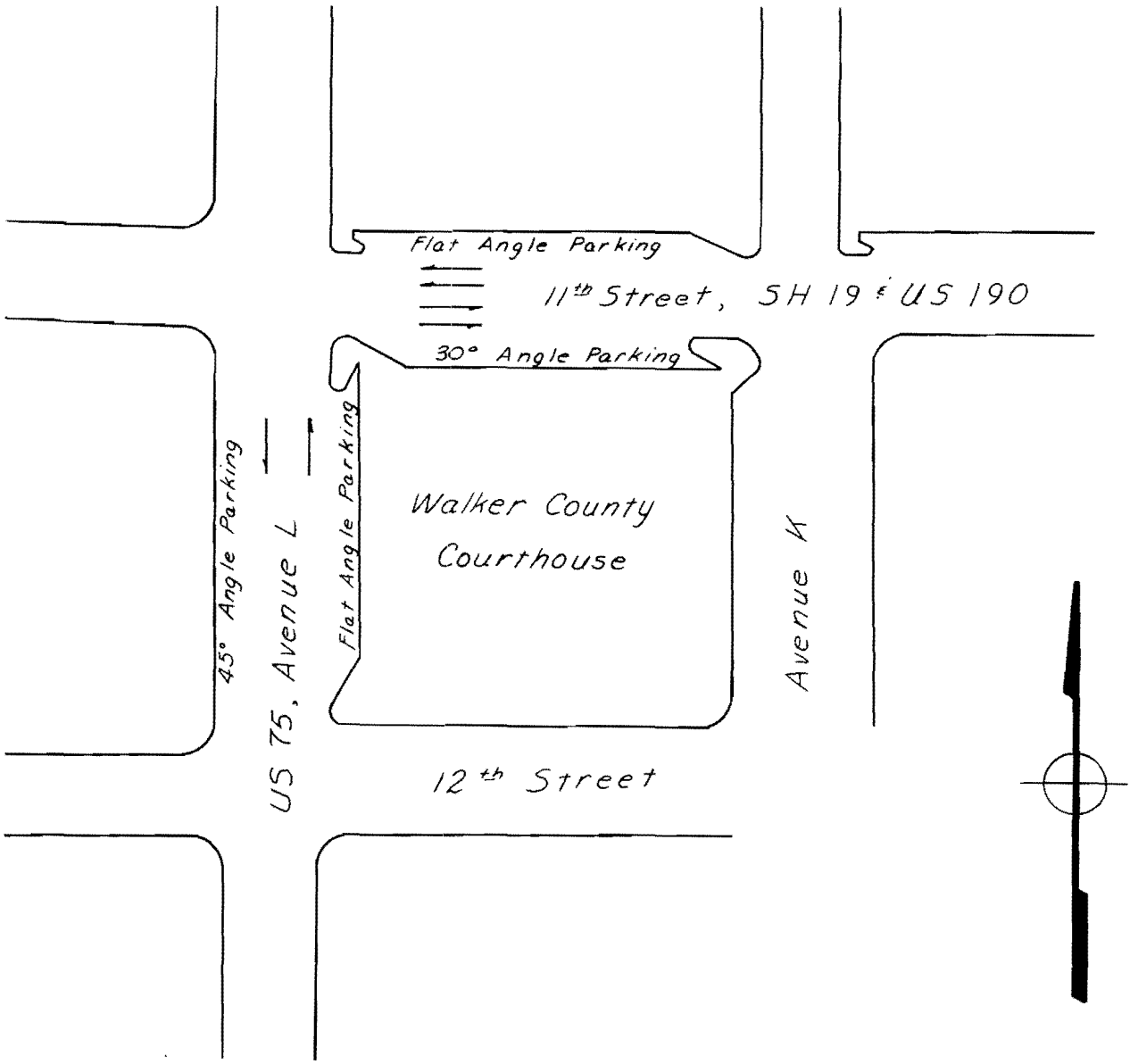

Diagram 9
AREA OF PARKING STUDY
HUNTSVILLE, TEXAS

Part II - Selection of Parking Arrangement in Huntsville

Evaluation of Existing Conditions

A highway improvement is planned for US 75 (also known as Ave. L and Sam Houston Ave.) in the City of Huntsville. In the one block area between 11th and 12th Streets and immediately west of the Walker County Courthouse, angle parking is presently permitted. In plan development, it was necessary to decide whether parallel parking should be required or whether the angle parking arrangement should be retained with some modifications.

A review of accident records involving parking was made for this area. Also, for purposes of comparison, parking accidents in the block immediately north of the Courthouse were reviewed. This block of 11th Street is also the route of US 190 and SH 19. The areas studied and the existing parking arrangements are shown on Diagram 9.

A thorough review of all reports of accidents in the study area was made from the files of the Huntsville Police Department. The period of time covered was from March, 1969, through July, 1971. It was found that 13 accidents involving parking were reported for the two block area during the 28 month period studied.

No personal injuries or fatalities resulted from these accidents. Most of the police reports do not include a monetary estimate of vehicle damage but use the terms slight, minor, medium, severe, etc., to describe the extent of damage. Three of the accidents were reported as resulting in a

total of $575.00 in damages. The damages resulting from other accidents appeared to be relatively minor. A summary of the parking accidents by location and type follows:

Type of Accident	11th St. (Between Avenues K and L)	Ave. L (Between 11th & 12th Sts.)
Moving vehicle collided with parked vehicle	2	0
Unparking vehicle hit vehicle in travel lane	2	4
Unparking vehicle hit parked vehicle in adjacent space	2	0
Parking vehicle hit parked vehicle in adjacent space	2	1
TOTAL	8	5

Reports of individual accidents are given in Appendix A.

The review of accident records does not indicate an unusually high frequency or severity rate for the existing situation. It appears that minor changes in the existing parking arrangements would tend to reduce the number of accidents of the types reported. It is recognized that some of the existing parking spaces should be wider to help eliminate accidents involving a parking or unparking vehicle and a vehicle parked in an adjacent space. Five of the 13 accidents reported were of this type. Also, providing flat angle parking in lieu of 45° and 30° angle parking should reduce the possibility of a vehicle in a travel lane being struck by a vehicle backing from a parking space.

Proposed Parking Arrangements in Huntsville

For the block of Avenue L between 11th and 12th Streets, it is proposed to provide for four 11 foot travel lanes with flat angle parking on both sides of the street. The work will be performed as a part of a construction project for improvement of Avenue L from 11th Street to Sycamore Street, a distance of approximately 1.9 miles.

The improvement project is warranted to improve the safety and capacity of the existing facility. The present street is inadequate for existing traffic volumes. In order to estimate the capacity of the street after improvements, information from the Highway Capacity Manual was used. As noted previously, the Manual does not include guides for use with flat angle parking. The study of flat angle parking indicated that this arrangement has less effect on travel lanes than does parallel parking. Based upon this, the estimate of street capacity was made as being between the capacity with parallel parking and with no parking. The estimates of capacity are shown in Appendix B.

The results of this study indicate that the proposed improvements to Avenue L will be adequate for the needs of traffic and that the proposed flat angle parking arrangement between 11th and 12th Streets will have a beneficial effect on capacity and safety in comparison to the alternate of parallel parking.

APPENDIX A

Listing of Accidents Involving Parking
Taken from Records of Huntsville Police
Department

11th Street (US 190 and SH 19) between Ave. K and Ave. L

Date: 3-27-69
Type: Vehicle backing from angle parking space hit left rear fender of vehicle in adjacent parking space.
Cause: Negligent collision
Violation: No charge
Damage: $100 to parked vehicle

Date: 9-4-69
Type: Side collision
Cause: Vehicle backing from angle parking space hit vehicle parked alongside.
Violation: Improper backing from parked position
Damage: $150

Date: 3-15-70
Type: Parked vehicle was hit by vehicle traveling west on 11th St.
Cause: Not watching car parked on right
Violation: None
Damage: Moderate

Date: 7-3-70
Type: Parked vehicle was hit in rear by moving vehicle .
Cause: Negligent collision
Violation: Yes
Damage: $225 moving vehicle; $100 parked vehicle

Date: 2-8-71
Type: Vehicle attempted to enter a parking space and struck another vehicle.
Cause: Improper right turn; insufficient clearance
Violation: Charged with insufficient clearance
Damage: Minor to both vehicles

Date: 5-11-71
Type: Vehicle was moving into parking space; passenger of parked vehicle opened door striking parking vehicle in left front door.
Cause: Passenger was not looking
Violation: No charges files
Damage: Light to both cars

Date: 5-11-71
Type: Vehicle backing from parking area backed into vehicle waiting for traffic signal.
Cause: Failure to yield ROW
Violation: Backing vehicle charged with failure to yield right of way
Damage: Light to both vehicles

Date: 6-22-71
Type: Vehicle backing out from curb backed into right front fender of another vehicle.
Cause: Failure to yield ROW
Violation: No charges filed
Damage: Light damage to second vehicle

Avenue L (US 75) between 11th and 12th Streets

Date: 4-25-70
Type: Parking vehicle struck vehicle in adjacent space.
Cause: Improper parking
Violation: None
Damage: Slight

Date: 8-5-70
Type: Vehicle backed from curb and struck another vehicle on right rear fender.
Cause: Failure to yield ROW
Violation: None
Damage: Slight to both cars

Date: 2-4-71
Type: Vehicle was backing from curb and hit vehicle traveling south on Avenue L in right front fender.
Cause: Failure to yield ROW
Violation: Backing vehicle charged. Failure to yield ROW.
Damage: Minor to both cars

Date: 2-19-71
Type: Vehicle backed out from parking space into side of another vehicle.
Cause: Failure to yield ROW
Violation: No charge
Damage: Minor to vehicle hit

Date: 6-1-71
Type: Vehicle parked at curb backed into traffic lane striking vehicle which was traveling south on Avenue L.
Cause: Improper start from parked position
Violation: Improper backing
Damage: Light

APPENDIX B

Capacity Estimation for Avenue L between 11th and 12th Streets City of Huntsville

Current traffic volume: 14,675 ADT
Directional Factor: .60
Peak hour - ADT ratio: .13
G/C: 0.75
Peak hourly demand (one direction) = 14,675 (.60)(.13) = 1,150 vph

From Tables 6.8 and 6.9 Capacity Manual
Assumed P.H.F. = 0.85
Population = 75,000 (Smallest given)
Outlying Business District
Estimate to be based on street width available for traffic

Parallel Parking	No Parking
2-11' lanes + 10' parking lane = 32'	2-11' lanes + 2' lateral clear.
L.F. = 0.7	L.F. = 0.7
Appr. Vol. Table 6.9 = 1,800	Appr. Vol. Table 6.8 = 1,900
1800(1.25)(.91)(.75) = 1,535 vph	1900(1.25)(.91)(.75) = 1,639 vph
L.F. = 0.3	L.F. = 0.3
Appr. Vol. Table 6.9 = 1,600	Appr. Vol. Table 6.8 = 1,700
1600(1.25)(.91)(.75) = 1,365 vph	1700(1.25)(.91)(.75) = 1,450 vph

All of conditions checked give a capacity greater than that required for traffic demand. With flat angle parking, the estimated capacity is 1,400 vph. It would be incorrect to make an estimate using street width including width of angle parking areas in entering Tables 6.8 and 6.9 as this area is outside the travelway and cannot be used by moving traffic.