Corridor Analysis of Travel Desires as Utilized in Major Street Planning

JOSEPH W. GUYTON and W. S. POLLARD, JR., respectively,
Transportation Planning Engineer and Partner, Harland Bartholomew and Associates,
Fayettsville, N.C.

• FOR MANY YEARS origin-destination surveys have provided basic travel desire data for guiding traffic engineers and planners in developing major street and highway locations. The methodology for gathering O-D data has been thoroughly discussed, debated, and developed over the years. However, relatively little has been set forth regarding how to use these data for developing a major thoroughfare system for an urban area.

This paper discusses procedures developed by Harland Bartholomew and Associates for utilizing travel desire charts to aid in preparing major street and highway plans for urban areas. The analysis procedures provide a means for determining major thoroughfare systems by traffic service requirements rather than by the procedure of trying to fit traffic to alternative systems in order to find the best plan. Research on possible refinements to the procedures outlined is also discussed.

A corridor analysis of travel desires is designed to provide the following data guides for developing a major street and highway plan for an urban area:

1. A readily perceptible representation of travel desires.
2. An accurate portrayal of desire-volume differential by areas.
3. Representation of desires with a minimum of diversion or "playing" with desire lines.
4. Sufficiently accurate indications of design year capacity deficiencies by areas to indicate the number of new traffic lanes required for adequate service.
5. Versatile tabulations of data that enable specialized studies for smaller, specific areas (such as the central business district).
6. Representation of 24-hr volume levels that can be assigned to study routes to test alternate plans.
7. Data that can be easily adjusted to reflect changing conditions over the years and then to retest the planned elements.
8. Data that can be easily adjusted even during initial study to reflect major changes in land use, the existing street network, or proposed limited-access facilities.

Before presenting the analysis procedures, it is desirable to discuss the philosophies involved in major thoroughfare planning. To provide a frame of reference for this presentation, an urban area of 100,000 population is used. However, the procedures are easily adaptable to smaller or larger areas, even to regions for highway studies.

PLANNING PHILOSOPHY

Experience in various cities throughout the United States has indicated that traffic can best be accommodated by developing relatively few streets and highways with wide pavement widths and generally straight alignment. These major streets have traffic control devices arranged to favor traffic flow and actually carry the majority of vehicular travel. These streets typically accommodate 80 percent of a community's traffic on a coordinated system involving only about 20 to 25 percent of the total street mileage.

With relatively few streets accommodating the majority of the traffic, the remaining streets can be improved with a narrower, less expensive pavement and right-of-way, particularly when located in residential areas. These minor streets need not have direct alignments because their major function is land service. In addition, in developing a system of major and minor streets, greater safety is provided, traffic is accommodated better, and residential areas are protected.

The major streets of a community must be designed as a coordinated network connecting all residential areas with the primary traffic generators—recreational areas, business areas, industrial areas, and other places of employment. There are two basic types of major street systems which are generally utilized in various degrees and combinations. One system is usually referred to as radial or radial-circumferential. It is best adapted to an urban area in which the major traffic generators are concentrated in the central section.

The second type of basic street network is a gridiron pattern. There are, of course, certain elements of radial routes included in the system. With relatively minor alterations, this is the type of network that the majority of cities in the United States have in their built-up areas. Very often this network is used with circumferential elements in the form of bypasses.

Within the general term "major street" there is a varied nomenclature to categorize the streets even further. Certain terms are applied toward legal definitions and others toward defining maintenance responsibilities or levels of service. To avoid confusion of terms this article is written using three basic types of major streets and highways. These are limited access, primary arterials, and secondary arterials.

The primary function of minor streets is to serve abutting property. They should be indirect in alignment and their pavement width should be relatively narrow to discourage through or fast traffic. Some minor streets act as collectors to gather traffic from abutting properties and intersecting streets and direct it to the nearest major street for safe and expeditious movement to its destination. These are termed collector streets. Several subclassifications of collector streets are possible depending on the type of land use served. The streets are often defined as commercial, industrial, or residential collectors. They normally provide for two lanes of traffic and two parking lanes.

In residential areas the basic minor streets, are local streets which need have only 28 to 30 ft of paved width on a 50-ft right-of-way. This is ample for parking and traffic flow in those areas. Additional width is a needless expense and a waste of land.

The public depends on a good transportation system for the efficient movement of goods and persons. It is mandatory that such a system be adequate to meet not only present needs but also anticipated future traffic. A major planning principle is that provisions be made for street and highway improvements so that when the need arises the opportunity exists. Because proposed improvements must be programed commensurate with demand, pre-obtaining of right-of-way properly located to allow improvements ultimately to be required is mandatory. Conversely, a plan enables designation of minor streets with a resulting savings where wide rights-of-way are not required.

It is not the purpose of a master thoroughfare plan to present an idealistic pattern warped to resemble slightly the city for which it is recommended. The master thoroughfare plan must embody practical elements of improvement and still adequately meet the anticipated traffic requirements while embodying those details of good planning necessary to present a pleasing, economical, and efficient street network.

A traffic service demand exists anywhere that a driver desires to travel. However, this cannot be considered a "traffic service requirement" for a street until there are enough grouped individual desires to warrant constructing that street. One-half a traffic lane, in all practicality, cannot be built. Conversely, at certain times it is more economical to construct the entire street cross-section rather than just a portion of it.

In addition to a traffic service requirement, there are certain other planning requirements for streets to provide continuity or aesthetic values. Basic principles guiding the location of major streets indicate the desirability to route "through" traffic in this instance means traffic that does not desire to go to a particular district but is routed through that area due to its origin and destination with respect to the street system in existence. Good planning enables the traffic to circumvent the district and thus minimize delay and congestion. Examples of these congested areas are a city, the CBD, major industrial areas, and major college and university campuses.

It is also desirable for major streets carrying traffic to the CBD to route that traffic directly to off-street parking areas. Other major focuses of traffic ideally should be located adjacent to a major street with appropriate minor collector streets to serve the area directly. In all instances there should be provided a minimum of travel distance and a maximum of convenience.

The cornerstone of any master thoroughfare plan should be the existing street system. The key to the adequacy or inadequacy of the existing major street network is a relating of its capacity to the demands of motor vehicular traffic at the design year. The over-all degree of accuracy of such an analysis therefore becomes that which is necessary to insure that there will not be a difference in the requirement of traffic lanes.

The procedure discussed herein determines required traffic lanes by location. It involves determination of capacity deficiencies in lanes at a multiplicity of analysis lines throughout the urban area being studied. Before discussing the procedure, the following definitions are given to provide a basis for mutual understanding of terminology.

1. Major Street, Thoroughfare, or Arterial Street. —An element of the street and highway system that traditionally comprises approximately 20 percent of the mileage in the community but carries about 80 percent of the traffic.
2. Collector Street or Local Street. —Part of the minor street network comprising the remaining 80 percent of the street mileage.
3. Desire Trip. —One vehicular trip as determined from origin-destination charts listing a zone or station of origin and a zone or station of destination.
4. Desire Line. —A straight line drawn between the point of origin and the point of destination of traffic without reference to existing streets and highways. The point of origin or destination is normally considered to be a station for external trip ends and a zone centroid for internal trip ends.
5. Semi-Assigned Desire. —The routing of a vehicle trip from point of origin to point of destination other than in a straight line but not along a specific existing street.
6. Assigned Desire. —The routing of a vehicle trip from point of origin to point of destination along a specific existing or proposed street or highway.
7. Analysis Screen Line. —One of many straight lines defined with respect to the major street network of a community and used in corridor analyses. Each analysis screen line forms one boundary of a corridor and is used for tabulating desire trip volumes by location.
8. Analysis Screen-Line Section. —The portion of a single analysis screen line contained within an intersecting corridor.
9. Internal Traffic. —Traffic having both origin and destination within the survey or study area.
10. Local Traffic. —Traffic having either origin or destination, but not both, within the survey area.
11. Through Traffic. —Traffic having both origin and destination outside the survey area but passing through the survey area. These trips are normally indicated as station-to-station movements.

TYPICAL STUDY OF TRAFFIC DESIRES

Philosophy of Corridor Analyses

The basic theory of a screen-line check of travel desire trips against actual ground traffic counts is not new, having been used for years as part of O-D survey techniques. It is also applicable to major street planning for a design year. The philosophy used can be easily summarized:

1. Across any straight line through an area, the theoretical volumes (desire trips) should balance actual vehicular trips, if certain precautions are taken regarding circulation of traffic, double crossings, daily volume variations, etc.
2. By using a series of screen lines, checks of design year desire trips can be

made at sufficient intervals to provide sound planning data regarding the collective demand for street facilities.

3. If screen lines are prudently located, an accurate estimate can be obtained of actual design year vehicular trips across each line. This involves recognition of several facts:

a. Consideration must be given to circulation and forced double crossings of the screen line.
b. Many of the relatively short trips, as well as the beginnings or ends of other trips, are made on local streets and not major streets. (Traditionally, this has been considered to be approximately 20 percent of all travel.)
c. Diversions of traffic from the most direct path will occur; but travel time factors being equal, this tends to be compensative between various routes for the study area as a whole.
d. Traffic zones for tabulating and grouping trips with similar origins and destinations must be small enough to distribute desire trips adequately. At the same time, the zones should not be so small that undue tabulating time is required.

Preparatory Data

The following supporting data are necessary in these phases of major street planning, and should be obtained before initiating the corridor analysis tabulations:

1. Definition of existing major street network. This may be from the existing thoroughfare plan, or it may require designation of a major street network as determined by public use of the streets. This latter method necessarily involves much judgment, but is often necessitated in smaller communities having no formal thoroughfare plan.

2. Inventory of rights-of-way, pavement widths, parking restrictions, and traffic control measures.

3. Determination of existing traffic flow characteristics on the major street network. This involves tabulation of turning movements at key intersections, calculations of peak-hour volumes as a percentage of 24-hr volumes, determination of directional distribution factors for morning and evening peak hours, and development of existing 24-hr volume data.

4. Development of design year travel desires. This in itself may be a major step, and often involves projection of an existing origin-destination survey tabulation to the appropriate design year.

5. Location of physical factors influencing major street locations. Prudent location of the analysis screen lines is a necessity for the analysis of over-all travel as well as the specialized studies required later. The locations of major traffic generators, both existing and planned, are needed, as well as such pertinent physical factors as major railroads, rivers, topographic conditions, and even limited access routes locations.

Analysis Procedures

The technique of corridor analysis is not completely new, but the procedures discussed herein are the evolution of years of modifications of procedures used by Harland Bartholomew and Associates in various studies in Illinois, Michigan, North Carolina, Tennessee, Texas, and Virginia. These procedures are not considered perfect or inflexible, but they provide the theory and generalized methodologies involved and must be adjusted to the specific requirements and peculiarities of each individual study.

There are two basic purposes of the various tabulations and illustrations prepared in the corridor analyses. The first of these is to present as concisely and explicitly as possible the desire trip tabulations by corridor groupings to enable study of high concentrations of desire volumes. The other purpose is a determination of capacity deficiencies by areas.

Desire Trip Tabulations. —Screen lines for analysis purposes can be oriented in any number of ways. In various studies throughout the country, radial lines from the CBD, concentric circles, and series of parallel lines forming corridors have been used. Experience has indicated that for even the most radially oriented city, a series of parallel lines can effectively be used. Because computations are simplified with parallel analysis lines, the "corridor" approach has become standard although modifications can always be introduced for specialized requirements.

The analysis lines forming the corridors for any given study can be oriented at any angle to the existing street network. Thus an initial step in a corridor analysis is to designate the series of lines to be used for analysis purposes. These are referred to as corridor lines or analysis screen lines, for each pair of parallel analysis screen lines forms a corridor. Each series of corridor orientations is composed of two groupings, each at right angles to the other. The corridor lines are each located to provide volume tabulations at critical locations, such as a river or a major railroad, but at the same time they must be systematically spaced across the study area.

The location of the analysis screen lines becomes most important. For any particular study, the number of corridor orientations used will vary. However, in a typical study, two area-wide orientations will most likely be used in addition to special corridor studies involving a portion of the urban area. These two basic series of corridor orientations are each composed of the two groupings of corridors, each at right angles to the other. The orientation used in the final depicting of lane deficiencies is referred to as the cardinal corridor orientation whereas the second grouping is usually a 45° orientation. These cardinal corridors are designated basically paralleling the existing thoroughfare network (Fig. 1). The analysis screen lines for the cardinal corridors should be such that the following obtain:

1. Each is a straight line parallel to the designated X or the designated Y axis.
   a. The X and Y axes are at right angles to each other.
   b. The X and Y axes are established generally parallel to the basic existing major street network.
2. Each pair of parallel lines forms a cardinal corridor.
3. No analysis line crosses the intersection of two existing major streets.
4. No analysis line crosses through any design year analysis zone centroid.
5. All lines follow as closely as possible the analysis zone boundaries.
6. The CBD is enclosed by sections of four analysis screen lines.
7. Where possible, lines should generally follow
   a. Main line railroads,
   b. Rivers,
   c. One side of an existing expressway,
   d. Other elements when it is desirable to know design year volume crossings.
8. The cardinal corridors formed should be
   a. Approximately ¾ to 1¼ mi wide,
   b. Narrower near the CBD and wider near the fringes,
   c. Located to include at least one major through street, if possible.

The remaining series of corridor orientations involve corridors oriented at an angle to the cardinal corridors. These may be a rotation of the system about the CBD, although the spacing of the analysis lines normally varies for different corridor orientations. For a typical study each orientation involves twenty corridors, ten in each direction. The analysis screen lines for each series of supplementary corridors are generally located in the same manner as those analysis screen lines for the cardinal corridors, except they are at an angle to the designated X or Y axis. The most typical orientation is usually at 45°.

In the development of all tabulations of corridor desires, internal trips are assumed to be concentrated at their respective zone centroids. Vehicle trips involving an external survey station are plotted from the location of the station involved to the appropriate zone or other station. Care must be taken to minimize the effect of so grouping the travel desires, and two precautions are always followed. In the development of the design year desire trip tabulations, zone boundaries are caused to coin-

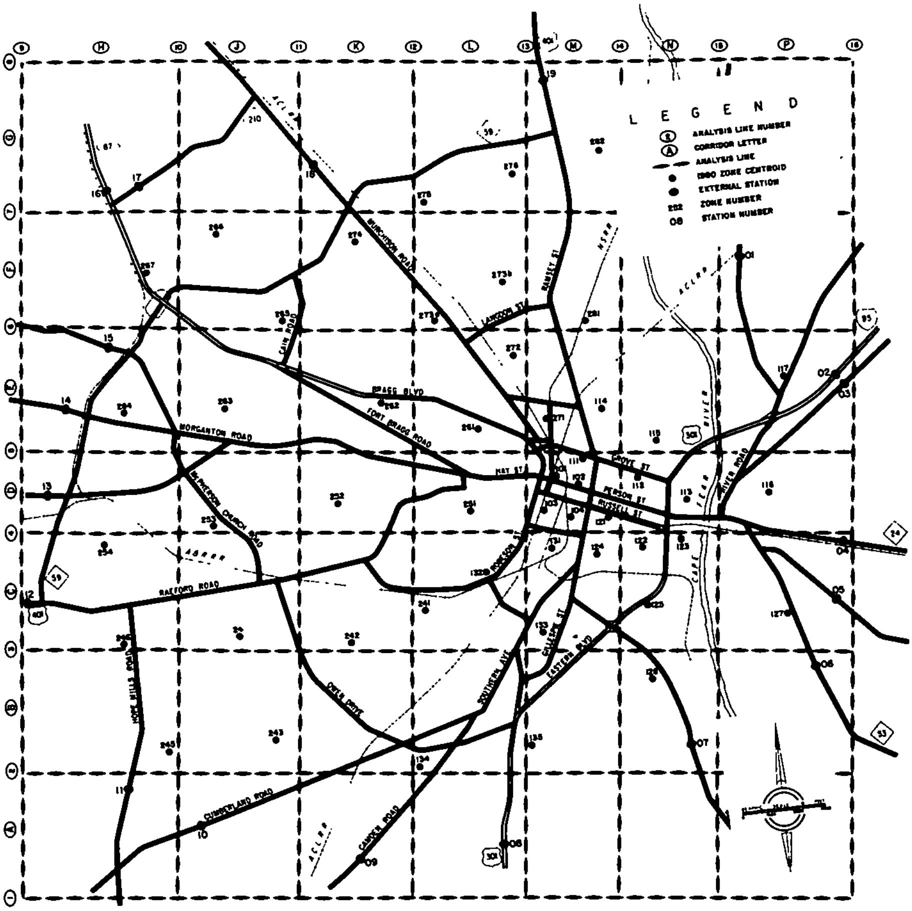

Figure 1. Orientation of cardinal corridors, Fayetteville, N. C., urban area.

cide as closely as possible with the analysis screen lines to be used. This often dictates the splitting of the initial origin-destination survey traffic zones. This is of primary importance relative to the cardinal corridor analysis screen lines. In addition, land uses with very high trip generations per acre (such as a major shopping center) are considered as separate zones.

The total volume of traffic crossing an analysis line section is determined by considering each desire movement (zone to zone, zone to station, or station to station) as traveling in a straight line, or desire line, from centroid to centroid. This is done even if there is no major street in the corridor the desire line traverses. Each time the tracing of the desire line movement crosses an analysis line, the desire volume is tabulated at that line section. When all movements being considered for that particular tabulation have been treated in this manner, those crossing each analysis line section are summed and the resulting volumes then are plotted to scale on a map of the urban area.

To define corridor desires further and facilitate later analyses, it is also desirable to differentiate between various types of desires tabulated at each analysis screen-line section. For example, internal, local, and through traffic may be traced separately, and further delineation can be made by separating truck and passenger vehicle volumes. In addition to these differentations, it is most desirable to contrast true corridor desires with those desires that do not trace their entire movement with a single corridor. True corridor desires are those movements between zone centroids which lie completely within a given corridor. Therefore, all movements within a study area can be categorized as true cardinal, true 45°, and "all others."

For a corridor analysis of design year travel desires for a typical urban area, the following tabulations are most often required. For each of these, separation by type of traffic (external, internal, truck, passenger, etc.) should be done as required for the particular study analyses involved.

1. Cardinal corridor analysis lines
   a. True cardinal corridor desires (design year),
   b. Forty-five degree corridor desires (design year),
   c. All other corridor desires (design year),
   d. All travel desires (design year),
   e. All desires eliminating those assigned to special facilities (design year),
   f. All existing year desires.
2. Forty-five degree corridor analysis lines
   a. True 45° corridor desires (design year),
   b. True 45° corridor desires eliminating true cardinal corridor desires (design year),
   c. All desires (design year).
3. Special corridor analysis lines
   a. True corridor desires (design year),
   b. True corridor desires eliminating true cardinal corridor (design year).
   c. All desires (design year).

Appendix A contains a procedural outline of the steps involved in obtaining basic desire trip tabulations. This general outline has been designed to provide typical tabulations and should be modified to provide the necessary data for the particular study involved. A section is included regarding a hand (mechanical) procedure for desire tabulations as well as a computer program which provides the same type of data. Examples of coding sheets are included.

From these tabulations of desire year, desires, corridor desire volumes are plotted on maps of the urban area to provide graphic portrayal of the volumes. All of the data indicated previously should be considered, but the desire maps most often utilized are indicated below. The raw tabulations of other data on an area-wide basis are usually sufficient for typical studies inasumuch as the specific items required for a specific location can be obtained from those listings.

1. True cardinal corridor desires (Fig. 2).
2. True 45° corridor desires (Fig. 3).
3. True radial corridor desires (Fig. 4).
4. Semi-assigned cardinal corridor desires, separated to indicate those volumes actually semi-assigned and those volumes which are true corridor desires (Fig. 5).

The true cardinal and the true 45° corridor desires are used in study of possible radial street movements, both existing and contemplated. In addition, the 45° corridor desires are used in later studies involving tentative assignments of volumes to street systems to determine 24-hr volume levels for streets proposed for construction. By combining data from those cardinal and 45° corridors radiating from the CBD, a true radial corridor desire portrayal can be prepared. In the development of these data, an example of which is shown in Figure 4, care must be exercised to eliminate duplication of desire trips in the data from the two corridor networks. Those desire volumes between the corridors radiating from the CBD can either be semi-assigned to the corridors used in the figure or they can be indicated as separate movements between corridors.

The true corridor desires for 45° corridors are then semi-assigned to the cardinal corridor system in addition to all other desire movements that have not been considered. These volumes are then indicated on a map of the area similar to that in Figure 5 with the true cardinal corridor desires. This provides representation of 100 percent of the design year trippages. It is most advantageous to differentiate be-

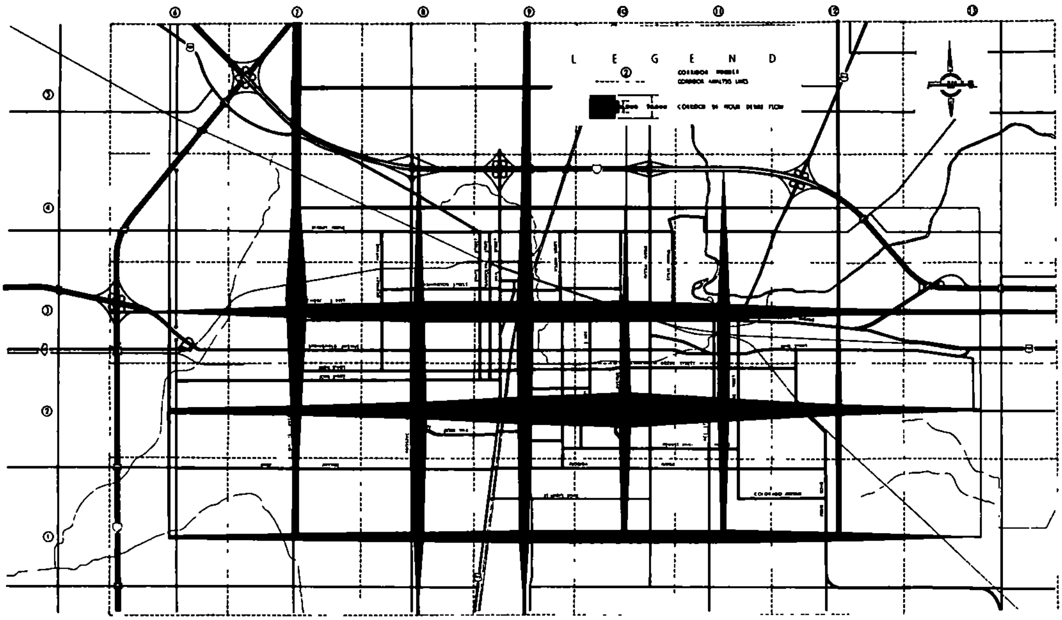

Figure 2. 1980 cardinal corridor desire flow, Champaign-Urbana, Ill., urban area.

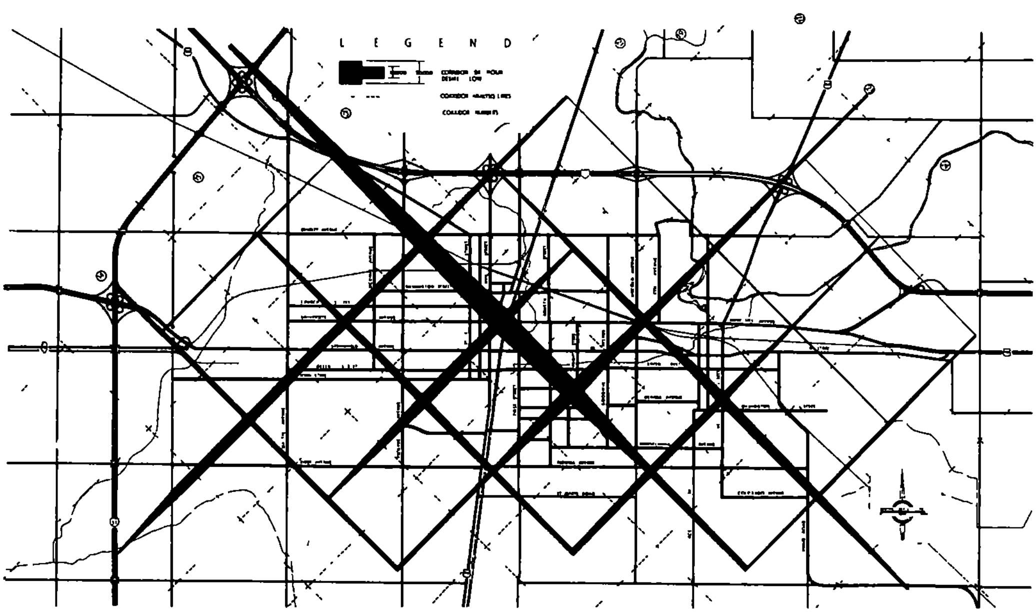

Figure 3. 1980 45° corridor desire flow, Champaign-Urbana, Ill., urban area.

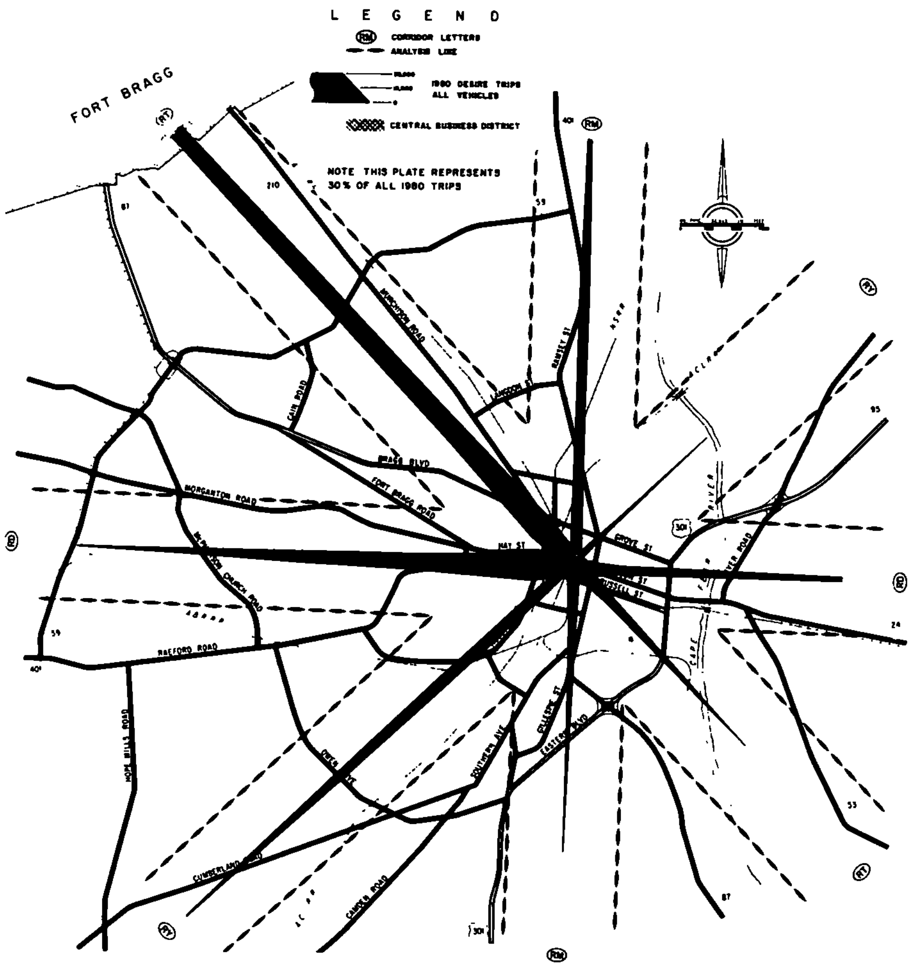

Figure 4. 1980 radial corridor desires, Fayetteville, N.C., urban area.

tween the true corridor desires and the semi-assigned volumes in this portrayal. If such is done, future efforts regarding estimating traffic volume levels for particular streets by the design year are simplified.

Table 1 gives pertinent data relative to these desire volume tabulations. The true corridor desires, though comprising a high percentage of trips, do not include desire volume crossings in proportion to the number of trips because most of the short trips are contained whereas the majority of long trips are considered "all other" desire movements. On the average, cardinal corridor desires represent 35 to 40 percent of all trips within a study area while constituting only one-fourth of the analysis line volume crossings. The average internal trip length factor for cardinal corridor desires is usually only 60 to 70 percent of the value for all internal trips. A comparison of these trip length factors is given in the table for a typical study area. Average trip length factors are based on the total volumes crossing the analysis lines, the average spacing of analysis lines, and the total number of trips included in the volumes used to determine crossings.

The treatment of limited-access facilities, either existing or proposed, requires special steps in addition to those outlined previously. When a limited-access facility is introduced into the street system, the previously discussed desire tabulations should be developed and then supplemented with modifications made in consideration of the effect of the limited-access facility. In this, each interchange of the limited-access

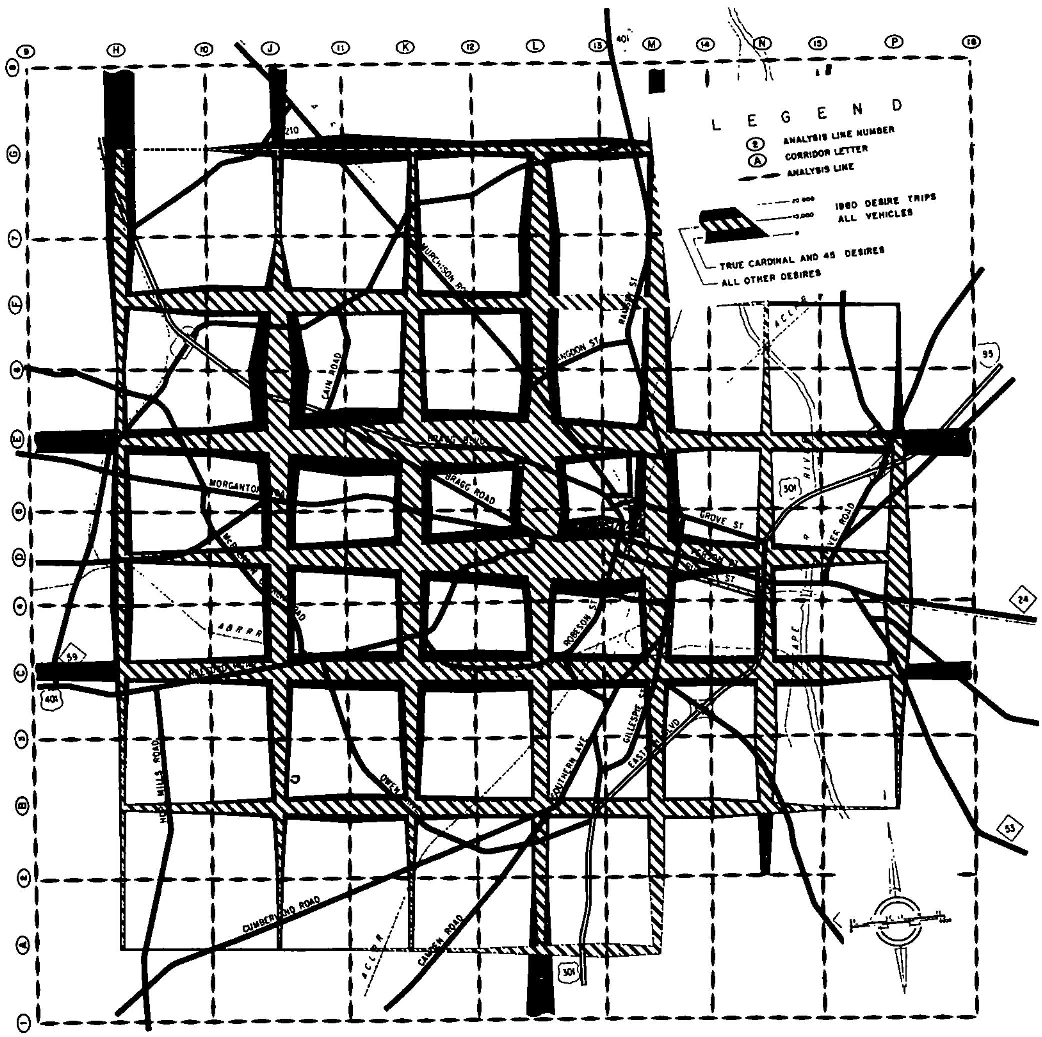

Figure 5. 1980 24-hr semi-assigned desires, Fayetteville, N. C., urban area.

facility is treated as a zone centroid, travel time ratio assignments of desire trips to the limited-access facility are made, and the origin-destination desire tabulations are adjusted to include limited-access interchange zone centroids. In this manner, a trip using the limited-access facility is traced for the purposes of the corridor analysis as follows:

1. From a zone centroid to the interchange at which the trip enters the limited-access facility.
2. From that interchange location to the interchange at which it leaves the limited-access facility.
3. From the final interchange to its zone of destination.

For purposes of preparing study maps of desire volumes within the study area, the trip movements on the limited access facility (step 2) are plotted separately and are not included in the corridor desire portrayals. In effect, this removes the travel on

TABLE 1

SUMMARY OF CORRIDOR DESIRE TABULATIONS FOR TYPICAL URBAN AREA

Corridor Desires	Total Crossings of Analysis Screen Lines	No. of Trips Included	Trip Length Factor
True cardinal	154,000	99,000	1.8
True 45°	112,000	65,000	2.1
All others	338,000	84,000	4.8
All semi-assigned to cardinal corridors	604,000	248,000	2 9

limited-access facilities from the corridor analysis and enables separate study of the requirements for the limited-access facility and for the requirements of the arterial street system.

After development of all the previously discussed corridor desire tabulations, including specialized limited-access facility studies, the next step involves the determination of peak-hour traffic desires by corridors. This is normally a matter of converting the 24-hr desires shown in Figure 5 to peak-hour volumes at each analysis screen-line section. This is accomplished utilizing factors derived from study of existing peaking characteristics determined for the major street network. An example of these peaking characteristics for a typical community is shown in Figure 6.

From study of the data in Figure 6, peak-hour factors and directional distributions are determined for each analysis line section. The peak-hour percentage factor is applied to the 24-hr desire volume, and in turn this is multiplied by the directional distribution factor to provide one-way, peak-hour desires. This result is the one-way volume that the major street system in that corridor must be able to accommodate. The ability of the existing major street network to meet this one-way volume desire is determined through a capacity analysis of the existing streets on a corridor basis.

For complete study of an urban area, peak-hour volume determinations are required for morning and evening peaks for both the cardinal corridor orientation and the 45° corridor orientation. For brevity, discussion here is limited to capacity deficiency studies determined using the cardinal corridors and the evening peak-hour volumes because the procedures are applicable to all orientations.

Corridor Capacity Determinations.—The purpose of the corridor capacity data is to provide a measure of the ability of the existing major street network to meet the design year peak-hour desires by location to determine where lanes of traffic are required by the design year. Final determinations of exact level of development of cross-section elements for a specific street or highway are not made from this phase of the analysis but are made after assignment of volumes to specific routes. However, this analysis must represent as accurately as possible the lane capacity to be provided by the design year, as well as those locations which will require intersection improvements. Consideration of these factors indicates the degree of refinement required in the corridor capacity determinations.

In view of these factors, a set of standard capacity charts has been prepared for corridor analyses. These capacity charts are used to determine the capacities of the various elements of the major street network within each corridor at as many locations as are required. Corridor capacities are then determined by summing the capacities of each individual street element. For each corridor, capacities normally are required at analysis lines, major street intersections, major crossings of railroads, rivers, and limited-access facilities, and all other locations deemed critical.

Intersection capacities are normally based on the 1958 revisions of the Bureau of Public Roads standard capacity charts for average conditions, adjusted to reflect practical capacity. The more detailed charts can be used when needed; however, such

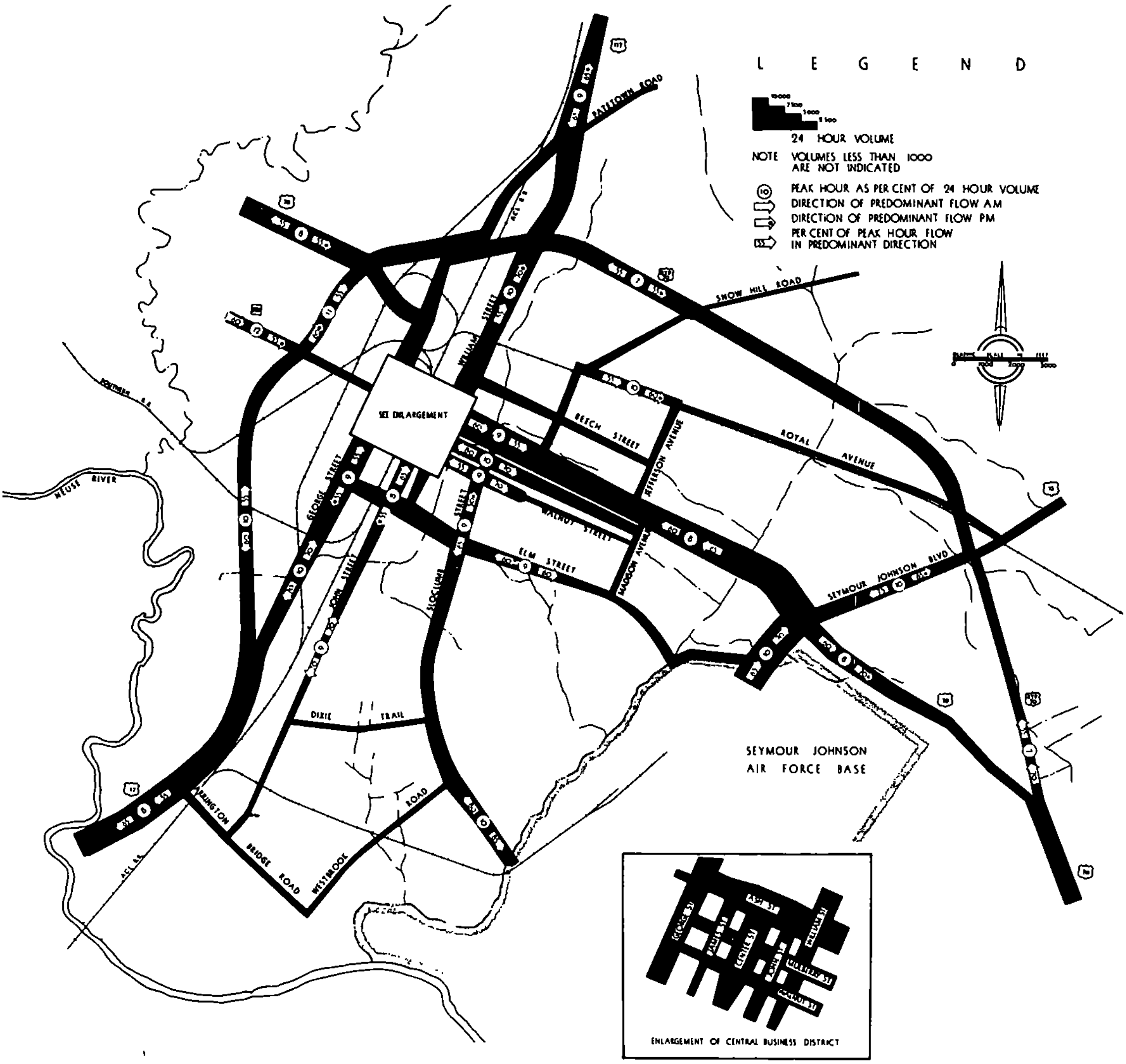

Figure 6. 1960 24-hr volumes, Goldsboro, N. C., master thoroughfare plan.

comprehensive capacity studies are warranted at this phase of the analysis only where multiphase controllers are used at signalized intersections or very heavy turning movements are involved. Although oversimplification must be avoided, at the same time unnecessary "exactness" of detail is not warranted either. Consideration must be given to the over-all accuracies involved and the desired end result in determining the required degree of refinement.

Figure 7 shows the series of capacity charts for one-way streets and Figure 8 shows charts for two-way streets. These charts represent typical conditions involving 20 percent turning movements, 10 percent truck volumes, and average interference from bus maneuvers and pedestrians. The practical capacities provided are one-direction approach volumes in vehicles per hour of green time, which must be adjusted to reflect the percent of green time for the street approach under consideration.

Corridor capacities for uninterrupted flow conditions are based on operating speeds desirable for the various types of major streets considered. Criteria for operating speeds recommended for general use where local criteria are not available are given

TABLE 2

CRITERIA FOR OPERATING SPEEDS WHERE LOCAL STANDARDS ARE NOT AVAILABLE

Area	Operating Speed (mph)		
	Principal Highways	Secondary Routes	Other Major Streets
Rural	55	50	--
Suburban	45	40	35
Other	40	30	30

in Table 2. For operating speeds above 30 mph, as speeds increase, practical capacity decreases. Thus, for general use, Figures 9 and 10 have been prepared from data in the U.S. Bureau of Public Roads "Highway Capacity Manual," 1950, to relate capacity in vehicles per hour to operating speed. Figure 9 shows these data for two-lane routes for 12- and 10-ft lanes. These curves assume a 1,500-ft minimum restricted sight distance, 10 percent truck volumes, and obstructions not closer than 6 ft. The capacities shown in Figure 9 are two-way in vehicles per hour and must be adjusted to one-way capacities by applying a directional distribution factor. Adjustments can be made for greater sight distance restrictions or truck volumes and for different lane widths in accordance with factors provided in the "Highway Capacity Manual."

Figure 10 relates capacity to operating speed for multilane routes and provides one-way lane capacity in vehicles per hour. Again, it is assumed that 10 percent of the volume is composed of commercial vehicles and there are no obstructions closer than 6 ft. Adjustments can also be made for different conditions or for different lane widths in accordance to factors provided in the "Highway Capacity Manual." The values derived from Figures 9 and 10 are generally comparable to those provided in AASHO policy manuals, "A Policy on Geometric Design of Rural Highways," 1954; and " A Policy on Arterial Highways in Urban Areas," 1957.

For stop-sign conditions on major streets, two policies are normally employed. All-way stop-sign control is generally calculated on the basis of 400 vehicles per hour approach lane. This is generally compatible with capacity determinations across the country and presumes relatively balanced lane volumes between approaches and approximately 10 percent commercial vehicles. More refined estimates are considered unwarranted, and for long-range planning it is presumed that all-way stops will probably be replaced with traffic signals.

Two-way stop signs at intersections of major streets are considered to proportion the intersection capacity to the streets at 100 percent for the unimpeded street and 0 percent to the stopped street. The philosophy used in this is that assignment of less than the unimpeded (free-flow) capacity to the non-stop street is not warranted; therefore, the stop-street should have no capacity assigned to it for the corridor capacity determination.

In considering corridor capacities, it is imperative to remember that they represent conditions for the existing major street network. Present traffic control measures, including signal timing where applicable, are used, and in some instances capacity above that indicated for a corridor is available merely by removing parking or improving the signal phasing.

Capacity Deficiency Analysis. —The resulting capacities by corridor sections within the urban area can be graphically compared to the estimated desire volumes by corridor sections to provide a positive guide for the location of major streets. Figure 11 shows such a comparison for a typical study. It is apparent from this portrayal that certain areas have lane capacity deficiencies or intersection capacity deficiencies, whereas other areas provide capacity sufficiencies. Generally speaking, areas of deficiency at analysis lines require major widenings or construction by the design year, whereas little or no gross widening programs are necessary where sufficiences are indicated. In the latter instances, however, intersection widenings may be required.

To summarize the relationships shown in Figure 11, it is desirable to translate the analysis line deficiencies from vehicles per hour to lanes of traffic. A most meaningful tabulation therefore becomes an indication of two-way lane deficiencies at each analysis screen-line section. Figure 12 shows the two-way lane deficiencies developed in this manner for a typical study. In developing these data from these shown in Figure 11, a lane of traffic was considered to represent 600 vehicles per hour on the

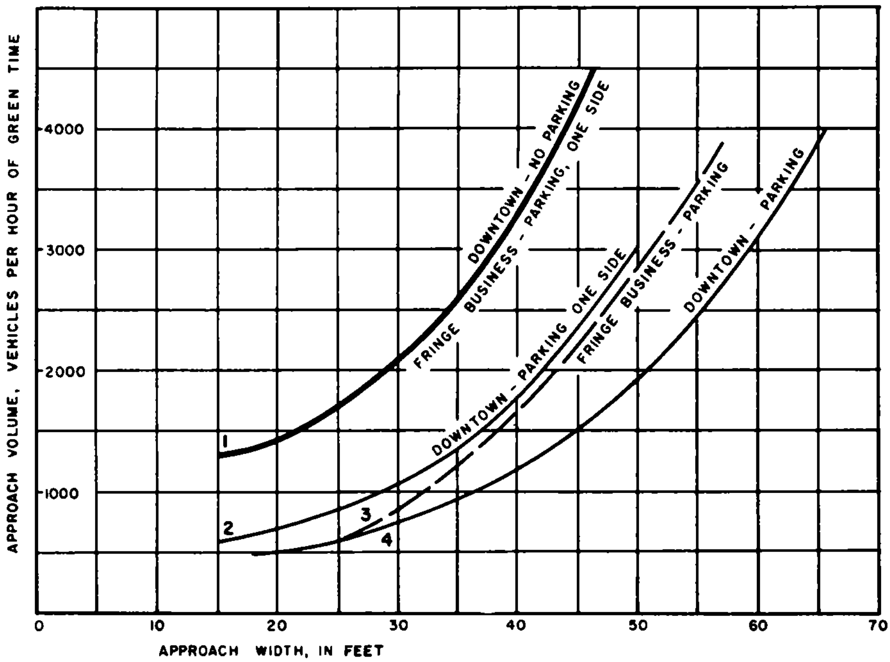

Figure 7. Intersection capacity, one-way streets.

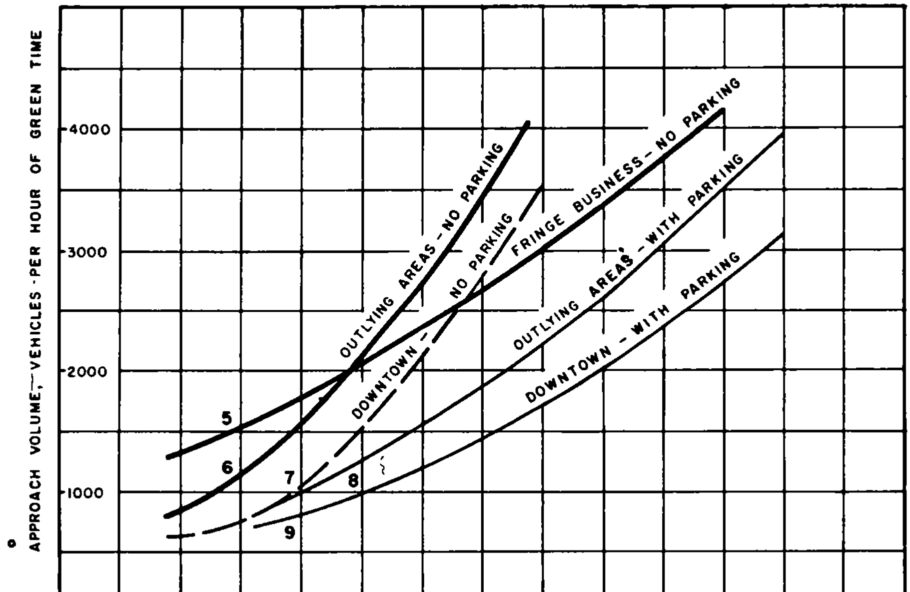

Figure 8. Intersection capacity, two-way streets.

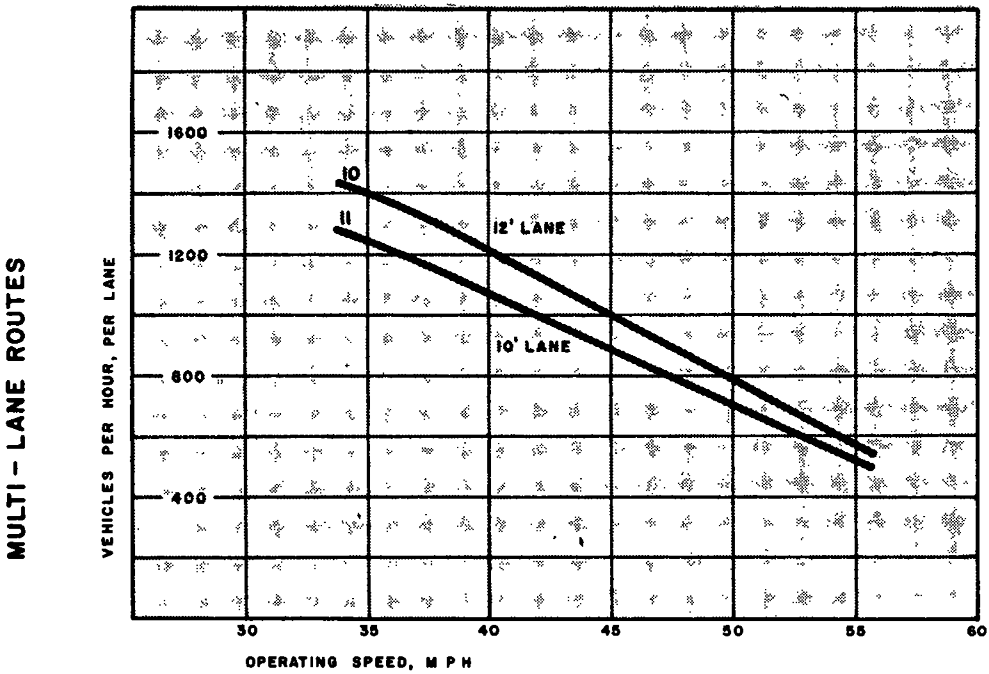

Figure 9. Capacity vs operating speed, multi-lane routes.

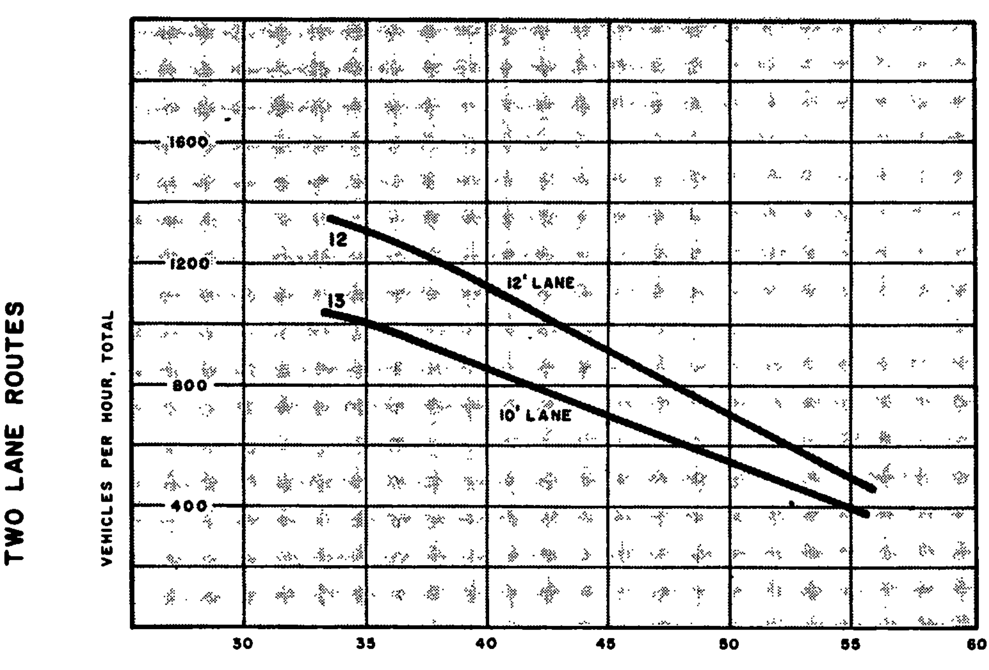

Figure 10. Capacity vs operating speed, two-lane routes.

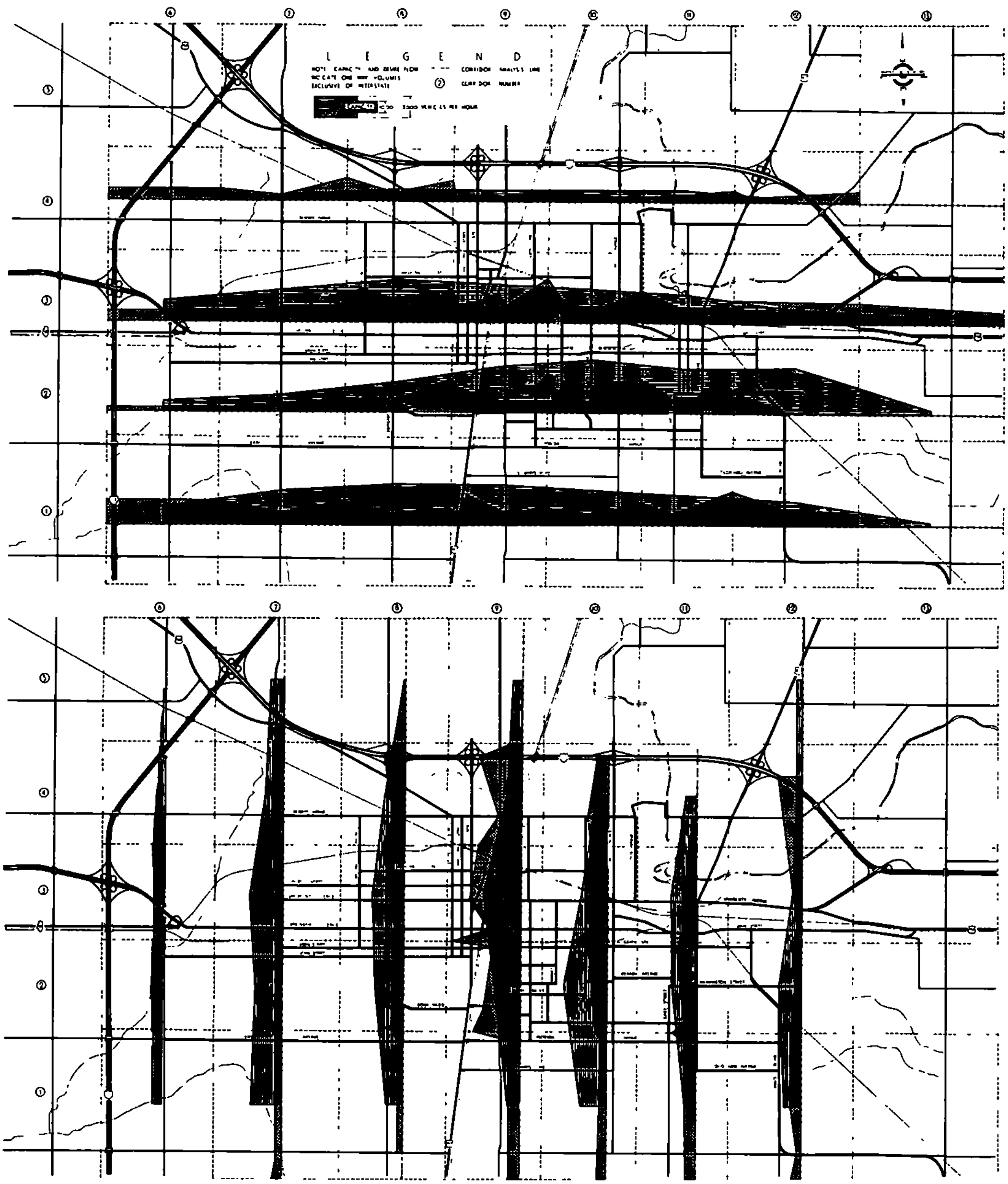

Figure 11. 1980 peak-hour desire flow, Champaign-Urbana, Ill., urban area.

average. However, a deficiency of 0- to 50-vehicle capacity during the peak hour is not normally considered sufficient to dictate a lane of deficiency at analysis line sections where there are no existing major streets in peripheral areas. Logically, arguments can be presented for using various figures other than 600 vehicles per hour per lane as a guide to the number of lanes of deficiency at an analysis screen line. Limited-access facilities can provide two to three times the lane capacity of a normal arterial street, which in itself varies considerably depending on the character of adjacent land uses. However, the "average value" approach proposed herein is con-

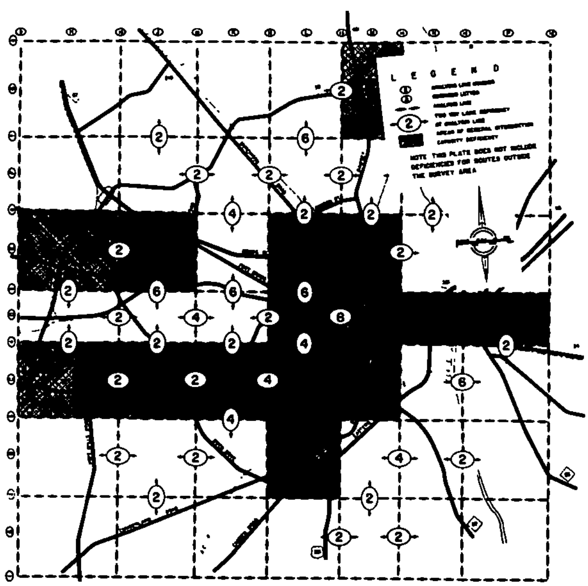

Figure 12. 1980 capacity deficiency, Fayetteville, N. C., urban area.

sidered best in view of the intent of the procedures and the fact that detailed analysis of specific street capacities are considered in later phases of the entire study.

Thus, the number within each ellipse in Figure 12 is considered the two-way traffic service requirement in lanes by location for the design year. In addition to lane deficiencies, Figure 12 also shows general intersection capacity deficiencies above the lane requirements as determined from Figure 11.

Although the capacity deficiencies for the existing major street network are indicated by areas, it is not axiomatic that proposed improvements by solely located in accordance with such deficiencies. This is due in part to the grouping of desires to depict deficient areas in a readily perceptible manner. Other considerations, particularly of an economic, planning, or aesthetic nature, may dictate that portions of the corridor desires be diverted to adjacent corridors.

The corridor analysis is an engineering-planning tool to aid in the development of a major street system rather than an unequivocal dictate of street and highway location. The capacity deficiencies are used in evaluating study plans to determine the traffic call for a particular lane capacity by location, and those thoroughfares that can meet such a traffic call are normally indicated in all trial study plans whereas other improvements are considered a lane service or long-range planning element. Thus the capacity deficiencies developed can be used to test the adequacy of any number of alternative plans being considered for implementation.

APPLICATION TO MAJOR STREET LOCATION PLANNING

The capacity deficiency analysis provides a sound guide to test families of plans and, in many instances, determine the necessity of various street elements. In addition to that guide, it is also necessary to consider physical factors influencing the desirable location of major streets for the study area involved. Figure 13 is an example of a summary of the principal factors affecting major street locations as prepared for a recent study. Primary traffic generators, daily train movements, substandard housing, existing grade separations, and other physical factors are among those items indicated. Other considerations include the location of existing streets relative to established neighborhoods, the degree of continuity afforded, and the existing standard of development of each route studied.

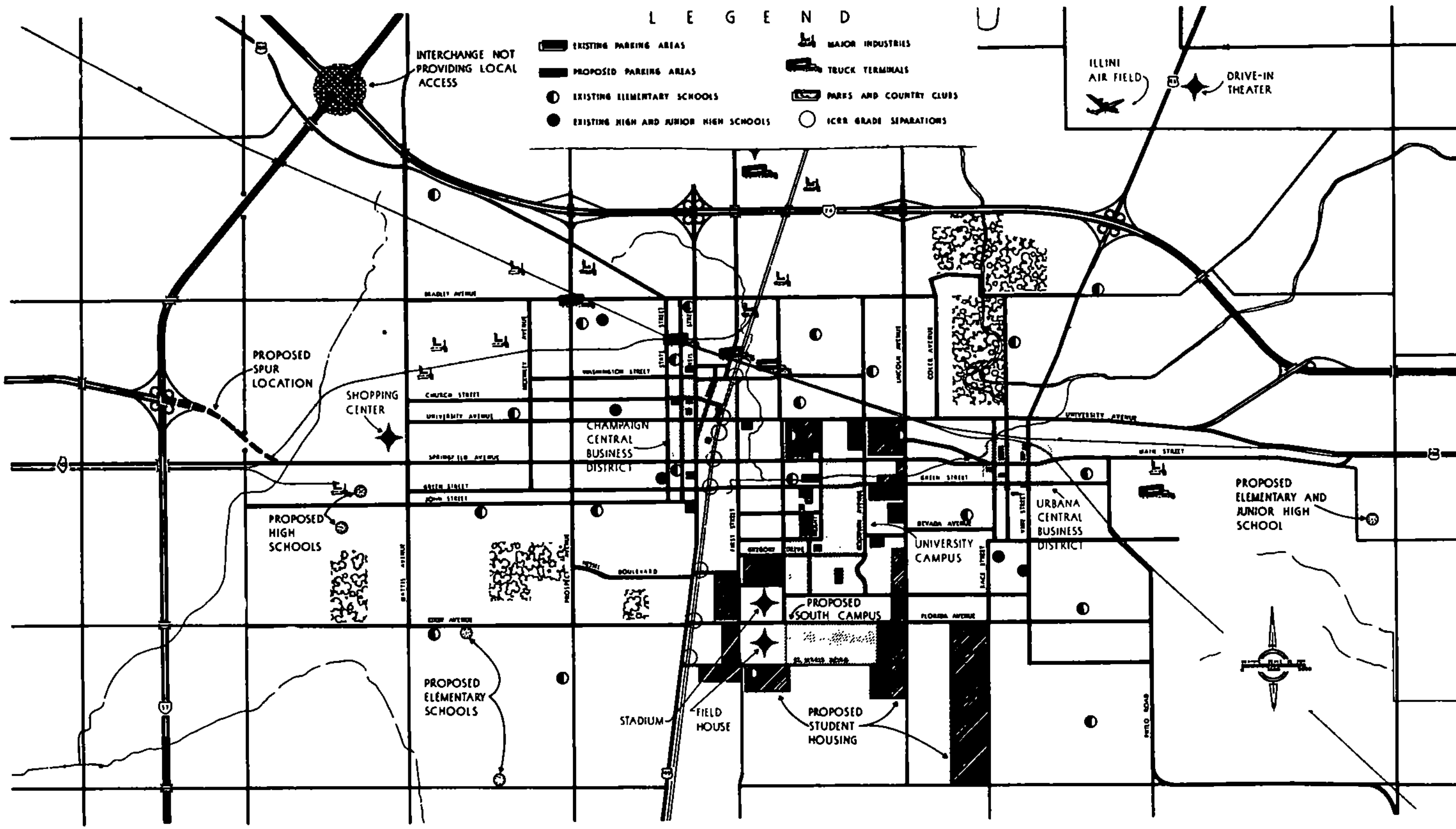

Figure 13. Factors affecting major street locations, Champaign-Urbana, Ill., urban area.

Testing Alternative Plans

The usual procedure followed in developing the final thoroughfare plan involves delineating on study plans the elements to meet design year traffic requirements, to meet land service requirements, and to provide possible long-range extensions. The design year capacity deficiencies in lanes provide a means of testing each plan studied. In addition, Figure 13 aids in the criticism of each study plan. A thorough knowledge of the area traversed by each street element is also necessary.

After the development of study plans, estimates of 24-hr volume levels for the design year are prepared for each street location possibility. This is accomplished by preparing an overlay for the study plan map on which the following data are indicated at each analysis screen-line section:

1. The true cardinal corridor desires.
2. The semi-assigned 45° corridor desires.
3. The semi-assigned "all other" desires.
4. The total design year desires.
5. The total existing desires.
6. The total existing volumes crossing that section on existing major streets.

Using these data, estimates are prepared for each tentative element of the study thoroughfare plans to indicate the volume level that desires to utilize each portion of the arterial street network. From study of the resulting information, in conjunction with an inventory of available rights-of-way and pavement widths, consideration is given to the level of development dictated for each route, the development of new limited-access facilities, and the necessity by the design year for each of the elements tentatively included. Revisions then are made as required to the study plans, to the volume levels tentatively assigned to routes, and to the level of development to be proposed for each element. This results in a final master thoroughfare plan as well as a guide for required developments by the design year.

In deciding the desirability of adding new limited-access route considerations and the question of inclusion or elimination of various elements, detailed analyses for specific sections of the study area may be required. Two examples of this are the CBD and a major river crossing. In these special studies it is often desirable to tabulate the desire crossings by categories as shown in Figure 14. This involves denoting by direction those desires crossing each analysis line section as well as those volumes terminating just across the analysis line. A typical tabulation for a CBD is given in Table 3. Such data facilitate preliminary estimates of volumes that may be diverted to limited-access facilities near the special section studies.

Traffic Assignment

On delineation of the master thoroughfare plan, including all limited-access facilities, a restudy of 24-hr volumes (design year) for each element of the plan may be necessary. Volumes for limited-access facilities are determined by travel-time ratio assignments using standard diversion curves. The remaining volumes are then assigned to specific streets of the network. A summary of the typical relationship between screen-line section desire crossings and actual major street volumes based on studies relating those items for existing conditions provides excellent guidance here. Generally speaking, the screen-line sections enclosing the

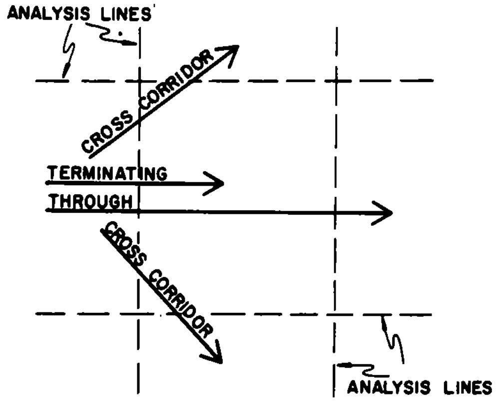

Figure 14. Corridor section, desire volume definitions.

TABLE 3

SUMMARY OF CENTRAL BUSINESS DISTRICT CORRIDOR SECTION SPECIAL ANALYSES, 1980 DESIRE CROSSINGS, 24-HR

Analysis Line	True Cardinal	True 45°	All Other	Total	Cross-Corridor	Through	Terminating
4	4,900	3,500	14,200	22,600	5,700	3,900	13,000
5	6,900	7,600	14,200	28,700	12,800	3,900	12,000
13	11,200	12,300	30,600	54,100	10,600	4,500	39,000
14	3,400	4,800	14,200	22,400	7,900	4,500	10,000
Total	26,400	28,200	73,200	127,800	37,000	16,800	74,000

CBD indicate a 1.4 ratio of actual volumes to desire crossings. This can be compared to results from other research showing approximately 50 percent of the vehicles entering the CBD between 10:00 AM and 6:00 PM do not stop to park. Similar comparisons of actual and desire volumes for other analysis screen-line sections indicate ratios of 0.9 for intermediate areas and 0.8 for outlying areas. The ratio of actual major street volumes to desire crossings approximates 0.9 for study areas as a whole. The difference between actual and desire volume plus the approximately 10 percent of the desire trips (mostly intrazone) that do not cross analysis lines represent those volumes relegated to minor street travel.

Specific guidance is derived from each corridor screen-line tabulation, the limited-access route assignments, existing volume levels, or travel time studies for estimating design year 24-hr volumes. However, in developing a plan with guidance by the corridor analysis procedures discussed, arterial streets are located in accordance to desire volume demand resulting in a balanced location of traffic lanes. This enables minimizing differences in travel time via alternate arterial streets of equal length; thus travel time ratio assignments are only required where limited-access routes are involved.

Traffic assignments in thoroughfare planning normally involve assigning to a complete network of streets and highways which has been designed to minimize circuity and enable direct routing of desire trips. Traffic assignment may be thought of as the determination of the routes that people are most likely to use in getting from one place to another and in further determining how many vehicles will travel on each of the possible routes. The primary controllants are time of travel and distance of travel, with time seeming to be the primary determinant of route selection by most drivers.

Traffic assignment and traffic distribution on alternate routes should be carefully distinguished. Traffic assignment, properly done, reveals the amount of traffic that most logically is assignable to a given route by virtue of its location and its general characteristics. Assignment, for planning purposes, is most ideally an indication of what the driver would do on a generally free choice basis without the sometimes present restriction of route saturation. Traffic distribution to alternate routes is more an indication of what people do because of existing conditions. Traffic flow maps, for example, can be misleading to one who does not appreciate the fact that the relative amount of traffic on present routes might very well be where it is for the simple reason that there is no other way for this traffic to get from its origin to its destination.

Thus, through the use of the corridor analysis technique, the location of the elements of the thoroughfare plan is accomplished on a service of desire basis. It is then necessary to evaluate the ability of the area concerned to provide the entire system, to outline the required and proposed elements to be provided by the design year, and then to determine the level of development required for each section on the basis of traffic assigned to the elements proposed for construction by the design year. These programed developments require periodic review, as does the thoroughfare plan, and the corridor analyses aid greatly in these steps.

CONCLUSION AND SUMMARY

The preceding discussion presents in general terms a procedure for analyzing street and highway requirements for an urban area as well as a technique for testing alternative plans proposed for the major thoroughfare network for that area. Among other things, the procedure enables designation of design year capacity deficiencies by area to determine the number of new facilities required for adequate service as well as an estimate of traffic assignable to the entire street network proposed. Desire volume data are based on tabulations in origin-destination desire charts which can be easily adjusted to reflect major changes in land use at a later date, if the need arises. These adjustments are simply added to, or deducted from, the original desire tabulations, to permit re-evaluation of lane requirements.

This generalized technique is still being refined and modified as it is utilized in various studies throughout the country. The procedures presented for major thoroughfare studies represent those currently considered appropriate for typical analyses, although special mitigating circumstances often dictate modifications. Among the areas currently being researched are the following:

1. Which tabulations are most meaningful for most studies, and which are supplementary or of secondary benefit?
2. Is there a significant difference between the two methods for determining peak-hour, one-way desire volume, the two methods being factoring down from (a) 24-hr data, and (b) peak-hour data tabulations, which would require separate projections.
3. What is the desirable scope of computer program(s) to accommodate desire volume tabulations? The existing working program, although a tested and reliable one, has been designed primarily to provide great versatility of application in aiding the researches involved in defining procedures.
4. To what degree do shifts in contemplated land uses, or trip generation, or trip linkages between zones, actually affect the lane calls for the entire urban area?

Also, the general procedures discussed here have application in such studies as mass transit requirements, special truck routings, or even pedestrian movements. The corridor analysis technique can be adapted to small city studies or to regional studies, as the need arises. The discussion in this article are oriented towards urban are populations of approximately 100,000. The procedurial outline in the Appendix is also generalized and certain sections must be expanded or simplified, depending on the study area involved.

ACKNOWLEDGMENTS

The authors wish to thank the North Carolina State Highway Commission for use of Figures 1, 4, 5, 6, and 12, and the Illinois Division of Highways for Figures 2, 3, 11, and 13.

PROCEDURAL OUTLINE FOR CORRIDOR CAPACITY DEFICIENCY STUDY

1. General

A. The indication of capacity deficiencies by corridor sections provides a guide for the location of major streets in an urban area. In addition, it indicates the degree of development required for the major street network. This generalized outline provides a basic guide for the typical capacity-deficiency analysis. However, for a specific application of this procedure, certain sections of the outline may require expansion while other sections may be grossly simplified due to the nature of development within the area.

B. Although the final capacity deficiencies for the existing major street network are indicated by areas, it is not axiomatic that proposed improvements be solely located in accordance with such deficiencies. Other considerations, particularly of an economic, planning, or aesthetic nature, may dictate that portions of the corridor desires be diverted to adjacent corridors. This is an engineering-planning tool to aid in the development of major street planning rather than an unequivocal dictate of street and highway location.

C. The following phases of study must be completed prior to a corridor capacity-deficiency analysis.

(1) Land-use projection to design year.
(2) Design year traffic origin and destination desires by zones.
(3) Location of analysis zone centroids for design year.
(4) Designation of the existing major street system.

D. Examples of the forms used are reproduced at the end of this outline.

2. Corridor Designations

A. Determine the basic orientation of the existing major street network.

B. Designate cardinal corridors generally paralleling the existing major street network by establishing the location of the analysis screen lines. These analysis screen lines generally should be designated so that

(1) Each is a straight line parallel to either the designated x or y axis.
   a. The x and y axes are at right angles to each other.
   b. The x and y axes are established generally parallel to the basic major street network.
(2) Each pair of parallel lines forms a cardinal corridor.
(3) No line crosses the intersection of two existing major streets.
(4) No line crosses through any design year analysis zone centroid.
(5) All lines follow as closely as possible the analysis zone boundaries. (Zones must be split and trip linkages re-estimated if necessary.)
(6) The CBD (central business district) is enclosed by sections of four analysis screen lines.
(7) Where possible, lines should generally follow
   a. Main line railroad tracks.
   b. Rivers.
   c. One side of an existing expressway.
   d. Other elements where it is desirable to know design year volume crossings.
(8) The cardinal corridors formed should be
   a. Approximately $^3/_4$ to $1^1/_2$ mi wide.
   b. Narrower near the CBD and wider near the fringes.
   c. Located to include at least one major through street where possible.

C. Designate supplementary corridors at an angle to the cardinal corridors.

(1) Generally there will be at least one set oriented at approximately a 45^0

angle to the x and y axes. Quite often several supplementary orientations will be necessary to study specific desires.

(2) Conceivably could have radiating wedges or radials and circumferentials can be considered in travel time ratio assignments to separate corridors in a later step.

(3) Analysis screen lines are generally designated in the same manner as in step B, but at an angle to the x and y axes.

D. Prepare exact scale maps to indicate the locations of existing major streets, the analysis zone centroids, and each set of corridors. Analysis zone centroids are determined by locating the approximate center of traffic generation by the design year within each zone. These maps will then be used in the following analysis steps:

(1) Coding for computer analysis, if used.
(2) Designation of study locations for limited-access facilities (expressways).
(3) Designation of movements that could conceivably use expressways.
(4) Determining travel time estimates for percent of diversion of traffic to expressway and limited-access locations.

E. Designate study locations or probable locations for limited-access facilities. These locations should be relatively general at this stage and may be thought of as special "corridors" rather than exact thoroughfare locations.

(1) Locations should be indicated on a work map with the existing major streets, the cardinal corridors, and the analysis zone centroids.
(2) Traffic assignments will be made to all locations warranting detailed study. Such assignments will be made on a travel time ratio basis.

3. Analysis Procedure

A. General

(1) The primary purpose of a corridor analysis is to tabulate the design year desire volumes by locations and compare these to the capacity potential of the existing major street system.

(2) Existing limited-access facilities must be given special consideration. This includes facilities planned and located but not yet constructed.
   a. Traffic assignments should be made to these facilities utilizing standard traffic diversion curves relating travel time ratios to percent of traffic diverted.
   b. In determining capacity deficiencies of the basic street system, routing of volumes assigned to existing limited-access facilities must reflect travel to and from the facility interchanges rather than as straight line desires from origin to destination.

(3) True corridor desires should be developed to study possible locations for radials, circumferentials, or other limited-access faciliites. True corridor desires are those desires wholly within a single given corridor.

B. Mechanical (Hand) Procedure for Desire Tabulations

(1) Assign traffic to existing limited-access facilities by travel time ratios.

(2) Tabulate on form CD-1 desires falling entirely within cardinal corridors as determined by locations of analysis centroids with respect to the corridors (true corridor desires).
   a. Through, local, and internal movements should be tallied separately.
   b. All zones with centroids located to provide desire movements cleanly within a corridor are included.
   c. Volumes assigned to limited-access facilities should be excluded (use form CD-2) but must be included in corridors leading to the expressway.

(3) Tabulate desires falling within secondary corridors as determined by location of analysis centroids (form CD-1). Some movements still may be

unassigned after this step, depending on the number of secondary orientations used.

(4) Tabulate all other desires on the appropriate screen lines, using CD-1. This results in semi-assignment of the desires to the various corridor orientations.

(5) Prepare graphic representation of each of the desire tabulations.

(6) From data previously prepared, determine locations of circumferentials and/or radials requiring detailed special analysis.
   a. These normally consist of considerations for limited-access facilities because the cardinal and secondary corridor tabulations will enable considerations of normal major streets.
   b. Existing routes or special locations can be included.
   c. Designate locations as separate special corridors.

(7) Assign desires to special corridors by travel time diversion curves and tabulate on form CD-2.
   a. Assigned desires previously indicated in cardinal or secondary corridors must be deducted from those corridors for determining final 24-hr volumes.
   b. Travel time ratios and the percent diversion are tabulated on form CD-4 for each zone-to-zone or station-to-station movement. Form CD-2 is then used in tabulating these movements as they cross various screen lines.

(8) Assign all secondary corridor desires to cardinal corridors as necessary.
   a. Consider straight line movements from zone centroid to zone centroid.
   b. Tabulate the total desires and each cardinal analysis line that it crosses.
   c. This results in semi-assigned desires to the various cardinal corridor sections.
   d. Exclude desires assigned to limited-access facilities.

(9) Investigate the desirability of eliminating or adding new "special" corridors.
   a. Repeat assignments if changes warrant such.
   b. Proceed if assumed special corridors are justified.
   c. The cardinal corridors contain the desires that the major street network must accommodate.
   d. The special corridors must provide adequate lane capacities for the assigned desire volumes.

(10) Summarize cardinal, secondary, and special corridor desire information on form CD-3.
   a. Through, local, and internal desires are separated.
   b. Through desires and assigned or semi-assigned desires are separated.
   c. Peak-hour volumes are calculated using corridor percentage factors.

C. Desire Tabulations by Electronic Computer (IBM 704)

(1) This program was developed to trace desires as straight-line movements from zone or station centroid to zone centroid and tabulate all desire volumes crossing each screen-line section. Each of these movements can be traced and tabulated six separate times with one different factor being applied each time and the values then being totaled on a single set of analysis screen lines. This is possible for two sets of analysis lines for each run of the computer. This enables the following:
   a. Including only true corridor desires by applying either a 1.00 or 0.00 factor to each movement, depending on its orientation with respect to the corridors.
   b. Excluding a percentage of a movement that has been assigned by travel time ratio to a limited-access facility.
   c. Excluding movements (0.00 factor) that have previously been placed in a corridor series.
   d. Factoring down (or up) to change the volume to represent a different design year. (Care must be exercised to insure that the zone centroid location changes are properly evaluated).

e. Separating through, local, and internal desires; although this may also be done by introducing a different deck of cards representing the trip data.
f. Factoring 24-hr volumes to peak-hour volumes, secondary peaks, etc.

(2) Coding procedure
a. The instruction cards to the computer consist of
1. Basic instruction deck (same for each problem).
2. Trip data cards.
3. Cardinal screen lines.
4. Secondary screen lines (one set only per run).
5. Zone centroid coordinates.
6. Control cards.

b. Trip data cards
1. Each zonal movement (i.e., a movement from an origin zone or station to a destination zone or station) is represented by a trip data card in giving input data to the computer. An example of the code sheets for this card is form CD-6.
2. The groups of factors are used to tell the computer whether to include or exclude (or the proportion to include) the volume listed in columns 13 to 18 in the particular tabulation on the respective analysis screen lines. This could enable, for example, the following tabulations for a given run of trip data cards through the computer:
(a) The A-1 factor could be used to indicate those zone-to-zone movements that are true cardinal corridor movements.
(b) The A-2 factor could be used to indicate (by punching either 100 or 000) those movements that are not cardinal corridor oriented and are not in the secondary corridors (are "all other" movements).
(c) The A-3 factor could be used to indicate the percentage of the volume in columns 13 to 18 which was not travel time ratio assigned to an expressway.
(d) The A-4 factor could then always be 1.00 which would enable calculations of all movements within the area as tabulations on the cardinal screen lines.
(e) Another possible use of the factors would be to indicate a percentage of each volume to be included to show that portion of the total volumes which was assigned to a particular expressway system. The same percent diverted to the expressway would be used as the factor for that tabulation.
(f) A similar series of factor uses could be made with the group B factors which would be tabulated on the secondary screen lines rather than the cardinal screen lines.

c. Cardinal screen-line cards
1. The cardinal screen lines are coded as card 2 using form CD-7. (This same form is used for coding the secondary screen lines)
2. Each analysis screen line for the cardinal corridor network is defined by rectangular coordinates.
3. The coordinates used can be taken from the basic map indicating locations of the screen lines and the analysis zone centroids, but care must be exercised to insure that the analysis screen lines are indeed rectangular. It is recommended that the map of the area which indicates the location of analysis screen lines and zone centroids should be developed at an appropriate scale to include the entire area easily. Measurements should then be made from the x and y axes to provide the necessary coordinates.

d. Secondary screen lines
1. These analysis screen lines are defined on form CD-7 and are indicated as card 3.

2. The secondary screen lines will be at an angle to the cardinal screen lines or corridors. No matter what the exact angle is, the following is the recommended procedure for determining coordinates for screen line entries.
   (a) Prepare a map to scale indicating the locations of the zone centroids to be utilized in the study and the locations of the x and y axes. (The x and y axes have been defined in previous sections and consist of the cardinal analysis screen lines that are the farthest to the left and the farthest to the bottom of the map of the area.)
   (b) Prepare in sketch form as an overlay the general locations desired for the secondary corridors and therefore for the secondary analysis screen lines.
   (c) Plot one of the analysis screen lines on the previously prepared map.
   (d) Determine from the single secondary screen line the slope of the line with respect to the x and y axes.
   (e) Determine graphically by measurement the coordinates of one point on the first secondary screen line in terms of the x and y axes. Enter on form CD-7.
   (f) Calculate the x and y coordinates of the second point by using the slope previously calculated. Enter on form CD-7.
   (g) Locate the next secondary screen line on the base map and determine the x and y values for point one by measurement.
   (h) Determine the x and y coordinates of point two by applying the slope determined for the first secondary screen line. (This is necessary in order to insure that line 2 is parallel to line 1.)
   (i) Make the appropriate entries on form CD-7 for this screen line.
   (j) Continue in this manner until all of the analysis screen lines parallel to the first line have been entered.
   (k) Prepare the secondary analysis screen lines perpendicular to the first set of secondary analysis screen lines using the slope of the first secondary screen lines defined so that the two sets of screen lines are indeed perpendicular to each other. (If the slope of the first set is 1.1/1.2, the slope of the second set of lines becomes -1.2/1.1.) Determine coordinates for the remaining screen lines in the same manner as the coordinates were determined for the previous screen lines. Make all entries on form CD-7.

e. Zone centroid coordinates
   1. The coordinates of each zone or station centroid are entered on a separate card punched from data on form CD-8.
   2. From the basic map indicating the location of the zone centroids and the x and y axes for the cardinal corridors, the coordinates of the zone centroids are measured using the same scales which were used in determining coordinates for the analysis screen lines. The appropriate entries are made on form CD-8.

f. Control card
   1. Each control card is coded to indicate the number of number 2 cards; the number of A factors to be applied; the number of number 3 cards; and the number of B factors to be applied.

g. It is also recommended that for each study a tabulation be made of all the trip data cards (card 1) to indicate the total volume punched into columns 13 to 18 for each run. This tabulation will provide a check to be sure that all zone movements have been included and that no sheets have been lost in the process of data punching. Additional consideration should be given in this tabulation to totaling those volumes included by 1.00 factors in order to be able to compute a percentage of the total traffic desires included in that factor application. For example, this would enable indicating the cardinal corridor-oriented desires as a percent of the total desires within the area.

(4) The following corridor desire tabulations should be made for all studies for all analysis lines in order to evaluate desire movements properly.
   a. True desires within each corridor orientation.
   b. "All other" desires.
   c. 24-hr semi-assigned desires (includes all movements).
   d. 24-hr semi-assigned desires corrected for movements to limited-access facilities (special corridors).
   e. True desires for secondary corridors exclusive of movements that are also a true cardinal corridor desire.

(5) Other tabulations will be necessary, depending on the particular area being studied.

CORRIDOR ANALYSIS TABULATION

HARLAND BARTHOLOMEW AND ASSOCIATES

City Planners, Civil Engineers, Landscape Architects

Calc. by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______

PROJECT ______________________________

Sheet No ____ of ____

CORRIDOR DESIRES (THROUGH) (LOCAL) (INTERNAL)

CORRIDOR ________ (CARDINAL) (SECONDARY) (SPECIAL)

DEFINITIONS: CROSSING- VOLUME CROSSES SCREEN LINES ON BOTH SIDES OF GIVEN LINE
IN TERMINUS - VOLUME DOES NOT CROSS SCREEN LINE BEFORE GIVEN LINE.
OUT TERMINUS - VOLUME DOES NOT CROSS SCREEN LINE AFTER GIVEN LINE

DESIRE MOVEMENT		SCREEN LINE CROSSINGS									
CROSSING											
IN TERMINUS											
OUT TERMINUS											
TOTAL											

12-61 HB & A FORM CD-1

CORRIDOR ANALYSIS TABULATION

HARLAND BARTHOLOMEW AND ASSOCIATES

City Planners, Civil Engineers, Landscape Architects

Calc by ______ Date ______

Checked by ______ Date ______

Revised by ______ Date ______

PROJECT ________________________________

Sheet No ________ of ________

ASSIGNED CORRIDOR DESIRES (THROUGH) (LOCAL) (INTERNAL)

CORRIDOR ________ (CARDINAL) (SECONDARY) (SPECIAL)

SCREEN LINE CROSSINGS																							
% ASSIGN																							
24 HR. VOLUME																							
DESIRE MOVEMENT																					CROSSING	IN TERMINUS	OUT TERMINUS	TOTAL

12-61

HB & A FORM CD-2

CORRIDOR ANALYSIS TABULATION

HARLAND BARTHOLOMEW AND ASSOCIATES

City Planners, Civil Engineers, Landscape Architects

Calc. by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______

PROJECT ____________________ Sheet No ______ of ______

CORRIDOR DESIRE SUMMARY

CORRIDOR ______ (CARDINAL) (SECONDARY) (SPECIAL)

SCREEN LINE	DESIRES FROM	SEMI-ASSIGNED DESIRES: THROUGH — ACROSS SECTION	THROUGH — SECTION TERMINUS	LOCAL — ACROSS SECTION	LOCAL — SECTION TERMINUS	INTERNAL — ACROSS SECTION	INTERNAL — SECTION TERMINUS	24 HR VOLUME	PEAK HOUR %	DIRECTIONAL DISTRIBUTION	ONE-WAY PEAK HOUR VOLUME	PRACTICAL CAPACITY
	CD-1											
	CD-2											
	TOTAL											
	CD-1											
	CD-2											
	TOTAL											
	CD-1											
	CD-2											
	TOTAL											
	CD-1											
	CD-2											
	TOTAL											
	CD-1											
	CD-2											
	TOTAL											
	CD-1											
	CD-2											
	TOTAL											
	CD-1											
	CD-2											
	TOTAL											

12-61

HB & A FORM CD-3

HARLAND BARTHOLOMEW AND ASSOCIATES
City Planners, Civil Engineers, Landscape Architects

PROJECT ______________________

Calc by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______
Sheet No ______ of ______

TRAFFIC DIVERSION ESTIMATES

ROUTE A ______________

DESIRE MOVEMENT		TRAVEL TIMES ROUTE A	ROUTE B	ROUTE C	RATIO B/A	% DIVERTED	RATIO C/A	% DIVERTED

HB&A FORM CD-4

HARLAND BARTHOLOMEW AND ASSOCIATES
City Planners, Civil Engineers, Landscape Architects

PROJECT ______________________

Calc by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______
Sheet No. ______ of ______

CAPACITY ANALYSIS
CORRIDOR ______

LOCATION		CONDITIONS	CURVE AND CHART REFERENCE	CAPACITY SECTION	CAPACITY CORRIDOR

12-61

HB & A FORM CD-5

CORRIDOR ANALYSIS CODING SHEET – TRIP DATA

HARLAND BARTHOLOMEW AND ASSOCIATES

City Planners, Civil Enginee Landscape Architects

PROJECT ______________________

Calc. by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______
Sheet No ______ of ______

CARD NUMBER [1]
1

CITY NUMBER [ ][ ]
78 79

RUN NUMBER [ ]
80

SERIAL NUMBER					ORIGIN ZONE			DEST ZONE			VOLUME						GROUP A FACTORS																		GROUP B FACTORS																	
																	A 1			A 2			A 3			A 4			A 5			A 6			B 1			B 2			B 3			B 4			B 5			B 6		
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54

HB & A FORM CD6

CORRIDOR ANALYSIS CODING SHEET

HARLAND BARTHOLOMEW AND ASSOCIATES

City Planners, Civil Engineers, Landscape Architects

Calc by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______
Sheet No ______ of ______

PROJECT ______________________________

CARD NUMBER [ ] 1 ________ **SCREEN LINES**

CITY NUMBER [ ][ ] 78 79 RUN NUMBER [ ] 80

SERIAL NUMBER					LINE NR			POINT 1										POINT 2									
								X1					Y1					X2					Y2				
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

HB & A FORM CD-7

CORRIDOR ANALYSIS CODING SHEET

HARLAND BARTHOLOMEW AND ASSOCIATES

City Planners, Civil Engineers, Landscape Architects

Calc by ______ Date ______
Checked by ______ Date ______
Revised by ______ Date ______
Sheet No. ______ of ______

PROJECT ______________________________

CARD NUMBER [4] 1 **ZONE CENTROID COORDINATES**

CITY NUMBER [ ][ ] 78 79 RUN NUMBER [ ] 80

SERIAL NUMBER					ZONE NR			COORDINATES									
								X					Y				
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

HB& A FORM CD-8