Intercity Traffic Projections

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•THE projection of intercity highway travel was made as a part of the highway needs and fiscal studies prepared for the States of Arizona and Illinois. The projections provided information for development of functional classification systems of streets and highways. Also, the traffic volumes and trip length data were utilized in the development of future physical needs of the various facilities.

In each state basic origin-destination data were available; however, different types of analyses were required to develop the current year trip matrix. In Arizona, the State Highway Department had conducted extensive interviews along all of the major highway facilities. Comprehensive transportation studies provided data for the three largest cities. Growth factors were developed to project traffic to 1985 levels.

The statewide multiple screen line origin-destination survey conducted by the Illinois Division of Highways provided the basic source of data. As established by the Mississippi Valley Highway Conference, the screen lines were spaced at one degree longitude and one degree latitude. Also, data were available from the Chicago Area Transportation Study. Generation-distribution equations were developed and applied to ascertain existing and future trip interchanges. In the following sections the basic procedures utilized in the two states are presented.

ARIZONA

The State Highway Department conducted extensive O-D interviews from 1957 through 1961 on the state highway system in rural locations, as shown in Figure 1. These interviews intercepted the major intercity traffic movements and furnished comprehensive data of all travel patterns. The results of the study provided fundamental information for development of the 1965 travel patterns. In addition, recent interviews made by the State Highway Department in the Navajo Indian Reservation area provided data, and external cordon interview data from the urban area studies conducted in Phoenix, Tucson, and Yuma were also used. The data, when adjusted to 1965 levels, were sufficient to provide a zone-to-zone trip matrix similar to the existing traffic patterns. Traffic was assigned to a network consisting of all major intercity routes and comparisons were made of the assigned volumes and the existing traffic volumes as indicated on the flow maps prepared by the highway department.

Projections of travel patterns to 1985 were based on anticipated population growth and vehicle registration. In addition, the recreation traffic was particularly analyzed in view of anticipated increased visits to the various parks, dams, and national forests.

The statewide O-D surveys conducted in 1957 through 1961 by the Arizona Highway Department resulted in about 450,000 interviews at more than 100 interview stations on principal intercity highway routes. The transstate movements were summarized in a 1965 report (1).

Data were also available from the Valley Area Traffic and Transportation Study for which interviews were taken in the fall of 1964. The Yuma Area Transportation Study (2) and the Tucson Area Transportation Study (3), undertaken in 1961, provided additional interview data.

The 1965 and 1985 trips were assigned to major highway networks representing principal corridors of travel. Vehicle-mile and trip length analyses were undertaken

Paper sponsored by Committee on Origin and Destination.

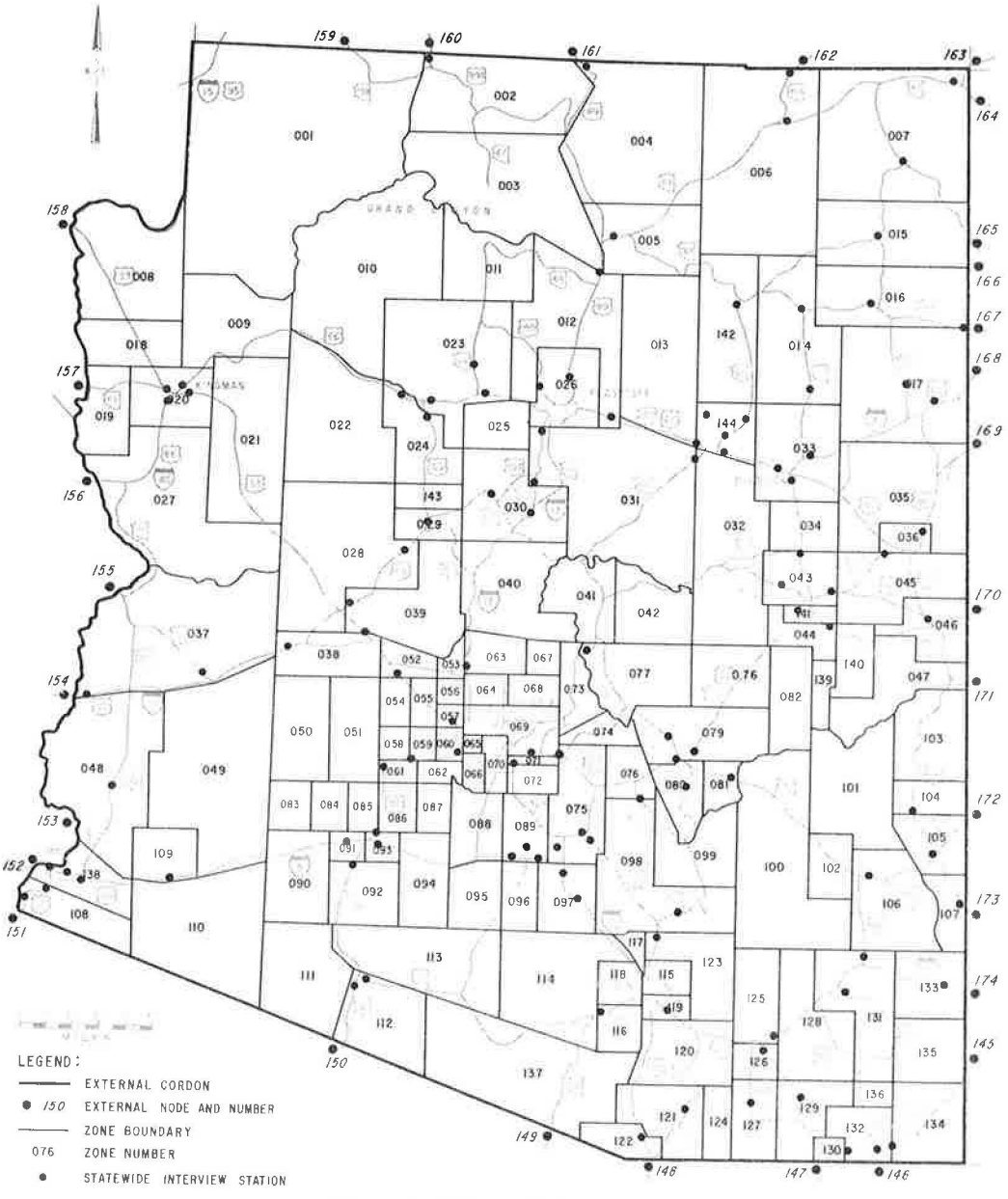

Figure 1. Arizona highway system.

for each route to assist in the determination of future corridor needs. A flow chart indicating the analysis procedure is shown in Figure 2.

Development of 1965 Travel Patterns

In the following paragraphs the analyses utilized to develop the existing year (1965) trip matrix are presented. Traffic was assigned to the highway network and comparisons were made with measured or recorded traffic volumes.

Traffic Zones—The state was divided into 144 traffic analysis zones, as shown in Figure 1. The zones were designated on the basis of population and vehicle registra-

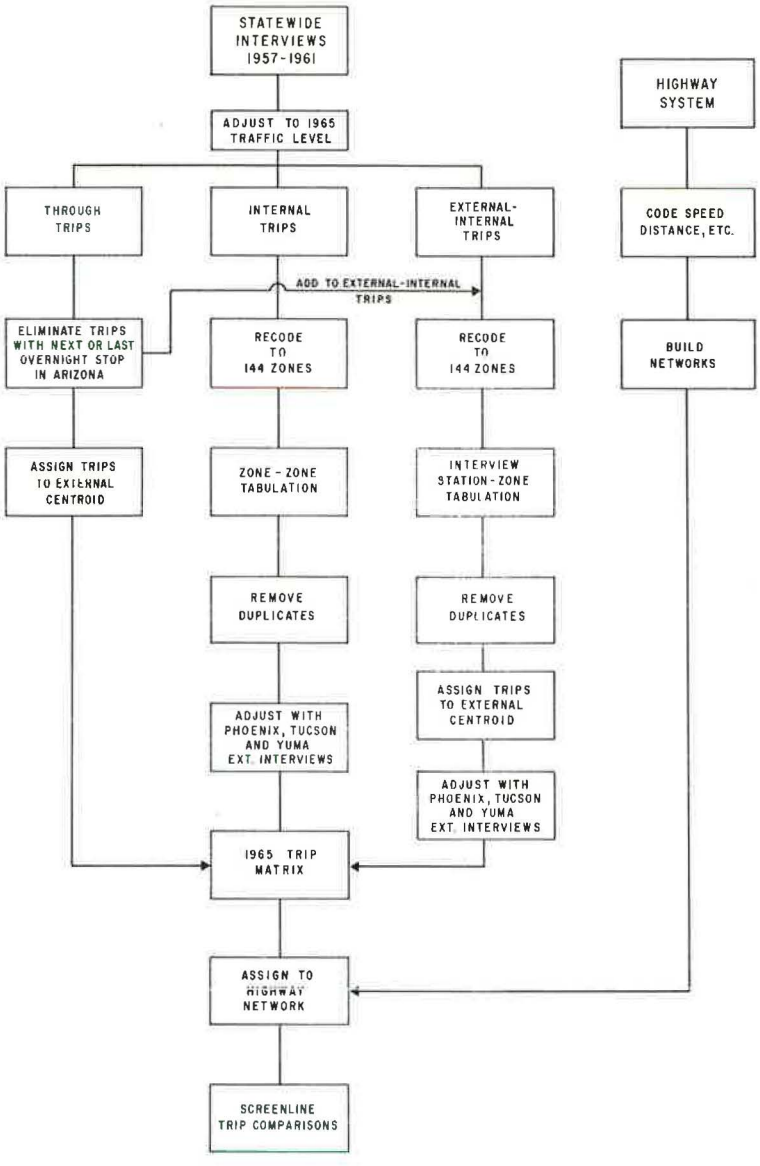

Figure 2. Analysis procedure, Arizona.

tion, which provided for distribution of volumes on the assignment network. External stations were established at 30 state-line entry points.

Population and Related Projections—Significant trends indicate increasing dependence of the state's economy on motor vehicle transportation. The large metropolitan areas are growing, covering more territory with low-density urban populations. Automobile registrations are increasing at a more rapid rate than population, and commercial vehicle registrations are increasing at a rate greater than automobiles. Personal incomes are also increasing and resulting in further demand for automotive transportation. Both rural and urban populations are largely dependent on motor vehicles.

It is anticipated that the statewide population of 1,300,000 in 1960 will increase to 3,100,000 by 1986, an increase of 138 percent. A substantial increase in vehicle

registration is also anticipated between 1965 and 1986, gaining from 830,000 to about 2,000,000 vehicles. Employment is expected to increase from 454,000 in 1960 to 1,100,000 in 1986, an increase of 135 percent. Total personal income is estimated to increase by 152 percent between 1965 and 1986, from $3.7 billion to $9.4 billion.

Traffic Assignment Network—The 1965 traffic assignment network consisted of about 8,094 miles and about 1,001 miles of centroid connectors. This included primarily the US-numbered highways and the major state highways, the primary intercity traffic carriers. Time, speed, and distance were ascertained to describe each link of the highway assignment network. The assigned speeds ranged according to the area and the type of traffic facility. The speeds assumed were 30 mph for the centroid connectors to 60 mph for freeways. All of the zones and the entry points throughout the state were included in the assignment network. For the analysis of the proposed freeway corridors, time and distance networks were established. The standard traffic assignment computer programs were included in the analyses.

Basic Tabulations—The 455,000 interviews procured in the 1957 through 1961 study period were adjusted to 1965 daily traffic levels. Factors were applied to both summer and winter interviews for each of the 106 interview stations. The interview stations were divided into three basic categories—internal, combination, and border. The border stations were those located at state boundaries. The internal stations were somewhat removed from the border and the data were used for trips which had the origin and destination in Arizona. Some of the border stations had to be classified as combination stations since they were located several miles from the state line. Travel intercepted at these stations consisted of internal, external-internal, and through movements.

The origins and destinations within Arizona were recoded to the 144 zones and a series of analysis tabulations were prepared utilizing the basic O-D data. Internal movements were ascertained using data from the internal and combination stations. The basic tabulation included low zone (recoded number), high zone (recoded number), interview station, trip purpose, and season.

The interview station was included to facilitate the removal of duplicates. For example, trips between Tucson and Phoenix could be intercepted several times on the same route and also on parallel routes. This required a manual analysis to remove the duplicates and also provided a system for averaging the movements along a particular route. In all cases the data were developed on a seasonal basis by trip purpose. Because of the nature of the many scenic and recreational attractions in Arizona, specific zone-to-zone trip interchanges were found on many routes. For example, several routes of travel were utilized for trips between Tucson and the Grand Canyon area. This basic tabulation and analysis resulted in the development of a zone-to-zone matrix for trips originating within and ending within Arizona.

The second tabulation summarized through trips intercepted at combination and border stations. The tabulation included route of entry and route of exit (state-line designation assigned by state highway department), interview station, trip purpose, and season. This summarized the transstate movements, i.e., where the origin and ultimate destination were outside of the state. Realizing that many stops had been and would be made along the way, two additional tabulations were prepared. Trips which included an overnight stop in Arizona were recoded and included in the external-internal trip matrix to depict average daily traffic. The last overnight stop in Arizona was considered the zone of origin or destination. The remaining trips were considered as through trips in the analyses. The routes of entry and exit were recoded to the appropriate external centroid (numbers 145-174 as indicated in Fig. 1) consistent with the assignment networks.

To ascertain the external-internal movements a summary was developed from combination and border stations. It included interview station, route of entry, purpose, and season. The manual analysis included the removal of duplicate trips and the merging with data developed from the recoding of external trips with overnight stops.

Thus, three trip tables were prepared and summarized depicting the basic movement of internal, external-internal, and through trips. Total trips were as follows:

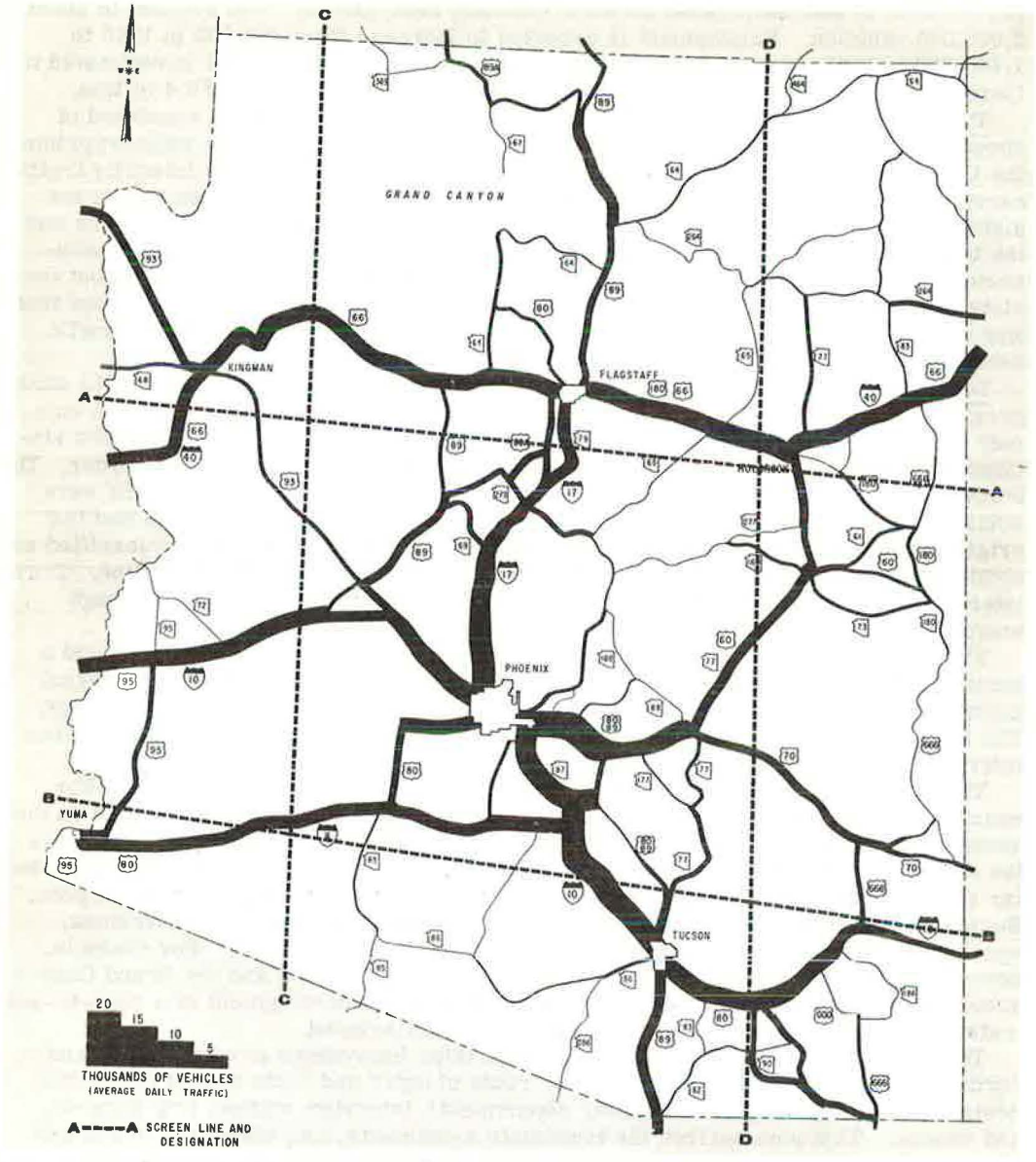

Figure 3. 1965 traffic assignment, Arizona.

Internal	94,285
External-internal	33,858
Through	4,661
Total	132,804

Traffic Assignments—The three sets of data (internal, external-internal, and through trips) were combined into one matrix. The zone-to-zone matrix was utilized to prepare assignments to the existing year highway network. The standard minimum path time network was utilized for making the assignments. It is realized that all interzonal trips did not follow the same paths; however, very close correlations with actual volumes were found along the major routes in the critical travel corridors.

TABLE 1

1965 TRAFFIC VOLUME COMPARISON

Screen Line[a]	Traffic Volume	
	Measured Traffic[b]	Assigned Traffic
A East-west—south of Kingman, Flagstaff, and Holbrook	14,144	17,130
B East-west—south of Safford, north of Tucson, south of Casa Grande and Gila Bend, but north of Yuma	18,793	19,910
C North-south—boundary between Yuma County and Maricopa County, and between Mohave and Coconino Counties	15,164	16,100
D North-south—eastern part of state, parallel to, but west of US 666	22,009	20,950

[a]Screen lines are shown in Figure 3.
[b]Source: Arizona Highway Department, Planning Survey Division.

The assigned 1965 traffic volumes for the basic highway system are shown in Figure 3. The actual assignment network included additional routes to facilitate the zone-to-zone interchange. However, the figure depicts the major corridors of travel.

For comparison purposes, two east-west and two north-south screen lines were established. The actual and estimated volumes recorded across these screen lines are given in Table 1. Based on these and other analyses, it was concluded that the trip matrix properly reflected the 1965 level of intercity travel. It is realized that all trips are not included in the trip matrix; however, sufficient data were available to predict the major desire lines.

Vehicle-Miles and Trip Length—The 132,804 trips in 1965 resulted in about 12,781,000 vehicle-miles of travel. As given in Table 2, internal trips accounted for 54 percent of the vehicle-miles of travel and the average trip length was 73 miles. External trips averaged 149 miles. For all trips the average was 96 miles.

TABLE 2

1965 TRAVEL CHARACTERISTICS

Characteristic	Type of Trip		Total
	Internal	External	
Trips:			
Number	94,285	38,519	132,804
Percent	71	29	100
Vehicle-miles:			
Number	6,928,000	5,753,000	12,781,000
Percent	54	46	100
Average trip length, miles	73	149	96

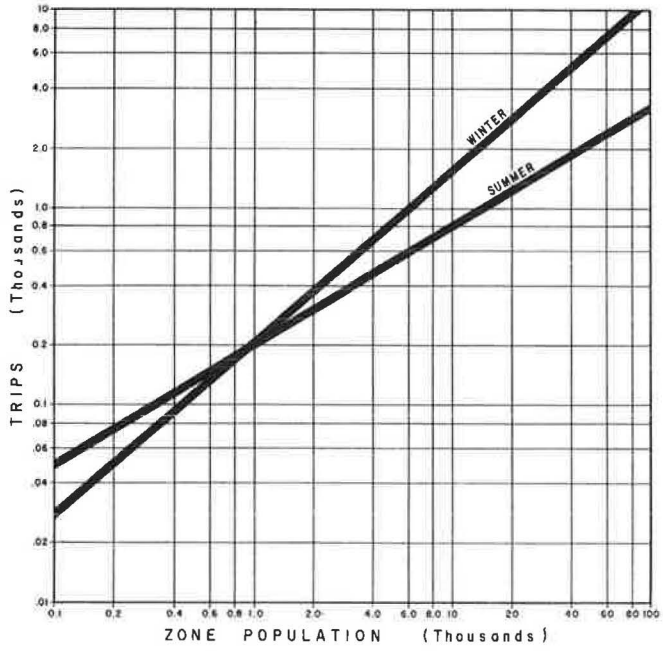

Figure 4. Internal trips, work, Arizona.

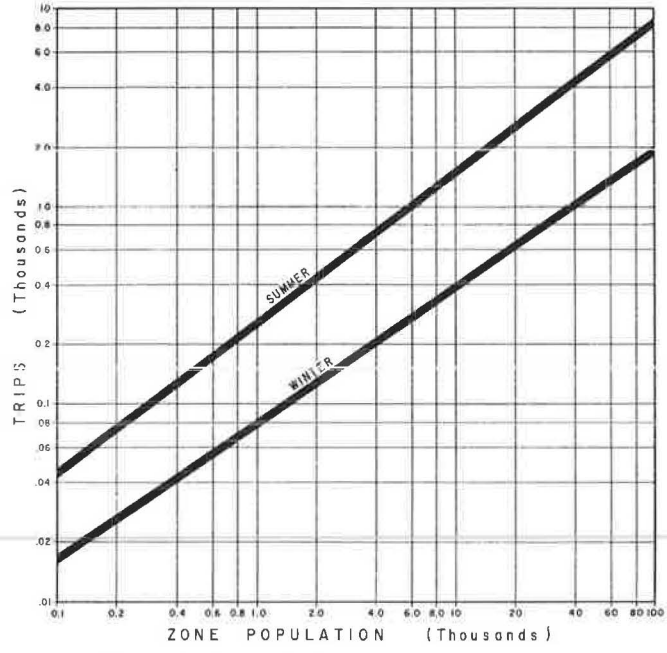

Figure 5. Internal trips, recreation, Arizona.

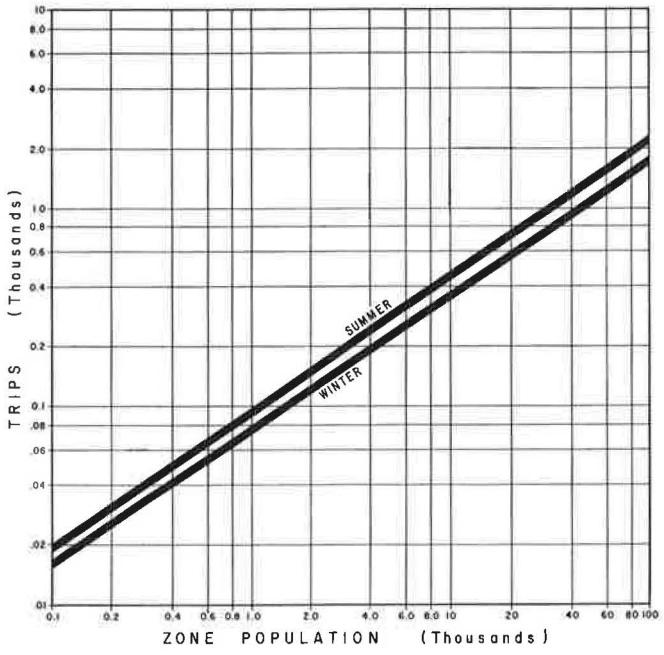

Figure 6. Internal trips, other, Arizona.

1985 Trip Projections

Utilizing the population projections, anticipated vehicle registration increases, and the expected number of visits to recreational areas, 1985 trips were developed.

Internal Trips—A growth factor technique was utilized to develop the appropriate projections for both internal and external traffic. In Figures 4, 5, and 6, the 1965 trip generation is depicted for each purpose by seasons. These are illustrated for the basic internal trip purposes of work, recreation, and other. The generation rates were used to determine the basic growth factor for each zone. This factor was further modified by the increase in vehicle registration which is expected to occur in each county. Therefore, the growth factors for the trips to and from each of the 144 internal zones

TABLE 3

INTERCITY TRIP PROJECTIONS, ARIZONA

Type of Trip	Number of Trips		Percent Increase
	1965	1985	
Internal:			
Work	46,648	93,190	100
Recreation	37,075	100,332	170
Other	10,562	20,370	93
Total internal	94,285	213,892	127
External:			
External-internal	33,858	79,280	134
Through	4,661	11,073	139
Total external	38,519	90,353	135
Total trips	132,804	304,245	129

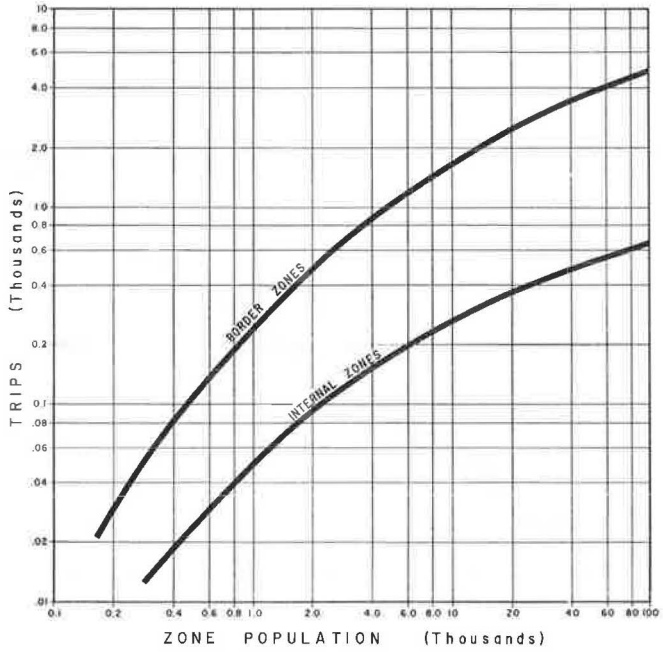

Figure 7. External-internal trips, Arizona.

were based on the estimated population change modified by the future vehicle registration for each county.

For the recreation trips, estimates of the increase in visits were made for the national parks, the national recreation areas, and other facilities. These increases were assigned to the appropriate zones. For the zones which did not have the recreational facilities, the population, vehicle registration and overall increase in vehicle-miles of travel were utilized in the calculation.

As given in Table 3, it is estimated that all internal trips will total 213,892 by 1986. This would represent a 127 percent increase in total internal travel. Work trips are anticipated to increase 100 percent whereas a 170 percent increase is anticipated for recreation trips. Other trips will increase from 10,502 to 20,370, a gain of 93 percent.

External Trips—For external trips, growth factors were developed for each entry point based on trends in growth and estimated increases. Factors were also applied to each zone based on 1965 external trips compared to zone population. The zones were divided into two categories, internal and border. The border zones located at or near the external stations generated trips at a much higher rate than the internal zones, as shown in Figure 7. The growth factors for the external stations and for the internal stations were balanced to develop an overall external matrix.

It is anticipated that the external travel will increase 135 percent, from 38,519 in 1965 to 90,583 in 1985. The through trips should total approximately 11,073 in 1985, an increase of 139 percent. The external-internal travel is expected to be 79,280 trips in 1985, as contrasted with 33,858 in 1965. The total intercity travel movements are expected to be 304,245 in 1985, representing an overall growth of 129 percent over the 132,804 in 1965.

Traffic Assignments—Travel assignments to the major freeway and highway networks are shown in Figure 8. The basic traffic volumes have been adjusted (1.15 factor) to reflect the influence of establishing an Interstate freeway in a particular corridor. It has been assumed in the assignments that the Interstate System will provide the basic framework of the future highway network.

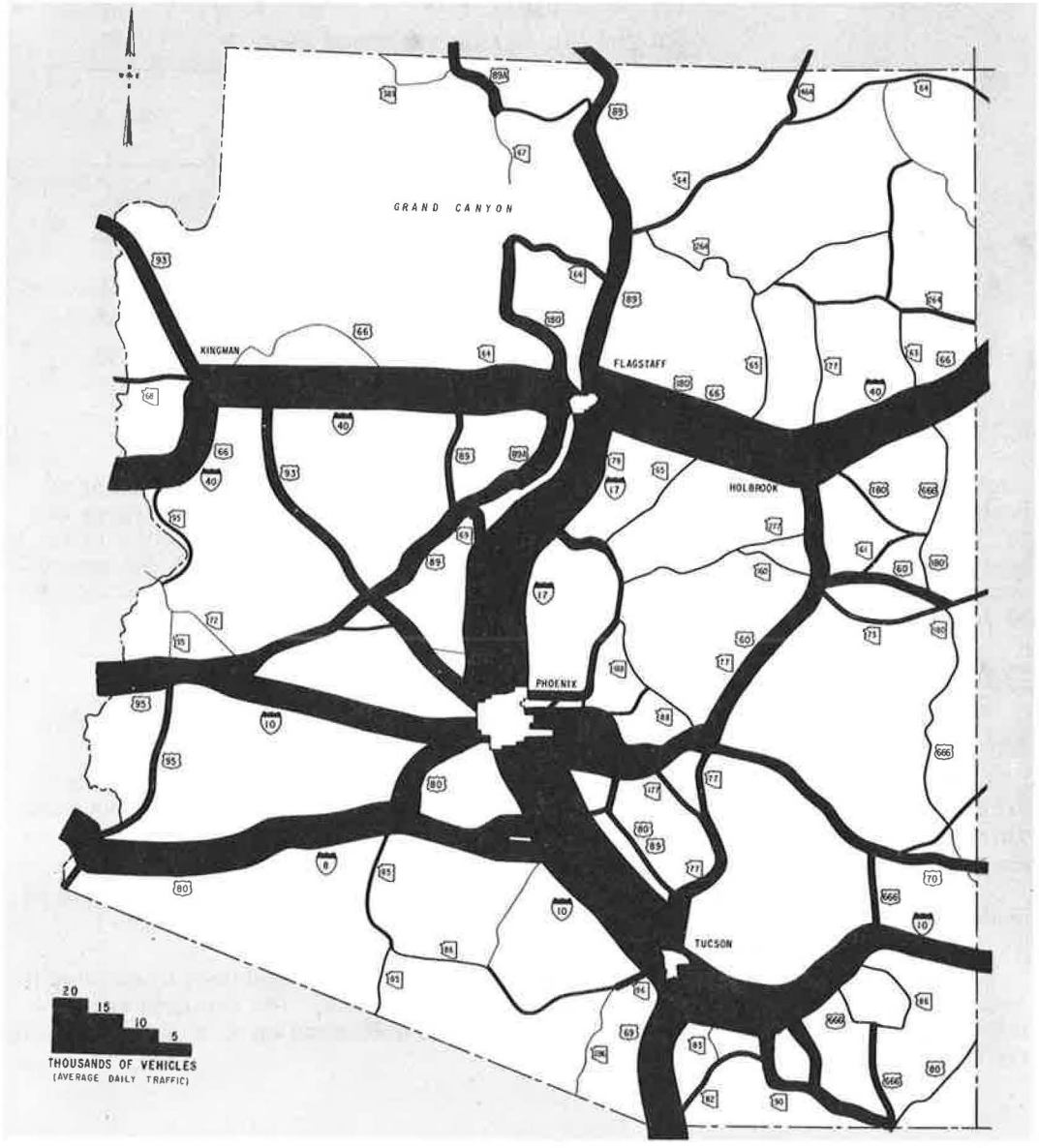

Figure 8. 1985 traffic assignment, Arizona.

1985 Travel Characteristics

About 70 percent of the 1985 trips will be internal and 30 percent external. The internal trips will produce 16,421,000 vehicle-miles of the total 30,138,000, or about 55 percent. The average trip length for internal trips will be 77 miles as compared with 152 miles for external trips. Combining these, the average trip length will be 99 miles. Therefore, internal trips will account for 70 percent of the total trips but only 55 percent of the total vehicle-miles of travel, as given in Table 4.

The distribution of travel for 1985 was calculated for the several types of facilities. The highway facilities were subdivided into connectors, other routes, and the Interstate System, as given in Table 5. The connectors reflect the travel between the zone centroid and the basic highway network. It is anticipated that internal trips will produce

TABLE 4
1985 TRAVEL CHARACTERISTICS

Characteristic	Type of Trip		Total
	Internal	External	
Trips:			
Number	213,892	90,353	304,245
Percent	70	30	100
Vehicle-miles:			
Number	16,421,000	13,717,000	30,138,000
Percent	55	45	100
Average trip length, miles	77	152	99

a total of about 16,421,000 vehicle-miles of travel. Of this amount, 6,535,000 or 40 percent will utilize the freeway system. About two-thirds of the external travel will be accommodated by the freeway system and will account for 9,061,000 of the 13,717,000 vehicle-miles. For total travel, it is estimated that there will be 30,138,000 vehicle-miles of travel daily. Of this, slightly more than half, 15,596,000 vehicle-miles, will be accommodated by the Interstate System.

Trip Length Analysis

Vehicle-miles of travel were ascertained for each network link and traffic zone. The following procedure was employed using future trips and networks:

1. A matrix of interzonal vehicle-miles of travel was developed by multiplying the 1985 interzonal trips by interzonal distances utilizing the traffic assignment network. This produced a tabulation of vehicle-miles of trips having an origin or destination in each zone.
2. A table of zones "ranked" according to vehicle-miles of travel originating in or destined to each zone was developed.
3. Vehicle-miles were assigned to highway networks.
4. Average trip length on each highway network link was ascertained by dividing the vehicle-miles on a given link by the assigned traffic volume. The assigned vehicle-miles represent the total vehicle-miles from origin to destination of all trips traversing the link.

TABLE 5
1985 DISTRIBUTION OF TRAVEL

Type of Facility	Type of Trip				Total	
	Internal		External			
	Vehicle-Miles	Percent	Vehicle-Miles	Percent	Vehicle-Miles	Percent
Connectors	1,248,000	8	411,000	3	1,659,000	5
Other routes	8,638,000	52	4,245,000	31	12,883,000	43
Interstate System	6,535,000	40	9,061,000	66	15,596,000	52
Total	16,421,000	100	13,717,000	100	30,138,000	100

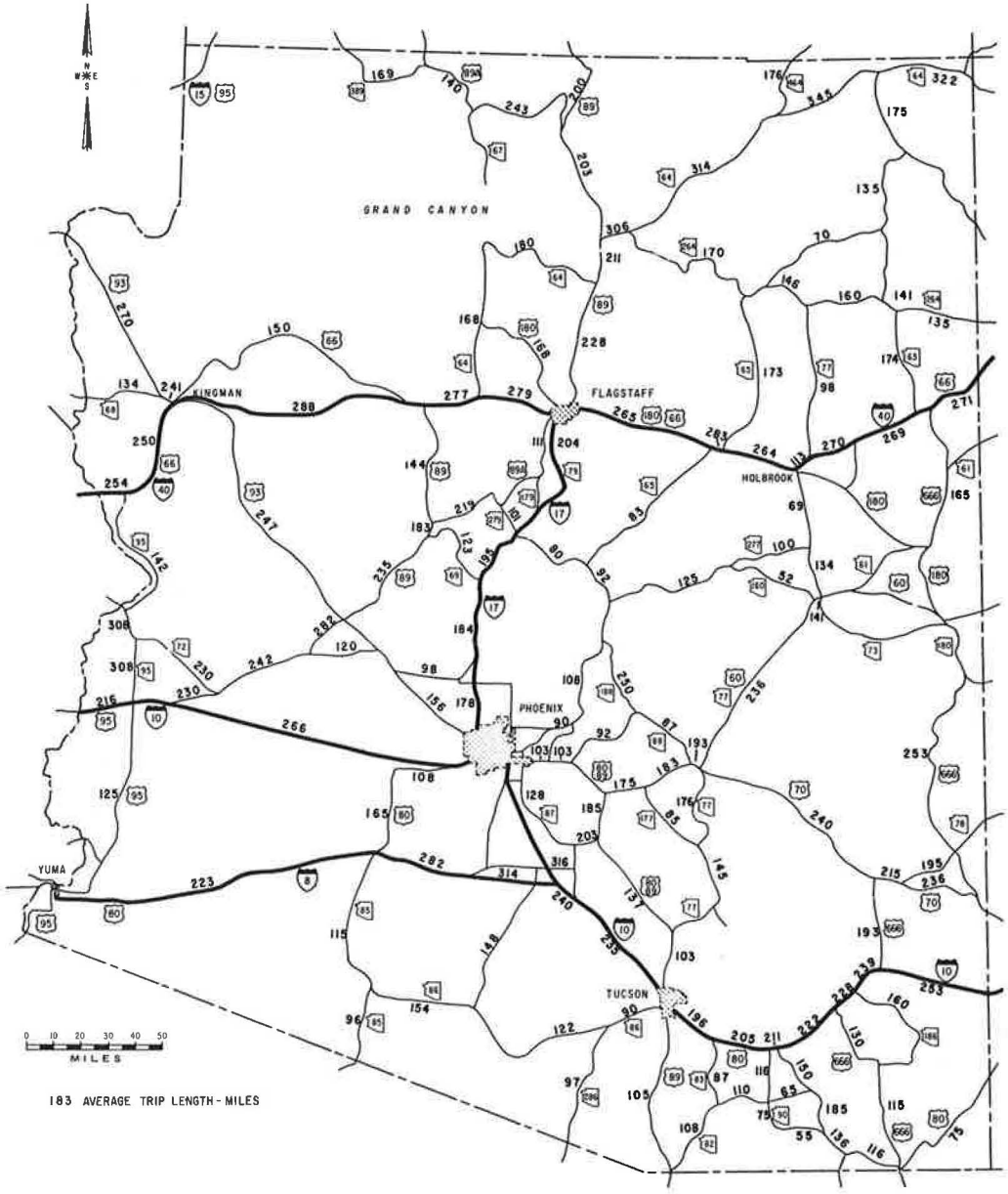

Figure 9. 1985 relative average trip lengths, Arizona.

The relative average trip lengths calculated for various sections of the proposed highway system are shown in Figure 9. As anticipated, the highest average trip lengths will occur on the Interstate System, which will be located in the primary corridors of long-distance travel. The relative average distance will be more than 200 miles on all parts of the Interstate System. The average distance will be about 100 miles on the other major highway systems.

Intrazonal trips were not included in the calculations. Also, the distances for external trips were measured from the state-line points of entry or exit to the zone centroid.

ILLINOIS

The basic procedure followed in the study consisted of synthesizing existing travel patterns and utilizing population, vehicle registration, and available origin-destination data. Zone-to-zone trip interchanges were calculated for all intercity movements. Traffic was assigned to a network consisting of all major routes, and comparisons were made of synthesized and recorded existing traffic volumes along east-west screen lines. Projection of travel to 1985 was based on estimated growth in population and vehicle registration.

The statewide multiple screen line O-D survey conducted in 1959 by the Illinois Division of Highways provided the basic source of data (4). This consisted of extensive O-D surveys on principal intercity highway routes. Interview stations were located on north-south and east-west screen lines throughout the state. They were part of a grid system with one-degree longitude and one-degree latitude spacing as established by the Mississippi Valley Highway Conference. This study was part of a cooperative project to develop basic O-D data for the Midwest region. Data were produced relative to trip origin, destination, purpose, and mode of travel.

Data were also available from the Chicago Area Transportation Study (CATS) concerning external trips. Basic projections and freeway assignments prepared as part of CATS were also utilized for the state-line stations in the area. The volumes projected by CATS on major routes crossing the Illinois-Indiana border were included in the analyses.

The state also interviewed at several locations on the state boundary and included the data in the multiple screen line tabulation. These include data obtained for the Mississippi River Bridge stations located between St. Louis and East St. Louis.

Separate analyses were prepared for trips which originated and ended within the state (internal), trips which had one end outside of the state (external-internal), and for trips which had both the origin and destination in other states (through).

The 1964 and 1985 travel patterns were assigned to the existing and proposed major highway networks. A vehicle-mile and trip length analysis was undertaken for each route to assist in the determination of future highway needs. A flow chart indicating the analysis procedure is shown in Figure 10.

Development of 1964 Travel Patterns

In the following paragraphs, procedures employed to develop the existing year (1964) trip matrix are presented.

Traffic Zones—The state was divided into a total of 526 traffic analysis zones, as shown in Figure 11. This consisted of groupings of townships within the 102 counties, approximately five zones per county. The City of Chicago was subdivided into seven zones for analytical purposes. External stations were established at 59 state-line entry points. In some instances two or more routes were combined, but all significant routes were intercepted.

Population and Related Projections—Population estimates were prepared for each county and zone in the survey area for the years 1960 and 1985. This report revealed a statewide population of 10,081,000 in 1960, which can be expected to increase to 13,851,000 by 1985, an increase of over 37 percent.

Between 1960 and 1985 it is anticipated that the vehicle driver-age population will increase from 6,104,000 to about 8,736,000, an increase of about 43 percent. A significant and even greater increase in vehicle registration is also anticipated. The 1985 total automobile registration is anticipated to reach 6,990,000, an increase of 112 percent over 3,296,262 in 1960.

Traffic Assignment Network—The 1964 traffic assignment network (about 11,500 miles and about 6,500 miles of centroid connectors) consisted primarily of the US-numbered and major state highways, the main intercity traffic carriers. Time, speed, and distance were ascertained to describe each link of the highway assignment network. The distances were determined from route logs and state maps. The assigned speeds ranged according to the area and type of facility. The assigned speeds were 30 mph for centroid connectors to between 50 and 60 mph for freeway corridors. Turn penalties

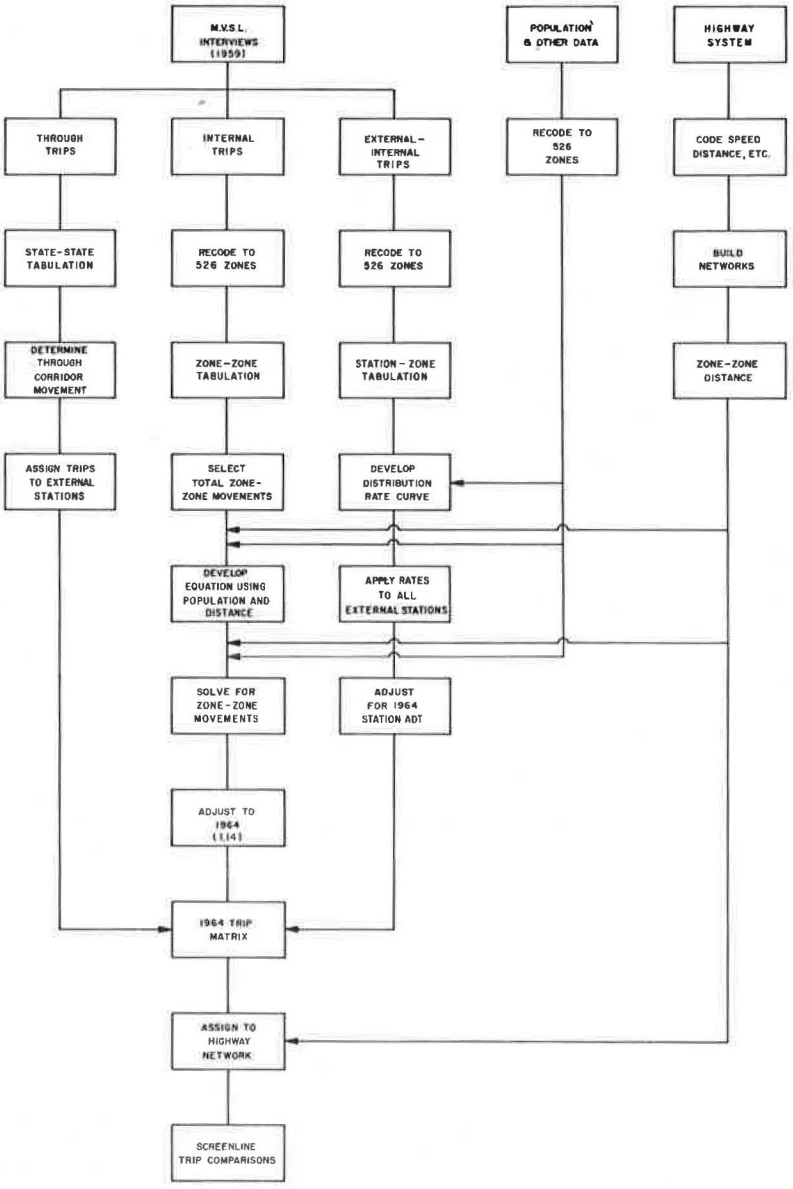

Figure 10. Analysis procedure, Illinois.

and prohibitors were not used. Centroids were established for each of the 526 traffic zones and the 49 state-line stations which were connected to the highway system. For the analysis of proposed freeway corridors both time and distance networks were established.

Internal Trips—The screen line interview stations provided extensive data on intercity traffic movements. However, it was not possible to develop from these data an overall zone-to-zone trip matrix because of the screen line spacing. With 526 zones there was a possibility of about 140,000 zone-to-zone trip interchanges. Therefore, correlations were developed to synthesize the principal movements.

Interview data were stratified by mode of travel and trip purpose. The interview results were recoded to conform with the 526 zones. A tabulation was prepared listing

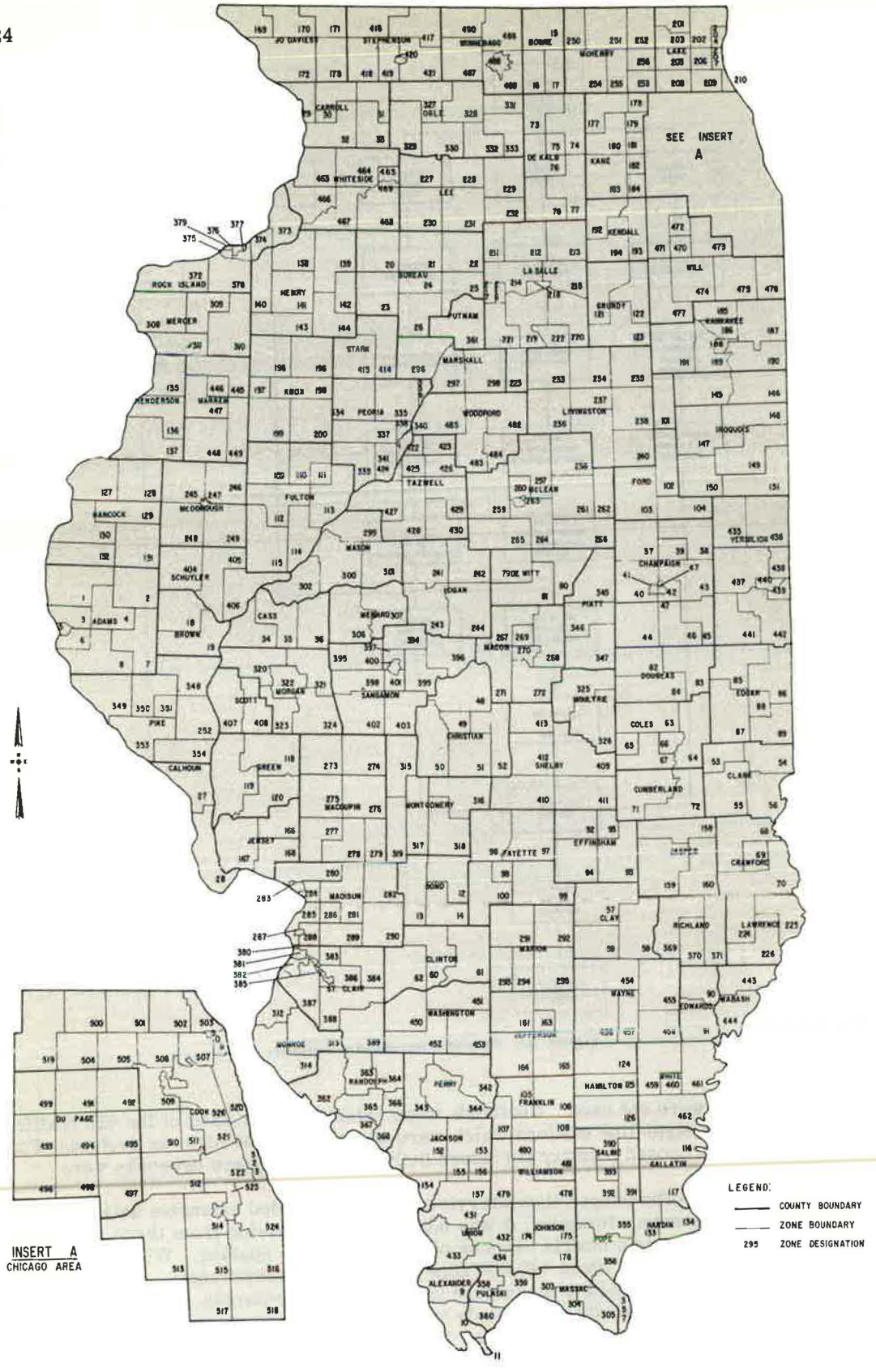

Figure 11. Traffic analysis zones established for statewide traffic projections, Illinois.

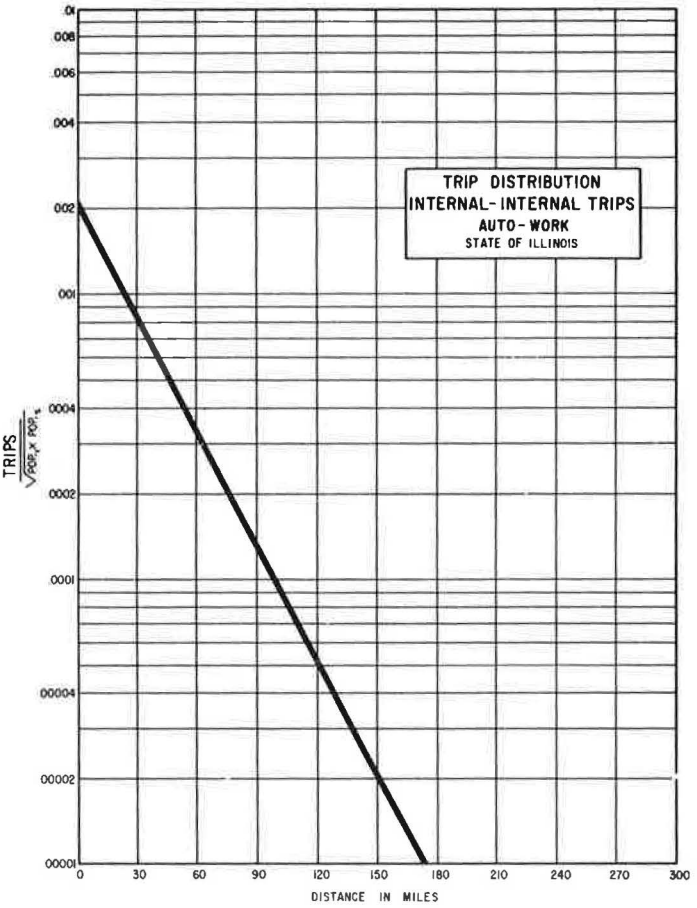

Figure 12. Trip distribution, internal trips, auto-work, Illinois.

zone-to-zone movements for auto and truck trips, and the auto trips were further stratified by work and other trip purposes. A manual analysis was made to eliminate duplicate movements and to offset the results from poorly located interview stations.

The Chicago metropolitan area, which encompasses over half of the total state population, has significantly different travel characteristics from the remainder of the state. Therefore, correlations were prepared for Chicago-oriented trips (one or both trip ends in Chicago) and non-Chicago trips (both trip ends outside the Chicago area).

It was assumed that the traffic interchange between two zones was dependent on the zonal populations and the highway distance between the zones. The "skim distance trees" of the coded network provided the highway distance between zones. A special computer program was prepared which related the distance, populations, and zone interchange, and determined the appropriate equation. Thus the analysis simultaneously produced both trip generation and zone-to-zone distribution.

Driver-age population was also considered in the analyses, but total zone population provided the best correlation. The basic equations for non-Chicago trips are as follows:

Type of Trip	Equation
Auto driver, work	$T(1\text{-}2) = 0.0026 \sqrt{P_1 P_2}\ e^{-0.035D}$
Auto driver, other	$T(1\text{-}2) = 0.0032 \sqrt{P_1 P_2}\ e^{-0.038D}$
Truck	$T(1\text{-}2) = 0.0023 \sqrt{P_1 P_2}\ e^{-0.035D}$

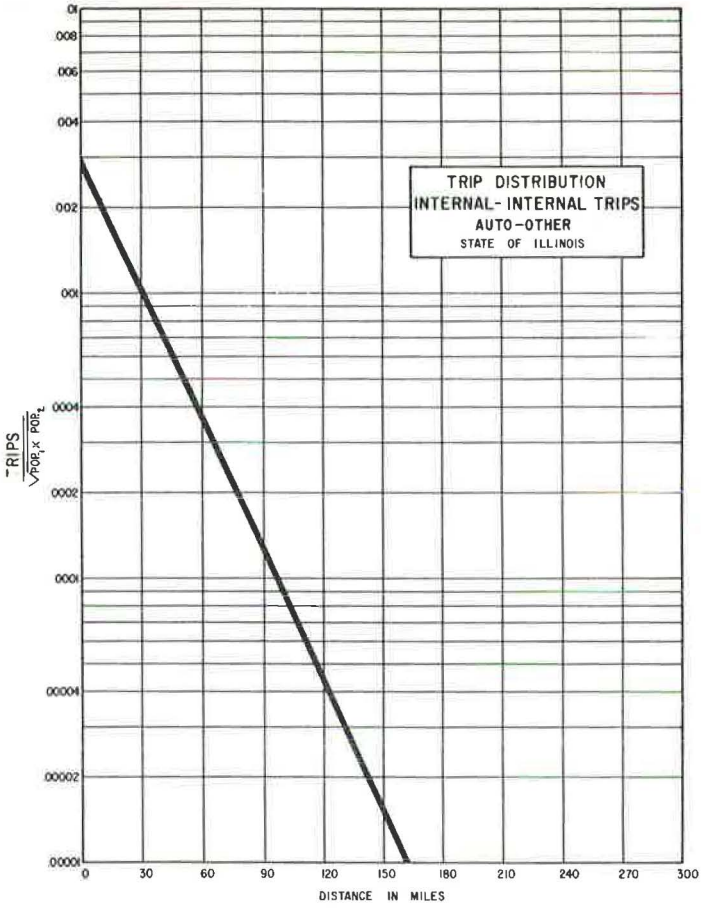

Figure 13.

where:

P_1 = Population of Zone 1;
P_2 = Population of Zone 2;
$T(1-2)$ = Trips between Zone 1 and Zone 2; and
D = Highway distance between Zone 1 and Zone 2.

The basic relationships developed are presented in Figures 12, 13, and 14 for the three different types of trips for non-Chicago trips. The trip interchange between the two zones was divided by the square root of the product of populations and was related to the distance between the two zones. Quite similar relationships were developed for auto driver-work and auto driver-other and for truck trips. There was a significantly sharp decrease in the trip interchange between population centers as the distance between them increased. This provided a good means of reflecting "isolation" of some cities. For cities of similar size, the trip interchange at 30 miles would be three times the rate at 60 miles and almost nine times the interchange rate for 90-mile trips.

Significantly higher intercity trip production rates were found for non-Chicago trips (neither zone located in the Chicago area). The Chicago-oriented trip interchange rate was about 45 percent to 55 percent of the non-Chicago trip rate, depending on trip purpose.

Based on these correlations, the population of each zone and a table of distances between each zone pair were developed, and through the use of a computer program

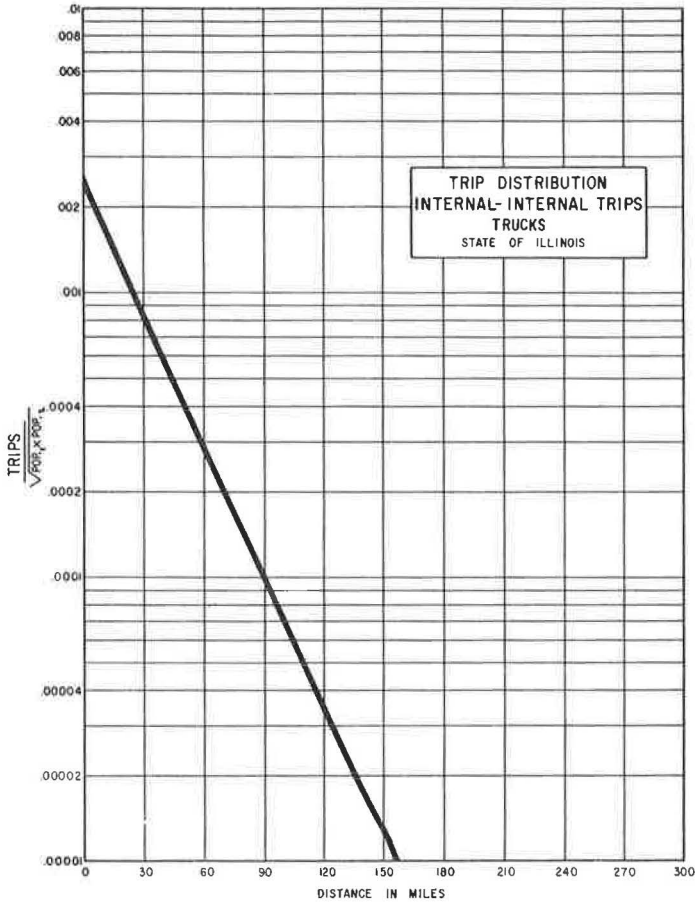

Figure 14.

all zone-to-zone movements were calculated. Based on a review of Illinois travel data it was estimated that intercity travel increased 14 percent between 1959-60 and 1964. Therefore, this overall adjustment was applied to the trip matrix to develop traffic for 1964 levels. There was a total internal intercity interchange of 677,825 trips in 1964.

External-Internal Trips—On a typical 1964 weekday there was a total movement of 418,000 vehicles as measured at 49 stations along the state boundaries. Of this total, 374,000 trips were external-internal movements, and about 44,000 were through trip movements.

Primary external state-line movements occurred in the Chicago area at the Illinois-Indiana border, north of Chicago at the Wisconsin boundary, and across the Mississippi River bridges in the St. Louis-East St. Louis and Quad City areas.

Stations were grouped for the St. Louis area and also the Quad City area. The volume in the St. Louis-East St. Louis area totaled 83,600 vehicles per day in 1964, and a total of 53,000 vehicles crossed the Mississippi River in the Quad City area. In the Chicago area three stations were established with a total volume across the Illinois-Indiana line of 71,000 vehicles a day.

For selected interview stations located at or near the state line, the internal-external trips per 1,000 population were related to the distance between the station and the destination zone to develop a relative distribution rate. Separate analyses were undertaken for stations near the large metropolitan areas of Chicago and St. Louis

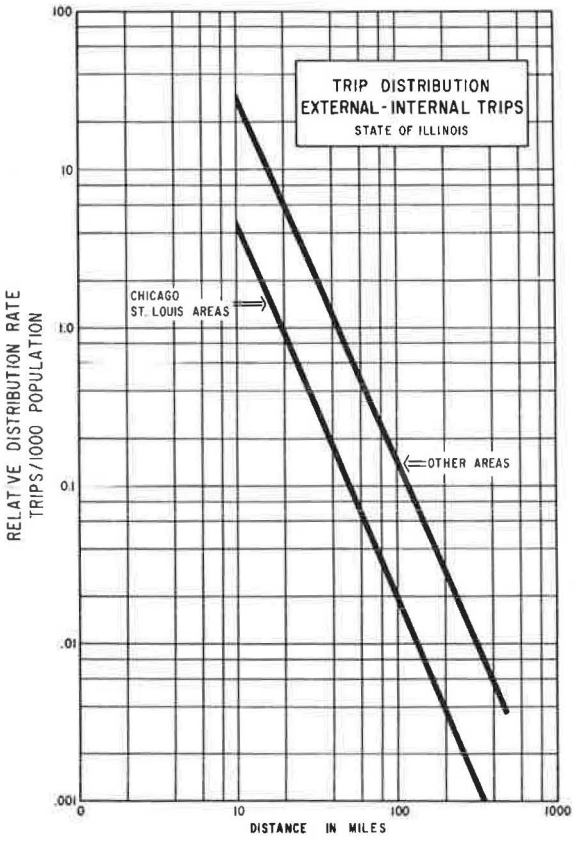

Figure 15.

since the distribution rate for these stations was lower than for other areas. As shown in Figure 15, for the Chicago and St. Louis areas the trip distibution rate at a distance of 20 miles was about one-sixth of that found in other areas. For the Chicago and St. Louis areas the lower distribution rate by zones near an external station reflected several adjacent zones with intense population densities; for other areas the route may serve only one major zone in the immediate vicinity of the station.

Equations were not developed for external-internal trips; however, the calculated distribution rates were used to manually distribute the estimated 1964 volume of about 374,000 trips between external stations and internal zones. The recorded volumes were used as control totals after applying the distribution rates.

Through Trips—Through movements represented only a small part of the intercity trips; however, their longer trip length and restriction to only a few corridors created significant movements along some routes.

The available data were adequate to determine the through trip movements. However, a manual analysis was required to establish station-to-station movements since the interview data did not include points of route of entry or exit at the state boundaries for the trips. Therefore, the external movements were assigned to the appropriate stations based on the percent of the state-to-state movement occurring at each station with the recorded through volumes along major routes used as a comparison.

1964 Traffic Assignments—The three sets of synthesized data (internal, external-internal, and through trips) were combined into one matrix of 1964 intercity trips. The zone-to-zone matrix was utilized to prepare assignments to the existing (1964) year network to provide comparisons with actual intercity traffic volumes. This is the most important test since the primary purpose of the projection is the determination of travel volumes in key corridors. These data were converted for computer input and standard minimum path assignment programs were used. (The zone-to-zone trip matrix was

converted into Memory J format. The assignment procedure utilized minimum time between zones via the highway network.)

The actual and estimated volumes recorded at the east-west interview screen lines established in the multiple screen line study were as follows:

Latitude (deg. N)	1964 Volume (actual)	1964 Volume (estimated)
38	20,000	15,381
39	32,200	31,978
40	42,450	37,831
41	44,900	55,272
42	14,900	13,248
Total	154,450	153,710

Screen line comparisons for the four screen lines are given in Table 6.

1985 Trip Projections

Utilizing population projections and anticipated vehicle registration increases, the 1985 trips were developed.

Internal Trips—Several factors will determine the magnitude of future intercity trips. First, the overall state population is estimated to increase from 10,081,000 in 1960 to 13,851,000 in 1985. Vehicle registration will more than double. There has been a steady increase in traffic along the intercity routes as improvements have been implemented. It is anticipated that this growth will continue at a rate less than the overall vehicle registration but substantially higher than population. The overall travel growth is expected to be about 86 percent, an average of 3 percent compounded annually.

Utilizing the projected populations for each zone and the generation-distribution equations, the 1985 zone-to-zone internal trip interchanges were calculated. An adjustment factor was applied to account for increased vehicle registration and use to achieve an overall increase of 86 percent. Based on these analyses there will be an estimated internal movement of 1,256,025 trips in 1985 as compared to 677,000 in 1964.

External-Internal Trips—Anticipated 1985 daily traffic volumes were estimated for the 49 external stations. Projections made by the CATS study, the Lake County Transportation Study, and by the highway departments of Wisconsin, Iowa, Missouri, Kentucky, and Illinois for the Interstate and other highways were reviewed. The estimates were

TABLE 6

SCREEN LINE COMPARISONS

Screen Line[a]	Location	1964 Volume[b] (actual)	1964 Volume (estimated)
1	South of Ill. 13	12,750	11,930
2	North of US 40 and Ill. 16	36,550	34,040
3	North of US 136 and US 24	46,850	47,110
4	North of Ill. 116	50,200	56,760
Total		146,350	149,840

[a] Screen line locations are shown in Figure 11.

[b] Source: Traffic Volume Map, State of Illinois, prepared by Bureau of Planning, Division of Highways, Department of Public Works and Buildings.

TABLE 7

ESTIMATED INTERCITY TRIPS, ILLINOIS

Type of Trip	Year		Increase (percent)
	1964	1985	
Internal-Internal	677,825	1,256,025	86
External-Internal	374,031	791,593	112
External-External	43,112	114,782	167
Total	1,094,968	2,162,400	97

also based on volume trends at each station and the anticipated population growth of the particular region of the state. It is estimated that the total state-line volume will increase from 418,000 in 1964 to about 906,000 in 1985, an increase of 118 percent.

Utilizing the trip rates developed for 1964 traffic, external-internal trips were distributed to the traffic zones. Factors were applied to adjust to the estimated station control total. The total external-internal volume in 1985 is estimated to be 791,593 vehicles compared to 374,031 vehicles in 1964.

Through Trips—A 1985 through movement of 114,800 is anticipated as compared to 43,000 trips in 1964. Through trips were estimated for each station and distributed utilizing the Fratar method, which takes into consideration future station volume and the existing station-to-station trip interchange.

Trip Comparisons—As given in Table 7, it is estimated that the total intercity movement will be 2,162,400 trips by 1985, an increase of 97 percent over the 1964 level. The through trip volume is expected to increase at the highest rate, followed by external-internal travel, which reflects a substantial anticipated increase in the use of Interstate and other major facilities. Chicago and St. Louis, which will experience relatively high population growth, and since they are located at the state boundaries, will contribute to the major increase in the external-internal trips.

1985 Traffic Assignments—Traffic has been assigned, using the minimum time path technique, to the proposed statewide system of freeways and major highways designed to serve 1985 travel demands. (The minimum time between zones via the highway network was used.) Also, trip length and vehicle-mile analyses have been made.

The assignments to the freeway and major highway networks are shown in Figure 16. The basic traffic volumes have been adjusted (1.15 factor) to reflect the influence of establishing an Interstate freeway in a particular corridor.[1] Also, factors have been used ranging from 1.30 to 1.60 for generation of additional traffic due to the provision of more superior traffic service. It is realized that volumes will increase on the urban area approaches, whereas the intercity values generally reflect anticipated rural traffic volumes.

It was assumed that the basic projection procedure accounted for the A, S, and L factors. Generation on a limited-access facility has been found to range from 30 percent to about 60 percent. This accounts for trips resulting from new developments along the route occasioned by construction of the facility, and more trips including travel mode change because of the new or greatly improved route. With the nationwide system of Interstate highways having a common identification and being located in major

[1]From The 1965 Estimate of the Cost of Completing the Interstate System, U.S. Department of Commerce, Bureau of Public Roads, 1963. The basic formula is as follows:

$$\text{Design year traffic} = AG\,(1+SLI)$$

where

A = base year assigned traffic, G = generation factor, S = statewide percentage traffic increase, L = factor to convert statewide percentage increase(s) to the percentage increase for a particular location, and I = factor to reflect more rapid rate of growth along Interstate system when improved to Interstate standards.

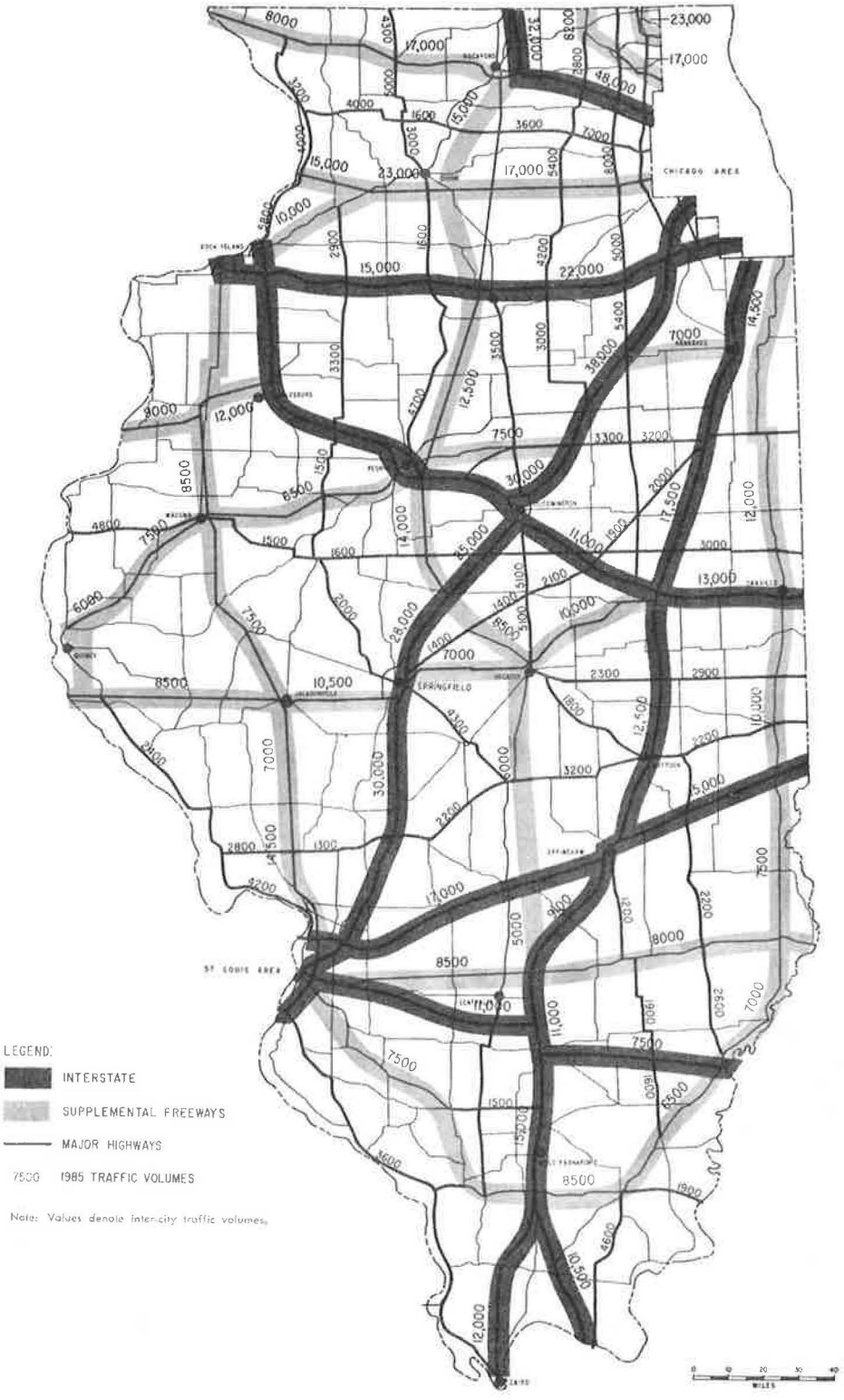

Figure 16. 1985 traffic volumes, proposed freeway and major highway corridors, State of Illinois.

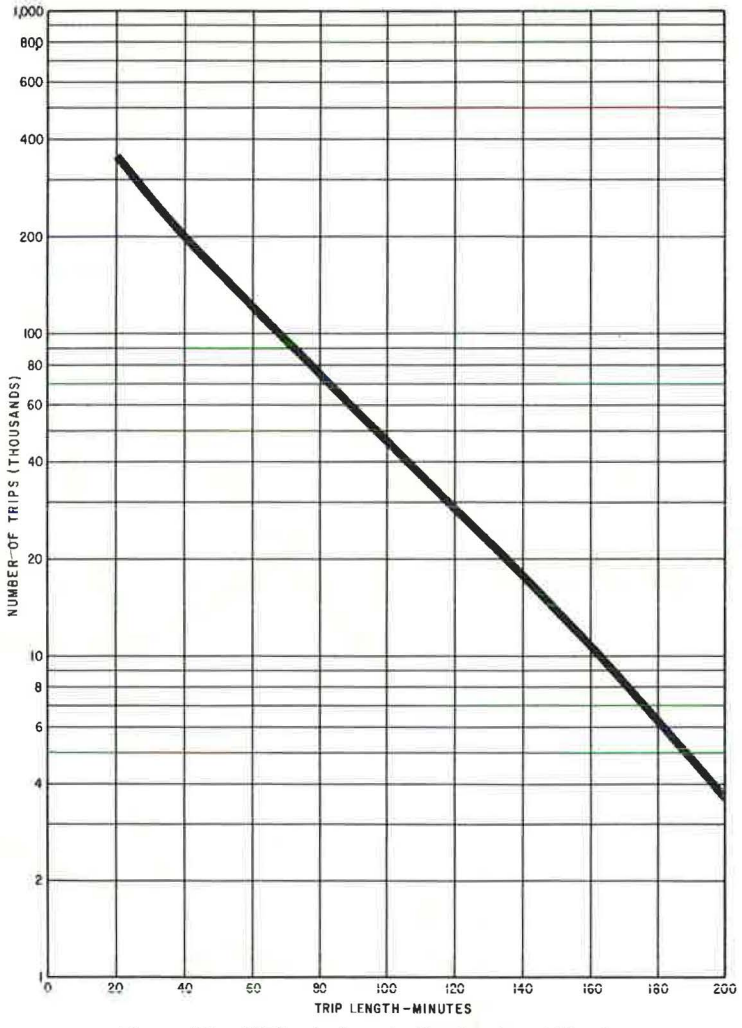

Figure 17. 1985 trip length distribution, Illinois.

travel corridors, it is anticipated that a more rapid growth will occur. Therefore, an additional value of 1.15 (the I factor) is suggested for these routes.

The relationship of trip length and time is shown in Figure 17 for 1985 conditions for the assumed network. There will be a substantial number of trips in the short time periods, rapidly decreasing for longer time and distance ranges. The average trip length for trips assigned to the highway network would be 38.6 miles and average speed would approximate 46 mph. This would produce about 83,000,000 vehicle-miles of travel. The trip length and vehicle-miles should be considered as relative. Distances from centroids to the assignment network and the elimination of many short trips due to the limited number of zones tend to increase trip length.

Vehicle-Miles and Trip Length

Vehicle-miles of travel was ascertained for each network link and traffic zone. The same procedure used for the Arizona analyses was followed in utilizing computer programs.

The 526 internal zones were divided into five groups or increments (about 105 zones in each group) according to vehicle-miles of travel. As shown in Figure 18, the first increment produced about two-thirds of the vehicle-miles and the first two increments

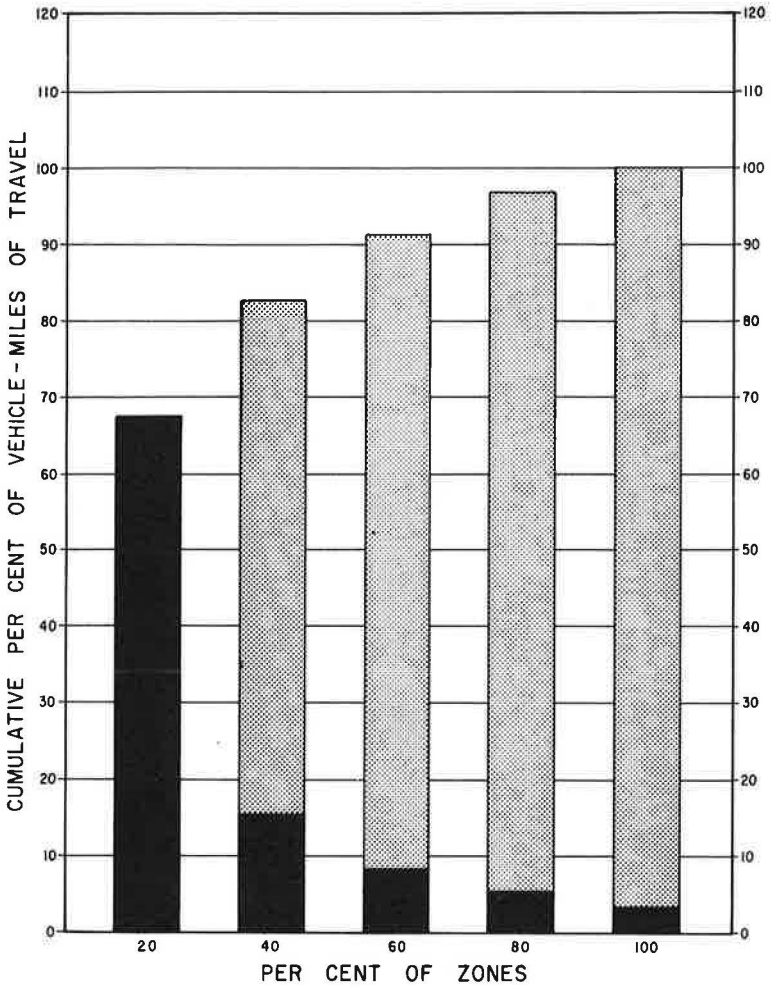

Figure 18. Interzonal vehicle-miles of travel, Illinois.

(40 percent of the zones) accounted for 83 percent of the total travel. The first three increments are shown in Figure 19 by individual zone, representing 91 percent of total travel. They are generally located in the metropolitan areas.

IN RETROSPECT

By utilizing available origin-destination data, trip matrixes were developed for the base year for Arizona and Illinois. While this did not include all of the intercity traffic trips in Arizona or all movements between zones, it did reflect the major corridors of travel. Assignments to a traffic network of highways revealed close correlations with volumes that would normally be found between cities. It is recognized that traffic volumes substantially increase adjacent to and within the urbanized area. These present and future volumes and capacities are being developed in the urban comprehensive studies, such as are under way in the Phoenix, Tucson, and Yuma areas.

The basic projection procedure involved applications of growth factors which reflected anticipated increases in population, vehicle registration, and recreational area visitation. In Illinois the equations were developed utilizing origin-destination data. These equations were also used to project travel to 1985 levels. For each state the

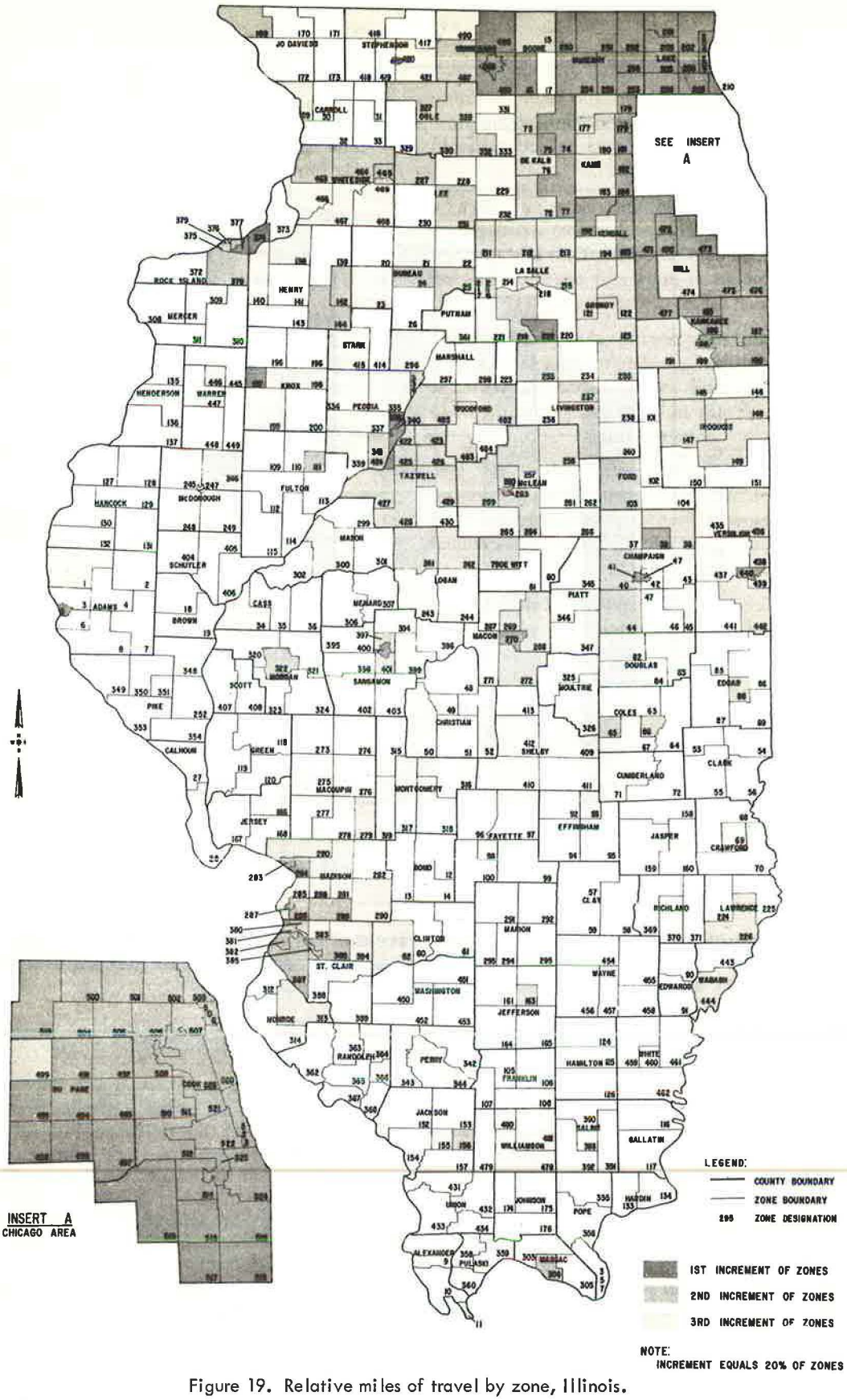

Figure 19. Relative miles of travel by zone, Illinois.

trip matrixes were prepared and assignment networks formulated to permit the testing of other alternatives of movements. Differences in growth patterns for zones also can be reflected.

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