I-29
Usage
Study

SOUTH DAKOTA INTERSTATE HIGHWAY 29

Planning
Report
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SOUTH DAKOTA DEPARTMENT OF HIGHWAYS

RESEARCH AND PLANNING DIVISION

INTERSTATE HIGHWAY 29 USAGE STUDY

Sioux City — Sioux Falls

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In Cooperation With
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INTERSTATE HIGHWAY 29 USAGE STUDY

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I-29 USAGE STUDY

SIOUX CITY – SIOUX FALLS

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GENERATION

The percentage of generated traffic for major intra-study area trips, even those made most attractive by the construction of I-29, fell far short of the normal 30 to 60 percent. Possibly either I-29 had not been completed for a long enough period of time when the "after" interviewing was conducted for maximum generation to have developed, or the bulk of generated traffic occurs in longer trips rather than in the shorter intra-study area trips used in the analysis. A third possibility is that I-29 travel is not a great deal more attractive to local motorists than travel on the old existing highways such as U.S. 77. Certainly congestion on U.S. 77 was not a problem of the magnitude of that existing on many two lane highways, as in urban areas, which carry much higher traffic volumes.

There is some indication that the rate of generation for heavy trucks significantly exceeded the passenger vehicle rate. Lack of data relative to normal local truck travel growth, however, precludes a sound basis for comparison.

DIVERSION – South Dakota Information
NUMBER OF TRIPS ASSIGNED
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Assignment Methods

The actual or observed number of major intra-study area trips using the interstate was 4,388. This number was most closely matched by the 1/4 Time - 3/4 Distance factor assignment method, which assigned 4,179 trips to the freeway. All methods employing greater weights of time resulted in over assignment to I-29, with the 100% time method putting the greatest number of trips, 5,552, on the interstate. The shortest distance path method assigned only 3,551 trips to the freeway.

Partial Diversion Assignment Methods

The South Dakota time, distance and time-distance factor ratio curves produced assignments very near the actual freeway data from which they were developed. The South Dakota travel time ratio curve was significantly less accurate than the other South Dakota curves, as time ratio criteria would not fit the I-29 data well enough for a time ratio curve to be plotted which would be both symmetrical and accurate. The Bureau of Public Roads time ratio curve and the California diversion formula assigned 4,008 and 4,602 trips, respectively, to I-29. This ranks these two methods below the South Dakota curves, but above all shortest path methods except the 1/4T - 3/4D factor method, in accuracy in the number of trips assigned to the freeway.

WEIGHTED AVERAGE NETWORK SPEED

Shortest Path Methods

The actual or observed weighted average network speed was 53.42 miles per hour. The shortest path method which best matched this speed is the shortest distance path method, with a 53.4 mph speed. The 1/4 T - 3/4 D method was next with 53.9 mph. All other methods produced higher speeds.

Partial Diversion Methods

The South Dakota distance ratio curve was most accurate with 53.3 mph followed by the Bureau of Public Roads curve with 53.19 mph. The California diversion formula method produced a speed of 54.3 mph. The ratio methods all resulted in more accurate speeds than any of the shortest path methods except the 100% distance method. Two of the shortest path methods produced more accurate speeds than the California diversion formula.

DIVERSION – South Dakota I-29 and Kansas I-70
Information Assigned by the Shortest
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NUMBER OF TRIPS ASSIGNED

The actual number of trips in each study could be best simulated on each freeway by using a T-D factor with a weight for time of between 1/4 and 1/3. The mean of the percentages (assigned trips divided by actual trips) for the two freeways indicates that the 1/4T - 3/4D method assigned most accurately (in number of freeway trips) of the seven methods used.

WEIGHTED AVERAGE NETWORK SPEEDS

A T-D factor using a weight for time of between 1/4 and 1/3 would best simulate the actual speed in the Kansas study, while the shortest distance method produced the most accurate speed in the South Dakota study. The mean of the South Dakota and Kansas speeds simulated by each method, compared to the mean of the actual speeds, reveals that the 1/4T - 3/4D method mean speed best simulates the mean actual speed.

The shortest time path method was the least accurate of the several shortest path methods, both in number of trips and in speeds, in both the South Dakota and Kansas studies.

PERCENT RMS ERROR IN SOUTH DAKOTA STUDY BASED ON ALL TRIPS CROSSING TEN SCREENLINES

The lowest percent RMS error in the South Dakota study was computed for the T-D factor method employing 1/4T - 3/4D. The highest percent RMS error was computed for the shortest time method.

DIVERSION – South Dakota, Kansas, Cabrillo, Alvarado, Shirley and Kokomo Information Assigned by Five Ratio Procedures And the California Time-Distance Differential Formula

MEAN OF: TRIPS ASSIGNED, WEIGHTED AVERAGE NETWORK SPEEDS AND PERCENT RMS ERROR

South Dakota and Kansas Studies

The South Dakota TD factor ratio curves employing weights of 1/4T - 3/4D and 1/3T - 2/3D ranked either first or second in order of preference in each of the three evaluation categories (trips assigned, speed and percent RMS error).

Cabrillo, Alvarado, Shirley and Kokomo Studies

The 1/4T - 3/4D curve placed first in the speed and percent RMS error categories and second in number of freeway trips assigned. The California formula placed first in number of trips assigned, second in speed and fourth in percent RMS error. The 1/3T - 2/3D curve ranked third in trips assigned and speed and second in percent RMS error.

All Six Studies

The 1/4 T - 3/4 D curve was first in each of the three categories. The 1/3 T - 2/3 D curve placed third in trips assigned and speed and second in percent RMS error. Results of the California formula assignment indicated that it was second in trips assigned and speed and fourth in percent RMS error.

The Three Study Groupings:
South Dakota and Kansas; Cabrillo, Alvarado, Shirley and Kokomo; and All Six Studies

The two TD factor ratio curves, particularly the curve developed using weights of 1/4T - 3/4D, produced consistently more accurate numbers of trips and weighted average network speeds and lower percent RMS errors of estimate than the BPR travel time ratio curve in each of the three study groups.

I-29 BARRIER EFFECT

Only 95, or 1.9%, of the total of 5,036 trips of 25 miles or less in length which crossed I-29 had adverse travel due to the interstate. These motorists had 170.6 miles of adverse travel, an average of 1.8 miles per trip. This information is based on interviews conducted after the interstate highway in the study area was completed; therefore it is possible that some motorists adversely affected have limited the number of their trips now requiring circuitous travel.

INTRODUCTION

This study was completed in accordance with Item 6, Page A-3 of the "Guide for Forecasting Traffic on the Interstate System for the 1965 Cost Estimate". Procedures used were generally as discussed beginning on Page 4-VII-5 of the Highway Planning Program Manual.

In view of the continuing need for research in connection with the traffic usage of the Interstate System, this study was initiated to determine factors of generation and diversion and to collect other pertinent traffic data.

It was felt that the corridor from Sioux Falls to Sioux City would be ideally suited for study of the changes resulting from the construction of the Interstate Highway for the following reasons:

1. These are the two largest cities within the surrounding area and therefore exert an important influence on the travel patterns in the corridor.
2. The Interstate System was to be systematically completed at an early date.
3. The Interstate System within both cities was essentially complete.
4. Because of the highway layout, it would be possible to intercept all of the full length trips with a minimum of interview stations.
5. The corridor lies in a populous agricultural area which should involve local farm to market trips as well as the longer distance trips. Little was known in BPR Region 5 of the effect of the Interstate System on local rural travel.

The 76 mile segment of Interstate 29 between Sioux Falls (Minnehaha County line) and Sioux City (Big Sioux River) was officially opened to traffic in September of 1962. It was constructed in four stages with official opening dates as follows:

1. The 18 mile segment from Interstate 90 south to the Worthing Interchange (12 miles of which are in the study area) - October, 1960.
2. The two mile segment from the Worthing Interchange to a point two miles south - September, 1961.
3. The 27 mile segment from Sioux City, Iowa north to Junction City - December, 1961.
4. The 35 mile segment from Junction City to a point two miles south of the Worthing Interchange - September, 1962.

Interstate 29 generally parallels U.S. 77, a concrete highway built over a 13 year period from 1928 through 1940. U.S. 77 has a 20 foot driving surface and shoulders that vary from 5 to 8 feet in width.

The total 79 miles of U.S. Highway 77 from the North Sioux City bridge to the south Minnehaha County line contained 30 miles of No Passing Zones, including 85 deficiencies in horizontal and vertical alignment. The 1962 sufficiency rating for this section of highway was as follows:

Good	17 miles
Satisfactory	15 miles
Tolerable	33 miles
Unsatisfactory	14 miles

Interstate 29, a divided controlled access highway, is constructed of concrete, has four 12 foot driving lanes and has a ten foot right asphalt shoulder and a six foot left asphalt shoulder. The dividing grassy median is 44 feet wide.

SURVEY PROCEDURE

In order to obtain information concerning the traffic patterns and volumes existing prior to the construction of Interstate 29, roadside interviewing operations were conducted during the summer of 1961. A representative number of motorists passing 19 locations within the Sioux Falls-Sioux City corridor were questioned concerning their origin, destination and other pertinent data about their trips. Information collected at four locations during 1956 and at three locations during 1960 was also used, making a total of 26 interview stations used before the construction of Interstate 29. Eighteen of these interview stations were operated for 12-hour periods, five for 24-hour periods and interviewing was conducted at the remaining three stations for periods of eight, ten and sixteen hours.

Interviews collected at all interview stations were expanded to volumes representative of average 1961 summer traffic as determined from counts taken from mechanical traffic counters.

Information concerning traffic patterns and volumes after the construction of Interstate 29 was obtained during the summer of 1963. Interviews were obtained at the 26 locations at which the "Before" information was obtained and at 29 additional locations. Fifty of these interview stations were operated for 14-hour periods, four for 16-hour periods and the remaining two for 24-hour periods. Interviews obtained in 1963 were expanded to average 1963 summer traffic volumes as determined from counts taken from mechanical traffic counters.

"Before" and "After" interview station locations are shown in Figures 2 and 3, Pages 29 and 31.

The following method was used to gather information concerning trips on I-29 in 1963:

1. Traffic leaving the interstate was sampled by interviewing motorists as they left the interstate at all interchanges.
2. Southbound traffic on the mainline of the interstate near Sioux City and northbound traffic on the mainline of the interstate near Sioux Falls was used to account for the remaining interstate traffic.

Motorists not using but crossing the interstate at interchanges and grade separations were also interviewed to obtain information to be used in the study of the barrier effect of I-29.

Information obtained at both the "Before" and "After" interview stations was adjusted for multiple interceptions, coded, punched on IBM cards and tabulated. Average daily summer traffic and vehicle miles of travel on each segment of Interstate 29 were determined from the "After" tabulation obtained. Table 1, Page 11 shows a comparison of this information with annual average daily traffic volumes and vehicle miles for the year of 1963 as determined from mechanical traffic counters. A factor of 1.3 was used to increase the mechanically counted annual average daily traffic to volumes representative of summer travel in order to make them comparable with the data gathered at the summer origin-destination interview stations.

PART I – GENERAL

The boundaries of the study area were defined generally (See Figure 1, Page 28) as follows:

1. North boundary: South McCook and Minnehaha (S.D.) and Rock (Minn.) County lines.
2. East boundary: U.S. Highway 75.
3. South boundary: Missouri River.
4. West boundary: U.S. Highway 81.

Major intra-study area movements, defined as those of 9.5 trips or more per day, excluding Iowa to Iowa movements and movements with a rural origin or destination, were selected for analyses of diversion and generation. Fourteen of the 102 movements so selected were eliminated from the diversion analyses due to lack of accessibility to Interstate 29 or apparent interviewing or coding discrepancies.

Seventy-five of the 102 movements were used in the generation analyses. Included in these 75 movements were 68 of the 88 movements used in the diversion analyses and seven of the fourteen movements eliminated from the diversion analyses.

Movements used in the generation analyses are shown in Table 2, Page 12. Information shown in Table 4, Page 15 includes a list of movements used in the analyses of diversion.

PART II – GENERATION

Generated traffic is defined, on Page A-26 of the "Guide for Forecasting Traffic on the Interstate System for the 1965 Cost Estimate", as follows:

"When an existing route is paralleled by a much more attractive highway such as a freeway, the total traffic on the two roads will be considerably greater than that on the old road before the new one was opened. The additional traffic above that which can be accounted for by diversion from other routes in the general vicinity and normal growth is defined as 'generated traffic'. This generated traffic is made up of the following classes of trips:

a. Trips which would not have been made at all, or would have been made less frequently, if the attractive route were not available.
b. Trips which would have been made to other destinations or from other origins, if the route had been less attractive. For example, places of shopping or doing business might be changed because of a shift in relative ease of travel.
c. Trips diverted from other forms of transportation.
d. Long trips diverted from distant routes, now less attractive, relatively.
e. Trips resulting from new developments along the road that take place simultaneously with the construction of the road."

Analysis of "Before" and "After" major intra-study area movements (volumes of 10 or more trips per day in either the "Before" or "After" tabulations, excluding movements with a rural trip terminus and Iowa to Iowa movements) was accomplished by trip purpose of passenger vehicle trips, by total passenger vehicle trips, by total heavy trucks, and by total trips.

A highway network was selected, length of each link was measured, average driving speed for each link was estimated (See Figure 4) and travel time for each link was computed. Using the information thus obtained, the shortest, fastest path for each vehicular movement was selected, first using the existing highway network without I-29, and then including I-29 in the network. This information was used to group the movements in several categories as follows:

1. Same distance or shorter via I-29
2. Longer but faster via I-29
3. Categories #1 and #2 combined
4. Cross I-29, but neither shorter nor faster via I-29.

Two methods were used in an attempt to determine normal growth due to factors other than the opening of Interstate 29. One method was the use of Category #4 as a control group, since it consists of movements not made shorter or faster by the use of Interstate 29. While the number of movements and total volume of trips in this category are relatively small, it is felt that some significance should be given to the absence of an increase in total traffic in this category "After" opening of the Interstate. The other method consisted of a comparison of local (licensed in S.D.) passenger car volumes noted at 12 abbreviated count program stations operated on the state trunk system during the summers of 1961 and 1963. An increase of about 6% was noted in the 1963 counts. Consideration of the results of the two methods indicates that normal growth would have been less than 6% had Interstate 29 not been constructed.

The "Before" and "After" volumes in each trip category mentioned earlier and the ratio of the "After" to "Before" volumes are shown in Table 3, Page 14. A look at the "After" to "Before" ratios for Passenger Vehicles, Heavy trucks and Total Vehicles indicated that, as expected, the percentage of increase in traffic varied directly with the savings in distance and time made available to motorists by the construction of I-29. The percentage of increase in Category #1 was as follows:

Vehicle Type	% of Increase
Passenger Vehicles	10
Heavy Trucks	20
All Vehicles	11

The following increases were noted in Category 2:

Vehicle Type	% of Increase
Passenger Vehicles	4
Heavy Trucks	13
All Vehicles	4

Combining Categories # 1 and # 2 revealed increases as follows:

Vehicle Type	% of Increase
Passenger Vehicles	7
Heavy Trucks	18
All Vehicles	8

Slight decreases in Passenger Vehicle and Total Traffic were noted in Category #4 after completion of the Interstate. The following are the Category #4 totals:

Vehicle Type	% of Decrease
Passenger Vehicles	2
Heavy Trucks	0
All Vehicles	2

The "Guide for Forecasting Traffic on the Interstate System for the 1965 Cost Estimate" also states, on Page A-29, that generation on a free, limited access highway normally ranges from about 30 percent to about 60 percent, with an average of about 45 percent. A look at the "Before" and "After" totals for Interstate 29 traffic in the preceding tables indicates that the percentage of generated traffic, even for the movements made most attractive by the construction of the interstate, falls far below the 30 percent figure.

The "Guide", however, also states that "The generated traffic does not always appear the first year a facility is opened, as there is sometimes an accelerated growth for several years which cannot be accounted for by new development along the route, and can only be considered as continuing generation."

The low rate of generation determined for I-29 might be explained in this manner:

> Either the two year period between the "Before" and "After" interviewing was too short for maximum generation to have developed.
>
> — or —
>
> The bulk of the generated travel occurs in longer trips rather than in the shorter intra-study area trips used in the analysis.

It is also possible that I-29 travel is not a great deal more attractive to local motorists than travel on the old highways such as U.S. Highway 77. Certainly congestion on U.S. 77 was not a problem of the magnitude of that existing on many two lane highways, as in urban areas, which carry much higher traffic volumes.

It is evident, at any rate, that the rate of generation of trips of the type used in the analysis had not, by the summer of 1963, reached the range described as normal in the "Guide". There is some indication in the preceding tables that the rate of generation for Heavy Trucks was higher than the rate for Passenger Vehicles. This cannot be definitely established, however, as no data is available concerning normal local truck travel growth such as the data relative to normal local passenger vehicle travel growth obtained at the abbreviated count program stations mentioned earlier.

Basic Data

"After" interview information only was used in the diversion analyses. The 88 movements, constituting 7,388 trips, which were used in the analyses are shown in Table 4.

A highway network was selected, length of each link was measured, average driving speed for each link was estimated (See Figure 4), and travel time for each link was computed. Using the information thus obtained, travel time and travel distance were computed for each community to community movement: first with the freeway removed from the network, and then with the freeway included in the network. The resulting freeway and alternate travel distances, travel times and speeds, along with the number and percentage of freeway and alternate trips and freeway/alternate time, distance and speed ratios, are also shown in Table 4.

Trips Assigned to Freeway by Various Procedures

Table 5, Page 18 , lists the trips assigned to the freeway by seven "shortest-path" or "all or nothing" assignment methods. These assignment methods range from a "shortest time path method", through five "time-distance factor" (1) methods, to an assignment based on "shortest distance path".

Time-distance factors, hereafter referred to as TD factors, are computed as follows:

Suppose that between two given communities the times and distances are as follows:

	TIME (Minutes)	DISTANCE (Miles)
Freeway	12.5	8.3
Alternate	13.2	6.4

If we give minutes a weight of 0.3 and miles a weight of 0.7, then the assignment factors would be as follows:

Freeway Assignment Factor = 12.5 x 0.3 + 8.3 x 0.7 = 9.56

Alternate Assignment Factor = 13.2 x 0.3 + 6.4 x 0.7 = 8.44

It will be noted that on the basis of shortest time the freeway gets all the trips, whereas on the basis of a factor composed of 0.3 time and 0.7 distance the alternate gets the trips. A shortest distance path assignment would also, of course, put all of the trips on the alternate.

Table 5 also shows the number of trips and percentage of the total trips in each movement assigned to the freeway by five ratio procedures and the California Time-Distance Differential Formula.

The Bureau of Public Roads travel time ratio curve for urban and rural areas, shown in Figure 5, Page 35 , was taken from the instruction manual for "The 1965 Estimate of the Cost of Completing the Interstate System".

The South Dakota Travel Time, Travel Distance and TD Factor Ratio curves, shown in Figures 5 through 7, Pages 35 through 37, were plotted using the basic data, or actual interview information. All ratios are freeway to alternate ratios, computed by dividing the freeway travel time, travel distance or TD factor by the alternate travel time, travel distance or TD factor. The best visual fit method was used in developing the curves. Several curves were developed for each assignment basis and the best curve was selected for each method using the criteria of accuracy in total number of trips assigned, symmetry and lowest percent root-mean-square (RMS) error. See Page 8 for a discussion of RMS error.

The California Time-Distance Differential Formula (2) used is as follows:

$$p = 50 + \frac{50\,(d + \tfrac{1}{2}t)}{\sqrt{(d - \tfrac{1}{2}t)^2 + 4.5}} \qquad \text{Where } 0 \leqq p \leqq 100$$

Where: d = distance in miles via best available freeway route minus distance in miles via best available alternate route.

t = travel time in minutes via best available freeway route minus travel time in minutes via best available alternate route.

p = the percentage of trips between given points assigned to the freeway.

The actual or observed number of trips using the interstate was 4,388. The shortest path or "all or nothing" assignment method which most closely approximated this figure was the 1/4 Time 3/4 Distance factor assignment, with 4,179 freeway trips. All methods employing greater weights of time produced an overassignment to I-29, with the 100% time method putting the greatest number of trips, 5,522, on the interstate. The shortest distance path method assigned only 3,551 trips to the freeway.

The South Dakota time, distance and T-D factor ratio curves produced assignments very near the actual freeway data, as might be expected since the actual data was used in developing the curves. The South Dakota time ratio curve assignment was significantly less accurate than the other South Dakota curves, as time ratio criteria would not fit the I-29 data well enough to plot a time ratio curve which would be both symmetrical and accurate. The Bureau of Public Roads curve and the California diversion formula assigned 4,008 and 4,602 trips, respectively, to I-29. This ranks these two methods below the South Dakota curves, but above all shortest path methods except the 1/4 Time 3/4 Distance factor method, in accuracy in the number of trips assigned to the freeway.

Vehicle Minutes and Vehicle Miles Assigned to Freeway By Various

Procedures and Summary of Speeds

Table 6, Page 22 shows vehicle miles and minutes on the freeway, on connecting roads, and on the alternate routes, for the actual routes traveled and for each of the 13 assignment methods mentioned earlier. These vehicle miles and minutes were used to compute the average speeds on the freeway, on connecting roads, total freeway, on the alternate and on all roads on the network, for the actual routes traveled and for each of the 13 assignment methods. This summary of speeds is shown in Table 6.

The actual or observed weighted average network speed for the trips used in the diversion analyses was 53.42 miles per hour. The shortest path or "all or nothing" assignment method which best matched this is the shortest distance method, with a 53.4 miles per hour speed. The 1/4 Time 3/4 Distance method was next with 53.9 miles per hour and the speeds increased with increasing weight given to time to a maximum 55.0 miles per hour speed obtained using the shortest time path method (100% time).

The most accurate of the partial diversion assignment methods, on the basis of weighted average network speed, was the South Dakota distance ratio curve which produced a speed of 53.3. A speed of 53.19 was derived using the Bureau of Public Roads curve while the other South Dakota curves resulted in speeds ranging from 53.56 for the South Dakota time ratio curve to 53.8 for the 1/3 Time 2/3 Distance ratio curve. The California diversion formula method produced a speed of 54.3 miles per hour. Thus the ratio methods all resulted in more accurate speeds than any of the shortest path methods except the 100% distance method. Two of the shortest path methods produced more accurate speeds than the California diversion formula.

Assignment and Weighted Average Network Speed on I-70 in Kansas and I-29 in South Dakota by Seven Shortest Path Assignment Procedures

Table 7, Page 23, shows a comparison of the accuracy of each of the seven "all or nothing" assignment methods in trips assigned to the freeway and in weighted average network speeds for I-70 in Kansas and I-29 in South Dakota. Table 7 also shows the percent RMS error, for each assignment method, in the South Dakota study based on all trips (freeway plus alternate) crossing ten screenlines. The screenlines used are shown in Figure 8, Page 38. Table 8, Page 24 shows the actual number of freeway and alternate crossings at each screenline and the percentage that freeway and alternate crossings assigned by each of the seven shortest path methods are of the actual crossings.

Kansas I-70 information used in this table was taken from a summary report entitled "Interstate 70 Usage Study, 1962 - 1965" published by the State Highway Commission of Kansas, with the following exceptions:

> Two of the movements used in the Interstate 70 Usage Study were excluded from the analyses in this report. These two movements were as follows:
>
> K.C., Ks., Lawrence and Topeka – Denver and Central Colo. (152 trips)
>
> K.C., Mo., and Northern Mo. – Denver and Central Colo. (182 trips)
>
> These two movements were excluded because it was felt that, due to their extreme travel distance and marginal freeway/alternate distance and time ratios (both just over 1.00), they were not comparable to the shorter trips used in the South Dakota Study. Also, a footnote in the Kansas Study relative to the K.C., Mo., and Northern Mo. – Denver and Central Colo. movement indicated that "In addition to the 182 trips observed on I-70 and K18 in this group, preliminary analysis to another study shows that approximately 70 additional trips between these areas were observed traveling other east-west highways."

The percentage that assigned trips is of actual trips on I-29 and I-70, for each of the shortest path assignment methods, indicates that the actual number of trips might be best simulated on each freeway by using a TD factor which employs a weight for time of between 1/4 and 1/3. The mean of the percentages for the two freeways indicates that the TD factor using 1/4 Time 3/4 Distance assigned the most accurately (in number of freeway trips) of the seven assignment methods used.

A comparison of assigned and actual weighted average network speeds revealed that a TD factor using a weight for time of between 1/4 and 1/3 would best simulate the actual speed in the Kansas Study, while the shortest distance method best simulated the actual speed in the South Dakota Study.

The mean of the Kansas and South Dakota speeds produced by each assignment method, compared to the mean of the actual speeds in the two studies, indicates that the mean of the 1/4T - 3/4 D TD factor method speeds best simulates the mean actual speed.

It should be noted that the shortest time method assignment was the least accurate of the several shortest path methods, both in number of trips and in speeds, in both the Kansas and South Dakota studies.

Table 7 also indicates that the lowest pct. RMS error in the South Dakota Study, based on all trips (freeway plus alternate) crossing ten screenlines, was computed for the TD factor method employing 1/4 T - 3/4 D. The highest pct. RMS error was computed for the shortest time method.

The percentage that the number of assigned trips is of actual trips on I-70 in Kansas and I-29 in South Dakota for each of the shortest path assignment methods is shown graphically in Figure 9, Page 39. The mean of the percentages for the two freeways is also portrayed in Figure 9.

Assigned Trips, Average Network Speeds, and Percent RMS Error of Estimate For Six Freeways Using Six Partial Diversion Methods

Table 9, Page 25 shows the results of the application of five ratio assignment procedures and the California diversion formula procedure to the South Dakota and Kansas information, and to information concerning four other freeways or bypasses (1). Percentages that assigned freeway trips are of actual freeway trips are shown for each assignment method for each freeway. Actual average network speeds are shown for each freeway, along with assigned average network speeds and percent RMS error of estimate for each assignment method for each freeway. This information is summarized, for ease of analysis, in another section of the Table. The mean of the percentages of assigned to actual freeway trips, the mean of the weighted average network speeds, and the mean of the percent RMS errors is shown for each partial division assignment method for each of the following groupings:

1. South Dakota and Kansas
2. Cabrillo, Alvarado, Shirley and Kokomo
3. All six studies (South Dakota, Kansas, Cabrillo, Alvarado, Shirley and Kokomo.)

The South Dakota and Kansas studies were combined because the study sections are located in predominantly rural areas, with comparatively high weighted average network speeds. The information from the other four studies was grouped because it was felt that they were representative of more populous areas and lower weighted average network speeds.

Each assignment method was assigned an order of preference for each of the three evaluation categories (number of trips assigned, weighted average network speed and percent RMS error) within each of the study groupings.

The information shown in Table 9 indicates that for the South Dakota and Kansas studies, the South Dakota T-D factor ratio curves employing weights of 1/4 Time - 3/4 Distance and 1/3 Time - 2/3 Distance ranked either first or second in order of preference in each of the three evaluation categories.

A look at the mean values calculated for the Cabrillo, Alvarado, Shirley and Kokomo studies reveals that the 1/4 T - 3/4 D curve placed first in the speed and percent RMS error categories and second in number of freeway trips assigned. The California formula placed first in number of trips assigned, second in speed and fourth in percent RMS error. The 1/3 T - 2/3 D curve ranked third in trips assigned and speed and second in percent RMS error.

The rankings for all six studies combined reveal that the 1/4 T - 3/4 D curve was first in each of the three categories. The 1/3 T - 2/3 D curve placed third in trips assigned and speed and second in percent RMS error. Results of the California formula assignment indicated that it was second in trips assigned and speed and fourth in percent RMS error.

It can be noted from the three summaries of freeways in Table 9 that the two T-D factor ratio curves, particularly the curve developed using weights of 1/4 T - 3/4 D, produced consistently more accurate numbers of trips and weighted average network speeds and lower percent RMS errors of estimate than the Bureau of Public Roads travel time ratio curve.

Some of the information shown in Table 9 is portrayed graphically in Figure 10, in which the percentage that assigned trips is of actual trips and the percent RMS error is shown for each of the six freeways or expressways for three of the more prominent partial diversion assignment methods.

Method of Computation of Percent Root-Mean-Square Error

The formula for the computation of percent RMS error was taken from the bottom of Page 66 of Highway Research Record Number 191, from Thomas F. Humphrey's article "A Report on the Accuracy of Traffic Assignment When Using Capacity Restraint". That formula is as follows:

$$RMS = \sqrt{\frac{\Sigma (X_{GC} - X_{TA})^2}{N - 1}}$$

in which X_{GC} = ground count on link L_i

X_{TA} = volume assigned to link L_i

N = total number of links

i = 1 through N

In adopting the formula for use in this study two types of computations were made, one for the shortest path method and one for the ratio or partial assignments. The computation of the percent RMS error for the shortest path method was based on the data in Table 8, Page 24 . Because of the "all or nothing" type of assignment it was necessary to set up screenlines in order to develop some reasonable basis for computing the percent RMS error. Shortest path method percent RMS error is not comparable to percent RMS error computed for the ratio or partial assignment methods.

In computing the RMS error for the ratio method or partial assignments the trips as actually traveled for each zone to zone movement correspond to the "Ground Count". A sample computation of the percent RMS error for this type of assignment (data from Table 4, Page 15 and Table 5, Page 18) follows:

South Dakota Travel Time Ratio

Community	Community	Freeway or Alternate	Actual Trips	Assigned Trips	Difference (Assigned - Actual)	Diff.^{2}
Sioux Falls	Hawarden, Ia.	Freeway	12	18	6	36
		Alternate	27	21	- 6	36
Sioux Falls	LeMars, Ia.	Freeway	15	24	9	81
		Alternate	27	18	- 9	81
Sioux Falls	Sioux City, Ia.	Freeway	364	316	- 48	2,304
		Alternate	21	69	+48	2,304
		(All remaining zone to zone movements)				
		Totals	7,388	7,388	0	231,662

Total number of movements = 88

Total number of routes = 88 x 2 = 176

Average volume = $\frac{7388}{176}$ = 42 trips

RMS error = $\sqrt{\frac{231,662}{175}}$ = 36 trips

Percent RMS = $\frac{36 \times 100}{42}$ = 85.7%

Roadside interviewing was accomplished, after the construction of the interstate, at all I-29 crossing points (grade separations and interchange crossroads) between the Missouri River and the Minnehaha - Lincoln county line in an attempt to determine the degree of impedance to east-west traffic caused by the construction of I-29. Information coded concerning these interviews included travel distance before and after completion of I-29 for all trips 25 miles or less in length. Travel distance was not coded for trips longer than 25 miles as it was assumed that no adverse travel would result for the longer trips.

Table 10, Page 26 shows the total number of trips, number of trips of 25 miles or less, number of trips with additional miles, and number of additional miles, by interview station, vehicle type and distance between crossing points.

The information given in Table 10 indicates that of a total of 5,036 trips of 25 miles or less crossing the interstate, only 95, or 1.9% had adverse travel due to the interstate. These motorists had 170.6 miles of adverse travel, an average of 1.8 miles per trip. The total number of trips crossing the interstate, if the trips over 25 miles in length are included, becomes 5,672 and the 95 with adverse travel would be 1.7% of the total.

A very small number of motorists wishing to cross I-29 are forced to travel additional distance in order to find a crossing point. Even if all of the adverse travel caused by the barrier effect of this segment of I-29 were eliminated, the road user cost savings which would accrue would probably not be sufficient to justify the cost of a single additional conventional grade separation structure using the benefit-cost ratio method. The results of the analysis indicate that the number of crossing points provided on the segment of I-29 between the Missouri River and the Minnehaha - Lincoln county line is entirely adequate. It should be pointed out, however, that this conclusion is contingent on the assumption that all motorists who crossed the interstate alignment prior to the construction of I-29 continued to make about the same trips with about the same frequency following the construction of the interstate. It is likely that some trips which were made before construction are now made less often or not at all because of the adverse travel now involved. Sufficient data concerning crossings of the interstate alignment prior to construction is not available to determine whether or not a decrease in trips of the adversely affected type has taken place.

TABLE 1

INTERSTATE 29 USAGE STUDY

FREEWAY TRAFFIC AND VEHICLE MILES: COMPARISON OF ORIGIN-DESTINATION INTERVIEW DATA TO GROUND COUNTS

Interchange Location	1963 ADT	Summer 1963 (ADT x 1.3)	O-D Data	O-D / Counts	Length of Each I-29 Segment in Miles	Daily Vehicle Miles: Traffic Counts	Daily Vehicle Miles: O-D
Sioux City (Riverside Drive)							
	4,660	6,100	5,300	.87	2.8	17,100	14,800
N. Sioux City (local road)							
	4,183	5,400	4,900	.91	1.9	10,300	9,300
McCook Lake (FAS 400)							
	3,357	4,400	4,300	.98	5.3	23,300	22,800
Jefferson (FAS 394)							
	3,376	4,400	4,000	.91	6.3	27,700	25,200
Elk Point south (FAS 394)							
	2,010	2,600	3,500	1.35	2.5	6,500	8,800
Elk Point north (FAS 394)							
	2,775	3,600	3,500	.97	8.3	29,900	29,000
South Dakota 50							
	1,524	2,000	2,800	1.40	4.6	9,200	12,900
South Dakota 48							
	1,783	2,300	2,700	1.17	7.0	16,100	18,900
Alsen (FAS 370)							
	1,865	2,400	2,700	1.12	4.0	9,600	10,800
Alcester (FAS 372)							
	1,928	2,500	2,700	1.08	5.0	12,500	13,500
Beresford (S.D. 46)							
	2,485	3,200	3,000	.94	3.0	9,600	9,000
Hudson (FAS 383)							
	2,139	2,800	3,100	1.11	3.0	8,400	9,300
Viborg (FAS 568)							
	2,358	3,100	3,100	1.00	3.0	9,300	9,300
Fairview (FAS 567)							
	2,114	2,700	3,100	1.15	3.0	8,100	9,300
Davis (U.S. 18)							
	2,512	3,300	3,500	1.06	3.0	9,900	10,500
Canton (US 18 & FAS 970)							
	2,878	3,700	3,600	.97	2.0	7,400	7,200
Worthing (S.D. 44)							
	3,067	4,000	3,600	.90	4.0	16,000	14,400
Lennox (FAS 380)							
	3,395	4,400	4,100	.93	3.0	13,200	12,300
Harrisburg (Local road)							
	3,681	4,800	4,200	.88	2.0	9,600	8,400
Tea (FAS 377)							
	4,004	5,200	4,500	.87	1.6	8,300	7,200
I-29 & I-229							
TOTALS		72,900	72,200			262,000	262,900

TABLE 2

INTERSTATE 29 USAGE STUDY

"BEFORE" AND "AFTER" VOLUMES
OF MOVEMENTS USED IN THE GENERATION ANALYSES

Average Daily Summer Traffic

"Before" (1961)	BETWEEN Community	Community	"After" (1963)
40	Sioux Falls	Hawarden, Ia.	39
33	Sioux Falls	LeMars, Ia.	42
308	Sioux Falls	Sioux City, Ia.	385
116	Sioux Falls	Vermillion	164
166	Sioux Falls	Yankton	163
49	Sioux Falls	Alcester	59
207	Sioux Falls	Beresford	267
131	Sioux Falls	Centerville	110
80	Sioux Falls	Chancellor	58
44	Sioux Falls	Davis	45
24	Sioux Falls	Elk Point	26
95	Sioux Falls	Hurley	79
32	Sioux Falls	Irene	44
445	Sioux Falls	Lennox	480
3	Sioux Falls	N. Sioux City	12
136	Sioux Falls	Tea	216
105	Sioux Falls	Viborg	85
10	Sioux Falls	Wakonda	18
214	Sioux Falls	Worthing	233
6	Sioux City, Ia.	Canton	19
388	Sioux City, Ia.	Vermillion	475
235	Sioux City, Ia.	Yankton	265
20	Sioux City, Ia.	Alcester	42
80	Sioux City, Ia.	Beresford	83
6	Sioux City, Ia.	Burbank	19
21	Sioux City, Ia.	Centerville	24
422	Sioux City, Ia.	Elk Point	395
11	Sioux City, Ia.	Gayville	5
3	Sioux City, Ia.	Hurley	13
748	Sioux City, Ia.	Jefferson	686
9	Sioux City, Ia.	Junction City	11
6	Sioux City, Ia.	Lennox	13
2	Sioux City, Ia.	Meckling	12
34	Sioux City, Ia.	Richland	12
17	Sioux City, Ia.	Viborg	7
12	Sioux City, Ia.	Wakonda	17
57	Beresford	Vermillion	62
23	Beresford	Yankton	39
147	Beresford	Centerville	142
–	Beresford	Davis	18
23	Beresford	Elk Point	23
4	Beresford	Hub City	17
21	Beresford	Irene	26
10	Beresford	Lennox	15
19	Beresford	Marion	5
12	Beresford	Spink	20
23	Beresford	Viborg	20
17	Beresford	Wakonda	15
22	Vermillion	Hawarden, Ia.	15
16	Vermillion	LeMars, Ia.	12

TABLE 2 (Continued)

INTERSTATE 29 USAGE STUDY

"BEFORE" AND "AFTER" VOLUMES
OF MOVEMENTS USED IN THE GENERATION ANALYSES

Average Daily Summer Traffic

	"Before" (1961)	BETWEEN Community	BETWEEN Community	"After" (1963)
	43	Vermillion	Akron, Ia.	45
	14	Vermillion	Canton	16
	26	Vermillion	Alcester	20
	143	Vermillion	Elk Point	160
	21	Vermillion	Jefferson	22
	49	Vermillion	Junction City	25
	10	Vermillion	Richland	13
	20	Vermillion	Spink	13
	12	Yankton	LeMars, Ia.	17
	13	Yankton	Alcester	13
	65	Yankton	Elk Point	25
	13	Yankton	Jefferson	4
	2	Yankton	N. Sioux City	14
	12	Elk Point	Burbank	19
	8	Elk Point	Junction City	10
	22	Elk Point	N. Sioux City	43
	10	Canton	Centerville	15
	13	Canton	Davis	1
	86	Canton	Lennox	70
	7	Canton	Parker	23
	14	Lennox	Harrisburg	16
	–	Lennox	Hudson	11
	87	Lennox	Worthing	78
	7	Hawarden, Ia.	Centerville	25
	17	Harrisburg	Tea	15
TOTALS	5,366			5,765

TABLE 3

INTERSTATE 29 USAGE STUDY

"BEFORE" AND "AFTER" VOLUMES BY TRIP PURPOSE OF PASSENGER VEHICLES AND TOTAL HEAVY TRUCKS WITHIN CATEGORIES BASED ON OPPORTUNITY FOR TIME AND DISTANCE SAVINGS BY USE OF INTERSTATE 29

	Passenger Vehicles								
	Work	Pers. Bus.	Shopping	Recreation Soc. & Vac.	Other	Total Pass. Veh.	Heavy Trucks	Total Traffic	Number of Movements Involved
Category #1, All Major Intra-Study Area Movements Same Distance or Shorter Via I-29									
"Before"	1,061	479	240	570	65	2,415	350	2,765	40
"After"	977	697	260	577	130	2,661	420	3,081	40
"After" / "Before"	0.940	1.455	1.083	1.012	2.000	1.102	1.200	1.114	
Category # 2, All Major Intra-Study Area Movements Longer but Faster Via I-29									
"Before"	864	526	217	329	80	2,016	154	2,170	23
"After"	787	496	312	403	90	2,088	174	2,262	23
"After" / "Before"	0.911	0.943	1.438	1.225	1.125	1.036	1.130	1.042	
Category #3 (#1 and #2 Combined)									
"Before"	1,925	1,005	457	899	145	4,431	504	4,935	63
"After"	1,784	1,193	572	980	220	4,749	594	5,343	63
"After" / "Before"	0.927	1.187	1.252	1.090	1.517	1.072	1.179	1.083	
Category #4, All Major Intra-Study Area Movements Which Would Cross I-29, but Be Neither Shorter Nor Faster Via I-29									
"Before"	144	91	43	86	22	386	45	431	12
"After"	99	95	29	133	21	377	45	422	12
"After" / "Before"	0.688	1.044	0.674	1.547	0.955	0.977	1.000	0.979	

TABLE 4

INTERSTATE 29 USAGE STUDY

BASIC DATA ON TRIPS, TRAVEL TIME AND DISTANCE FOR EACH COMMUNITY TO COMMUNITY MOVEMENT

BETWEEN		NUMBER OF TRIPS					TRAVEL TIME		TRAVEL DISTANCE		RATIOS: VIA FREE. / VIA ALT.			AVG. SPEED (MPH)	
		TOTAL TRIPS BETWEEN	TRIPS ON FREEWAY		TRIPS ON ALTERNATE		VIA FREE.	VIA ALT.	VIA FREE.	VIA ALT.				VIA	VIA
Community	Community	ZONES	No.	%	No.	%	MIN.	MIN.	MILES	MILES	TIME	DIST.	SPEED	FREEWAY	ALT.
Sioux Falls	Hawarden, Ia.	39	12	31	27	69	60.3	62.0	54.9	49.5	0.97	1.11	1.14	54.6	47.9
	LeMars, Ia.	42	15	36	27	64	89.7	94.6	84.5	76.5	0.95	1.10	1.16	56.5	48.5
	Sioux City, Ia.	385	364	95	21	5	79.8	102.5	81.6	84.5	0.78	0.97	1.24	61.4	49.5
	Doon, Ia.	5	-	-	5	100	57.2	50.0	48.7	39.4	1.14	1.24	1.08	51.1	47.3
	Inwood, Ia.	168	6	4	162	96	44.6	36.2	38.0	28.1	1.23	1.35	1.10	51.1	46.6
	Rock Valley, Ia.	100	11	11	89	89	60.1	52.9	51.7	42.4	1.14	1.22	1.07	51.6	48.1
	Sioux Center, Ia.	40	7	18	33	82	76.6	70.3	65.7	56.3	1.09	1.17	1.07	51.5	48.1
	Canton, S. Dak.	685	122	18	563	82	34.5	31.1	29.4	24.0	1.11	1.22	1.10	51.1	46.3
	Vermillion	164	160	98	4	2	63.2	75.1	61.5	62.6	.84	.98	1.17	58.4	50.0
	Yankton	163	132	81	31	19	87.2	94.8	79.1	80.6	.92	.98	1.07	54.4	51.0
	Alcester	59	20	34	39	66	50.8	53.4	46.3	45.0	.95	1.03	1.08	54.7	50.6
	Beresford	267	221	83	46	17	38.6	42.4	35.2	34.5	.91	1.02	1.12	54.7	48.8
	Centerville	110	107	97	3	3	45.2	51.1	40.3	41.9	.88	.96	1.09	53.5	49.2
	Chancellor	58	28	48	30	52	30.7	31.8	23.5	24.7	.97	.95	.98	45.9	46.6
	Davis	45	44	98	1	2	36.1	40.9	32.4	34.0	.88	.95	1.08	53.8	49.9
	Elk Point	26	24	92	2	8	64.1	79.1	63.6	66.8	.81	.95	1.17	59.5	50.7
	Fairview	6	-	-	6	100	47.8	44.4	41.1	35.7	1.08	1.15	1.07	51.6	48.2
	Hudson	66	17	26	49	74	54.3	53.4	47.9	42.5	1.02	1.13	1.11	52.9	47.8
	Hurley	79	68	86	11	14	43.7	46.6	34.4	35.6	.94	.97	1.03	47.2	45.8
	Irene	44	44	100	-	-	56.4	63.7	52.4	54.0	.89	.97	1.09	55.7	50.9
	Lennox	480	438	91	42	9	25.3	27.3	19.7	21.3	.93	.92	1.00	46.7	46.8
	Marion	5	4	80	1	20	51.6	45.9	40.9	38.0	1.12	1.08	.95	47.6	50.0
	N. Sioux City	12	12	100	-	-	79.0	97.7	79.7	82.1	.81	.97	1.20	60.5	50.4
	Parker	90	23	26	67	74	42.4	36.7	33.0	30.1	1.16	1.10	.95	46.7	49.2
	Tea	216	167	77	49	23	15.0	17.2	10.4	12.0	.87	.87	.99	41.6	41.9
	Viborg	85	82	96	3	4	47.4	52.2	42.4	44.0	.91	.96	1.06	53.7	50.6
	Wakonda	18	18	100	-	-	58.9	66.2	54.5	56.1	.89	.97	1.09	55.5	50.8
	Worthing	233	69	30	164	70	22.1	22.9	18.4	17.0	.97	1.08	1.12	50.0	44.5
Sioux City, Ia.	Canton	19	18	95	1	5	70.1	88.6	73.2	74.5	.79	.98	1.24	62.7	50.5
	Vermillion	475	463	97	12	3	33.4	44.8	34.1	36.5	.75	.93	1.25	61.3	48.9
	Yankton	265	263	99	2	1	63.2	74.6	60.2	62.6	.85	.96	1.14	57.2	50.3
	Alcester	42	20	48	22	52	49.1	54.9	44.5	44.1	.89	1.01	1.13	54.4	48.2
	Beresford	83	64	77	19	23	46.6	60.1	49.0	50.0	.78	.98	1.26	63.1	49.9
	Burbank	19	17	89	2	11	26.5	35.0	26.5	26.6	.76	1.00	1.32	60.0	45.6
	Centerville	24	24	100	-	-	55.5	71.4	58.3	60.5	.78	.96	1.24	63.0	50.8
	Elk Point	395	330	84	65	16	17.6	24.2	18.1	18.1	.73	1.00	1.37	61.7	44.9
	Gayville	5	5	100	-	-	50.3	61.7	48.9	51.3	.82	.95	1.17	58.3	49.9

TABLE 4
(Continued)

INTERSTATE 29 USAGE STUDY

BASIC DATA ON TRIPS, TRAVEL TIME AND DISTANCE FOR EACH COMMUNITY TO COMMUNITY MOVEMENT

BETWEEN		NUMBER OF TRIPS					TRAVEL TIME		TRAVEL DISTANCE		RATIOS: VIA FREE. / VIA ALT.			AVG. SPEED (MPH)	
		TOTAL TRIPS BETWEEN ZONES	TRIPS ON FREEWAY		TRIPS ON ALTERNATE		VIA FREE. MIN.	VIA ALT. MIN.	VIA FREE. MILES	VIA ALT. MILES				VIA FREEWAY	VIA ALT.
Community	Community		No.	%	No.	%					TIME	DIST.	SPEED		
Sioux City, Ia.	Hurley	13	13	100	-	-	73.2	92.0	76.2	78.4	.80	.97	1.22	62.5	51.1
	Jefferson	686	314	46	372	54	10.4	13.9	10.8	9.5	.75	1.14	1.52	62.3	41.0
	Junction City	11	6	55	5	45	25.3	36.1	27.4	29.2	.70	.94	1.34	65.0	48.5
	Lennox	13	13	100	-	-	66.9	88.7	70.9	74.5	.75	.95	1.26	63.6	50.4
	Meckling	12	12	100	-	-	43.2	54.6	42.7	45.1	.79	.95	1.20	59.3	49.6
	Richland	12	-	-	12	100	25.3	29.5	25.0	23.4	.86	1.07	1.25	59.3	47.6
	Viborg	7	5	71	2	29	66.5	82.4	68.2	70.4	.81	.97	1.20	61.5	51.3
	Wakonda	17	17	100	-	-	57.9	71.2	58.2	58.6	.81	.99	1.22	60.3	49.4
Beresford	Hawarden, Ia.	47	-	-	47	100	27.1	25.0	22.3	20.0	1.08	1.12	1.03	49.4	48.0
	Canton	78	13	17	65	83	28.9	28.5	26.8	24.5	1.01	1.09	1.08	55.6	51.6
	Vermillion	62	56	90	6	10	30.0	32.7	28.9	28.1	.92	1.03	1.12	57.8	51.6
	Yankton	39	19	49	20	51	59.8	54.0	55.0	46.5	1.11	1.18	1.07	55.2	51.7
	Alcester	103	-	-	103	100	19.1	13.8	15.8	11.5	1.38	1.37	.99	49.6	50.0
	Centerville	142	12	8	130	92	17.6	14.3	13.7	11.9	1.23	1.15	.94	46.7	49.9
	Davis	18	13	72	5	28	24.9	27.0	23.8	23.8	.92	1.00	1.08	57.3	52.9
	Elk Point	23	17	74	6	26	30.9	36.7	31.0	32.3	.84	.96	1.14	60.2	52.8
	Hub City	17	7	41	10	59	18.0	18.7	15.3	15.3	.96	1.00	1.04	51.0	49.1
	Hudson	33	-	-	33	100	26.7	22.8	21.3	19.0	1.17	1.12	.96	47.9	50.0
	Lennox	15	12	80	3	20	25.7	28.6	24.5	24.5	.90	1.00	1.11	57.2	51.4
	Marion	5	5	100	-	-	52.9	56.2	47.9	48.0	.94	1.00	1.06	54.3	51.2
	Spink	20	5	25	15	75	20.2	21.3	19.8	18.3	.95	1.08	1.14	58.8	51.5
	Viborg	20	10	50	10	50	28.8	25.3	21.8	21.8	1.14	1.00	.88	45.4	51.7
	Wakonda	15	-	-	15	100	25.9	25.9	21.8	21.8	1.00	1.00	1.00	50.5	50.5
Vermillion	Hawarden, Ia.	15	7	47	8	53	41.0	41.4	36.0	35.7	.99	1.01	1.02	52.7	51.7
	LeMars, Ia.	12	10	83	2	17	51.7	49.5	46.2	44.0	1.04	1.05	1.01	53.6	53.3
	Akron, Ia.	45	35	78	10	22	26.2	27.2	24.0	23.4	.96	1.03	1.07	55.0	51.6
	Canton	16	16	100	-	-	53.5	61.2	53.1	52.6	.87	1.01	1.16	59.6	51.6
	Alcester	20	10	50	10	50	34.5	36.8	32.1	31.8	.94	1.01	1.08	55.8	51.8
	Elk Point	160	93	58	67	42	18.1	20.8	16.3	15.7	.87	1.04	1.19	54.0	45.3
	Jefferson	22	22	100	-	-	25.4	30.9	24.9	27.0	.82	.92	1.12	58.8	52.4
	Spink	13	9	69	4	31	15.4	15.8	14.1	13.8	.97	1.02	1.05	54.9	52.4
Yankton	LeMars, Ia.	17	6	35	11	65	81.5	79.3	72.3	70.1	1.03	1.03	1.00	53.2	53.0
	Alcester	13	12	92	1	8	64.3	66.6	58.2	57.9	.97	1.01	1.04	54.3	52.2
	Elk Point	25	21	84	4	16	47.5	51.2	42.2	44.9	.93	.94	1.01	53.3	52.6
	Jefferson	4	2	50	2	50	55.2	60.7	51.0	53.1	.91	.96	1.06	55.4	52.5
	N. Sioux City	14	11	79	3	21	62.4	69.8	58.3	60.2	.89	.97	1.09	56.1	51.7
Elk Point	Akron, Ia.	59	-	-	59	100	27.1	17.4	26.1	15.0	1.56	1.74	1.12	57.8	51.7

TABLE 4
(Continued)

INTERSTATE 29 USAGE STUDY

BASIC DATA ON TRIPS, TRAVEL TIME AND DISTANCE FOR EACH COMMUNITY TO COMMUNITY MOVEMENT

BETWEEN		NUMBER OF TRIPS					TRAVEL TIME		TRAVEL DISTANCE		RATIOS: VIA FREE. / VIA ALT.			AVG. SPEED (MPH)	
		TOTAL TRIPS BETWEEN	TRIPS ON FREEWAY		TRIPS ON ALTERNATE		VIA FREE.	VIA ALT.	VIA FREE.	VIA ALT.				VIA	VIA
Community	Community	ZONES	No.	%	No.	%	MIN.	MIN.	MILES	MILES	TIME	DIST.	SPEED	FREEWAY	ALT.
Elk Point	Alcester	36	2	6	34	94	35.4	31.5	34.2	26.4	1.12	1.30	1.15	58.0	50.3
	Jefferson	158	36	23	122	77	9.6	10.3	8.9	8.6	.93	1.03	1.11	55.6	50.1
	Junction City	10	8	80	2	20	9.6	12.7	9.4	11.5	.76	.82	1.08	58.7	54.3
	N. Sioux City	43	34	79	9	21	16.8	19.4	16.2	15.7	.87	1.03	1.19	57.9	48.6
	Spink	21	3	14	18	86	16.3	16.4	16.2	14.4	.99	1.12	1.13	59.6	52.7
Canton	Centerville	15	10	67	5	33	35.5	37.7	31.9	31.9	.94	1.00	1.06	53.9	50.8
	Davis	1	1	100	-	-	26.4	27.0	24.0	24.0	.98	1.00	1.02	54.5	53.3
	Lennox	70	29	41	41	59	21.6	22.6	18.7	18.7	.96	1.00	1.05	51.9	49.6
	Parker	23	13	57	10	43	39.6	40.6	34.2	34.2	.98	1.00	1.03	51.8	50.5
	Worthing	63	-	-	63	100	16.0	13.4	14.0	11.0	1.19	1.27	1.06	52.5	49.3
Hawarden, Ia.	Centerville	25	3	12	22	88	36.0	37.7	31.6	31.5	.95	1.00	1.05	52.7	50.1
Hudson	Lennox	11	11	100	-	-	41.4	44.3	37.2	37.2	.93	1.00	1.07	53.9	50.4
Jefferson	N. Sioux City	47	14	30	33	70	9.6	9.1	8.9	7.1	1.05	1.25	1.19	55.6	46.8
Lennox	Tea	5	2	40	3	60	15.2	12.0	12.3	9.3	1.27	1.32	1.05	48.6	46.5
	TOTALS	7,388	4,388		3,000										

TABLE 5

INTERSTATE 29 USAGE STUDY

TRIPS ASSIGNED TO FREEWAY BY VARIOUS PROCEDURES

BETWEEN		TRIPS USING FREEWAY																				
		Trips As Actually Traveled		Trips Assigned																		
				Time - Distance Factor - Shortest Path Method							BPR Travel Time Ratio		S. D. Travel Time Ratio		S. D. Travel Distance Ratio		S. D. T-D Factor Ratio 1/3 T 2/3 D		S. D. T-D Factor Ratio 1/4 T 3/4 D		California Diversion Formula	
				Number of Trips																		
Community	Community	No. of Trips	% of Total	Least Time	2/3 T 1/3 D	1/2 T 1/2 D	.4 T .6 D	1/3 T 2/3 D	1/4 T 3/4 D	Least Dist.	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total
Sioux Falls	Hawarden, Ia.	12	31	39	-	-	-	-	-	-	18	45	18	46	17	43	12	31	11	27	6	16
	LeMars, Ia.	15	36	42	42	-	-	-	-	-	21	49	24	58	19	45	14	34	12	29	10	24
	Sioux City, Ia.	364	95	385	385	385	385	385	385	385	296	77	316	82	316	82	362	94	350	91	385	100
	Doon, Ia.	-	-	-	-	-	-	-	-	-	1	22	1	13	1	13	1	11	1	10	0	0
	Inwood, Ia.	6	4	-	-	-	-	-	-	-	20	12	12	7	5	3	3	2	5	3	0	0
	Rock Valley, Ia.	11	11	-	-	-	-	-	-	-	22	22	13	13	16	16	11	11	12	12	0	0
	Sioux Center, Ia.	7	18	-	-	-	-	-	-	-	11	27	8	19	11	27	6	16	6	16	0	0
	Canton, S. Dak.	122	18	-	-	-	-	-	-	-	171	25	110	16	110	16	82	12	82	12	0	0
	Vermillion	160	98	164	164	164	164	164	164	164	112	68	125	76	130	79	139	85	143	87	164	100
	Yankton	132	81	163	163	163	163	163	163	163	90	55	104	64	129	79	112	69	137	84	163	100
	Alcester	20	34	59	59	59	59	-	-	-	29	49	35	59	38	64	27	46	30	51	30	50
	Beresford	221	83	267	267	267	267	267	267	-	152	57	176	66	179	67	147	55	171	64	182	68
	Centerville	107	97	110	110	110	110	110	110	110	67	61	78	71	92	84	94	85	96	87	110	100
	Chancellor	28	48	58	58	58	58	58	58	58	26	45	27	46	50	86	40	69	49	85	58	100
	Davis	44	98	45	45	45	45	45	45	45	27	61	32	71	39	86	38	85	40	88	45	100
	Elk Point	24	92	26	26	26	26	26	26	26	19	73	21	79	22	86	24	93	24	91	26	100
	Fairview	-	-	-	-	-	-	-	-	-	2	28	1	20	2	32	1	20	1	18	0	0
	Hudson	17	26	-	-	-	-	-	-	-	25	38	20	31	24	37	16	24	15	23	0	0
	Hurley	68	86	79	79	79	79	79	79	79	40	51	48	61	65	82	55	69	66	84	79	100
	Irene	44	100	44	44	44	44	44	44	44	26	60	30	69	36	82	35	80	37	85	44	100
	Lennox	438	91	480	480	480	480	480	480	480	254	53	302	63	432	90	408	85	427	89	480	100
	Marion	4	80	-	-	-	-	-	-	-	1	23	1	15	3	51	1	24	1	23	-	0
	N. Sioux City	12	100	12	12	12	12	12	12	12	9	73	9	79	10	82	11	91	11	89	12	100
	Parker	23	26	-	-	-	-	-	-	-	18	20	11	12	40	45	19	21	18	20	0	0
	Tea	167	77	216	216	216	216	216	216	216	136	63	156	72	205	95	207	96	205	95	216	100

	N. Sioux City	12	100	12	12	12	12	12	12	12	9	73	9	79	10	82	11	91	11	89	12	100
	Parker	23	26	-	-	-	-	-	-	-	18	20	11	12	40	45	19	21	18	20	0	0
	Tea	167	77	216	216	216	216	216	216	216	136	63	156	72	205	95	207	96	205	95	216	100

TABLE 5
(Continued)
INTERSTATE 29 USAGE STUDY

TRIPS ASSIGNED TO FREEWAY BY VARIOUS PROCEDURES

BETWEEN		TRIPS USING FREEWAY																				
		Trips As Actually Traveled		Trips Assigned																		
				Time - Distance Factor - Shortest Path Method: Number of Trips							BPR Travel Time Ratio		S. D. Travel Time Ratio		S. D. Travel Distance Ratio		S. D. T-D Factor Ratio 1/3 T 2/3 D		S. D. T-D Factor Ratio 1/4 T 3/4 D		California Diversion Formula	
Community	Community	No. of Trips	% of Total	Least Time	2/3 T 1/3 D	1/2 T 1/2 D	.4 T .6 D	1/3 T 2/3 D	1/4 T 3/4 D	Least Dist.	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total
Sioux Falls	Viborg	82	96	85	85	85	85	85	85	85	48	57	56	66	71	84	68	80	72	85	85	100
	Wakonda	18	100	18	18	18	18	18	18	18	11	60	12	69	15	82	14	80	16	87	18	100
	Worthing	69	30	233	233	233	-	-	-	-	105	45	107	46	119	51	79	34	72	31	75	32
Sioux City, Ia.	Canton	18	95	19	19	19	19	19	19	19	14	76	15	81	15	79	17	91	17	88	19	100
	Vermillion	463	97	475	475	475	475	475	475	475	380	80	404	85	423	89	461	97	446	94	475	100
	Yankton	263	99	265	265	265	265	265	265	265	175	66	199	75	223	84	236	89	233	88	265	100
	Alcester	20	48	42	42	42	42	42	42	-	25	60	29	69	29	70	26	61	31	73	34	82
	Beresford	64	77	83	83	83	83	83	83	83	64	77	68	82	66	79	75	91	74	89	83	100
	Burbank	17	89	19	19	19	19	19	19	19	15	79	16	84	14	73	17	91	17	89	19	100
	Centerville	24	100	24	24	24	24	24	24	24	18	77	20	82	20	84	22	93	22	91	24	100
	Elk Point	330	84	395	395	395	395	395	395	395	324	82	344	87	288	73	371	94	352	89	395	100
	Gayville	5	100	5	5	5	5	5	5	5	4	71	4	78	4	86	5	93	5	91	5	100
	Hurley	13	100	13	13	13	13	13	13	13	10	74	10	80	11	82	12	91	12	89	13	100
	Jefferson	314	46	686	686	686	686	686	-	-	549	80	583	85	240	35	418	61	350	51	384	56
	Junction City	6	55	11	11	11	11	11	11	11	9	86	10	89	6	87	11	99	10	95	11	100
	Lennox	13	100	13	13	13	13	13	13	13	10	80	11	85	11	86	12	95	12	92	13	100
	Meckling	12	100	12	12	12	12	12	12	12	9	76	10	81	10	86	11	94	11	92	12	100
	Richland	-	-	12	12	12	12	12	-	-	8	64	9	73	6	54	6	52	7	57	7	56
	Viborg	5	71	7	7	7	7	7	7	7	5	73	6	79	6	82	6	91	6	89	7	100
	Wakonda	17	100	17	17	17	17	17	17	17	12	73	13	79	13	76	14	85	15	87	17	100
Beresford	Hawarden, Ia.	-	-	-	-	-	-	-	-	-	13	28	9	20	19	40	10	22	9	20	0	0
	Canton	13	17	-	-	-	-	-	-	-	31	40	26	33	37	48	24	31	21	27	0	0
	Vermillion	56	90	62	62	62	62	62	62	-	34	55	40	64	40	64	32	52	35	57	36	58
	Yankton	19	49	-	-	-	-	-	-	-	10	25	6	16	9	24	6	15	5	14	0	0
	Alcester	-	-	-	-	-	-	-	-	-	3	3	1	1	2	2	0	0	0	0	0	0

TABLE 5
(Continued)
INTERSTATE 29 USAGE STUDY

TRIPS ASSIGNED TO FREEWAY BY VARIOUS PROCEDURES

BETWEEN		TRIPS USING FREEWAY																					
		Trips As Actually Traveled		Trips Assigned																			
				Assignment Basis																			
				Time - Distance Factor - Shortest Path Method							BPR Travel Time Ratio		S. D. Travel Time Ratio		S. D. Travel Distance Ratio		S. D. T-D Factor Ratio 1/3 T 2/3 D		S. D. T-D Factor Ratio 1/4 T 3/4 D		California Diversion Formula	
				Number of Trips																			
Community	Community	No. of Trips	% of Total	Least Time	2/3 T 1/3 D	1/2 T 1/2 D	.4 T .6 D	1/3 T 2/3 D	1/4 T 3/4 D	Least Dist.	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total
Beresford	Centerville	12	8	-	-	-	-	-	-	-	17	12	10	7	45	32	17	12	18	13	0	0
	Davis	13	72	18	18	18	18	18	18	18	10	55	12	64	13	73	11	61	13	73	18	100
	Elk Point	17	74	23	23	23	23	23	23	23	16	68	17	76	19	84	20	89	20	88	23	100
	Hub City	7	41	17	17	17	17	17	17	17	8	47	9	52	12	73	9	52	11	64	17	100
	Hudson	-	-	-	-	-	-	-	-	-	6	18	4	11	13	40	6	16	6	17	0	0
	Lennox	12	80	15	15	15	15	15	15	15	9	58	10	68	11	73	10	69	12	81	15	100
	Marion	5	100	5	5	5	5	5	5	5	3	51	3	61	4	73	3	55	3	64	5	100
	Spink	5	25	20	20	-	-	-	-	-	10	49	12	58	10	51	7	36	7	33	7	34
	Viborg	10	50	-	-	-	-	-	-	20	4	22	3	13	15	73	6	32	7	33	0	0
	Wakonda	-	-	15	15	15	15	15	15	15	6	41	5	36	11	73	7	46	9	57	15	100
Vermillion	Hawarden, Ia.	7	47	15	15	15	-	-	-	-	6	42	6	38	10	70	7	46	9	57	7	48
	LeMars, Ia.	10	83	-	-	-	-	-	-	-	4	34	3	27	7	59	4	34	4	33	0	0
	Akron, Ia.	35	78	45	45	45	45	-	-	-	21	47	23	52	29	64	21	46	23	51	22	48
	Canton	16	100	16	16	16	16	16	16	-	10	63	12	72	11	70	11	69	13	81	14	85
	Alcester	10	50	20	20	20	20	20	20	-	10	51	12	61	14	70	10	52	13	64	13	67
	Elk Point	93	58	160	160	160	160	160	160	-	101	63	115	72	99	62	98	61	102	64	100	63
	Jefferson	22	100	22	22	22	22	22	22	22	16	71	17	78	20	90	21	95	20	93	22	100
	Spink	9	69	13	13	13	-	-	-	-	6	45	6	46	9	70	6	43	7	51	6	48
Yankton	LeMars, Ia.	6	35	-	-	-	-	-	-	-	6	36	5	29	11	64	6	36	6	36	0	0
	Alcester	12	92	13	13	13	13	13	13	-	6	45	6	46	9	70	7	52	7	57	9	67
	Elk Point	21	84	25	25	25	25	25	25	25	13	53	16	63	22	87	20	80	22	87	25	100
	Jefferson	2	50	4	4	4	4	4	4	4	2	57	3	66	3	84	3	80	3	87	4	100
	N. Sioux City	11	79	14	14	14	14	14	14	14	8	60	10	69	10	73	11	80	12	85	14	100
Elk Point	Akron, Ia.	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
	Alcester	2	6	-	-	-	-	-	-	-	8	23	5	15	6	7	3	8	3	7	0	0

TABLE 5
(Continued)
INTERSTATE 29 USAGE STUDY

TRIPS ASSIGNED TO FREEWAY BY VARIOUS PROCEDURES

BETWEEN		TRIPS USING FREEWAY: Trips As Actually Traveled		Trips Assigned: Time - Distance Factor - Shortest Path Method, Number of Trips							Trips Assigned: Assignment Basis											
											BPR Travel Time Ratio		S. D. Travel Time Ratio		S. D. Travel Distance Ratio		S. D. T-D Factor Ratio 1/3 T 2/3 D		S. D. T-D Factor Ratio 1/4 T 3/4 D		California Diversion Formula	
Community	Community	No. of Trips	% of Total	Least Time	2/3 T 1/3 D	1/2 T 1/2 D	.4 T .6 D	1/3 T 2/3 D	1/4 T 3/4 D	Least Dist.	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total	No. of Trips	% of Total
Elk Point	Jefferson	36	23	158	158	158	158	158	-	-	84	53	100	63	101	64	87	55	81	51	81	51
	Junction City	8	80	10	10	10	10	10	10	10	8	79	8	84	10	99	10	100	10	100	10	100
	N. Sioux City	34	79	43	43	43	43	43	43	-	27	63	31	72	28	64	26	61	32	73	28	64
	Spink	3	14	21	-	-	-	-	-	-	9	42	8	38	8	40	5	26	5	23	4	19
Canton	Centerville	10	67	15	15	15	15	15	15	15	8	51	9	61	11	73	9	61	10	64	15	100
	Davis	1	100	1	1	1	1	1	1	1	0	43	0	41	1	73	1	52	1	64	1	100
	Lennox	29	41	70	70	70	70	70	70	70	33	47	36	52	51	73	38	55	45	64	70	100
	Parker	13	57	23	23	23	23	23	23	23	10	43	9	41	17	73	12	52	15	64	23	100
	Worthing	-	-	-	-	-	-	-	-	-	10	16	6	10	6	10	5	8	4	7	0	0
Hawarden, Ia.	Centerville	3	12	25	25	25	25	25	25	-	12	47	14	56	18	73	14	55	16	64	16	66
Hudson	Lennox	11	100	11	11	11	11	11	11	11	6	53	7	63	8	73	6	55	8	73	11	100
Jefferson	N. Sioux City	14	30	-	-	-	-	-	-	-	15	31	11	24	6	12	6	12	6	12	0	0
Lennox	Tea	2	40	-	-	-	-	-	-	-	1	10	0	5	0	5	0	4	0	3	0	0
	TOTALS	4388		5522	5462	5400	5139	5035	4179	3551	4008		4249		4366		4361		4383		4602	

TABLE 6

INTERSTATE 29 USAGE STUDY

VEHICLE MINUTES AND VEHICLE MILES ASSIGNED TO FREEWAY BY VARIOUS PROCEDURES AND SUMMARY OF SPEEDS

Assignment Basis	Vehicle Miles of Travel in Thousands: Via Freeway: On Freeway	Via Freeway: On Connecting Roads	Via Freeway: Subtotal	Via Alternate	All Roads On Network	Vehicle Minutes of Travel in Thousands: Via Freeway: On Freeway	Via Freeway: On Connecting Roads	Via Freeway: Subtotal	Via Alternate	All Roads On Network
Actual Routes Traveled	113	53	166	71	237	105	72	177	89	266
Assignments by Shortest Path Method										
T D Factors										
Shortest Time (100% Time)	133	55	188	46	234	123	74	197	59	256
2/3 Time - 1/3 Distance	131	55	186	49	235	122	73	195	61	256
1/2 Time - 1/2 Distance	129	53	182	52	234	120	71	191	66	257
.4 Time - .6 Distance	126	51	177	57	234	116	68	184	72	256
1/3 Time - 2/3 Distance	124	50	174	60	234	114	66	180	76	256
1/4 Time - 3/4 Distance	115	49	164	69	233	107	64	171	88	259
Shortest Distance (100% Distance)	102	43	145	87	232	95	56	151	110	261
Assignments by Various Ratio Procedures										
BPR Travel Time Ratio	97	40	137	102	239	90	55	145	124	269
S.D. Travel Time Ratio	104	42	146	92	238	96	57	153	112	265
S. D. Travel Distance Ratio	106	50	156	80	236	98	69	167	99	266
S.D. TD Factor Ratio (1/3T - 2/3D)	110	45	155	81	236	102	62	164	99	263
S.D. TD Factor Ratio (1/4T - 3/4D)	111	48	159	78	237	102	65	167	96	263
Assignment by Time Distance Differential Formula										
California Formula (2)	119	49	168	66	234	110	68	178	82	260

S U M M A R Y   O F   S P E E D S

	MPH	MPH	MPH	MPH	MPH
Actual Routes Traveled	64.7	44.0	56.3	47.7	53.42
Assignments by Shortest Path Method					
T D Factors					
Shortest Time (100% Time)	64.7	44.9	57.3	47.3	55.0
2/3 Time - 1/3 Distance	64.7	44.9	57.3	47.3	54.9
1/2 Time - 1/2 Distance	64.7	44.8	57.3	47.4	54.8
.4 Time - .6 Distance	64.8	45.3	57.6	47.3	54.7
1/3 Time - 2/3 Distance	64.8	45.2	57.6	47.5	54.6
1/4 Time - 3/4 Distance	64.8	45.3	57.4	46.8	53.9
Shortest Distance (100% Distance)	64.8	45.9	57.7	47.4	53.4
Assignments by Various Ratio Procedures					
BPR Travel Time Ratio	64.8	43.7	56.8	49.0	53.19
S.D. Travel Time Ratio	64.8	43.7	56.9	49.0	53.56
S.D. Travel Distance Ratio	64.7	43.8	56.1	48.5	53.3
S.D. TD Factor Ratio (1/3T - 2/3D)	64.8	43.7	56.8	48.8	53.8
S.D. TD Factor Ratio (1/4T - 3/4D)	64.7	43.8	56.6	48.7	53.7
Assignment by Time-Distance Differential Formula					
California Formula (2)	64.8	43.9	56.8	48.7	54.3

TABLE 7

INTERSTATE 29 USAGE STUDY

PERCENT THAT NUMBER OF ASSIGNED TRIPS IS OF ACTUAL TRIPS ON I-70 IN KANSAS AND I-29 IN SOUTH DAKOTA, AND AVERAGE NETWORK SPEED, FOR VARIOUS WEIGHTS OF TIME AND DISTANCE IN T-D FACTOR USING SHORTEST PATH ASSIGNMENT PROCEDURES

	I-70 Kansas	I-29 So. Dak.	Mean of Percentage	Pct. RMS Error in So. Dak. Study*
Trips on Freeway	3967	4388		
No. of Zone to Zone Movements	46	88		
	Percent: Assigned Trips x 100 ÷ by Actual Trips			
Assignment Basis				
Shortest Time (100% Time)	125	126	125.5	40.3
2/3 Time - 1/3 Distance	123	124	123.5	38.2
1/2 Time - 1/2 Distance	119	123	121.0	36.4
.4 Time - .6 Distance	108	117	112.5	35.4
1/3 Time - 2/3 Distance	107	115	111.0	34.1
1/4 Time - 3/4 Distance	89	95	92.0	15.5
Shortest Distance (100% Distance)	82	81	81.5	15.8
	Weighted Average Network Speed - M.P.H.		Mean of (Two) Speeds	
Shortest Time (100% Time)	61.5	55.0	58.25	
2/3 Time - 1/3 Distance	61.4	54.9	58.15	
1/2 Time - 1/2 Distance	60.9	54.8	57.85	
.4 Time - .6 Distance	60.3	54.7	57.50	
1/3 Time - 2/3 Distance	60.2	54.6	57.40	
1/4 Time - 3/4 Distance	58.1	53.9	56.00	
Shortest Distance (100% Distance)	57.5	53.4	55.45	
Actual Routes Traveled	59.2	53.4	56.30	
Range of Average Network Speeds from 100% Time Basis to 100% Distance Basis.	4.0	1.6	2.80	

*Pct. RMS Error in South Dakota Study Based on All Trips (Freeway plus Alternate) Crossing 10 Screenlines

TABLE 8

INTERSTATE 29 USAGE STUDY

SOUTH DAKOTA STUDY: TRIPS CROSSING TEN SCREENLINES; FREEWAY AND ALTERNATE CROSSINGS AS ACTUALLY TRAVELED AND AS ASSIGNED BY SEVEN SHORTEST PATH METHODS

Screenline Number	Trips As Actually Travelled			Time-Distance Factor - Shortest Path Assignment Methods Percent That Assigned Freeway and Alternate Crossings are of Actual Crossings													
				Least Time		2/3 T 1/3 D		1/2 T 1/2 D		.4T - .6D		1/3 T 2/3 D		1/4 T 3/4 D		Least Distance	
	Free.	Alt.	Total	Free. %	Alt. %	Free. %	Alt. %	Free. %	Alt. %	Free. %	Alt. %	Free. %	Alt. %	Free. %	Alt. %	Free. %	Alt. %
1	1721	764	2485	144	0	144	0	144	0	144	0	144	0	104	92	101	97
2	1927	672	2599	132	7	132	7	132	7	132	7	132	7	96	111	92	124
3	1378	426	1804	120	37	118	42	118	42	118	42	118	42	117	44	106	82
4	919	537	1456	127	54	124	58	124	58	121	64	116	72	116	72	104	92
5	861	393	1254	130	34	130	34	123	49	123	49	123	49	123	49	110	78
6	810	541	1351	151	23	147	30	139	42	139	42	132	52	132	52	119	72
7	1109	622	1731	119	66	115	73	112	79	112	79	106	89	106	89	82	131
8	1177	652	1829	131	44	127	50	124	57	124	57	119	66	119	66	95	109
9	1503	1305	2808	114	84	109	90	106	93	106	93	102	98	102	98	84	118
10	2201	1489	3690	116	76	113	81	111	84	100	99	98	103	98	103	86	121
TOTALS	13606	7401	21007														

TABLE 9

INTERSTATE 29 USAGE STUDY

PERCENT THAT NUMBER OF ASSIGNED TRIPS IS OF ACTUAL TRIPS ON SIX FREEWAYS OR EXPRESSWAYS, AVERAGE NETWORK SPEED, AND PCT. RMS ERROR OF ESTIMATE FOR FIVE RATIO ASSIGNMENT PROCEDURES AND THE CALIFORNIA TIME - DISTANCE DIFFERENTIAL FORMULA

	I-29 So. Dak.	I-70 Kansas	Cabrillo	Alvarado	Shirley	Kokomo	South Dakota & Kansas Mean of Percentage	South Dakota & Kansas Order of Preference	Cabrillo Alvarado, Shirley & Kokomo Mean of Percentage	Cabrillo Alvarado, Shirley & Kokomo Order of Preference	All Six Studies Mean of Percentage	All Six Studies Order of Preference
Trips on Freeway	4388	3967	27,060	23,856	8152	2053						
No. of Zone to Zone Movements	88	46	101	154	88	69						
	Percent That Assigned Trips Are of Actual Trips											
Assignment Basis												
BPR Travel Time Ratio	91.3	98.8	129.4	145.8	91.2	151.1	95.0	6	129.4	5	117.9	5
S.D. Travel Time Ratio	96.8	104.3	135.2	148.0	92.5	161.9	100.6	3	134.4	6	123.1	6
S.D. Travel Distance Ratio	99.5	95.4	79.4	74.9	82.7	70.6	97.4	4	76.9	4	83.8	4
S.D. TD Factor Ratio (1/3T-2/3D)	99.4	100.8	107.8	110.3	83.9	127.9	100.1	1	107.5	3	105.0	3
S.D. TD Factor Ratio (1/4T-3/4D)	99.9	98.8	99.3	101.7	81.3	120.2	99.4	2	100.6	2	100.2	1
California Formula* (2)	104.9	102.8	106.7	102.0	78.4	111.0	103.8	5	99.5	1	101.0	2
	Weighted Average Network Speed in Miles Per Hour						Mean of Speeds (2)		Mean of Speeds (4)		Mean of Speeds (6)	
BPR Travel Time Ratio	53.2	59.3	32.5	33.8	27.4	35.3	56.2	3	32.2	5	40.2	4
S.D. Travel Time Ratio	53.6	59.8	32.8	34.0	27.6	36.1	56.7	4	32.6	6	40.6	5
S.D. Travel Distance Ratio	53.3	58.4	28.1	31.3	26.6	29.5	55.8	5	28.9	4	37.9	6
S.D. TD Factor Ratio (1/3T-2/3D)	53.8	59.3	30.5	32.6	27.0	33.4	56.55	1(tie)	30.9	3	39.43	3
S.D. TD Factor Ratio (1/4T-3/4D)	53.7	58.4	29.8	32.3	27.2	32.6	56.05	1(tie)	30.5	1	39.0	1
California Formula* (2)	54.3	59.5	30.6	32.4	27.3	32.2	56.9	6	30.6	2	39.38	2
Actual Routes Traveled	53.4	59.2	30.3	32.2	27.6	31.3	56.30		30.4		39.0	
	Pct. RMS Error Based on Zone to Zone Movements - Ungrouped Data Weighted According to Number of Trips in Each Movement**						Mean of Pct. RMS Errors (2)		Mean of Pct. RMS Errors (4)		Mean of Pct. RMS Errors (6)	
BPR Travel Time Ratio	92.1	65.9	88.1	49.8	28.6	103.1	79.0	5	67.4	5	71.3	5
S.D. Travel Time Ratio	85.7	74.4	99.2	59.9	33.9	115.4	80.0	6	77.1	6	78.1	6
S.D. Travel Distance Ratio	42.9	28.5	81.4	44.3	59.1	71.8	35.7	3	64.2	3	54.7	3
S.D. TD Factor Ratio (1/3T-2/3D)	43.6	25.0	66.0	40.9	47.2	67.3	34.3	2	55.4	2	48.3	2
S.D. TD Factor Ratio (1/4T-3/4D)	28.6	23.6	66.3	41.2	54.8	51.1	26.1	1	53.4	1	44.3	1
California Formula* (2)	51.2	35.9	71.8	37.7	52.3	100.9	43.6	4	65.7	4	58.3	4

* California Formula (Time-Distance Differential)

** Not comparable to Pct. RMS Error Based on Trips Crossing Screenlines tabulated in Table 4.

TABLE 10

I-29 USAGE STUDY

I-29 BARRIER EFFECT ON TRIPS OF 25 MILES OR LESS IN LENGTH

Only Crossing Point in Area of:	Interview Station Number	Total Number of Trips				Number of Trips of 25 Miles or Less				Number of Trips of 25 Miles or Less With Additional Miles				Total Additional Miles of Trips of 25 Miles or Less			
		Pass. Veh.	Hvy. Trucks	Farm Implements	Total	Pass. Veh.	Hvy. Trucks	Farm Implements	Total	Pass. Veh.	Hvy. Trucks	Farm Implements	Total	Pass. Veh.	Hvy. Trucks	Farm Implements	Total
2 Miles or Less	29	67.5	4.5	4.5	76.5	66.6	4.5	4.5	75.6	-	-	-	-	-	-	-	-
	33	25.2	-	-	25.2	25.2	-	-	25.2	-	-	-	-	-	-	-	-
	Totals	92.7	4.5	4.5	101.7	91.8	4.5	4.5	100.8	0	0	0	0	0	0	0	0
3 Miles or Less	17	186.4	30.8	-	217.2	169.2	20.1	-	189.3	1.4	-	-	1.4	3.6	-	-	3.6
	34	199.0	12.5	-	211.5	178.0	9.5	-	187.5	4.0	-	-	4.0	11.0	-	-	11.0
	38	62.4	12.8	-	75.2	62.4	12.8	-	75.2	-	1.6	-	1.6	-	.6	-	.6
	42	68.0	2.0	-	70.0	68.0	-	-	68.0	-	-	-	-	-	-	-	-
	50	189.9	46.4	-	236.3	187.3	45.1	-	232.4	2.5	-	-	2.5	3.0	-	-	3.0
	35	12.0	2.0	20.0	34.0	12.0	2.0	20.0	34.0	-	-	-	-	-	-	-	-
	Totals	717.7	106.5	20.0	844.2	676.9	89.5	20.0	786.4	7.9	1.6	0	9.5	17.6	.6	0	18.2
4 Miles or Less	30	42.6	6.6	-	49.2	38.4	6.6	-	45.0	7.8	1.2	-	9.0	16.9	1.8	-	18.7
	32	27.9	2.7	6.3	36.9	27.0	2.7	6.3	36.0	.9	-	-	.9	1.8	-	-	1.8
	15	104.8	14.5	-	119.3	40.9	11.3	-	52.2	-	-	-	-	-	-	-	-
	11	760.8	115.4	-	876.2	610.4	59.2	-	669.6	17.4	-	-	17.4	14.9	-	-	14.9
	39	65.6	27.2	6.4	99.2	65.6	27.2	6.4	99.2	3.2	-	-	3.2	3.0	-	-	3.0
	47	188.8	13.2	-	202.0	180.8	12.2	-	193.0	-	-	-	-	-	-	-	-
	51	132.3	8.4	-	140.7	126.0	8.4	-	134.4	10.5	-	-	10.5	30.4	-	-	30.4
	53	574.8	14.4	-	589.2	568.4	13.2	-	581.6	-	-	-	-	-	-	-	-
	Totals	1897.6	202.4	12.7	2112.7	1657.5	140.8	12.7	1811.0	39.8	1.2	0	41.0	67.0	1.8	0	68.8

TABLE 10 (Continued)

I - 29 USAGE STUDY

I - 29 BARRIER EFFECT ON TRIPS OF 25 MILES OR LESS IN LENGTH

Only Crossing Point in Area of:	Interview Station Number	Total Number of Trips				Number of Trips of 25 Miles or Less				Number of Trips of 25 Miles or Less With Additional Miles				Total Additional Miles of Trips of 25 Miles or Less			
		Pass. Veh.	Hvy. Trucks	Farm Implements	Total	Pass. Veh.	Hvy. Trucks	Farm Implements	Total	Pass. Veh.	Hvy. Trucks	Farm Implements	Total	Pass. Veh.	Hvy. Trucks	Farm Implements	Total
	28	39.0	12.7	2.2	53.9	36.8	12.7	2.2	51.7	3.9	-	-	3.9	9.0	-	-	9.0
	31	101.4	14.3	1.3	117.0	88.4	14.3	1.3	104.0	2.6	1.3	-	3.9	2.9	1.6	-	4.5
	41	36.0	4.4	-	40.4	32.8	3.6	-	36.4	.8	-	-	.8	.8	-	-	.8
5 Miles or Less	4	407.4	33.8	-	441.2	392.4	33.8	-	426.2	5.1	-	-	5.1	2.6	-	-	2.6
	48	54.6	-	-	54.6	54.6	-	-	54.6	-	-	-	-	-	-	-	-
	49	24.8	-	3.2	28.0	24.0	-	3.2	27.2	-	-	-	-	-	-	-	-
	52	111.6	5.4	-	117.0	109.8	5.4	-	115.2	1.8	-	-	1.8	2.5	-	-	2.5
	54	860.7	24.8	-	885.5	850.7	23.2	-	873.9	1.6	-	-	1.6	4.0	-	-	4.0
	Totals	1635.5	95.4	6.7	1737.6	1589.5	93.0	6.7	1689.2	15.8	1.3	0	17.1	21.8	1.6	0	23.4
	14	84.9	8.1	-	93.0	66.3	.9	-	67.2	9.9	-	-	9.9	21.3	-	-	21.3
	36	60.9	7.5	-	68.4	53.4	7.5	-	60.9	-	-	-	-	-	-	-	-
6 Miles or Less	37	39.8	10.8	-	50.6	32.4	7.4	-	39.8	3.4	3.4	-	6.8	7.8	6.8	-	14.6
	40	85.5	23.1	-	108.6	77.6	9.6	-	87.2	2.8	-	-	2.8	2.8	-	-	2.8
	43	40.5	7.5	-	48.0	39.0	7.5	-	46.5	1.5	-	-	1.5	1.5	-	-	1.5
	Totals	311.6	57.0	0	368.6	268.7	32.9	0	301.6	17.6	3.4	0	21.0	33.4	6.8	0	40.2
	6	317.7	45.1	-	362.8	188.6	26.0	-	214.6	-	-	-	-	-	-	-	-
7 Miles or Less	45	21.0	2.1	10.5	33.6	20.3	2.1	10.5	32.9	-	-	-	-	-	-	-	-
	46	22.8	.6	7.2	30.6	22.2	.6	7.2	30.0	1.8	-	1.8	3.6	5.5	-	4.3	9.8
	Totals	361.5	47.8	17.7	427.0	231.1	28.7	17.7	277.5	1.8	0	1.8	3.6	5.5	0	4.3	9.8
8 Miles or Less	NONE																
9 Miles or Less	44	78.9	1.3	-	80.2	67.9	1.3	-	69.2	2.9	-	-	2.9	10.2	-	-	10.2
	Totals	78.9	1.3	0	80.2	67.9	1.3	0	69.2	2.9	0	0	2.9	10.2	0	0	10.2
GRAND TOTALS		5095.5	514.9	61.6	5672.0	4583.4	390.7	61.6	5035.7	85.8	7.5	1.8	95.1	155.5	10.8	4.3	170.6

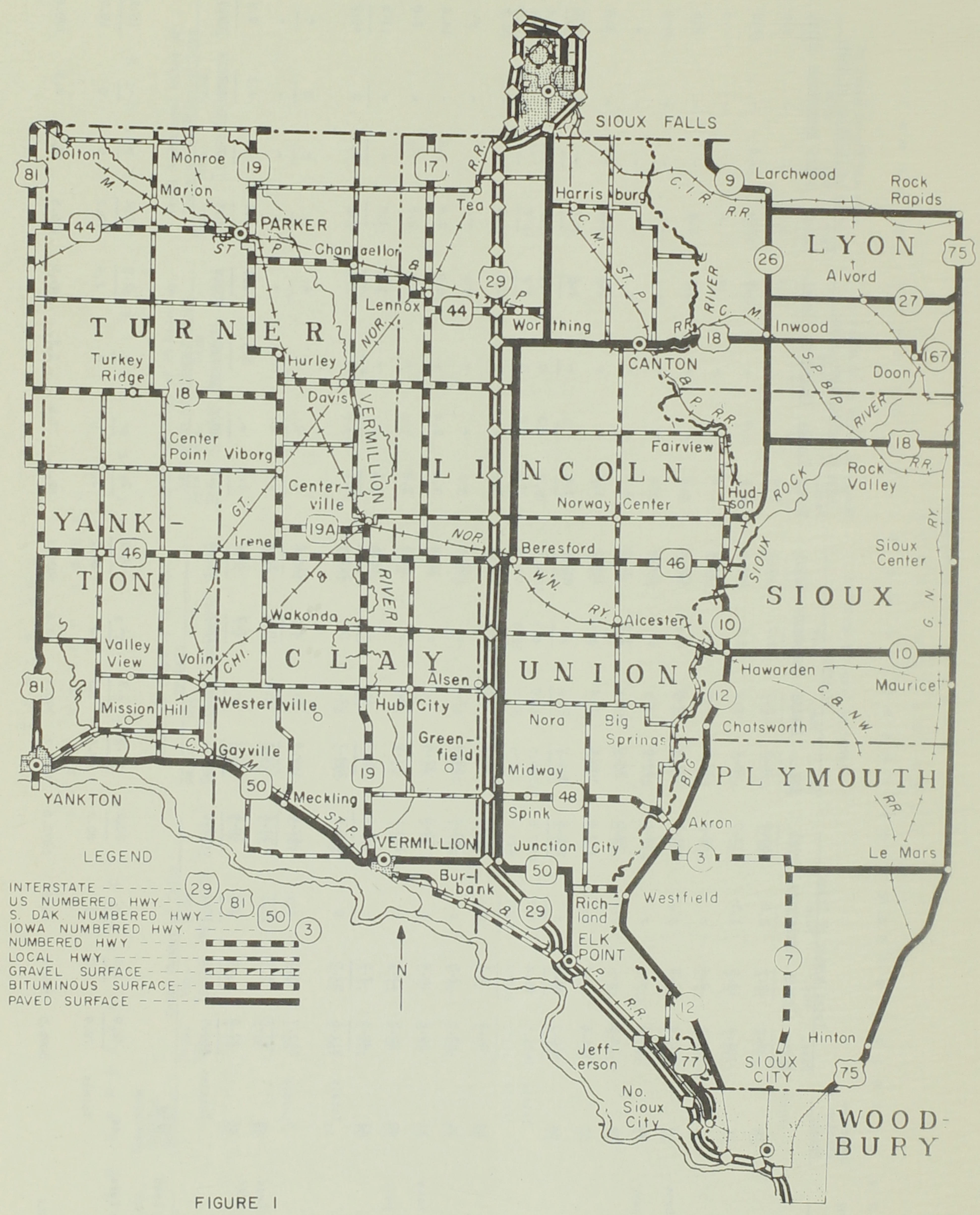


FIGURE I

MAP SHOWING STUDY AREA

FIGURE 2

LOCATION OF INTERVIEW STATIONS OPERATED "BEFORE" COMPLETION OF I-29

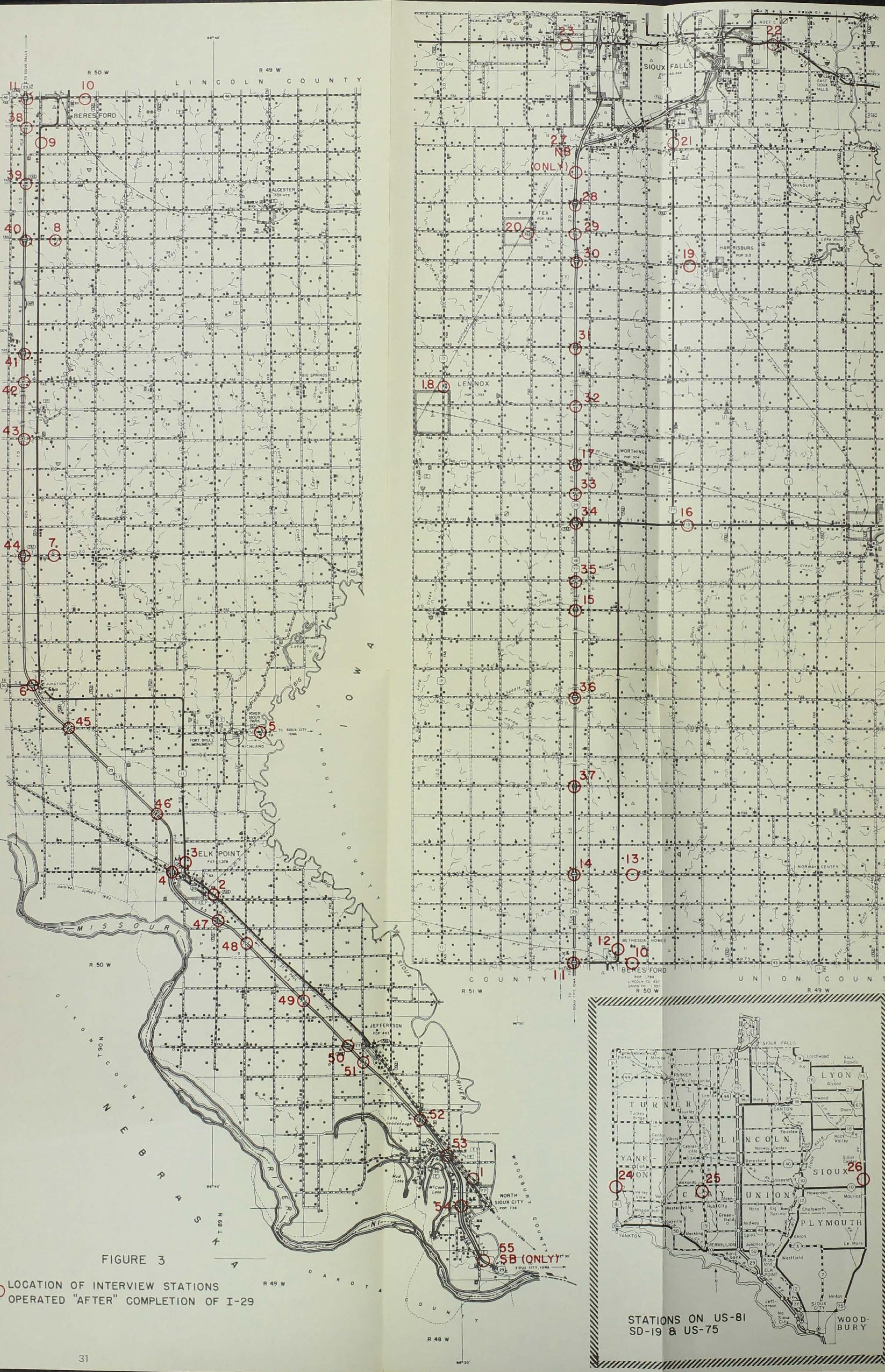


FIGURE 3

LOCATION OF INTERVIEW STATIONS OPERATED "AFTER" COMPLETION OF I-29

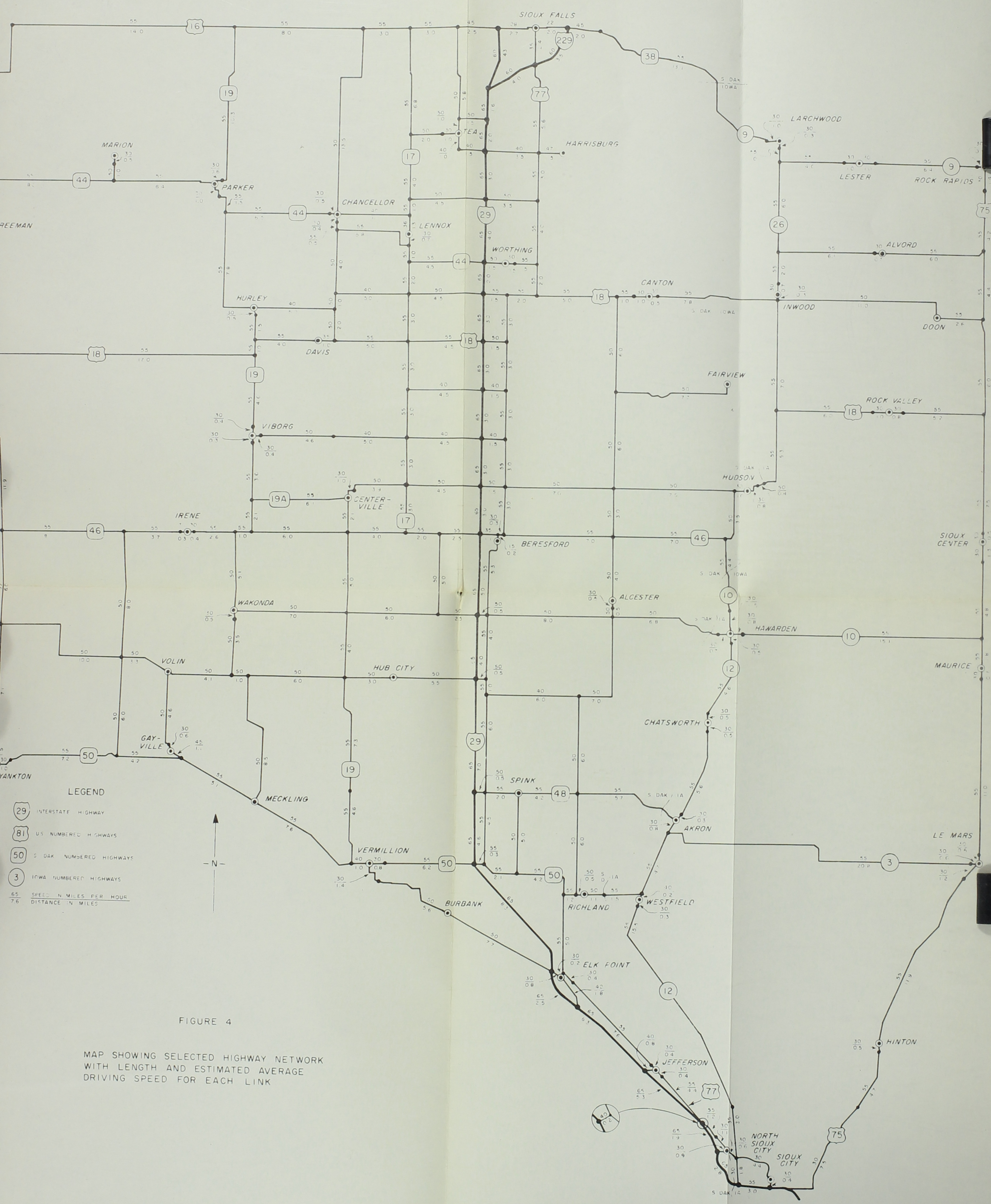
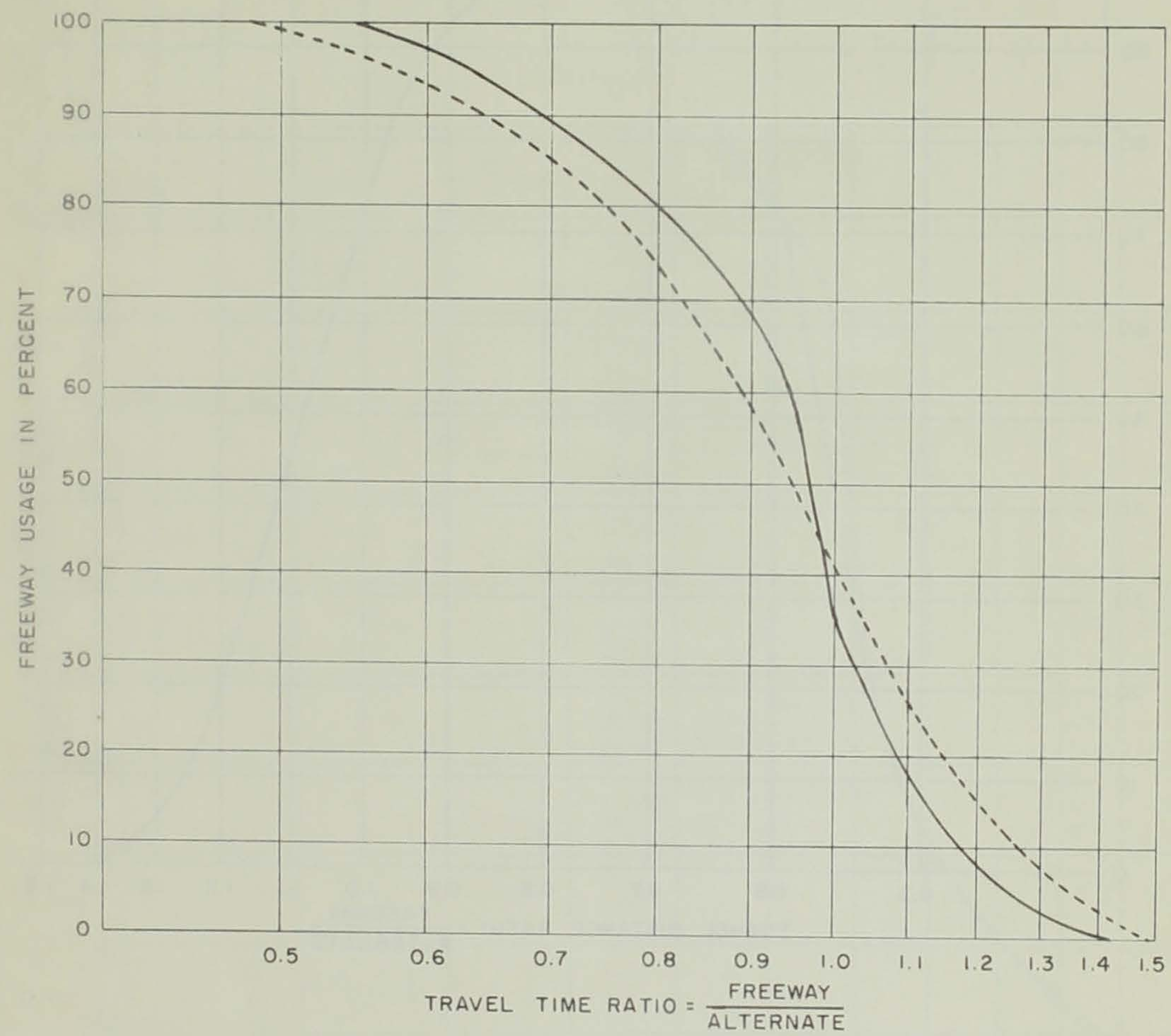


FIGURE 4

MAP SHOWING SELECTED HIGHWAY NETWORK
WITH LENGTH AND ESTIMATED AVERAGE
DRIVING SPEED FOR EACH LINK

FIGURE 5

SOUTH DAKOTA AND BPR TRAVEL TIME RATIO ASSIGNMENT CURVES



——— SOUTH DAKOTA TIME RATIO CURVE

- - - - - - BPR TIME RATIO CURVE (INSTRUCTION MANUAL FOR "THE 1965 ESTIMATE OF THE COST OF COMPLETING THE INTER-STATE SYSTEM")

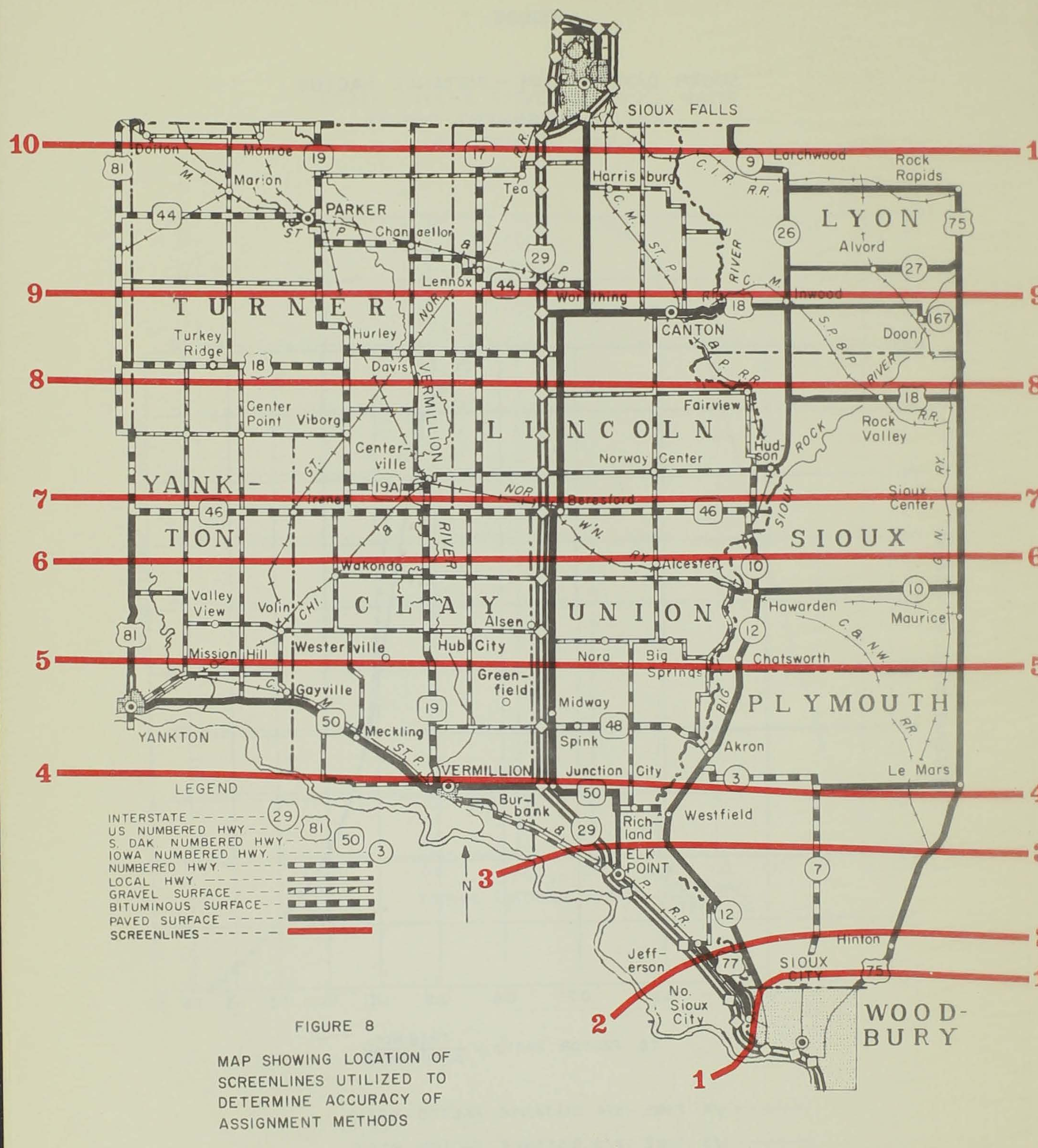


FIGURE 8

MAP SHOWING LOCATION OF SCREENLINES UTILIZED TO DETERMINE ACCURACY OF ASSIGNMENT METHODS

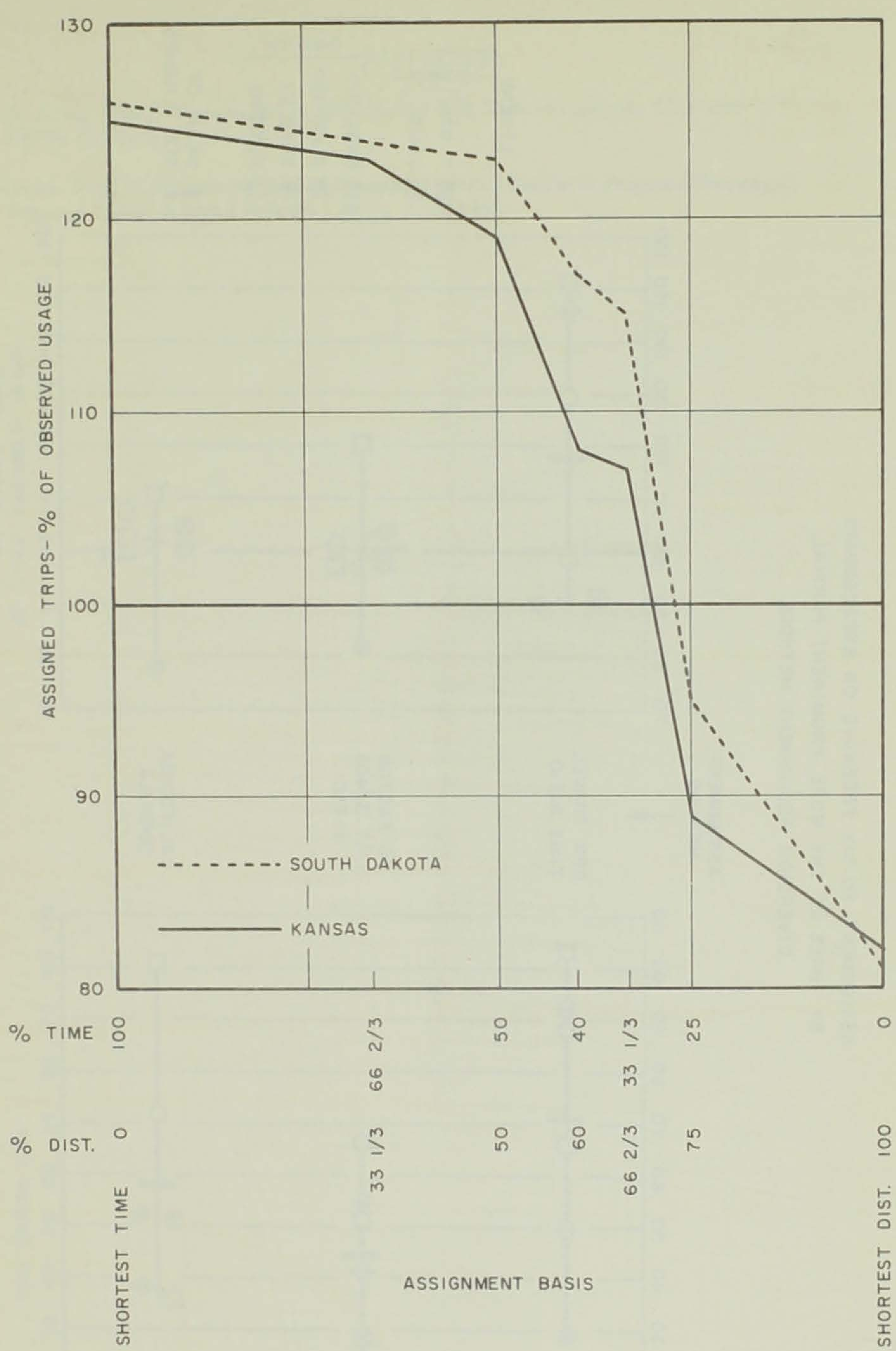


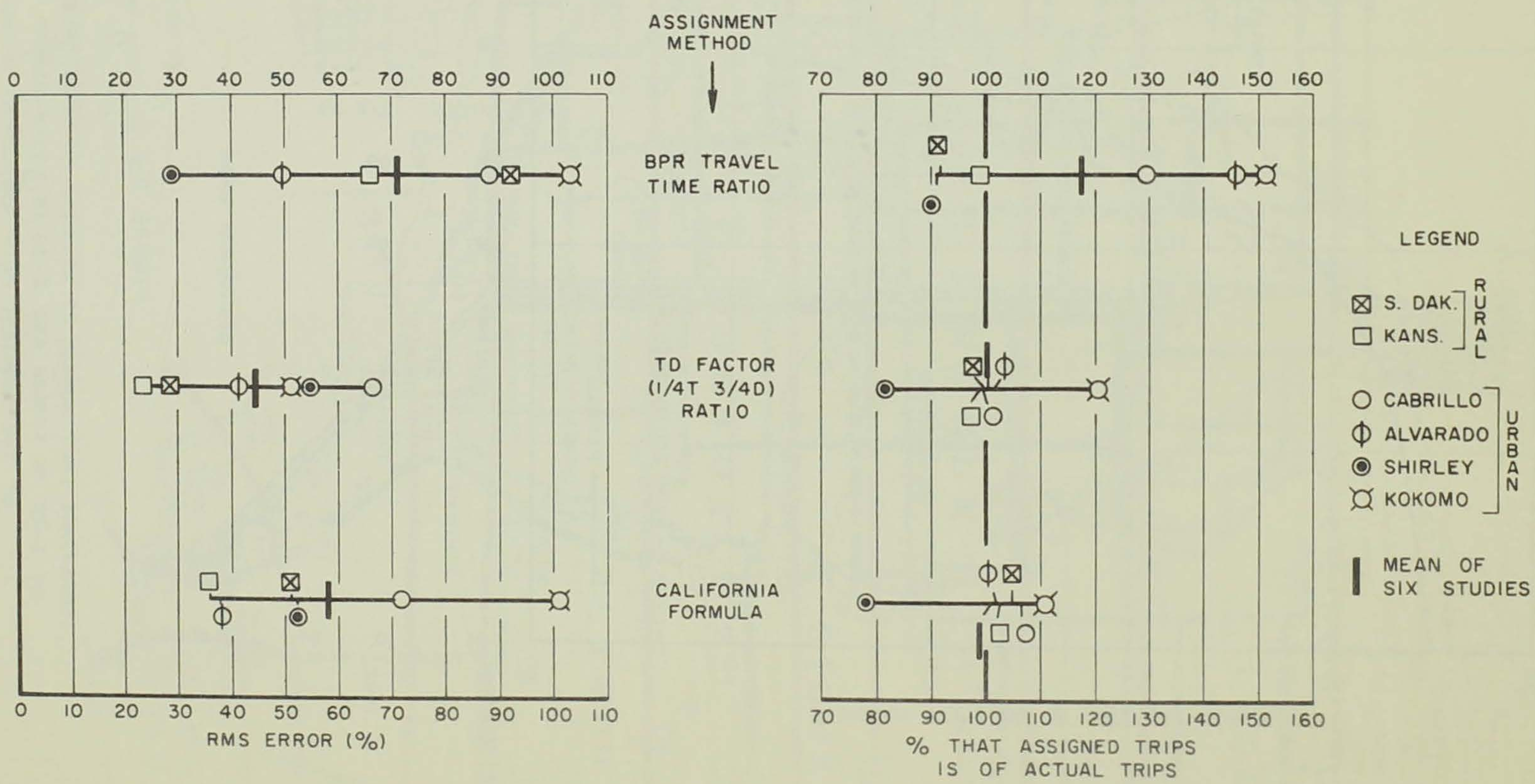
FIGURE 9

PERCENTAGE THAT NUMBER OF ASSIGNED TRIPS IS OF ACTUAL TRIPS ON I-70 IN KANSAS AND I-29 IN SOUTH DAKOTA FOR EACH OF THE SHORTEST PATH ASSIGNMENT METHODS

FIGURE 10

COMPARISON OF ACCURACY

ASSIGNMENT TO SIX FREEWAYS OR EXPRESSWAYS
BY THREE OF THE MORE PROMINENT PARTIAL
DIVERSION ASSIGNMENT METHODS



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(1) Benesh, A. H., "Traffic Assignment by the Shortest Path Method Using the TD Factor", **Traffic Quarterly**, October, 1967.

(2) Moskowitz, Karl, "California Method of Assigning Diverted Traffic to Proposed Freeways", **Highway Research Board Bulletin 130**, pp. 1-26, 1956.