# THE ROLE OF MASS TRANSIT





## TWIN CITIES METROPOLITAN AREA

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STATE OF MINNESOTA
DEPARTMENT OF HIGHWAYS

in cooperation with
U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

# FOREWORD

Mass transit's role in the overall motorized person transportation complex in the large metropolitan area is an important one.

A quantitative definition of that role can therefore contribute substantially to the growing body of knowledge which will have application in an integrated approach to the solution of the metropolitan area's transportation problems - that is, an approach incorporating all vehicle and motorized person travel in the metropolitan area and the major factors influencing its patterns, such as land use and socio-economic activities.

This publication reports the results of a study of mass transit person movement in the Minneapolis and St. Paul urban area. The study was undertaken jointly by the Minnesota Department of Highways, in cooperation with the U.S. Bureau of Public Roads, and the Twin Cities Metropolitan Planning Commission. A separate report will be published by the Twin Cities Metropolitan Planning Commission. The raw data for both publications were mainly obtained from a comprehensive body of travel survey data collected in 1958 in the Twin Cities Area Transportation Study, which was conducted by the Minnesota Highway Department in cooperation with the Bureau of Public Roads.

The objectives of this report are to describe the present characteristics of mass transit travel in the Twin Cities metropolitan area and identify the major factors influencing usage of the mass transit mode. These determinations, in a quantified form, provide basic relationships for planning and forecasting the future role of mass transit as a mode of person travel in the Twin Cities metropolitan area.

The study staff takes this opportunity to thank Twin City Rapid Transit Company officials for their cooperation in the course of this study.

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# CHAPTER I

## Introduction

While population in the Twin Cities metropolitan area increased by over one-fourth in the nine-year period between 1949 and 1958, and total daily person trips more than doubled, daily person trips by mass transit showed a decrease of several thousand. Despite this decline, mass transit, carrying an average of more than 416,000 trips per work day, remains an important mode of person travel in the Twin Cities metropolitan area.

Whether mass transit will retain its present 12.4% share of the 3,367,000 total daily person trips in the metropolitan area, or whether the factors that brought about the marked relative decline in the 1949-1958 period will adversely influence transit usage at the same rate in the future, must be considered if urban transportation and community planning is to be effective. In this regard, the role of community and transportation planning agencies is not necessarily a passive one. At the present time, several measures designed to improve the position of mass transit, including financial aid, have been instituted at the federal level.

In any case, judgments in the areas of land use planning, CBD (central business district) redevelopment, and transportation systems and traffic engineering must include an appraisal of the future role of mass transit as a mode of person travel, whether that role is to be influenced or merely forecast. And these judgments must be based on objective analyses.

By describing and analyzing the present characteristics of mass transit usage, such as locations of trip origins and destinations, trip length, hourly distribution of trips, and trip purpose, and by isolating the personal factors associated with transit ridership, such as age, sex and occupation, this report provides data by which the future position of mass transit in the Twin Cities metropolitan area may be objectively estimated.

As this report involves an inquiry into the role of mass transit in the overall transportation network, a comparison with other modes of travel becomes an integral part of the analysis and presentation. Such comparisons, therefore, appear throughout the report.

### SOURCE OF DATA

The mass transit ridership data upon which most of the analyses in this report are based, along with virtually all of the data used in comparisons of bus ridership with person trips by auto, were collected in 1958 in the Twin Cities Area Transportation Study. This group sampled travel and household characteristics in an area of 890 square miles, containing 408,061 dwelling units and a population of 1,376,000. The technique used was the home interview, and the sampling rate was 5%. Interviews were conducted Tuesdays through Saturdays, and the primary informa-

tion obtained was the number and characteristics of the previous day's trips by each household member over five years of age.

While the Twin Cities Area Transportation Study included a survey of external movement (trips entering, leaving and passing through the Study Area), this report is limited to internal movement. That is, the descriptions and analyses of mass transit travel are confined to trips with both origin and destination within the Study Area. The auto travel data presented for comparisons also consists entirely of internal travel.

In short, most of the mass transit person movement analyses in this report and the travel data used for comparative purposes, as well as all household information of a general nature, are based on data collected in 1958 in a 5% sample of 408,000 dwelling units in an area of 890 square miles. This area, surrounding the central cities of Minneapolis and St. Paul and most of the suburban communities in the metropolitan area, is delineated in Map 1.

For the purpose of coding the geographical locations of trip origins and destinations, the Twin Cities Area Transportation Study group divided the Study Area into 84 districts. The districts, in turn, were divided into zones and subzones. Presentation of the location of bus passenger trip origins and destinations in this report, however, is restricted for the most part to the district framework. Equal-sized areal units - sections and quarter sections - are also used.

The districts are shown in Map 2, along with the Study Area's political units. As it was not considered necessary for the purposes of this report to use subdivisions within the Minneapolis and St. Paul CBDs (throughout this report the term "CBDs" will mean the Minneapolis and St. Paul central business districts, both of which are delineated in Map 2), the several districts within each were consolidated. Thus the districts shown in Map 2, and used throughout this report, number 67, rather than the 84 originally delineated in the Twin Cities Area Transportation Study.

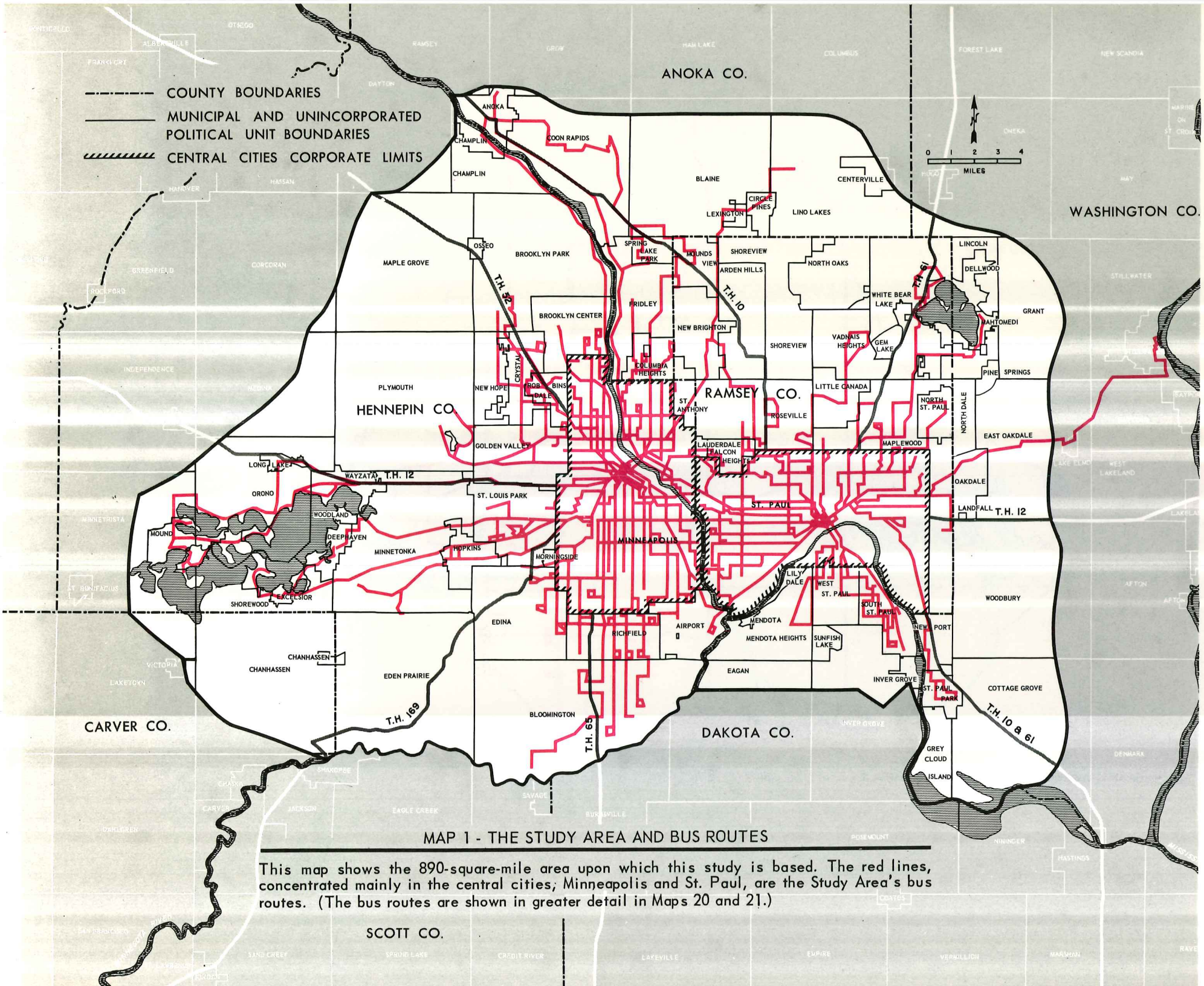
The purpose of each trip sampled in the Twin Cities Area Transportation Study was classified in one of ten categories: home, school, work, shop, social-recreation, eat, personal business, serve passenger, change mode, and ride. The origin of each trip was also classified in one of these categories. Several analyses in this report are based on distributions of trips by these classes.

One chapter of this report deals with changes in mass transit usage between 1949 and 1958. Other changes during this period, including general urban change, are also explored. The source of the 1949 data was an origin-destination study conducted by the Minnesota Department of Highways.

## THE MASS TRANSIT SYSTEM

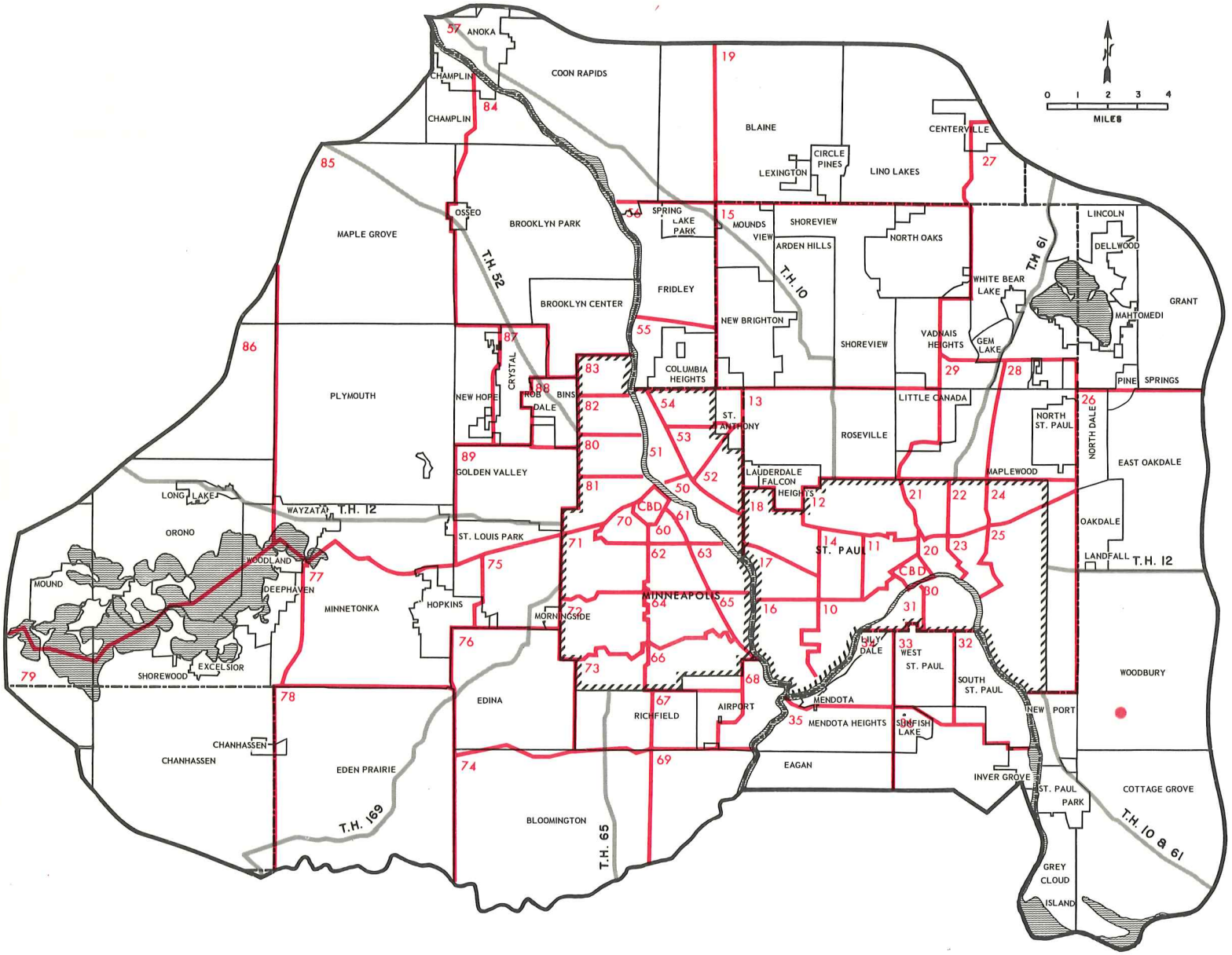
Virtually all motorized person movement in the Twin Cities metropolitan area is by bus and the privately owned automobile. Bus, the only form of mass transportation in the area, divides into three distinct systems: school buses, suburban bus companies, and the Twin City Rapid Transit Company, the only public carrier serving internal movement in Minneapolis and St. Paul. TCRT buses also serve several close-in suburban areas. Map 1, providing general orientation, also shows the routes of the suburban and TCRT bus lines.

The function of school buses is self-explanatory. The suburban buses and the TCRT system are both oriented to the CBDs, and differ primarily in the areas served. Service by the suburban bus lines is usually of the express variety and is offered only to certain areas, some at considerable distances from the CBDs. It is not possible to categorize the Study Area's daily bus passenger trips into the three systems described above because no




MAP 1 - THE STUDY AREA AND BUS ROUTES

This map shows the 890-square-mile area upon which this study is based. The red lines, concentrated mainly in the central cities, Minneapolis and St. Paul, are the Study Area's bus routes. (The bus routes are shown in greater detail in Maps 20 and 21.)




MAP 2 - STUDY AREA DISTRICTS

Much of the data in this report is expressed in terms of the district framework shown in red in this map. Table 20, in the Appendix, gives the number of dwelling units and residential acres in each district as well as the population.

distinction was made between the systems when the data was collected.[1]

Although the inability to separate trips by the three bus systems imposes certain limitations on the handling of the data, such limitations are not severe. Most of the meaningful relationships can be made by the exclusion of school trips. This is especially true of analyses for the purpose of determining the characteristics and factors related to choice of trip mode, as bus passengers going to or from school typically have little or no choice regarding mode of travel and, therefore, the bus mode is selected in an almost noncompetitive setting. Some analyses are based on the exclusion of trips to school; others are based on the exclusion of trips either to or from school. (School trips were isolated by sorting the total trips by the ten purpose classes mentioned previously.)

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[1]Data furnished by TCRT indicate 1958 ridership of about 210,000 to 230,000 revenue trips per average weekday, and the number of school trips in this total is thought to be about 35,000 to 40,000. This data, although useful in making a general check on the survey data and in providing an approximation of the portion of the total daily school trips carried by TCRT, cannot be considered as TCRT's component of the 416,300 total daily bus trips established by the TCATS survey. Differences would be expected for a number of reasons: TCRT and TCATS methods of arriving at an average weekday trip total differed somewhat; the average weekday bus trip total established by the survey includes charter bus trips while the daily total furnished by TCRT does not (such trips being on a contract basis, the exact number of persons carried is not recorded); in the survey, a person movement by bus was coded as two trips if some purpose was accomplished at the transfer point -- however, the number of such instances cannot be extracted from the survey total. By and large, the same problems obscure suburban bus trip data comparisons, and information relating to the number of trips by school bus was unobtainable.

For the foregoing reasons, data from sources outside the TCATS survey have not been applied as a means of separating the survey's daily bus trips by the three systems, and except for the section on utilization as it relates to capacity, such data have not been introduced into this report. Such data have been considered, however, and insofar as can be determined lend general support to the accuracy of the survey data.

# CHAPTER II

## Daily Person Movement by Mass Transit

This chapter undertakes description of total daily mass transit person movement in the Study Area - in terms of location of trip origins and destinations, trips by hour of day, and trip duration and length. Analyses are also made in terms of the ten purpose classes and land use at trip destinations. The chapter concludes with an examination of bus travel speed, and capacity and utilization of the Twin City Rapid Transit Company's facilities.

### TOTAL MASS TRANSIT PERSON MOVEMENT

On an average weekday, the Study Area's three bus systems (school, suburban, and TCRT) carry a total of 416,360 person trips. (Travel from origin to destination, one-way, constitutes a trip; e.g., from home to work is counted as a trip, the trip from work back home again is counted as another.) This number is equal to 12.4% of the 3,367,000 total daily person trips carried by all modes.

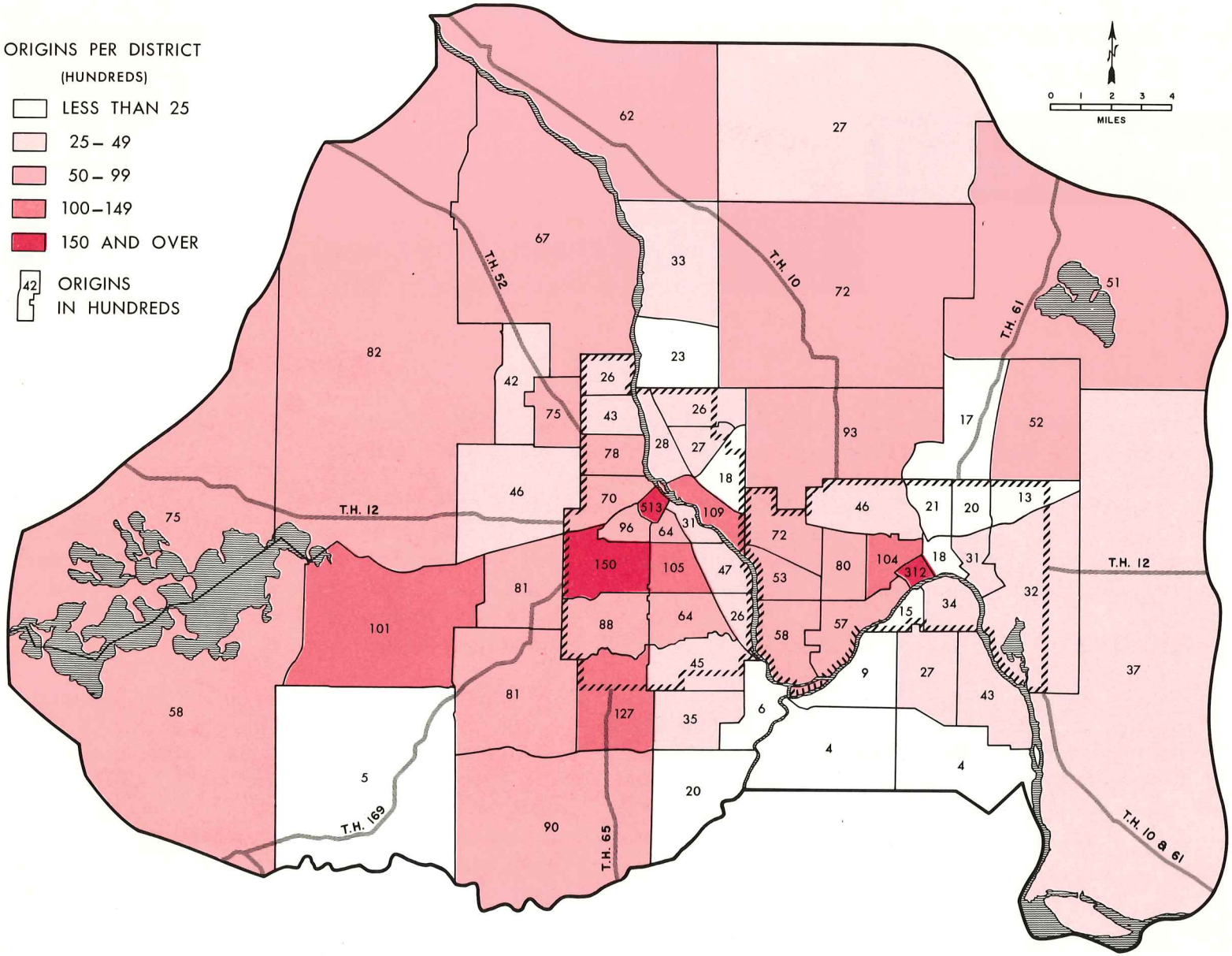
Almost 40% of the daily bus trips in the Study Area have school as either origin or destination. When only nonschool trips are considered, bus's share of daily trips drops to 8.1%, or 252,500 of the 3,115,600 nonschool trips by all modes. These figures show the dominance of the automobile in Twin Cities metropolitan area travel, and particularly in nonschool travel. As stated in Chapter 1, several analyses in this report are based only on nonschool trips.

#### Location of Trip Origins

The origins of daily bus passenger travel in terms of area will be described in two categories: total origins, and home origins only. Total origins are presented in the district framework, while home origins are shown both by district and by isoline on a square-mile basis.

*Total Origins.* The origins of the 416,360 total daily bus passenger trips are shown by district in Map 3. Origins are mainly concentrated in and around the Minneapolis and St. Paul CBDs. The Minneapolis CBD shows almost 51,300 origins, the St. Paul CBD, over 31,200. The two CBDs combined account for about 20% of the total daily bus passenger trip origins. Few of the trips originating in and near the CBDs involve school, whereas many of the trips originating in the large outlying districts have school as either origin or destination.

It should be noted that a map showing bus passenger trip origins would correspond for the most part to one showing bus passenger trip destinations. Small variations would result from other modes being employed in the course of a person's daily




MAP 3 - TRIP ORIGINS BY DISTRICT

On the average workday, 416,300 bus passenger trips are made in the Study Area. This map shows their origins. Many of the trips originating in the outlying districts are for school.

travel. Another factor that would occasion minor variations is that a certain number of trips would not have both their origins and destinations within the 24-hour period being sampled.

*Home Origins.* Of the 3,366,919 total daily internal person trips by all modes, 80.2% are home-based, i.e., have the home of the tripmaker as origin or destination. Home-based trips as a percent of the daily total of each of the three major trip modes - bus passenger, auto driver, and auto passenger (includes taxi passengers), which account for 99.98% of the Study Area's total daily internal trips - are as follows: 94.6% of the 416,360 bus passenger trips; 75.3% of the 1,963,023 auto driver trips; 83.7% of the 986,973 auto passenger trips. The proportion of home-based trips, then, is substantially higher in the bus passenger mode than it is in the two other modes.

Of the 416,360 daily bus passenger trips, 192,000 (not including a minor number of trips by CBD residents) have origin at home. These origins are depicted in Map 4 by square mile of origin. The preponderance of origins close to the CBDs is evident. However, this could be expected if only because of the higher population densities per square mile in areas close to the CBDs. To show the relative importance of bus travel in different areas, the number of bus trip home origins must be shown as a percent of the home origins by all modes. This can be shown on a district basis. Map 5 shows the total number of bus passenger trip home origins in each district, and this number is expressed in Map 6 as a percent of the total home origins in each district by all modes.

The expected pattern of higher percentages of trip origins accounted for by bus in districts near the CBDs does not emerge. This is due to the effect of the large number of school trips, most of which are by bus, in the outlying districts. In fact, some of the highest percentages are found at considerable distances from the CBDs.

Thus to indicate the usage of bus as a mode of travel by persons who in general have some degree of choice, it becomes necessary to exclude trips to or from school.[1] Map 7 shows bus passenger trip home origins with the origins of trips to school excluded. These same origins are shown in Map 8 as a percent of the origins of nonschool home-origin trips by all modes. With school trips excluded, a pattern emerges between the percentage of home origins accounted for in a district by bus passengers and the district's location relative to the CBDs. This pattern reflects a sharp increase in the percentage of origins accounted for by bus passengers in areas close to the CBDs.

## Trips by Area of Destination

Because daily bus passenger trip origins and destinations virtually correspond, and the total daily origins were shown in Map 3, only home-origin trip destinations will be considered here. Over one-third of these destinations are in the CBDs, as shown in Map 9.

The destinations of home-origin bus passenger trips are shown in Map 10 as a percent of the destinations of home-origin trips by all modes. Some of the higher percentages appear in the outlying areas as was the case for origins when school trips were included. If school trips were excluded, a pattern would emerge showing that bus passengers account for an increasing percentage of all destinations as the area of investigation moves from the outlying areas toward the CBDs. This can be seen in Map 15 (page 29), which shows the work destinations of home-origin bus

[1]While it is recognized that not everyone has an unlimited choice of mode, the limitations are greatest and unique in the case of school trips. In general, factors which could be considered as limiting in regard to choice of mode for nonschool trips are the significant ones which must be considered as factors related to the mode of travel.

passenger trips as a percentage of work destinations of home-origin trips by all modes.

Areas of Heavy Movement

The areas of heavy bus passenger travel are shown isolined by quarter section in Map 11. The pattern shown is the result of connecting the origin and destination of each of the 416,360 daily bus passenger trips with a straight line. The number of trips beginning, ending, and passing through each quarter section was then counted, and, finally, the data was generalized in the five magnitude classes shown. This process was largely computer-performed.

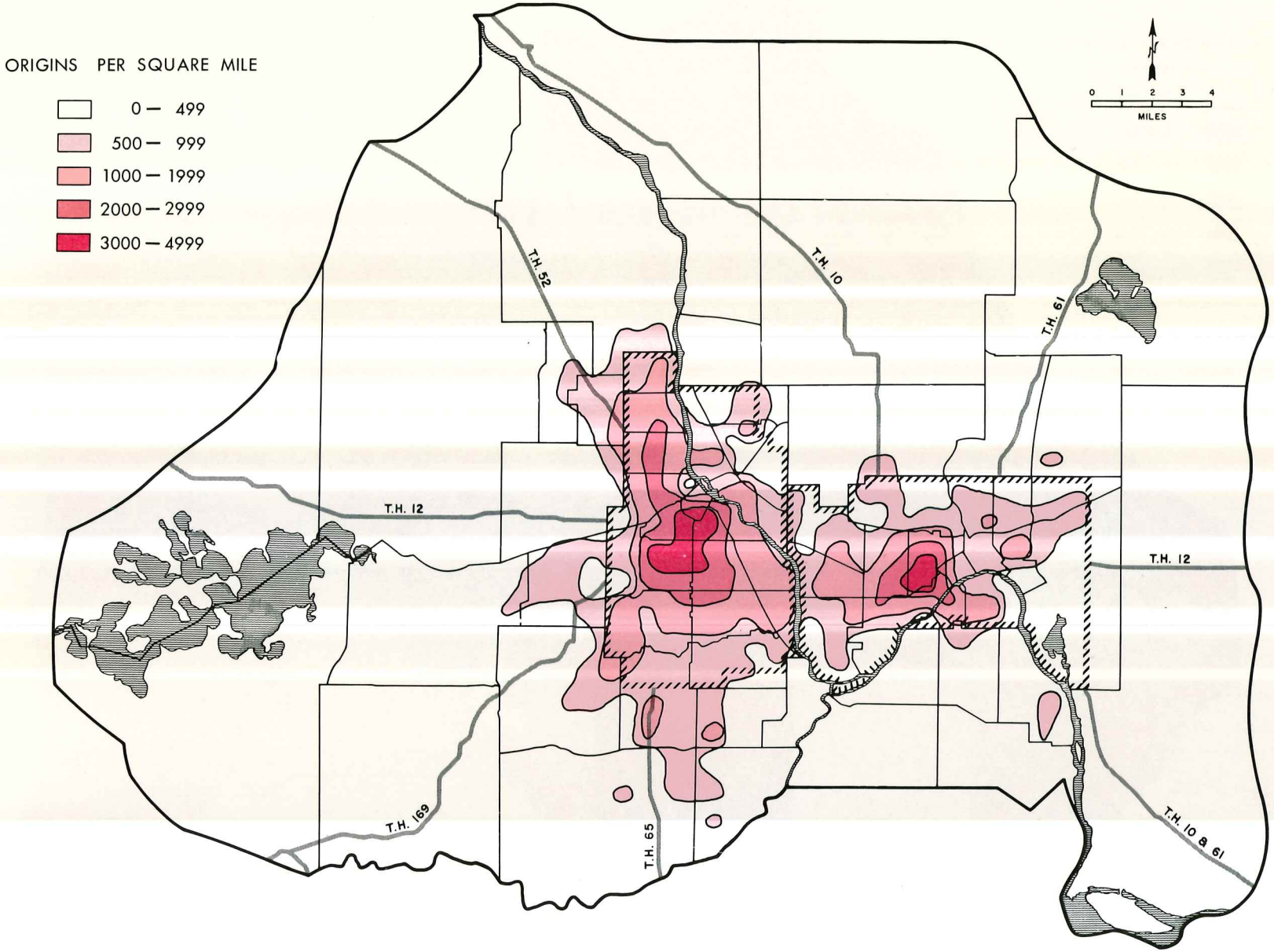
Heavy concentrations are in and near the CBDs, as would be expected since almost 40% of all bus passenger trips have either origin or destination in one of the CBDs. Isolated areas of heavy movement in the suburbs are for school purpose. A sharp reduction in activity is apparent in the area where the central cities abut, indicating that bus passenger movement between the two cities is very limited.

In order to indicate more specifically the areas of heavy movement by bus passengers, interdistrict movements must be considered. These movements are shown in Maps 12 and 13. These maps show interdistrict movements for all instances in which bus passenger trips going between any two districts exceed 500. Map 12 shows volumes of trips to and from the CBDs and their relationship to trips by all modes; Map 13 shows interdistrict volumes excluding CBD movements. (Detailed data are shown in the Appendix, Table 21.)

Of the 122 interdistrict bus passenger movements which exceed 500, 50 involve one of the CBDs. Heavy bus passenger movements to and from the Minneapolis CBD occur between the CBD and districts to the south and northwest. The largest interdistrict movement, totaling 11,226 bus passenger trips per day, occurs between the CBD and a district to the southwest. The districts with heavy CBD movements are within the Minneapolis city limits and are four miles or less from the CBD. Not only are bus passenger movements heavy between the CBD and these districts, but movements by bus passengers account for 40% to 50% of all person movement between these districts and the CBD, as indicated in Map 12. Bus passengers account for a slightly lower percentage of the trips to the CBD from other districts within Minneapolis.

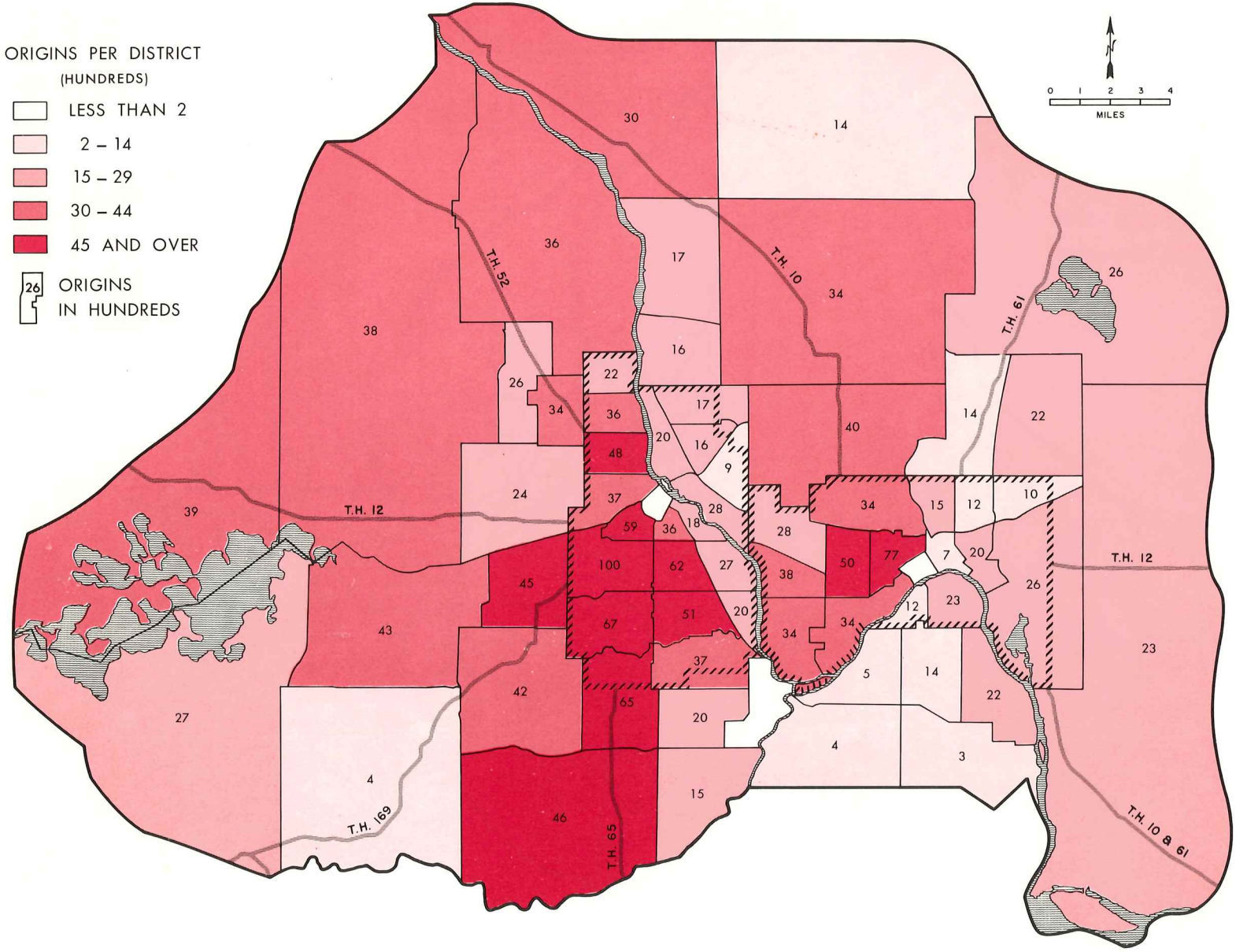
Heavy movements by bus passengers to and from the St. Paul CBD are linked with districts to the west. The heaviest interdistrict bus passenger movement in St. Paul shows a two-way total of over 9,500 trips. Bus passenger movements account for about one-third of the total person movement between the CBD and the districts to the west, and for a slightly lower proportion of the trips from other districts within St. Paul.

It is interesting to note the uniformity with which movements are oriented to the closest CBD. Only one district, located midway between the CBDs, serves as a base for at least 500 bus passenger trips between both the Minneapolis and St. Paul CBDs. Although this district is closer to the Minneapolis CBD, it is within the St. Paul city limits, and the movement to the St. Paul CBD from this district is much greater than that to the Minneapolis CBD. Furthermore, bus passengers account for 26.7% of the movement between this district and the St. Paul CBD, but for only 15.5% of its person trip interchange with the Minneapolis CBD. The higher percentage to the St. Paul CBD is very likely a reflection of the fact that only one fare is required for a trip from this district to the St. Paul CBD, while two fares are required to go to the Minneapolis CBD.



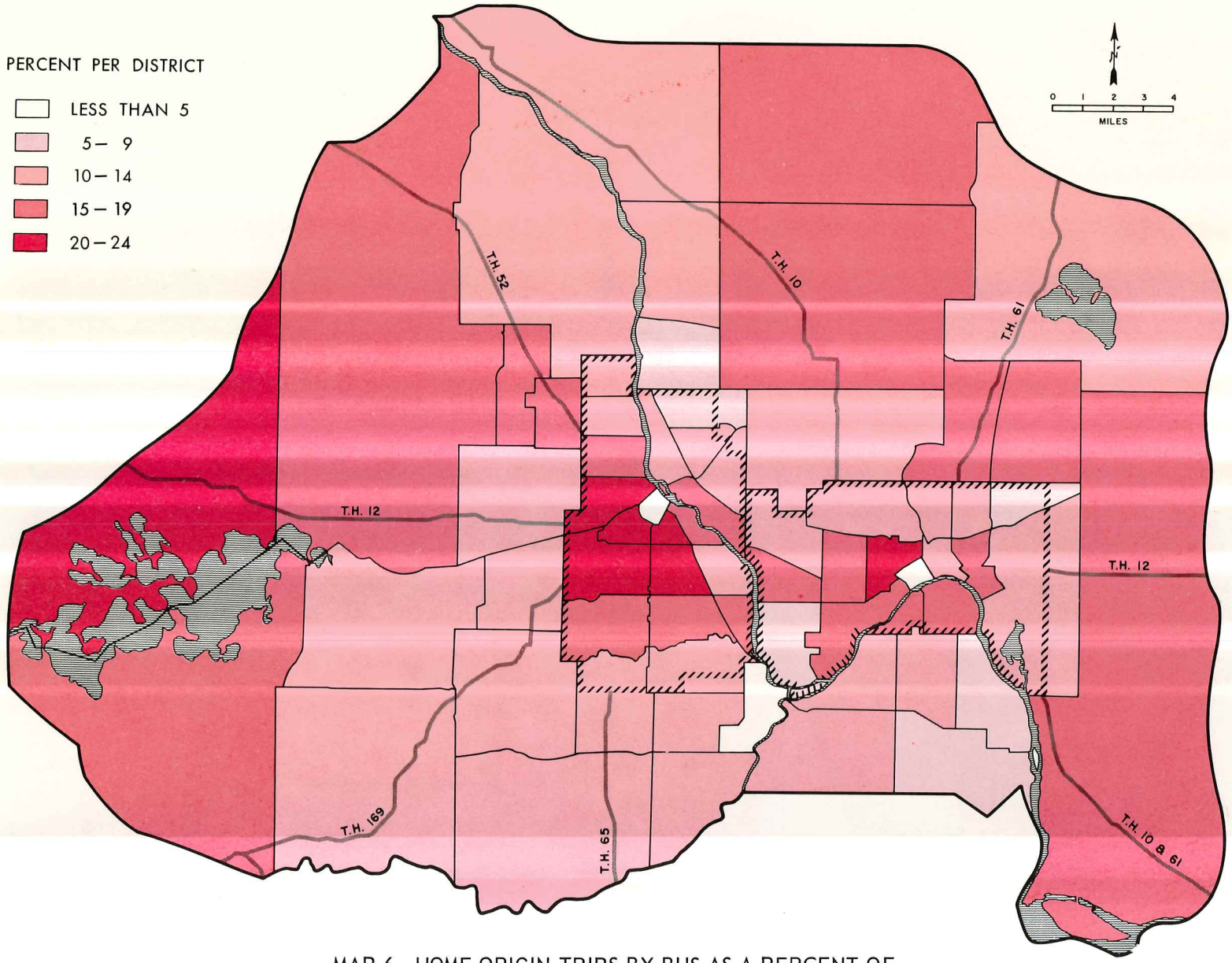

MAP 4 - HOME-ORIGIN TRIPS BY SQUARE MILE OF ORIGIN

About 95% of all bus passenger trips begin or end at home. Origins of trips beginning at home, shown in this map, reach a daily peak of 4,500 per square mile just south of the Minneapolis CBD.



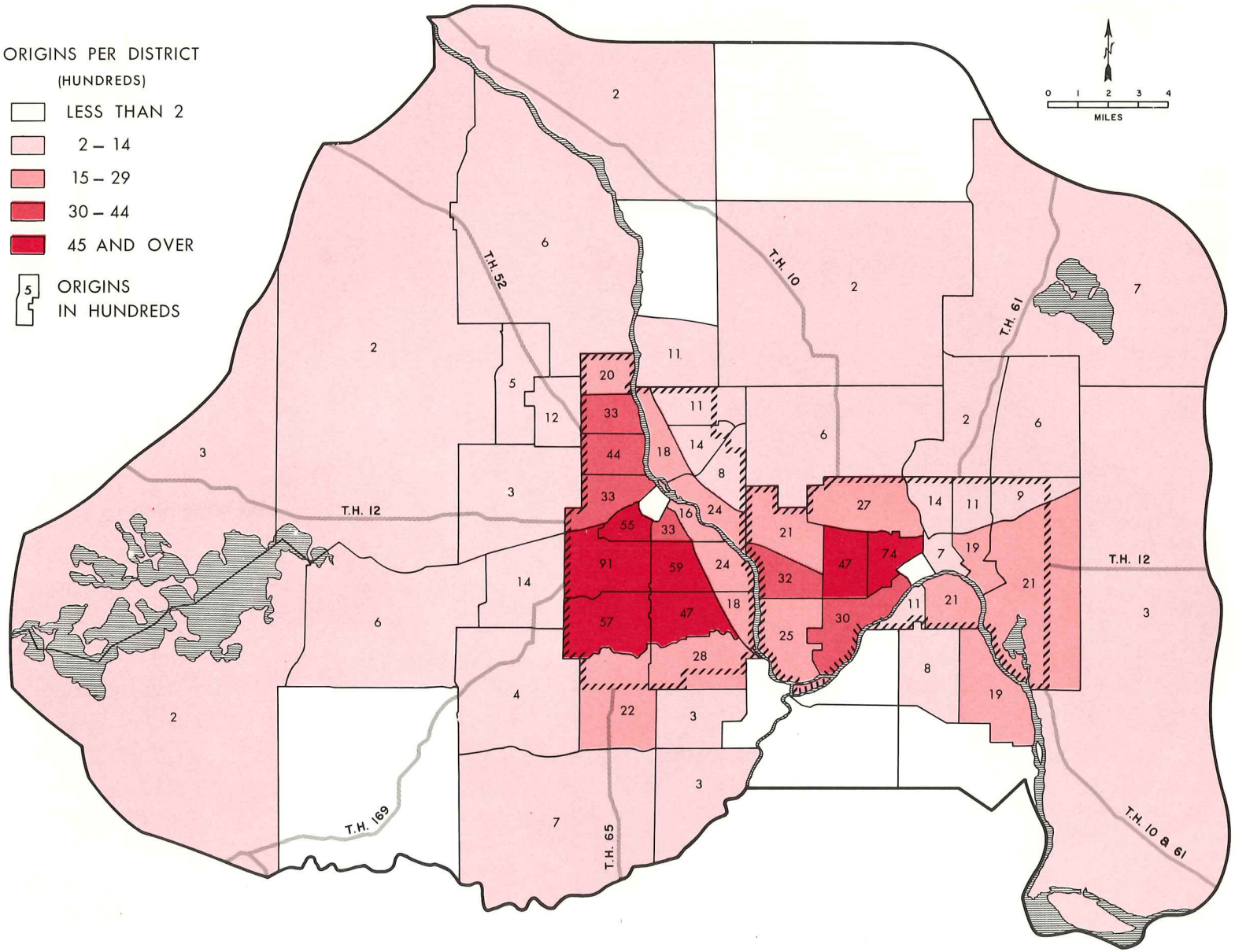

MAP 5 - HOME-ORIGIN TRIPS BY DISTRICT OF ORIGIN

This map shows by district the 192,000 origins of the daily bus passenger trips that begin at home. If trips to school are excluded, the number of origins in the outlying districts decreases markedly (see Map 7).



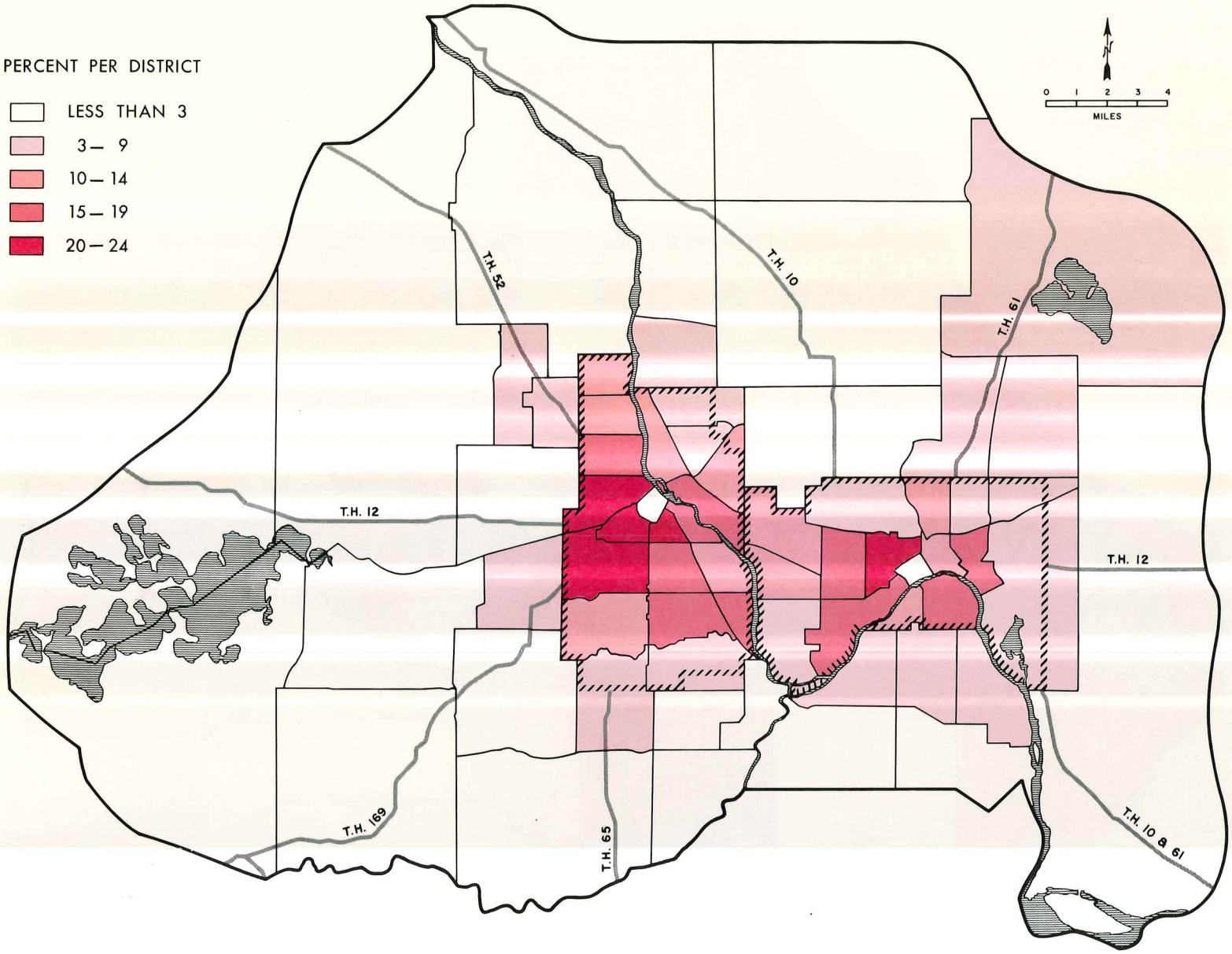

MAP 6 - HOME-ORIGIN TRIPS BY BUS AS A PERCENT OF HOME-ORIGIN TRIPS BY ALL MODES BY DISTRICT OF ORIGIN

Throughout the Study Area, bus passenger trips account for a fairly constant percentage of trips by all modes. However, the percentage drops substantially in the outlying districts when school trips are excluded (see Map 8).



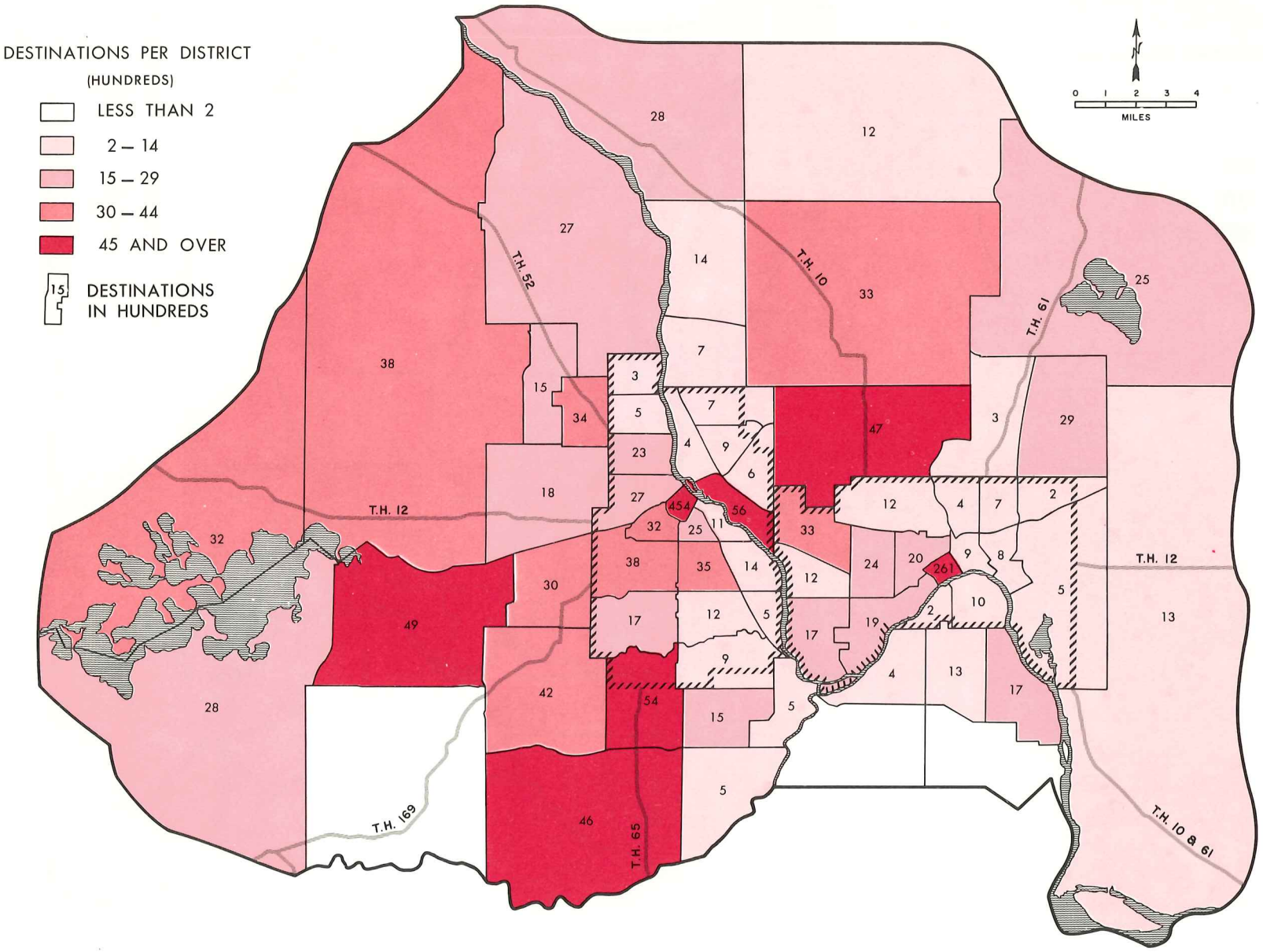

MAP 7 - ORIGINS OF NONSCHOOL HOME-ORIGIN TRIPS BY DISTRICT

Only a small number of the 116,000 daily home-origin bus passenger trips for nonschool purposes originate outside the central cities.



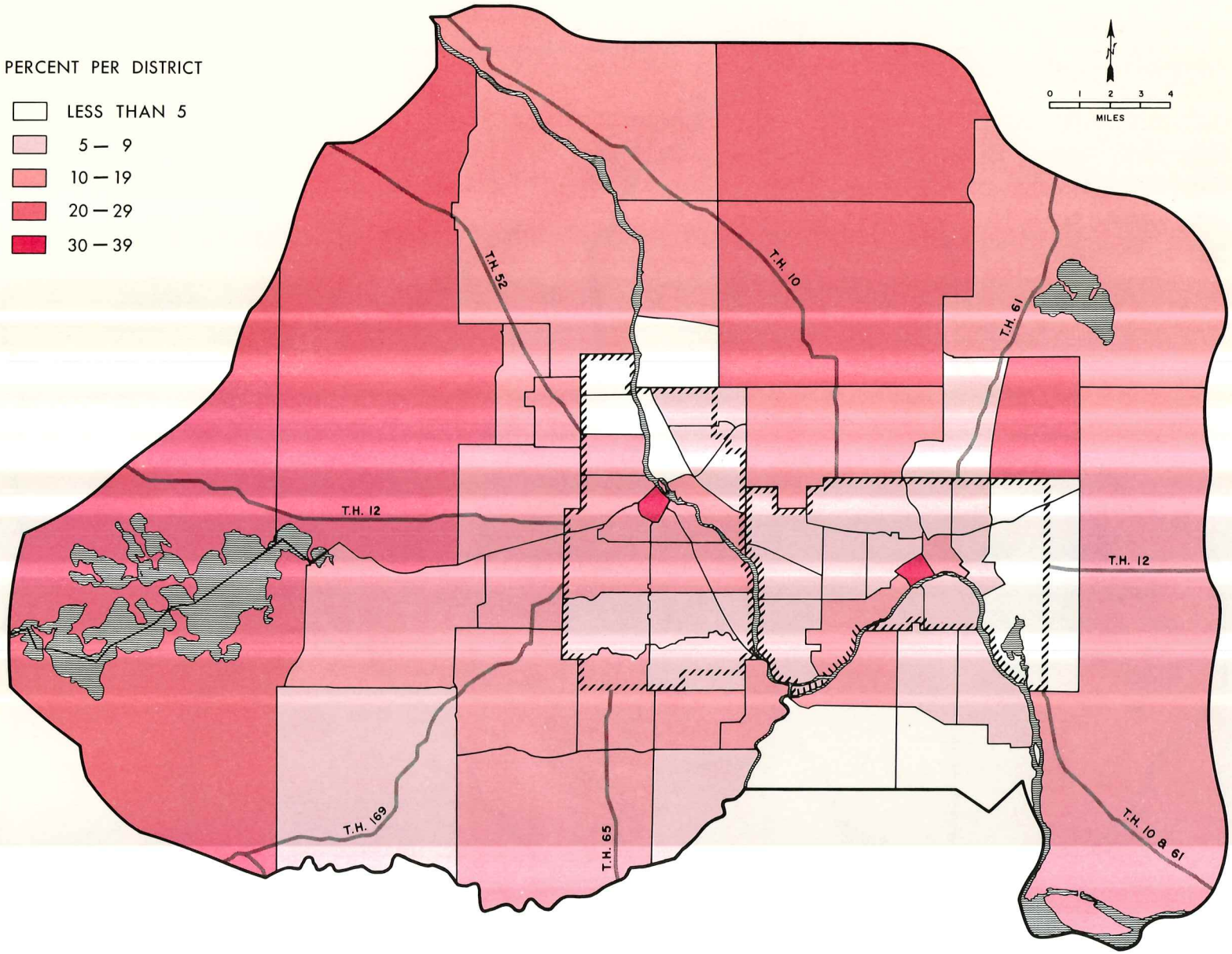

MAP 8 - NONSCHOOL HOME-ORIGIN TRIPS BY BUS AS A PERCENT OF NONSCHOOL HOME-ORIGIN TRIPS BY ALL MODES BY DISTRICT

Bus's share of the nonschool home-origin trips beginning in the outlying districts is very small. Its share is less than 3% in 20 districts which comprise three-fourths of the Study Area.

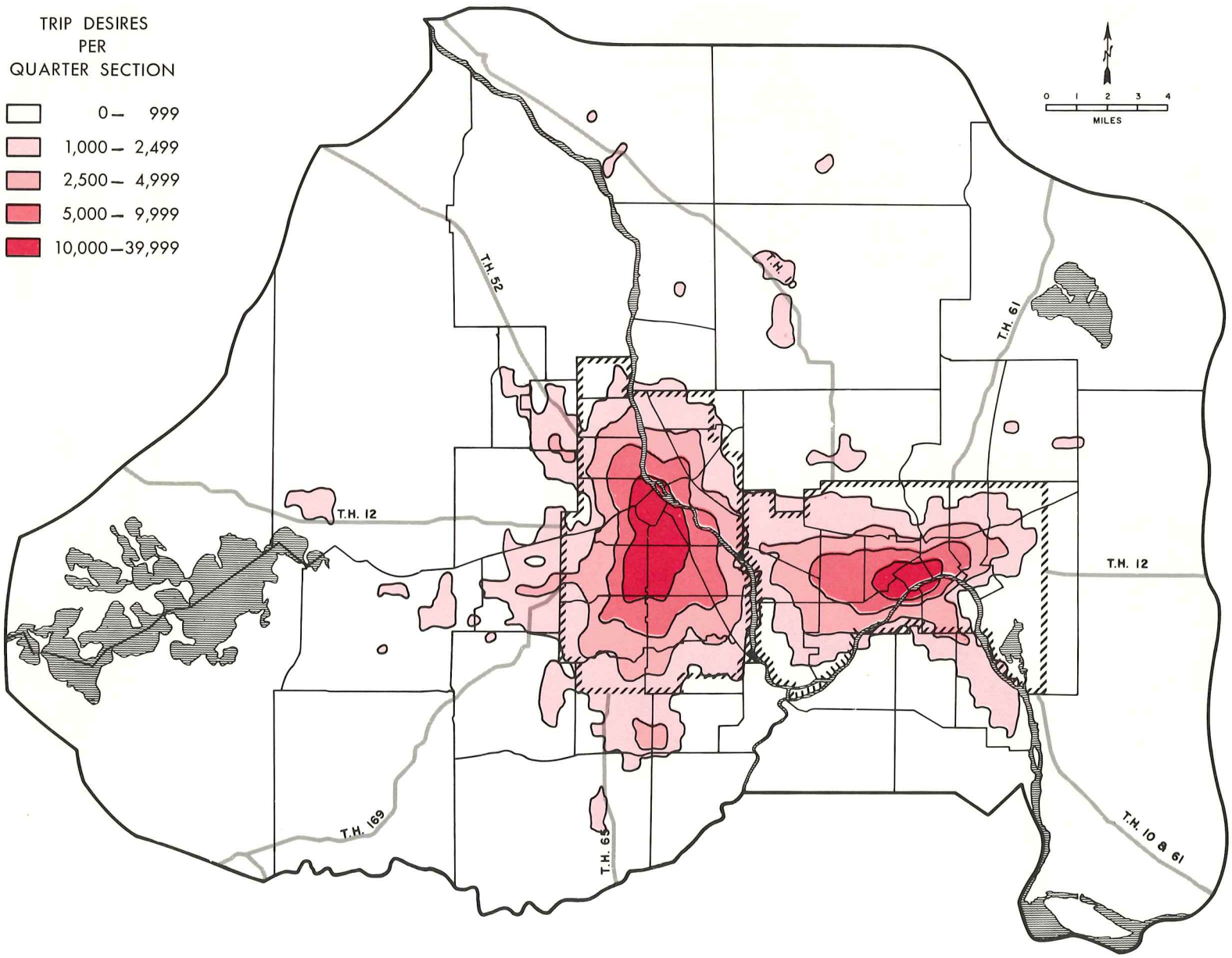



MAP 9 - DESTINATIONS OF HOME-ORIGIN TRIPS BY DISTRICT

Over 71,000 of the 192,000 daily home-origin trips by bus have destinations in the CBDs. In contrast to outlying destinations, few CBD destinations are for school.




MAP 10 - DESTINATIONS OF HOME-ORIGIN TRIPS BY BUS AS A PERCENT OF THE DESTINATIONS OF HOME-ORIGIN TRIPS BY ALL MODES BY DISTRICT




MAP 11 - INTENSITY OF BUS PASSENGER TRAVEL

This map shows by quarter section the daily number of trips which would pass through each quarter section if all trips followed a straight line between origin and destination. The low intensity where the central cities abut indicates that the number of trips beginning in one city and ending in the other is not substantial.

Slightly over 400 daily bus passenger trips are made between the Minneapolis and St. Paul CBDs. This number accounts for about one-fourth of the daily inter-CBD trips by all modes.

While virtually all of the trip movements shown in Map 12 are for nonschool purposes, many of the non-CBD interdistrict bus passenger trip movements shown in Map 13 include substantial numbers of trips to and from school. This is particularly true of the interdistrict movements occurring at considerable distances from the CBDs.

## Trips by Time of Day

*Area-Wide Travel.* Figure 1 shows the distribution by hour of destination of both the 416,360 total daily bus passenger trips and the 252,500 which do not involve school.

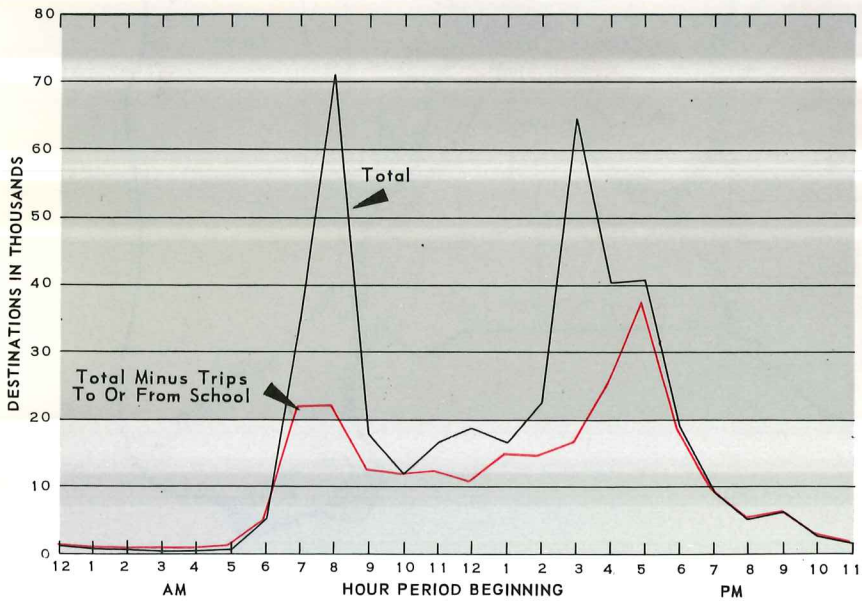



**FIGURE 1. HOURLY DISTRIBUTIONS OF DAILY BUS PASSENGER TRIP DESTINATIONS, TOTAL AND NONSCHOOL**

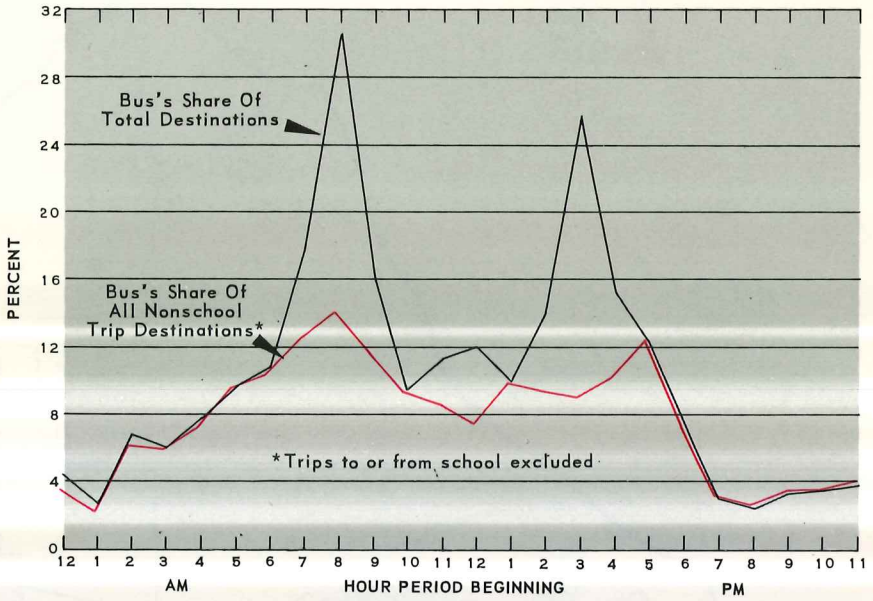
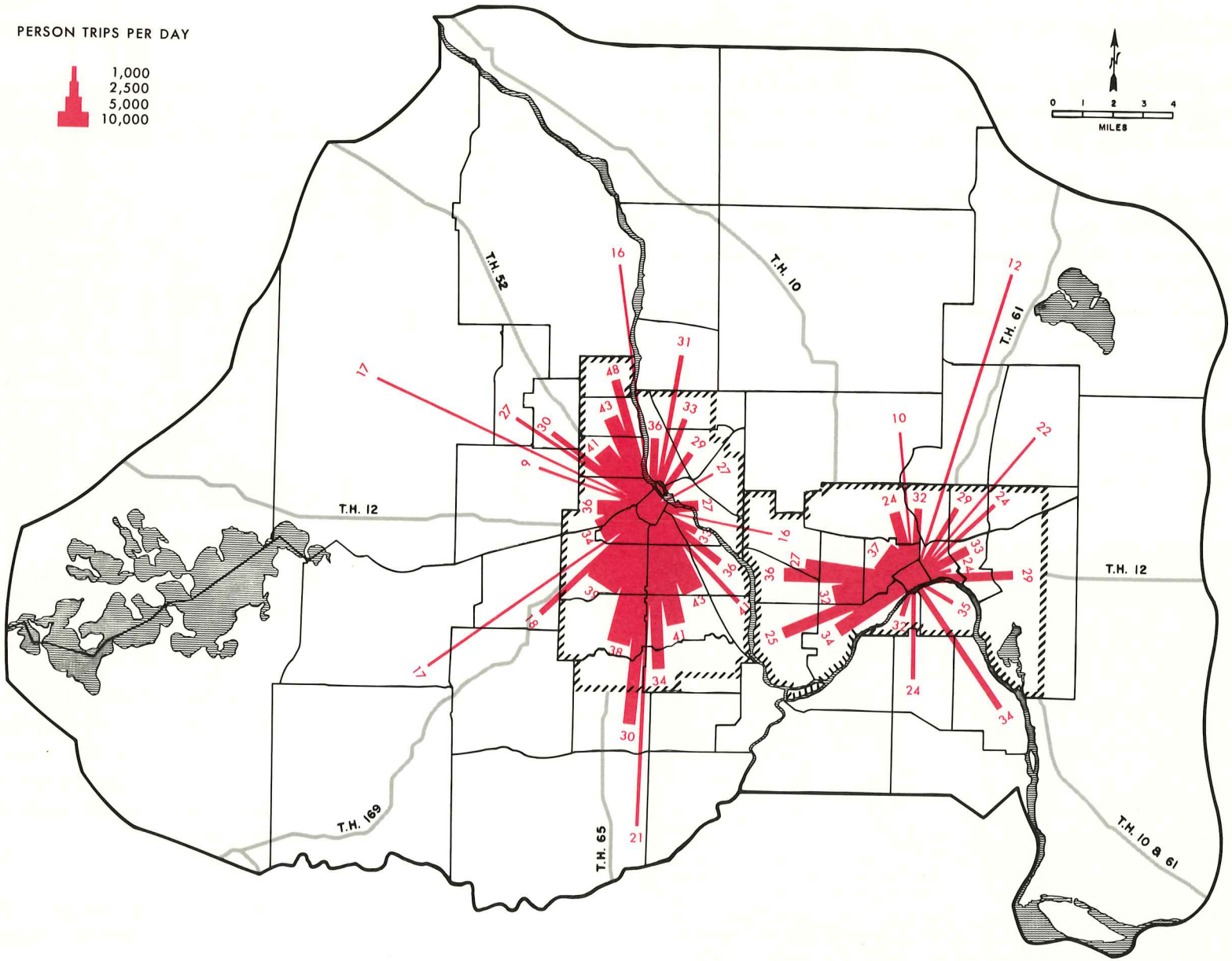



**FIGURE 2. HOURLY BUS PASSENGER TRIP DESTINATIONS AS A PERCENT OF HOURLY DESTINATIONS BY ALL MODES, TOTAL AND NONSCHOOL**

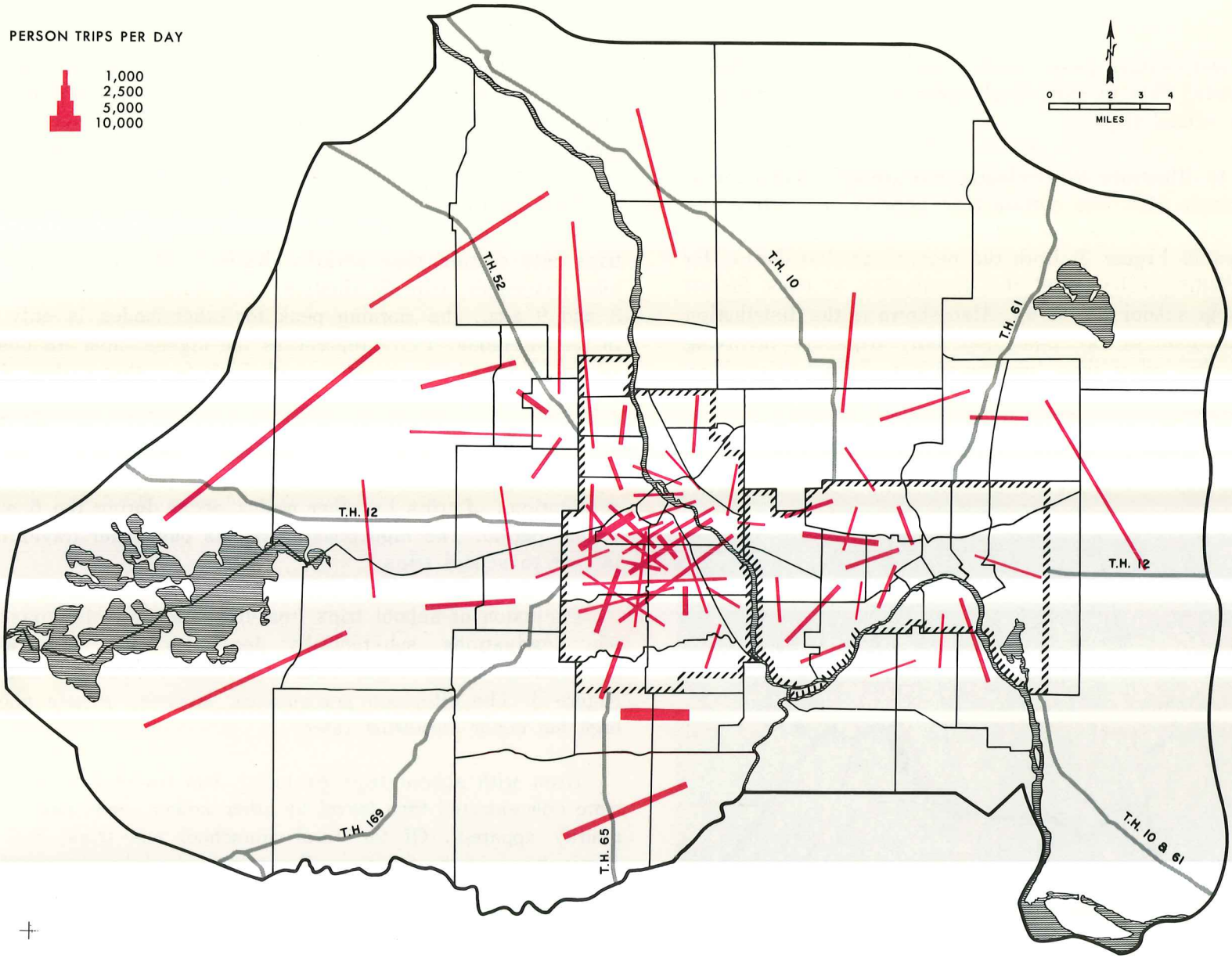
The magnitude of school trips as a component of all trips by bus passengers is evident, particularly in the morning and mid-afternoon, as would be expected. Regarding the nonschool trips, it is particularly interesting to note the large number of destinations between 5 and 6 p.m. Very few trips are made by bus passengers between midnight and 6 a.m.

The concentration of trips by bus passengers into certain time periods is to be expected since all person movement is bunched into certain time periods of the day, irrespective of mode. However, bus passengers account for different proportions of total destinations throughout the day, as shown in Figure 2. The bus carries a higher proportion of the total trips with destinations in




MAP 12 - PATTERNS OF TRAVEL TO AND FROM THE CBDs

Bar widths show the general magnitude of daily CBD travel movements by bus. Numbers show bus's percentage of the total. The bus accounts for over 40% of the total movement in several instances. Magnitudes below 500 are not shown.




MAP 13 - INTERDISTRICT TRAVEL PATTERNS--CBD MOVEMENTS EXCLUDED

In contrast with Map 12, many of the daily bus passenger trip movements shown in this map mainly comprise school trips. See Appendix, Table 21, for the magnitude of all intradistrict movements and for interdistrict movements below 500 trips daily.

the morning and evening peak travel periods than it does during off-peak periods. This is particularly pronounced if the comparisons include school trips.

In order to illustrate more clearly the greater concentration of bus passenger trips into certain time periods of the day, the percent of daily total bus passenger trip destinations in each hour is shown in Figure 3. Both the percentage distribution for all trips including school and the distribution of trips for all purposes except school are shown. Also shown is the distribution of the destinations of the 2,863,000 daily trips not involving school by modes other than bus passenger. School trips have been excluded from the distribution of trips by modes other than bus, but school trips are such a minor part of all trips by modes other than bus that their exclusion has only a negligible effect, and no distinction need be made between the two distributions.

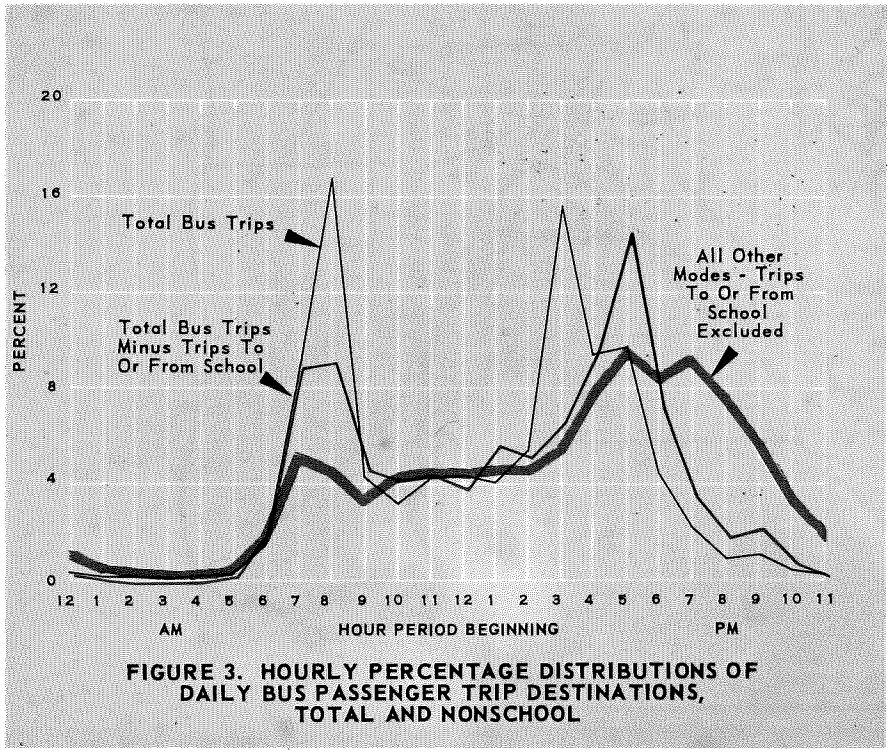



**FIGURE 3. HOURLY PERCENTAGE DISTRIBUTIONS OF DAILY BUS PASSENGER TRIP DESTINATIONS, TOTAL AND NONSCHOOL**

The significance of a comparison of trips by bus with trips by other modes is the greater concentration of bus passenger trips into certain time periods. While 17.2% of the daily total bus passenger trip destinations are found to occur between 8 and 9 a.m., the morning peak for other modes is only 5.3%. In the afternoon, 15.6% represents the highest hour for bus passenger trips, which compares with 9.6% for other modes. A very high proportion - 93% - of the total daily bus passenger movement (school trips included) takes place between 6 a.m. and 7 p.m. The decline in bus passenger trip destinations relative to other modes is particularly pronounced after 7 p.m. Only 70% of the destinations of trips by other modes occur during the 6 a.m. to 7 p.m. period. The high peaking in bus passenger travel is due in part to school trips.

Exclusion of school trips from the total daily bus passenger trip destinations substantially decreases the percentage of destinations which occur between 8 and 9 a.m., as shown in Figure 3. The afternoon percentages, however, remain about as high but occur somewhat later.

Even with school trips excluded, bus travel is considerably more concentrated than travel by other modes, as Figure 3 makes readily apparent. Of the total nonschool bus trips, 89% have destinations in the 6 a.m. to 7 p.m. period while nonschool trips by other modes have a little less than 70% of their daily destinations in this period.

*CBD Trips.* A large proportion of bus passenger travel consists of trips to and from the CBDs. Moreoever, bus accounts for a relatively high proportion of CBD trips by all modes. Thus

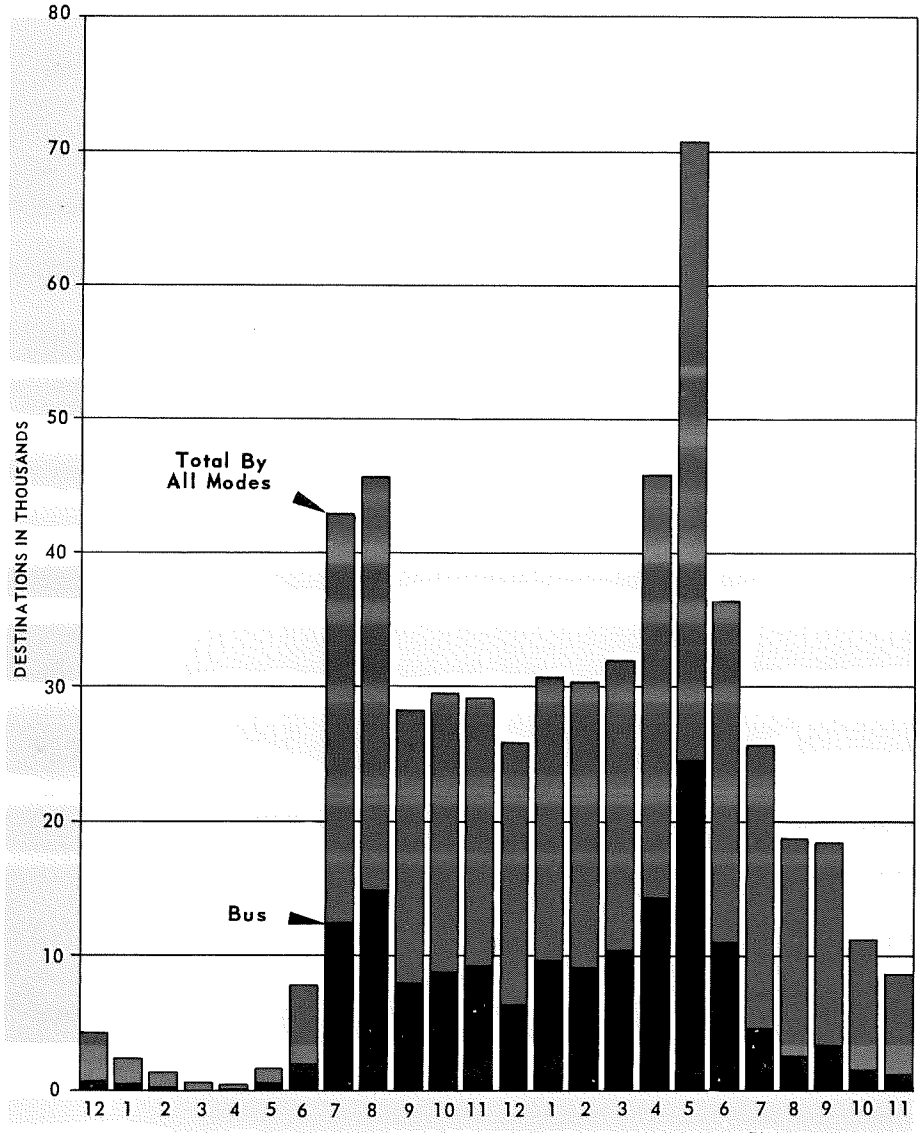



**FIGURE 4. DESTINATIONS OF PERSON TRIPS TO OR FROM THE CBDs BY HOUR, BUS AND ALL MODES**

(Trips to or From School Excluded)

bus passenger travel to and from the CBDs is of particular interest.

While bus trips account for only 12.4% of the total daily internal person trips in the Study Area (and only 8.1% of all nonschool trips), they account for about 28% of all CBD trips.

Figure 4 shows daily bus passenger trips to and from the CBDs by hour of destination. In Figure 5, the destinations of bus trips to and from the CBDs are shown as a percent of the hourly destinations of trips to and from the CBDs by all modes.

Although CBD trips by bus and those by other modes follow the same general pattern, the bus trips are more concentrated into the daylight hours. Almost 91% of the bus passenger trips going to or from the CBDs have destinations between 6 a.m. and 7 p.m.; this compares with 80% for modes other than bus. Bus passengers account for about 30% of the trips to and from the CBDs during the working hours of the day. The bus, then, carries a substantial proportion of CBD trips throughout the daylight hours - not just during the peak traffic periods. The high proportion of bus trips throughout these hours is attributable to shopping trips.

These comparisons indicate the importance of bus as a mode of travel to and from the CBDs. They indicate particularly the significance of the role of bus during the working hours - the time of day when the problems of parking and traffic congestion are most pronounced.

## Trip Duration

The median bus passenger trip duration is 28 minutes. This is almost twice the duration of the median internal auto driver trip, which is 16 minutes. Another significant difference between auto driver and bus passenger trip durations is the large number of short trips by the auto driver mode.

Over 30% of the auto driver trips are less than 12 minutes in duration while less than 7% of the bus passenger trips are of this short duration. Seventy percent of auto driver trips are less than 24 minutes, while 42% of the bus passenger trips are completed in this same time length.

Trip Length

Since auto travel is faster than bus, it could be expected that trip duration for auto drivers would be shorter, even though they covered the same distance. In order to control this factor, it is necessary to analyze trip length.

Figure 6 shows percentage distributions of the Study Area's daily bus passenger and auto driver trips by length. The trip length distributions are based on straight-line distance between origin and destination. The comparison shows the larger proportion of auto driver trips in the categories of very short and very long trips. The very short trips, 0.5 of a mile or less, constitute over 16% of the auto driver trips and less than 8% of the bus passenger trips. Slightly over 5% of the bus passenger trips exceed 6.5 miles in length, while more than 13% of the auto driver trips are in this category. The median trip lengths for bus passenger and auto driver trips are almost identical at about 2.1 miles.

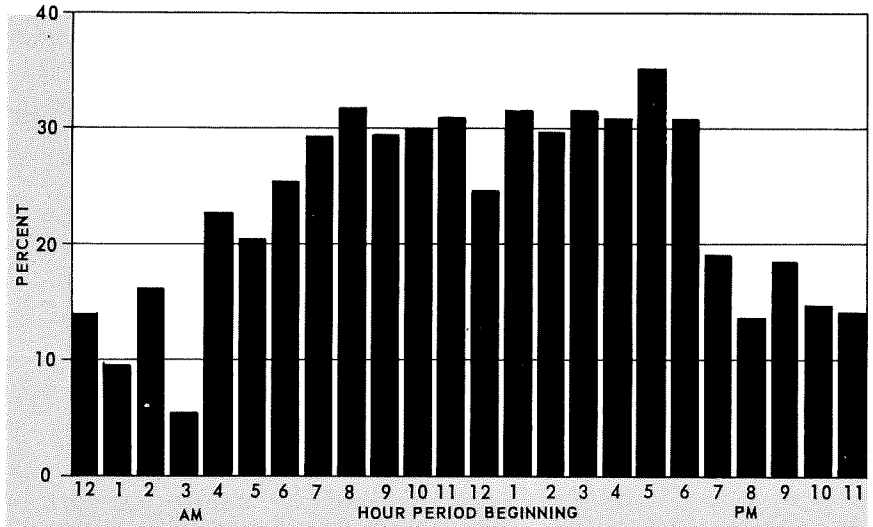



**FIGURE 5. DESTINATIONS OF BUS PASSENGER TRIPS TO OR FROM THE CBDs BY HOUR AS A PERCENT OF THE DESTINATIONS OF TRIPS TO OR FROM THE CBDs BY ALL MODES**
(Trips to or From School Excluded)

School trips have been included in these comparisons. Exclusion of such trips would likely eliminate many of the very short bus passenger trips, making the dominance of the auto driver trips even greater for very short trips.

## BUS PASSENGER TRIP PURPOSE

Bus passenger trips tend to concentrate into movement for certain purposes as well as into certain areas, time periods, and trip lengths. The following discussion relating to the purpose of bus passenger trips is in two parts: the first part deals with the destination purpose of bus passenger trips in the entire Study Area; the second part is concerned with the destination purpose of bus passenger trips to the CBDs.

Trip Purpose - Study Area-Wide

Table 1 shows the destination purposes of the 416,360 total daily bus passenger trips and the percentage of these trips accounted for by each purpose. (Origins as well as destinations are classified in the ten purpose categories in Table 22 in the Appendix.)

Almost one-half of the trips are destined to the homes of the persons making the trips. This magnitude reflects the great tendency of bus passenger trips to be home-based.

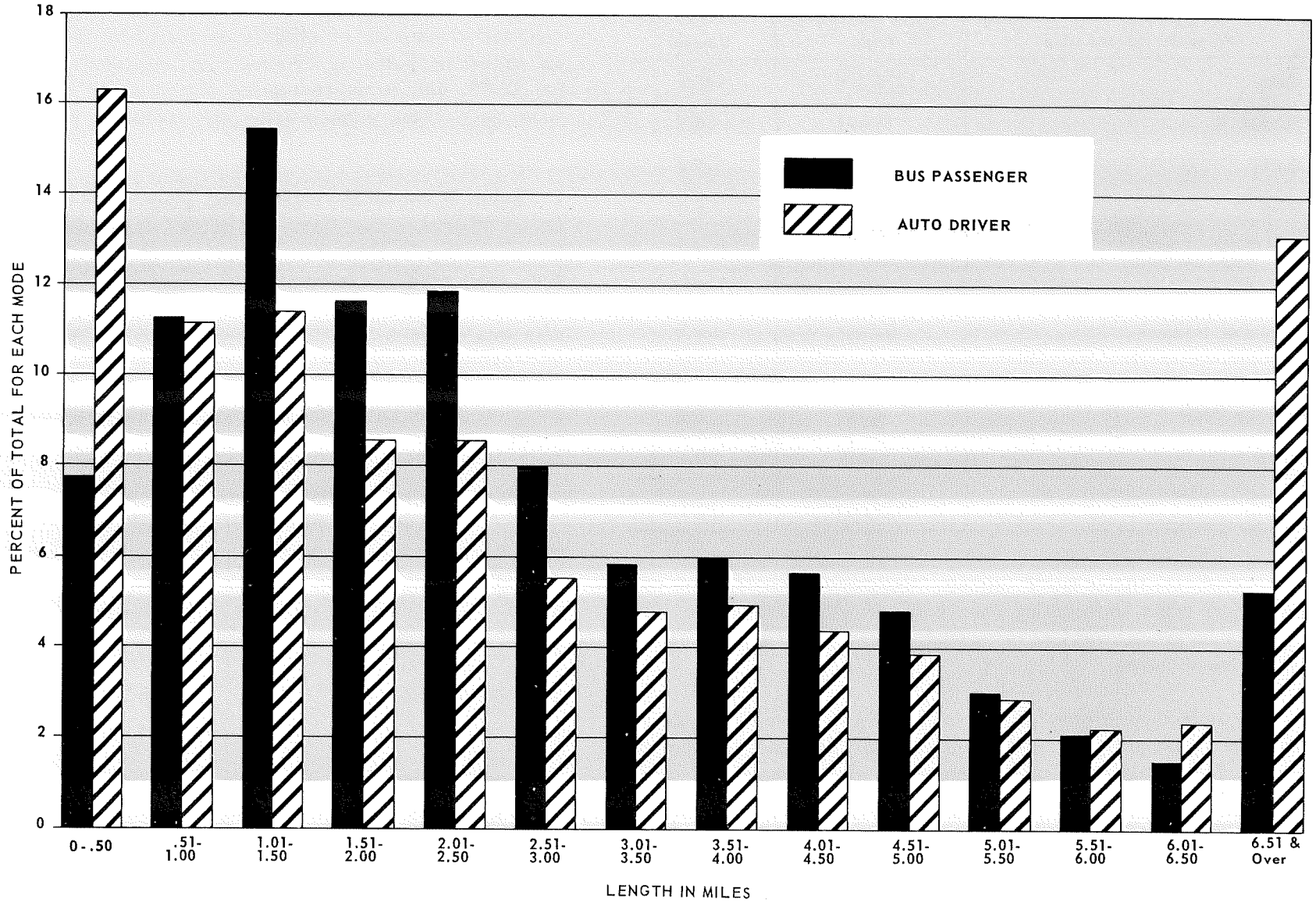



FIGURE 6. COMPARISON OF BUS PASSENGER AND AUTO DRIVER TRIP LENGTH DISTRIBUTIONS

**TABLE 1. TOTAL DAILY BUS PASSENGER TRAVEL BY PURPOSE**

| Purpose at Destination | Trips | Percent |
|---|---|---|
| Home | 200,186 | 48.1 |
| School | 77,841 | 18.7 |
| Work | 69,644 | 16.7 |
| Shop | 23,786 | 5.7 |
| Social-Recreation | 16,225 | 3.9 |
| Eat | 1,741 | 0.4 |
| Personal Business | 21,633 | 5.2 |
| Serve Passenger | - | - |
| Change Mode | 4,789 | 1.2 |
| Ride | 515 | 0.1 |
| Total | 416,360 | 100.0% |

School is the second highest destination purpose of bus passenger trips, accounting for 18.7% of all destinations. The majority of these trips are on school buses rather than on TCRT or suburban buses.

Because the majority of the school trips by bus are made by children, such trips can be considered to take place in the absence of an alternative mode. Therefore, exclusion of such trips is necessary in order to show the purpose of bus passenger trips for which restrictions on the choice of mode are not as stringent as those imposed on school children. Since home destination trips are actually the return part of a round trip made for some other purpose, such as work, shop, personal business, etc., their exclusion will enable a clearer illustration of the real purpose for which bus passenger trips are made.

With school and home destinations excluded, work is the destination purpose of slightly over half of the remaining trips, as shown in Table 2. Shopping and personal business account for 32.8%, and social-recreation accounts for 11.7%. Thus when home and school purpose trips are excluded, work is by far the most important single destination purpose.

Table 3 shows the destination purpose of the daily trips by modes other than bus. Home and school destinations are excluded. In comparing Tables 2 and 3, it is particularly interesting to note that work accounts for 50.3% of the bus passenger trip destinations and only 28.7% of the person trips by modes other than bus.

In Table 4, emphasis is directed toward quantifying the contribution of the bus passenger mode to the total person movement for each of the purposes. As would be expected, a high proportion

**TABLE 2. BUS PASSENGER TRIPS BY PURPOSE--TRIPS TO SCHOOL AND HOME EXCLUDED**

| Purpose at Destination | Trips | Percent |
|---|---|---|
| Work | 69,644 | 50.3 |
| Shop | 23,786 | 17.2 |
| Social-Recreation | 16,225 | 11.7 |
| Eat | 1,741 | 1.3 |
| Personal Business | 21,633 | 15.6 |
| Serve Passenger | - | - |
| Change Mode | 4,789 | 3.5 |
| Ride | 515 | .4 |
| Total | 138,333 | 100.0% |

**TABLE 3. NONBUS TRIPS BY PURPOSE--TRIPS TO SCHOOL AND HOME EXCLUDED**

| Purpose at Destination | Trips | Percent |
|---|---|---|
| Work | 506,172 | 28.7 |
| Shop | 339,112 | 19.3 |
| Social-Recreation | 323,517 | 18.4 |
| Eat | 64,700 | 3.7 |
| Personal Business | 251,746 | 14.3 |
| Serve Passenger | 198,760 | 11.3 |
| Change Mode | 9,970 | .6 |
| Ride | 66,039 | 3.7 |
| Total | 1,760,016 | 100.0% |

of the trips to school are made by bus passengers. Aside from trips for school purpose, almost a third of the trips for the purpose "change mode" are made by bus passengers. Most of the bus passenger trips with the change mode purpose at destination are trips coming from the CBDs out to a destination point at which the person making the trip is picked up as an auto passenger or has a car parked and becomes an auto driver. Such trips by bus passengers are most frequently involved as part of a person movement from work to home.

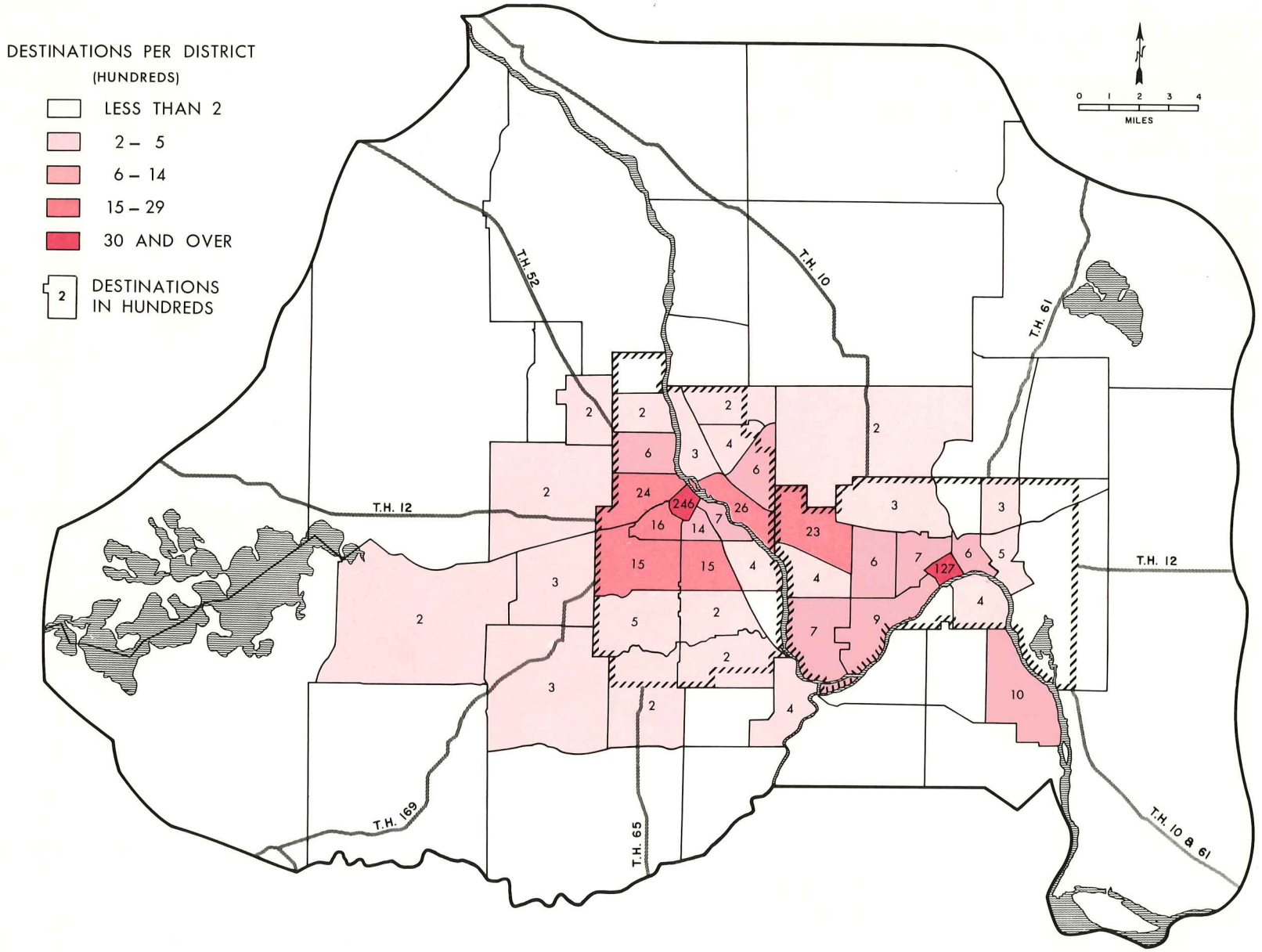
Bus passengers account for 12.1% of all work trip destinations. Although this is not a large percentage, such trips are of considerable interest because of their importance relative to all trips by bus passengers.

Map 14 shows work trip destinations, by district of destinations, for bus passenger trips with home origins. As expected, destinations are concentrated in and near the CBDs, the major employment areas. It should be noted, however, that bus passengers account for a substantially higher proportion of work trip destinations in and near the CBDs than in areas away from the CBDs, as seen in Map 15.

In addition to the destinations of work trips by bus passengers, the origins of such trips also are of considerable interest. Map 16 shows the origins of home-origin bus passenger trips with work destinations, by district of origin. Origins are concentrated around the CBDs. A large number of origins might be expected near the CBDs because of the large number of people living in these areas. However, it should be noted that the percentage of origins accounted for by bus passengers is considerably higher in districts close to the CBDs, as shown in Map 17.

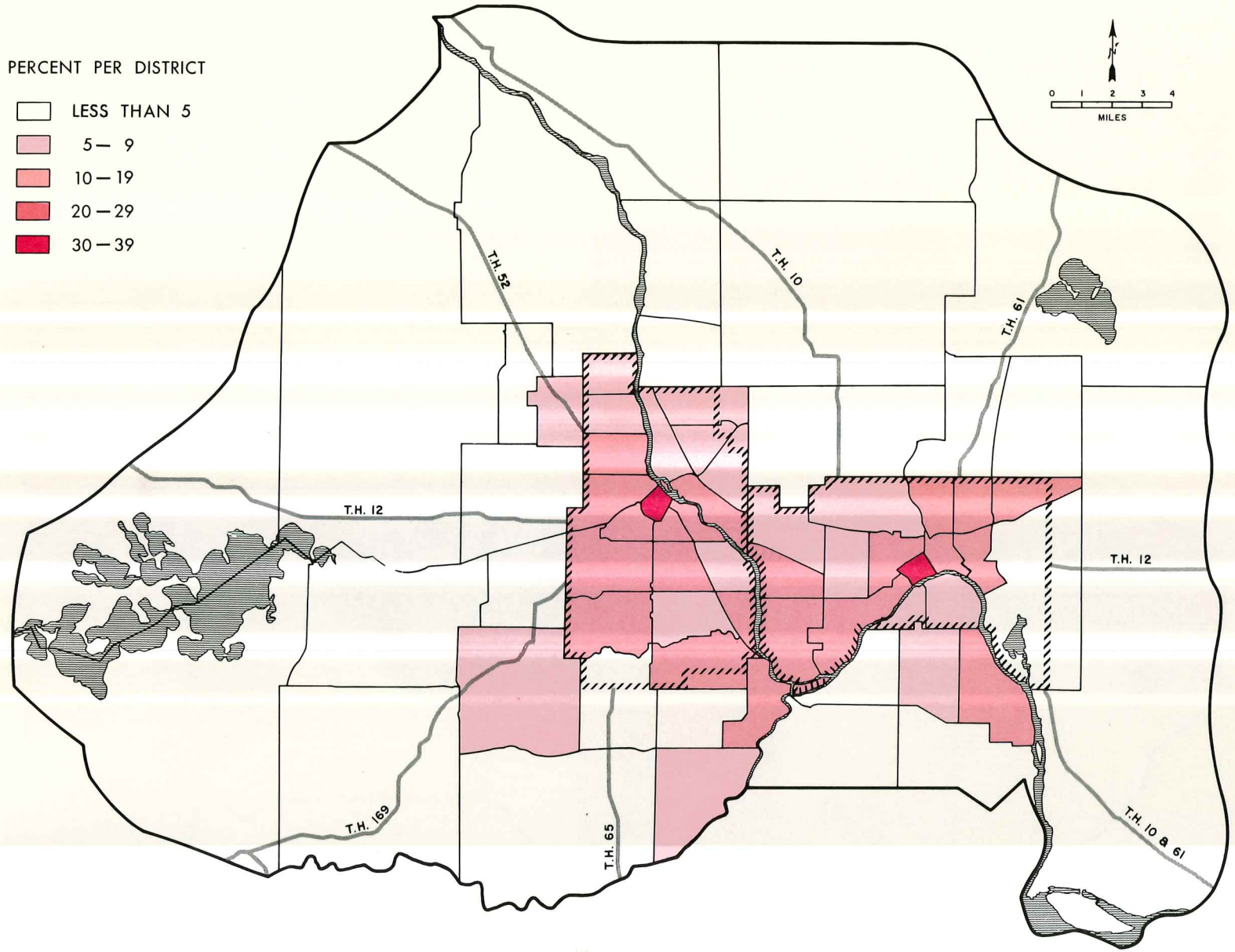
**TABLE 4. BUS'S SHARE OF TOTAL TRIPS BY PURPOSE**

| Purpose at Destination | Trips by All Modes | Percent by Bus |
|---|---|---|
| Home | 1,344,791 | 14.9 |
| School | 123,423 | 63.1 |
| Work | 576,172 | 12.1 |
| Shop | 362,898 | 6.6 |
| Social-Recreation | 339,742 | 4.8 |
| Eat | 66,441 | 2.6 |
| Personal Business | 273,379 | 7.9 |
| Serve Passenger | 198,760 | - |
| Change Mode | 14,759 | 32.4 |
| Ride | 66,554 | .8 |
| Total | 3,366,919 | 12.4% |



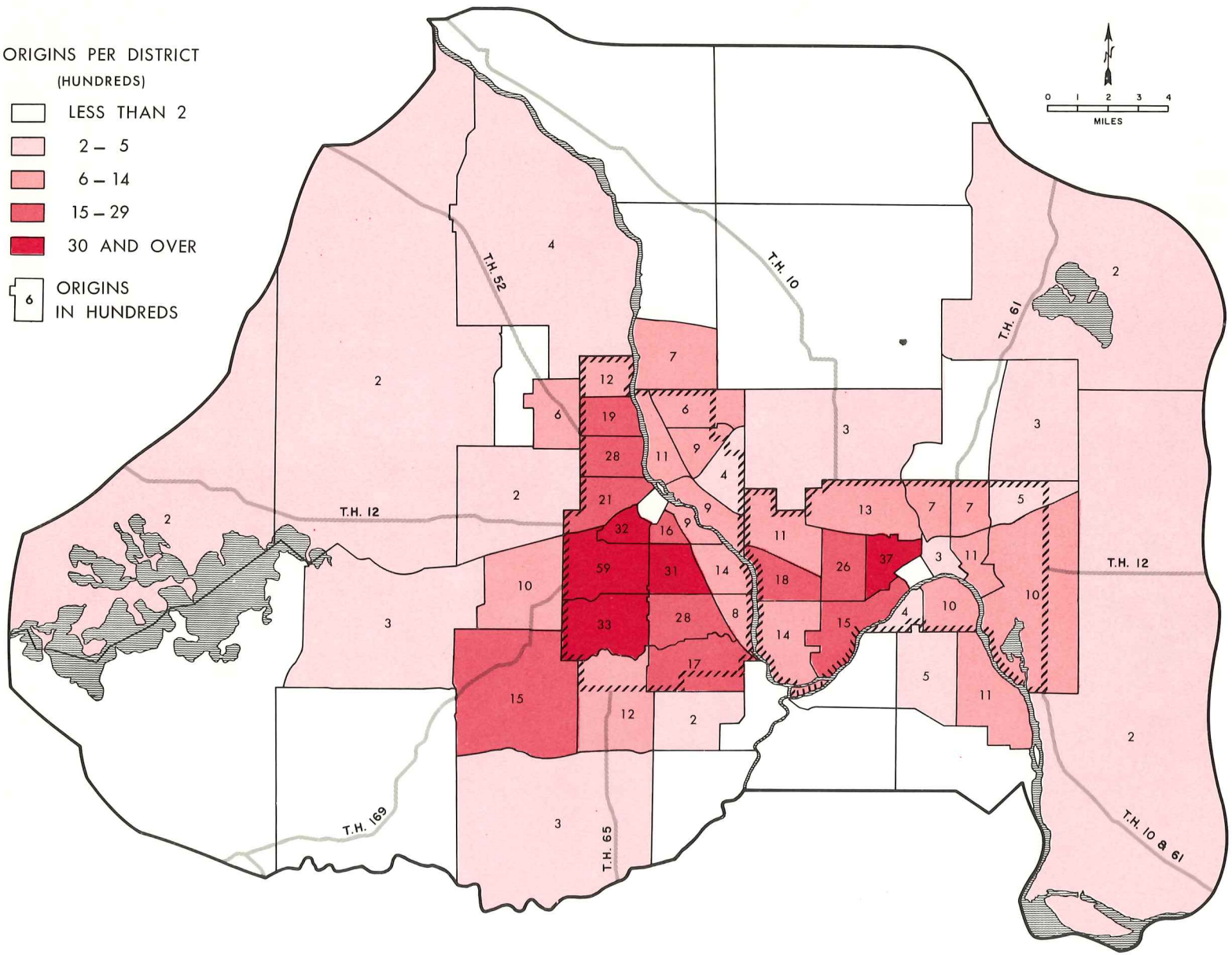

MAP 14 - DESTINATIONS OF HOME-ORIGIN WORK TRIPS BY DISTRICT

Almost 57% of the 65,000 daily home-origin work trips by bus have destinations in the CBDs.



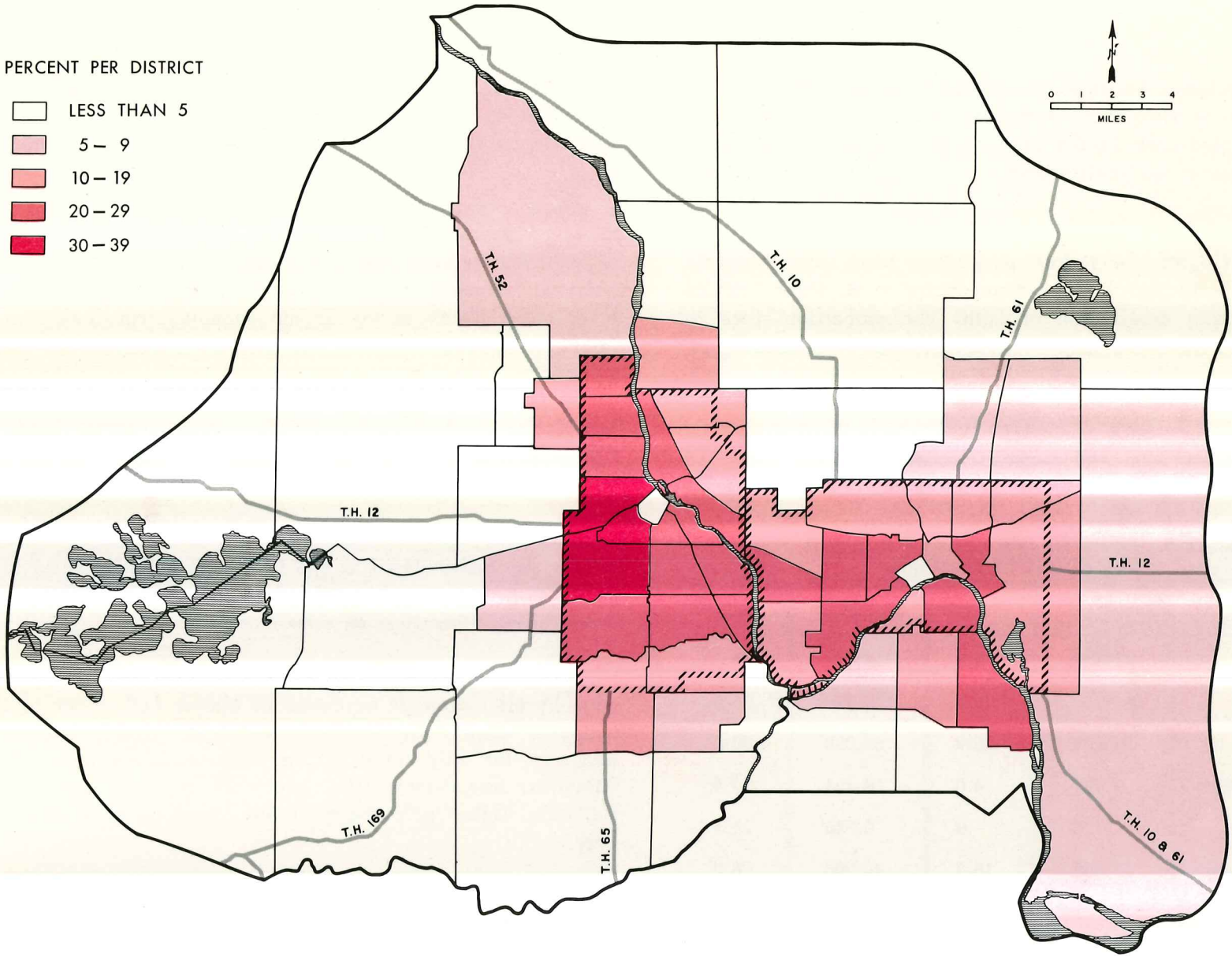

MAP 15 - DESTINATIONS OF HOME-ORIGIN WORK TRIPS BY BUS AS A PERCENT OF THE DESTINATIONS OF HOME-ORIGIN WORK TRIPS BY ALL MODES BY DISTRICT

The bus accounts for well over 30% of the CBD work trip destinations. Note that the percentage is much lower in districts outside the CBDs. Even the districts abutting the CBDs show a much lower percentage, as indicated by the absence of the 20% to 29% range.




MAP 16 - HOME-ORIGIN WORK TRIPS BY DISTRICT OF ORIGIN

This map shows the origins of the 65,000 daily home-origin work trips by bus. The destinations of these trips are shown in Map 14.




MAP 17 - HOME-ORIGIN WORK TRIPS BY BUS AS A PERCENT OF HOME-ORIGIN WORK TRIPS BY ALL MODES

The association between the proximity to the CBDs and the mode of travel of home-origin work trips is apparent. The association is reflected both in the case of the origins of such trips and in the case of the destinations.

Purpose of Bus Passenger Trips to the CBDs

Of the 416,360 daily bus passenger trips, approximately 161,500, or 38.8%, involve the Minneapolis or St. Paul CBD as either an origin, destination or both. The proportion rises to 62.5% when only the 252,500 nonschool trips are considered.

Work is the largest single destination purpose of bus passenger trips to the CBDs. As shown in Table 5, there are 39,350 work trip destinations, and these trips account for almost half of the bus passenger trip destinations in the CBDs. Shopping is the destination purpose of 21,267 trips, or almost 27% of the CBD bus passenger trip destinations, and personal business accounts for 12,000, or 15.2% of the destinations.

**TABLE 5. TRIPS TO THE CBDs BY BUS AND ALL MODES BY PURPOSE**

| Purpose at Destination | Trips by Bus* | Percent | Trips by All Modes* | Percent by Bus |
|---|---|---|---|---|
| School | 1,392 | 1.8 | 3,122 | 44.6 |
| Work | 39,350 | 49.7 | 127,224 | 30.9 |
| Shop | 21,267 | 26.9 | 52,099 | 40.8 |
| Social-Recreation | 3,207 | 4.0 | 18,404 | 17.4 |
| Eat | 726 | .9 | 6,386 | 11.4 |
| Personal Business | 12,000 | 15.2 | 46,206 | 26.0 |
| Serve Passenger | - | - | 25,545 | - |
| Change Mode | 967 | 1.2 | 2,216 | 43.6 |
| Ride | 219 | .3 | 4,542 | 4.8 |
| Totals | 79,128 | 100.0% | 285,744 | 27.7% |

**Trips to homes in the CBDs excluded*

When comparing CBD bus passenger trip destinations to those of the entire Study Area, it should be noted that 56.5% of the 69,644 work trip destinations and 55.3% of the 21,663 personal business trip destinations are in the CBDs. On the other hand, 89.3% of the 23,786 shopping trip destinations are in the CBDs.

Thus, bus passenger trips for the purpose of shopping are heavily oriented toward the CBDs. Also evident is the very minor degree to which the bus is used as a mode of travel for shopping trips with destinations outside the CBDs.

Bus passengers account for 27.7% of the 285,744 total daily person trip destinations in the CBDs. In contrast with this, bus passengers account for only 7.3% of the 1,898,705 non-CBD destinations other than at school or home.

While the bus mode accounts for 27.7% of the CBD person trips by all modes, it accounts for almost 41% of the total CBD shopping trips. On a Study Area-wide basis, however, bus accounts for only 6.6% of the daily shopping trips. Personal business, social-recreation, and work trips by bus also show markedly higher percentages when based on CBD destinations only.

## BUS PASSENGER TRIPS AND LAND USE

Bus passenger trip destinations concentrate in certain land use classes as well as in certain purpose classes. Table 6 shows the land use at destinations of home-origin trips. One-half of all home-origin bus passenger trips have destinations at public buildings (schools, government offices, etc.). Approxi-

**TABLE 6. HOME-ORIGIN BUS PASSENGER TRIPS BY DESTINATION LAND USE**

| Land Use at Destination | Trips | Percent | Percent Excluding School Trips |
|---|---|---|---|
| Residential | 9,520 | 5.0 | 8.2 |
| Manufacturing Industry | 11,544 | 6.0 | 9.9 |
| Nonmanufacturing Industry | 6,527 | 3.4 | 5.6 |
| Commercial Retail | 37,147 | 19.3 | 32.0 |
| Commercial Service | 27,115 | 14.1 | 23.3 |
| Commercial Wholesale | 2,530 | 1.3 | 2.2 |
| Public Buildings { School / Nonschool | 75,798 / 17,228 | 48.4 | 14.8 |
| Public Open Space | 2,255 | 1.2 | 1.9 |
| Miscellaneous Coding | 2,403 | 1.3 | 2.1 |
| Totals | 192,067* | 100.0% | 100.0% |

** Trips by CBD residents excluded*

mately 80% of these are school trips. When school trips are excluded from the distribution, commercial retail land use dominates, accounting for 32% of the remaining trips. Destinations at commercial retail land are composed primarily of shopping and work purpose trips, with the former accounting for the larger part.

Commercial service is the destination land use for slightly over 23% of the trips for all purposes except school. Work and personal business account for most of these trips.

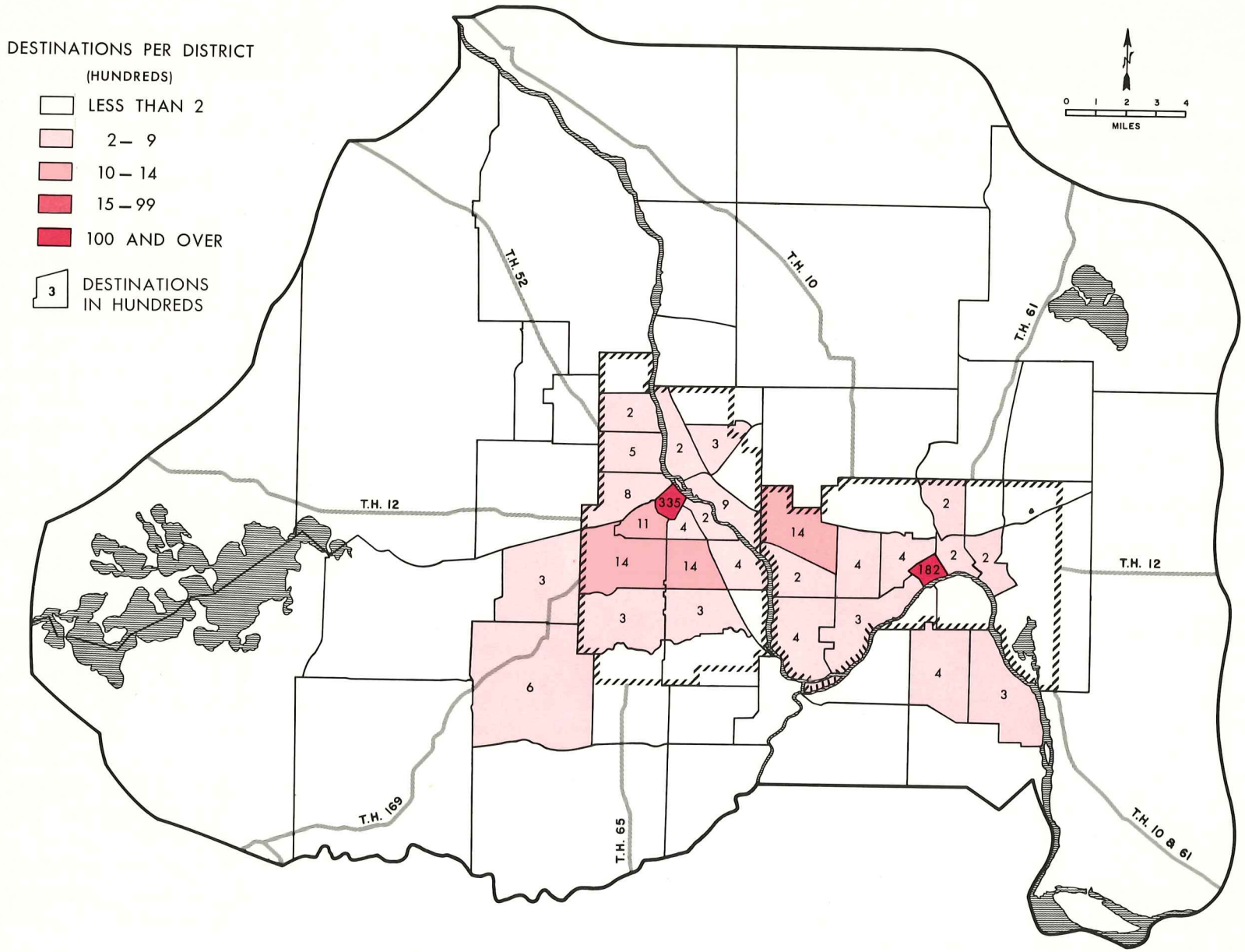
Industrial land use (manufacturing and nonmanufacturing) and public buildings each account for about 15% of the nonschool destinations. Most of the trips to industrial land use are work trips. A combination of work and personal business trips account for most nonschool trips to public buildings.

Of the remaining land uses, residential is the only one which accounts for trip destinations of any substantial magnitude. These are trips which originate at the home of the tripmaker and go to another home for the purpose of work (domestic help) or for social purposes. It should be noted that residential land use would account for about half of all destinations if the distribution was based on all destinations rather than destinations of home-origin trips only. This is due to the combined effect of trips returning to home and trips going from one home to another. A combination of the two more than offsets the trips which are not home-based.

Map 18 shows the destination land use of home-origin bus passenger trips by district of destination for three land use classes combined: commercial retail, commercial wholesale, and commercial service. These land uses account for 66,792 destinations, or 57.5% of the 116,269 destinations by bus passengers for all purposes except school. Of the 66,792 trip destinations, 51,688, or 77.4%, are in the CBDs. Furthermore, the 51,688 destinations at commercial land in the CBDs account for 44.5% of the 116,269 home-origin nonschool destinations. Thus shopping and work purpose trips to commercial land use classes in the CBDs clearly emerge as the major component of bus passenger movement for nonschool purposes.

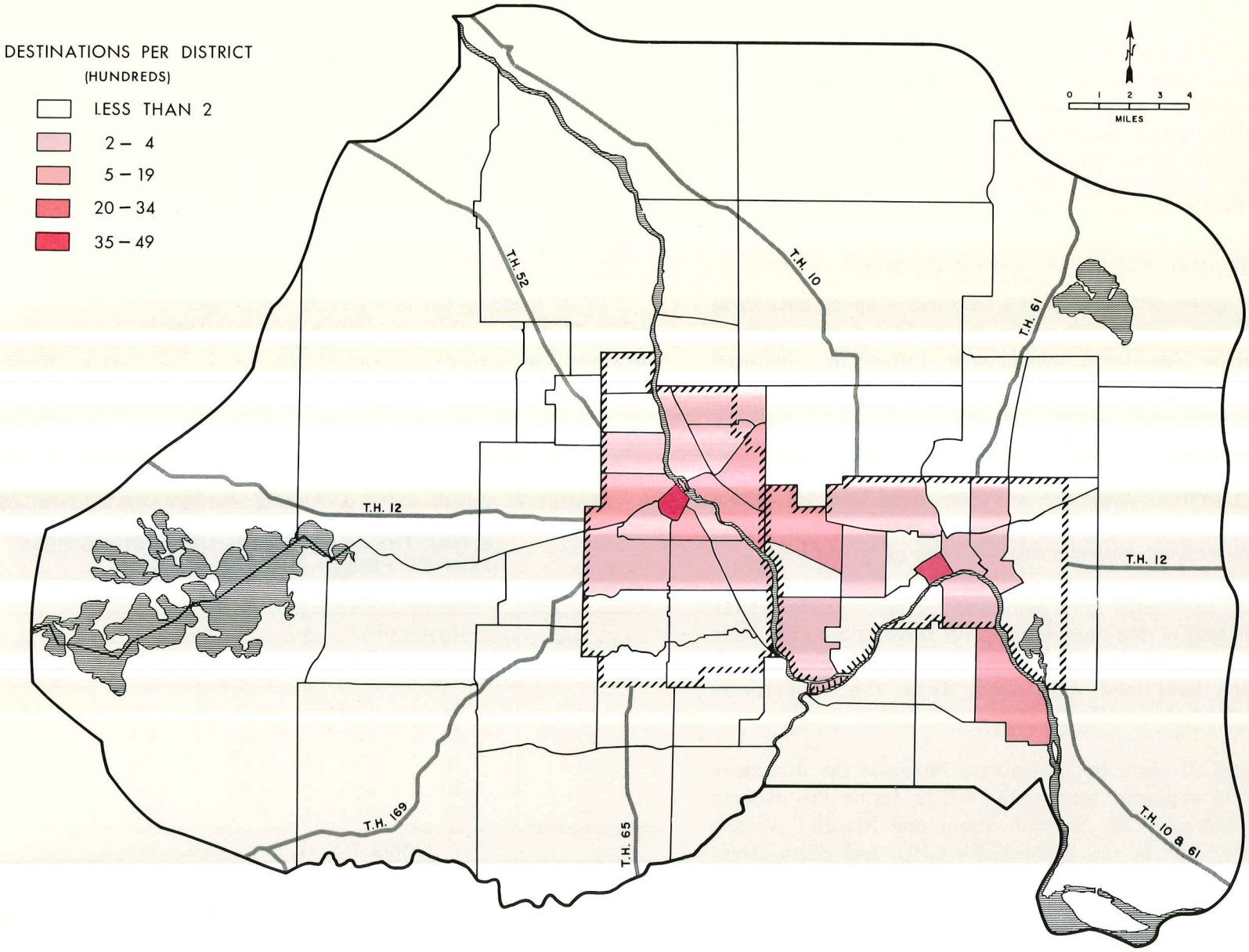
Map 19 shows bus passenger trip destinations at industrial land use. There are 18,071 destinations at industrial land use, 7,899, or 43.7%, of which are in the CBDs.

Bus passenger trip destinations at industrial land are not as concentrated into the CBDs as are destinations at commercial land. This is, of course, due primarily to the fact that the CBDs




MAP 18 - TRIP DESTINATIONS AT COMMERCIAL LAND BY DISTRICT

Of the 116,000 daily nonschool home-origin bus passenger trips, 67,000 have destinations at commercial land. Note that almost 52,000 of these destinations are in the CBDs.




MAP 19 - TRIP DESTINATIONS AT INDUSTRIAL LAND BY DISTRICT

Of the total daily home-origin bus passenger trips, only 18,000 have destinations at industrial land. Slightly less than 8,000 of these have destinations in the CBDs.

are composed to a large extent of commercial land while industrial land is concentrated on the edge of the CBDs. As a result, a higher proportion of bus passenger trips to industrial land have destinations outside the CBDs. Most of the destinations at industrial land outside the CBDs are, however, concentrated close to the CBDs.

## TRAVEL SPEED - BUS VERSUS AUTO

Bus travel speed and comparative auto travel speed data upon which the following maps and analyses are based were derived from two sources. Bus travel speeds were derived from detailed TCRT schedules, after extensive checking showed them to be accurate. The auto travel speed data with which the bus travel speeds are compared are based on a series of timed runs made by the Minnesota Department of Highways in conjunction with another project. While certain bus and auto travel time data might have been obtained from the Twin Cities Area Transportation Study, its form was not entirely suited to the purposes here.

Auto travel time runs were available for most of the TCRT bus routes. In only a few instances, auto travel time runs were unavailable for comparison on bus routes, and auto runs on routes adjacent to the bus lines were used. Thus, the comparisons between auto and bus are almost exclusively on bus routes.

Maps 20 and 21 show by five-minute intervals the distances travelled by bus and auto leaving the CBDs during the evening peak period, 3:30 to 5:30. Seventh Street and Nicollet Avenue is the starting point in the Minneapolis CBD, and Sixth Street and Cedar Avenue in St. Paul. The distances covered are representative of evening peak period travel under normal driving conditions. The average speed and distances covered at five-minute intervals are shown cumulatively in Table 7.

The average bus speed over all routes during the first 10 minutes of travel from the Minneapolis CBD is 9.1 mph, covering, as an average for all routes, 1.5 miles. During this same period, the auto covers 2.5 miles at an average speed of 14.8 mph. A similar relationship exists between bus and auto in St. Paul, although both modes are slightly faster. In both Minneapolis and St. Paul, the bus goes about 60% as far as the auto in the first 10 minutes (again as an average over all routes for which auto travel times are available).

In 20 minutes the bus travels about four miles (a little more in St. Paul, a little less in Minneapolis). This is longer than the average bus passenger trip length for TCRT buses, which is about 3.5 miles. The auto travels slightly over four miles in 15 minutes in Minneapolis and slightly over five in St. Paul. Thus, for a trip approximately one-half mile longer than the

**TABLE 7. CUMULATIVE AVERAGE SPEEDS AND DISTANCES COVERED OUTBOUND FROM CENTRAL POINTS WITHIN THE CBDs DURING THE EVENING PEAK TRAFFIC PERIOD--BUS AND AUTO**

FROM THE MINNEAPOLIS CBD

| Time Interval (minutes) | Automobile | | Bus | | No. of Routes On Which Comparison is Based |
|---|---|---|---|---|---|
| | Distance (miles) | Rate (mph) | Distance (miles) | Rate (mph) | |
| 5 | .93 | 11.2 | .58 | 7.0 | 17 |
| 10 | 2.47 | 14.8 | 1.52 | 9.1 | 18 |
| 15 | 4.15 | 16.6 | 2.63 | 10.5 | 13 |
| 20 | 6.10 | 18.3 | 3.84 | 11.5 | 9 |
| 25 | 8.37 | 20.1 | 5.12 | 12.3 | 6 |

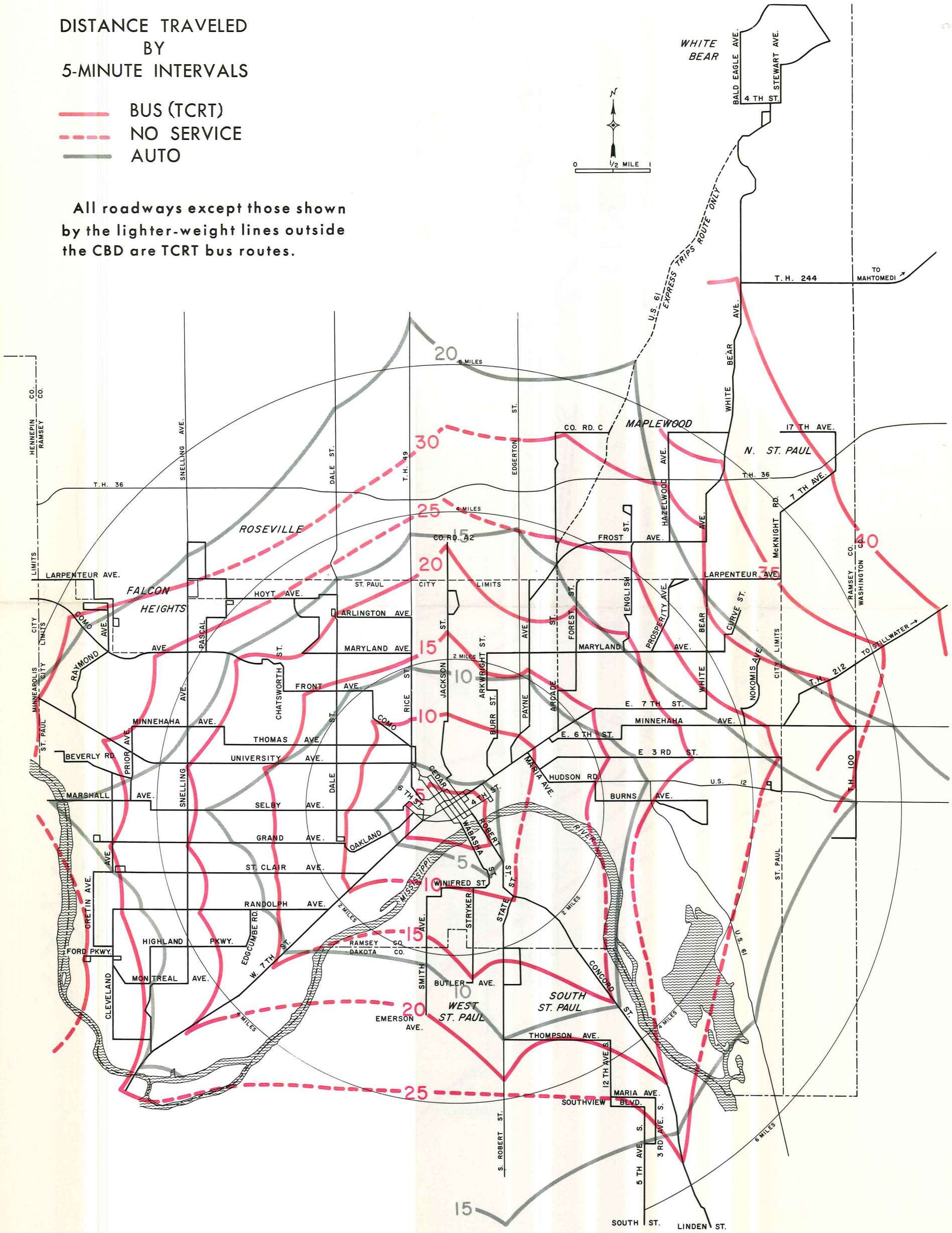
FROM THE ST. PAUL CBD

| Time Interval (minutes) | Automobile | | Bus | | No. of Routes On Which Comparison is Based |
|---|---|---|---|---|---|
| | Distance (miles) | Rate (mph) | Distance (miles) | Rate (mph) | |
| 5 | .95 | 11.5 | .60 | 7.2 | 9 |
| 10 | 2.98 | 17.9 | 1.68 | 10.1 | 17 |
| 15 | 5.08 | 20.3 | 2.85 | 11.4 | 18 |
| 20 | 7.41 | 22.2 | 4.28 | 12.8 | 8 |

DISTANCE TRAVELED
BY
5-MINUTE INTERVALS

BUS (TCRT)
NO SERVICE
AUTO

**All roadways except those shown by the lighter-weight lines outside the CBD are TCRT bus routes.**

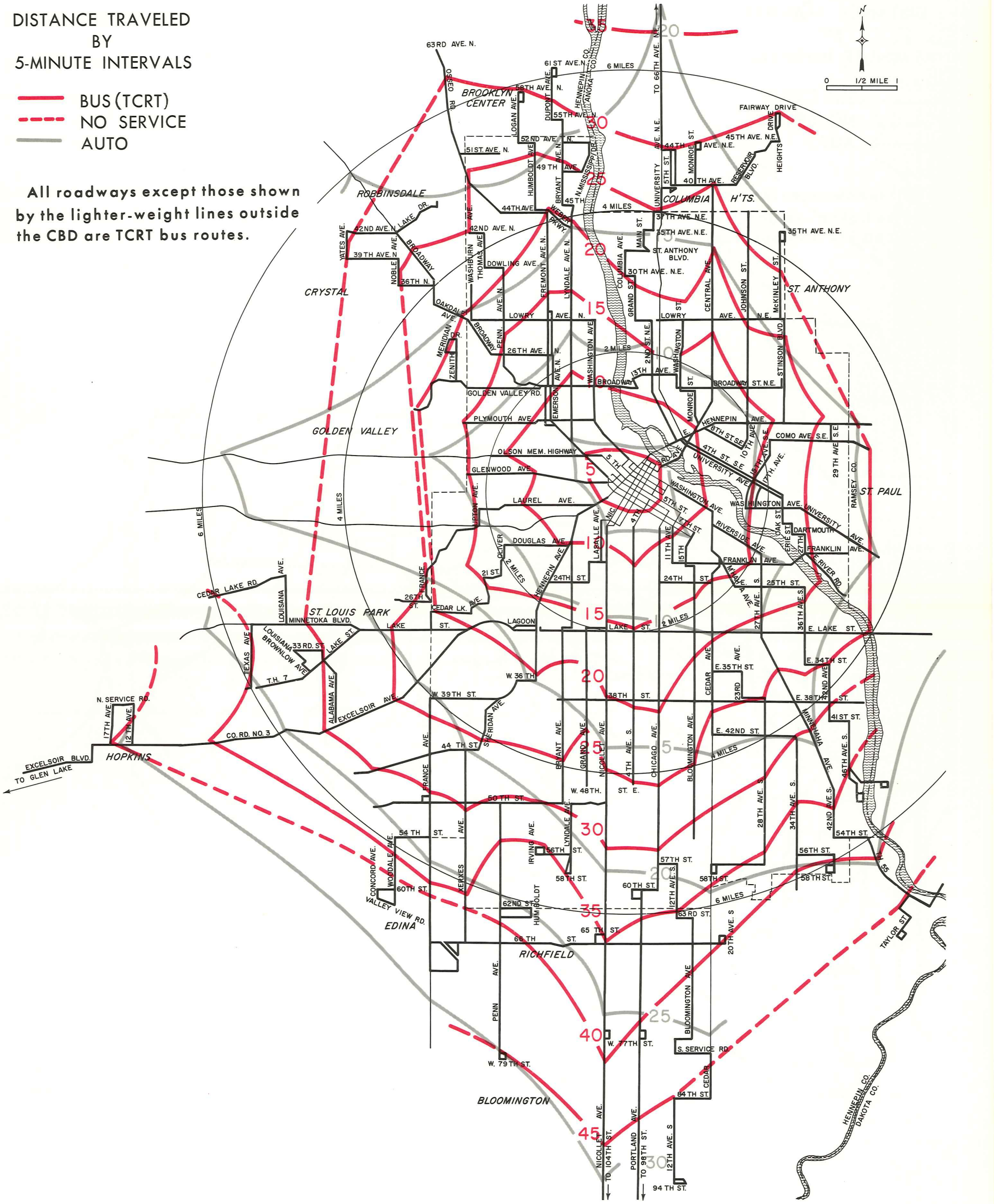



MAP 21 - COMPARATIVE SPEEDS OF BUS AND AUTO
EVENING PEAK TRAVEL OUTBOUND FROM THE ST. PAUL CBD

DISTANCE TRAVELED
BY
5-MINUTE INTERVALS

BUS (TCRT)
NO SERVICE
AUTO

**All roadways except those shown by the lighter-weight lines outside the CBD are TCRT bus routes.**




MAP 20 - COMPARATIVE SPEEDS OF BUS AND AUTO
EVENING PEAK TRAVEL OUTBOUND FROM THE MINNEAPOLIS CBD

average TCRT bus passenger trip, the auto would result in a six- to seven-minute saving on the "in motion" time.

Since the auto is faster than the bus, the auto covers area not covered by bus in any given time interval. Therefore, the average speeds for the two modes, indicated in Table 7, are not comparable by time interval. In order to correct for this limitation, it is necessary to establish the average speeds by bus and auto for similar areas.

The areas selected for these comparisons were those covered, as an average over all routes, by auto during the first, second, and third five-minute intervals. The average speed for both modes in these three areas is shown in Table 8. Also shown is the ratio of bus speed to auto speed.

In both Minneapolis and St. Paul, the ratio of bus speed to auto speed is slightly lower in the area covered by the auto in the second five minutes. This is the area which begins about one mile from the origin points in each of the CBDs and extends radially for 1½ to two miles. Reduction in the ratio is most pronounced in St. Paul, where the ratio drops from .75 in the area covered in the first five minutes by auto to .56 in the area covered by the auto in the second five minutes. Thus, the bus compares somewhat less favorably in the area just outside the CBDs, which is the area where substantial passenger unloading occurs.

The magnitude of "in motion" time saved by auto over bus depends upon the length of the trip. Data in Table 7 indicate an average saving by auto, over all routes, of approximately five minutes for a trip of 2¾ miles, and a six- to seven-minute saving on a four-mile trip. Beyond four miles, bus service begins to be quite limited. However, several bus lines extend over ten miles in a southerly direction from the Minneapolis CBD. Time savings by auto to points ten miles south are approximately 15 minutes (45 minutes by bus, 30 by auto; see Map 20).

**TABLE 8. COMPARISON OF BUS AND AUTOMOBILE SPEEDS OUTBOUND FROM CENTRAL POINTS WITHIN THE CBDs DURING THE EVENING PEAK TRAFFIC PERIOD**

FROM THE MINNEAPOLIS CBD

| Area Used for Comparison | Average Speed (mph) Over All Available Runs | | Ratio of Bus Speed to Auto Speed |
|---|---|---|---|
| | Automobile | Bus | |
| The area covered in the 1st 5 minutes by automobile | 11.2 | 8.1 | .73 |
| The area covered in the 2nd 5 minutes by automobile | 18.5 | 12.4 | .67 |
| The area covered in the 3rd 5 minutes by automobile | 20.1 | 14.5 | .72 |

FROM THE ST. PAUL CBD

| Area Used for Comparison | Average Speed (mph) Over All Available Runs | | Ratio of Bus Speed to Auto Speed |
|---|---|---|---|
| | Automobile | Bus | |
| The area covered in the 1st 5 minutes by automobile | 11.5 | 8.6 | .75 |
| The area covered in the 2nd 5 minutes by automobile | 24.3 | 13.8 | .56 |
| The area covered in the 3rd 5 minutes by automobile | 25.3 | 18.1 | .72 |

The establishment of exact travel speeds in a particular location during a specific time period is extremely difficult. The discussion regarding travel speeds is therefore quite general. Travel speeds are based on an average of different routes, and comparisons on one particular route are likely to be much less reliable.

In general, it can be concluded that bus speeds are slightly over two-thirds as fast as auto speeds during the evening peak traffic period, recognizing that the ratio of bus speed to auto

speed varies slightly as the area of inquiry is shifted outward from the CBDs, and that the ratio also varies from route to route.

All the preceding comparisons are based on "on the road" average speeds, and no account has been taken of terminal times. For this reason, such ratios are of limited value for use in explaining choice of mode, even if ratios were developed on certain segments of a particular route.

The time involved in making a trip usually involves walk time, parking time in the case of auto (particularly for trips to the CBDs), waiting time in the case of bus, and perhaps transfer time plus other considerations. These factors must be considered in addition to "on the road" speed. Furthermore, the above comparisons are based on average speeds for bus and auto on the bus routes. In many instances, alternative routes may be faster for the auto and short cuts may be taken.

Often the magnitude of these other factors is substantial relative to actual time on the road, and it is not unlikely that bus speeds relative to auto speeds are lowest over routes of heavy ridership because of frequent stops. These other factors are likely to be very important for short trips since, as indicated above, the difference in "in motion time" between bus and auto is not great for short trips.

Therefore, travel time ratios based on "on the road" average speeds become meaningful in explaining choice of mode only to the extent that other factors of a trip are assumed equal. Further investigation into the factors other than travel time ratios is more likely to reveal a clearer understanding of the choice of mode of travel than is further emphasis on travel time ratios.

## CAPACITY AND UTILIZATION OF THE TCRT BUS SYSTEM

The relationship between the capacity and utilization of transportation facilities is a major consideration in the planning of a transportation system. This relationship as it exists in the TCRT bus system is investigated in this section of the report with the purpose of ascertaining the extent to which bus service is being utilized.

Although the following usage-capacity analyses are based on data obtained in 1962 – rather than 1958, the year virtually all other data in this report were collected – the usage-capacity relationship is not thought to be greatly different from the survey year. It would be well to caution at this point, however, that the 200,000 daily TCRT bus trip total, which represents the usage component of these analyses, was furnished by the company, and no attempt should be made to consider it as the TCRT portion of the 416,000 daily bus trip total established in the 1958 survey. Aside from the four-year interval separating the collection of the data, its noncomparability is explained by the several reasons enumerated in the introductory chapter of this report (see footnote, page 5).

Daily capacity and utilization of the TCRT system are shown in Table 9. (Both capacity and utilization are measured in "seat

**TABLE 9. CAPACITY AND UTILIZATION OF THE TCRT BUS SYSTEM DURING THE AVERAGE WEEKDAY**

| Time Period | Capacity (Seat Miles of Service Offered) | Utilization* (Seat Miles of Service Used) | Utilization as a Percent of Capacity |
|---|---|---|---|
| 6 a.m. - 8:59 a.m. | 781,880 | 190,007 | 24.3 |
| 9 a.m. - 2:59 p.m. | 841,500 | 180,390 | 21.4 |
| 3 p.m. - 5:59 p.m. | 806,162 | 246,614 | 30.6 |
| 6 p.m. - 11:59 p.m. | 550,800 | 77,410 | 14.1 |
| Midnight - 5:59 a.m. | 103,280 | 5,579 | 5.4 |
| Totals | 3,083,622 | 700,000 | 22.7% |

** Utilization is the product of the number of trips and 3.5 miles - the average trip length*

miles.") The period from 6 to 8:59 a.m. represents the morning peak traffic period, and the period from 3 to 5:59 p.m. represents the evening peak. Three hours have been included in each of the peak periods because of the large number of bus trips, many of which are for school purpose, occurring up till 9 a.m. and in the relatively early afternoon.

Slightly over 3,083,000 seat miles of service are available during an average weekday. Of this total, 1,588,042, or 51.5%, are available during the morning and evening peak traffic periods, and 841,500, or 27.3%, are available between 9 a.m. and 2:59 p.m.

Usage on the average weekday, based on the 200,000 TCRT daily trip total furnished by the company, equals 700,000 seat miles. (Usage is the product of the number of trips in a time period times 3.5 miles – the average trip length.) Of the 700,000 total, 436,620, or 62.3%, are used during the morning and evening peak traffic periods, and 180,390, or 25.7%, are used between 9 a.m. and 2:59 p.m. Only 5,579, or 0.8%, of the daily utilization takes place between midnight and 5:59 a.m.

Thus it can be seen that both the number of seat miles available and the number of seat miles used vary among the different time periods of the day. This, of course, would be expected. Of particular interest, however, is the relation between service offered and service used during the five different periods as well as for the 24-hour period.

The 700,000 seat miles used on the average weekday are equal to only 22.7% of the 3,083,622 seat miles offered. During the evening peak traffic period, 30.6% of the available seat miles of service are used - the highest for any of the time periods selected. Utilization as a percent of capacity is lowest between midnight and 5:59 a.m., when only 5.4% of the seat miles of service are used.

Thus it is apparent that despite drastic adjustments in the level of service available the proportion of service used varies substantially and reaches a maximum of only 30.6%. Undoubtedly, a higher percentage could be expected for time periods of shorter duration. As an example, utilization as a percent of capacity from 4:30 to 5:30 p.m. would likely be over 40%. Reliable estimates for one-hour periods are more difficult to make, however, because of the problem of allocating trips into short time periods.

It should be noted that the capacity figures in Table 9 do not include standing room, even though standing trips are included in the usage figures. If standing room were considered as a part of capacity, usage rates would drop accordingly.

The problem of adjusting capacity to utilization is not unique to the TCRT bus system. The capacity of all transportation facilities is used to varying degrees throughout a 24-hour period. This variation is a result of the concentration of trips into certain time periods.

Bus passenger trips are concentrated into certain time periods to a greater degree than are auto driver trips. This aggravates the problem of adjusting bus service to the need for service. For example, 93% of the daily total bus passenger trips take place between 6 a.m. and 7 p.m. while, by contrast, only 70% of the daily auto driver trips occur during this period.

One facet of the problem of adjusting bus service to the need for service is seen in the low proportion of service utilized between midnight and 6 a.m. Trips are few and widely dispersed in this period, and maintenance of even a minimum level of bus service results in a large proportion of unused capacity.

The nature of the problem of adjusting capacity to need in the case of a bus system is somewhat different than is the pro-

blem for transportation facilities in general. The latter is essentially a question of street and highway design, the capacity of which cannot be altered throughout a 24-hour period. The capacity of the bus system can be changed, however, by changing the number of buses in operation, although idle capacity still remains in the form of stationary buses. This particular aspect is indicated by the fact that 600 buses are in operation during the evening peak, while only 27 operate between midnight and 6 a.m.

Thus, even though adjustments can be made in bus service offered throughout various periods of the day or night, unused capacity is not eliminated. And, again, the concentration of trips into certain time periods is the aggravating factor since 600 buses are required to provide adequate service during the evening peak traffic period but only 27 are needed between midnight and 5:59 a.m., and even this small number results in a very high proportion of unused capacity. On the other hand, if the 600 buses were not available during the evening peak traffic period, enlarged transport facilities would be needed for the auto and these in turn would be idle during off-peak periods.

In the Chicago area it is estimated that 40% of the seat miles of bus service are used.[1] This contrasts with 22.7% for the TCRT system. This large difference is not unexpected because of the high residential densities and tremendous concentrations of activity in Chicago, which result in greater movement by bus as well as rail.

Comments on the residential densities served in Chicago and a comparison to those served by the TCRT bus system are made in Chapter III, describing factors which influence choice of travel mode.

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[1]Chicago Area Transportation Study, Volume 1, 1959, p. 86.

# CHAPTER III

## Factors Which Influence Use of Mass Transit

Among the factors related to mass transit usage are age, sex, occupation, auto ownership, land use intensity and population distribution. These and other factors affecting usage of the mass transit travel mode will be investigated in this chapter.

Isolating these factors and determining their relative importance is often difficult. The primary complication is portrayed in the following illustration:

> Sex and occupation - both characteristics believed to be related to mass transit usage - are interrelated. That is, women are associated with certain occupations, men with others. If it is found, then, that bus is the travel mode of a high proportion of all trips by females, but accounts for only a small number of trips by males, the question is, is sex or occupation the relevant factor. Perhaps both are associated with mode of travel. While sex might appear to be the factor, occupation may be contributory.

The foregoing indicates the fundamental nature of the problem in determining the factors influencing the choice of travel mode. To minimize this problem, control is exercised over one or a number of factors while varying the factor which is being examined for a relationship.

Full control over all variables, however, is not always attainable; therefore, certain analyses are based on simple relationships. However, any simple relationship between mass transit usage and a variable - that is, when control has not been exercised on the interrelated variables - should be interpreted cautiously. Attempts to show causal relationships or to explain mass transit usage on the basis of one variable without controlling interrelated variables may be misleading and oversimplified.

On the other hand, the establishment of a relationship between mass transit usage and a single variable without control over interrelated variables may serve as an initial step in an investigation or may be used for predictive purposes.

It is not intended to convey the impression that two variable associations without control on other interrelated variables are useless or invalid. Rather, the intention is to point out the problems which may be involved in their usage so that interpretations are made accordingly.

The factors which are related to the use of mass transit are grouped into two general categories: one category deals with

personal and family characteristics, the other with factors related to the location and general setting of trips. The effects of population shifts within the central cities are also discussed.

## PERSONAL AND FAMILY CHARACTERISTICS

Age, sex and occupation as they relate to mode of travel are discussed in the first part of this section. In the second part, the relationship between automobile ownership and mode of travel is discussed.

The following analysis of the relationship between the age, sex, and occupation of the tripmaker and the mode of travel is based on home-origin trips originating in the central cities. (Data were limited to the central cities in order to control the level of service available and remove, insofar as possible, the effects of variation in bus service.) Furthermore, only those trips made by bus passengers, auto drivers and auto passengers are considered, and the very minor person movements by truck, rail and taxi are excluded. The mode of travel of work trips receives primary consideration. Secondary attention is given to the mode of travel of trips for the combined purposes of shopping, social-recreation and personal business.

### Age, Sex and Occupation and Mode of Travel

The mode of travel of persons making work trips has a definite relationship to the sex of the person making the trip. As shown in Figure 7, a very high proportion of the work trips by males are made as auto drivers. In contrast, a low proportion of the work trips by females are made as auto drivers; both auto passenger and bus passenger rank higher. (Work trip data relative to age, sex, and travel mode are shown in Table 23, in the Appendix.)

The age of the tripmaker is also related to the mode of travel. As seen in Figure 8, the young and old are more likely to make

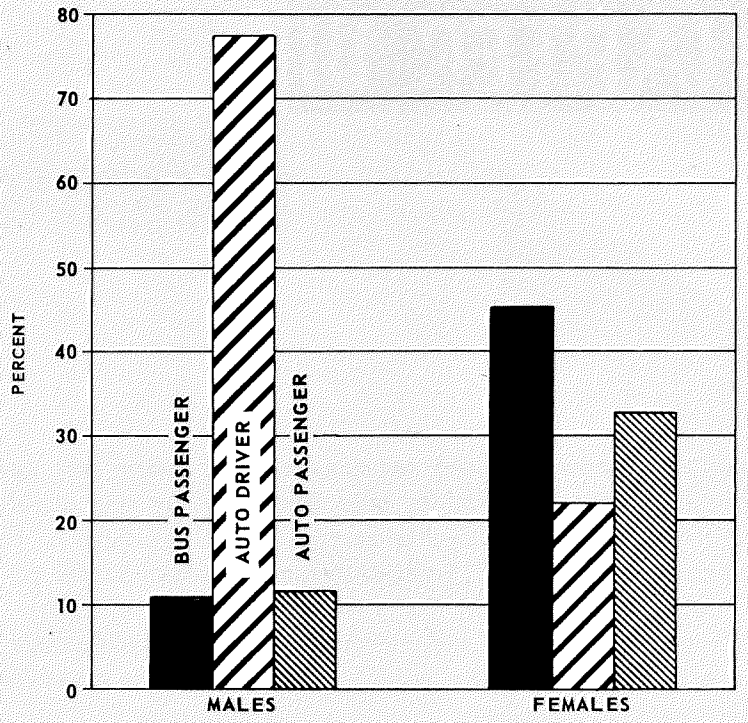



FIGURE 7. MODE OF CENTRAL CITY ORIGIN WORK TRIPS, MALE AND FEMALE
(Home-Origin Trips Only)

work trips as bus passengers than are the middle-aged. This is true for both males and females.

Differences are noted in the mode of travel of males and females in similar age groups. For instance, in the 30-34 age group, the group with the highest proportion of auto drivers, 84% of the trips by males are made as auto drivers while slightly over 34% of the trips by females are made as auto drivers and about an equal percent as bus passengers.

The proportion of trips made by auto drivers is lowest in the 15-19 age group for both sexes. However, 42% of the work trips made by males in this age group are made as auto drivers, while only 7% of the female trips are made by this mode.

Thus it can be seen that the influence of age on mode of travel follows a similar pattern for both sexes. The major difference between the mode of travel of males and females making work trips is the much greater tendency for males to make work trips as auto drivers, and for females to go as bus or auto passengers. Therefore, both sex and age are related to mode of travel.

In the preceding discussion, age, sex, and travel mode relationships were analyzed without regard to occupation, which is also related to mode of travel. Figure 9 shows the mode of travel of trips to work by males and females of all ages by occupation. Occupations are arranged in order of income. (See Appendix, Table 24, for detailed data.)

Males engaged as managers, officials and proprietors, and in sales have the highest proportion of auto driver trips and, along with the craftsmen-foremen group, the lowest proportion of bus trips. About 88% of the work trips by managers, officials and proprietors are made as auto drivers, while only slightly

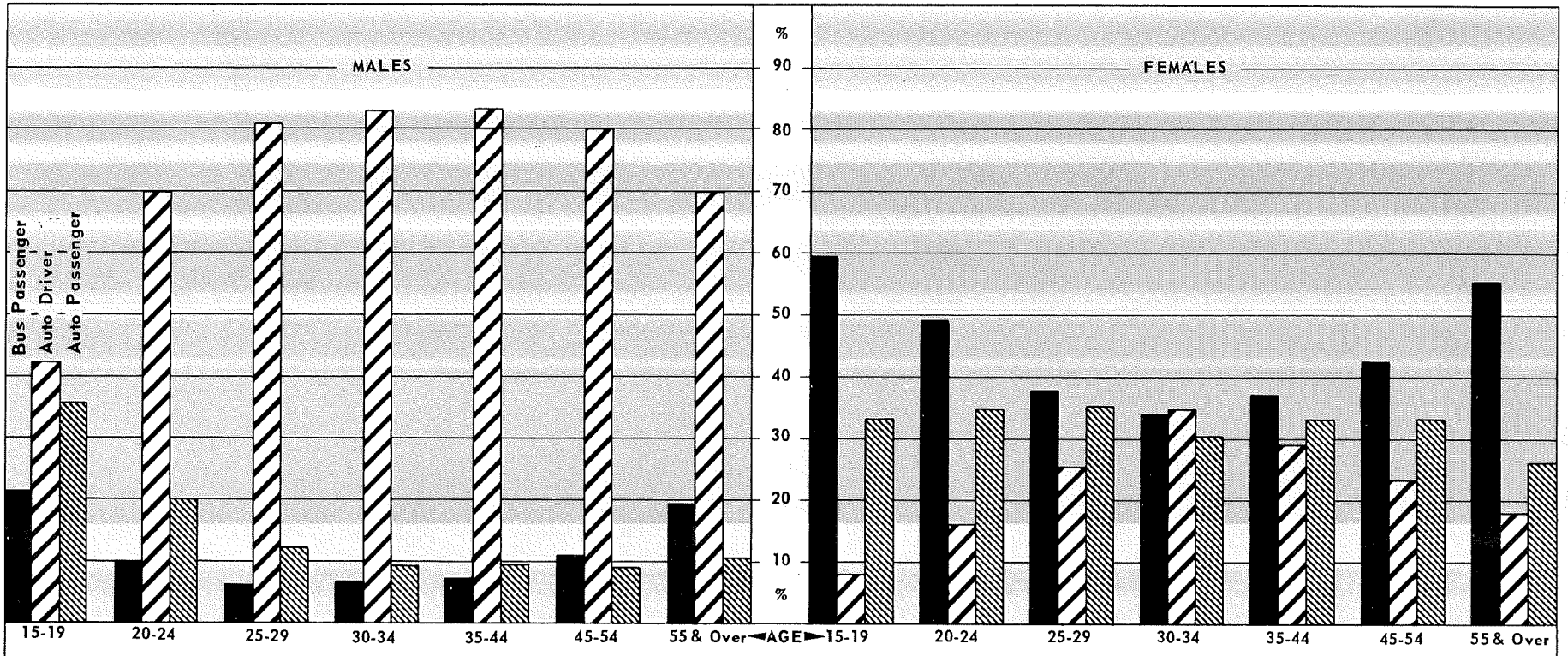



FIGURE 8. MODE OF CENTRAL CITY ORIGIN WORK TRIPS BY AGE, MALE AND FEMALE

(Home-Origin Trips Only)

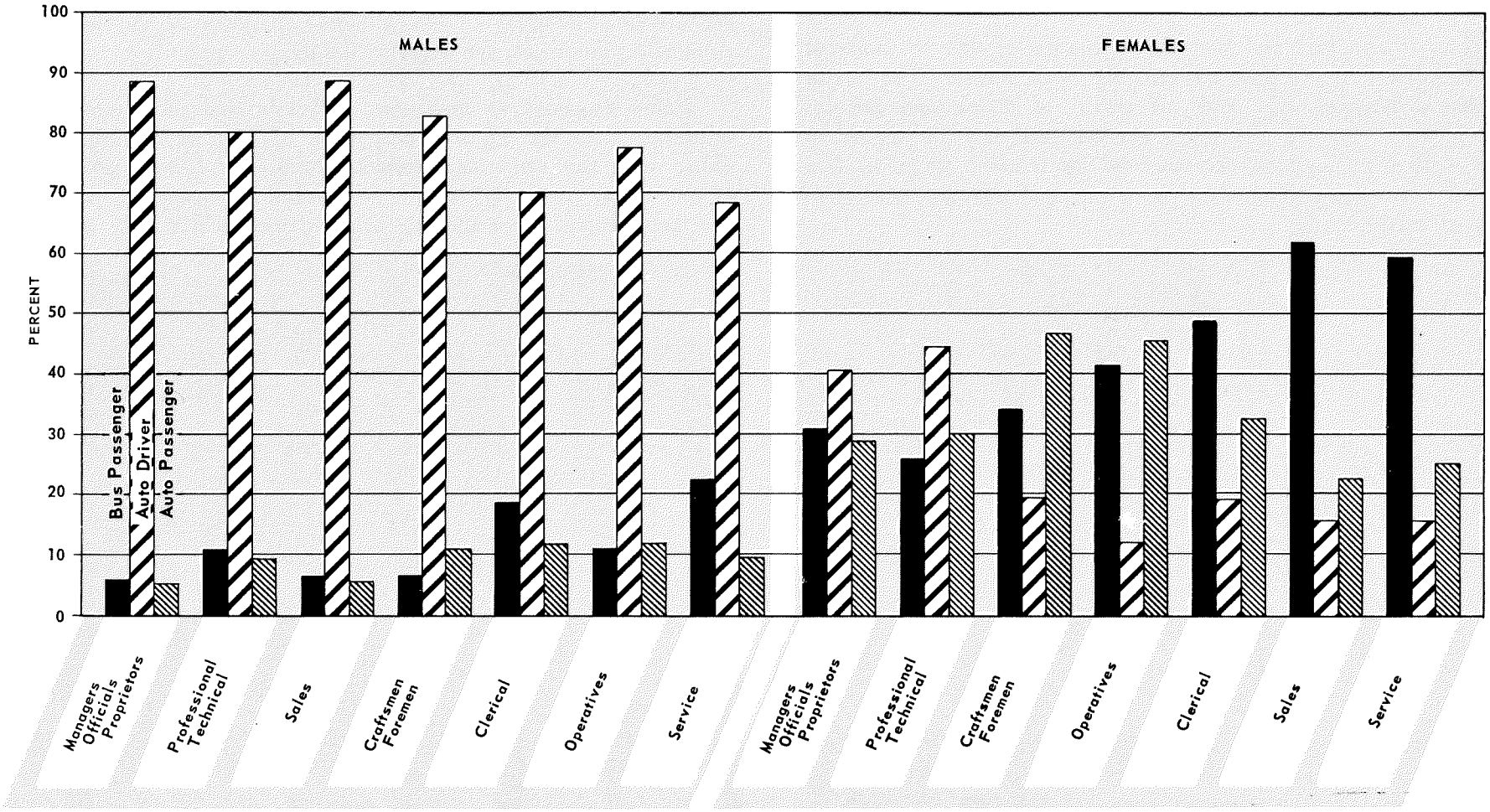



FIGURE 9. MODE OF CENTRAL CITY ORIGIN WORK TRIPS BY OCCUPATION, MALE AND FEMALE

(Home-Origin Trips Only)

over 6% are made as bus passengers. On the other hand, about 70% of the work trips by males engaged in clerical and service occupations are made as auto drivers and about 20% as bus passengers.

Among females, who on the whole are more likely to use the bus than are males, utilization also varies with occupation. Women engaged in professional, technical, managerial, official and proprietary occupations are more likely to make work trips as auto drivers and less likely to make them as bus passengers than are women engaged in sales, service, and clerical occupations.

The preceding discussion of the relationship between occupation and mode of travel is based on a composite of work trips by persons of all ages. However, mode of travel will be found to vary with age even within similar occupational groups. Figures 10 and 11 show the relationships between age and mode of travel within occupational categories grouped to combine similar income levels.

It can be seen that age is related to the mode of travel, of both males and females, within both the high and low income groups. The relationship is quite pronounced for trips by females in both the high and low income groups, and for trips by males

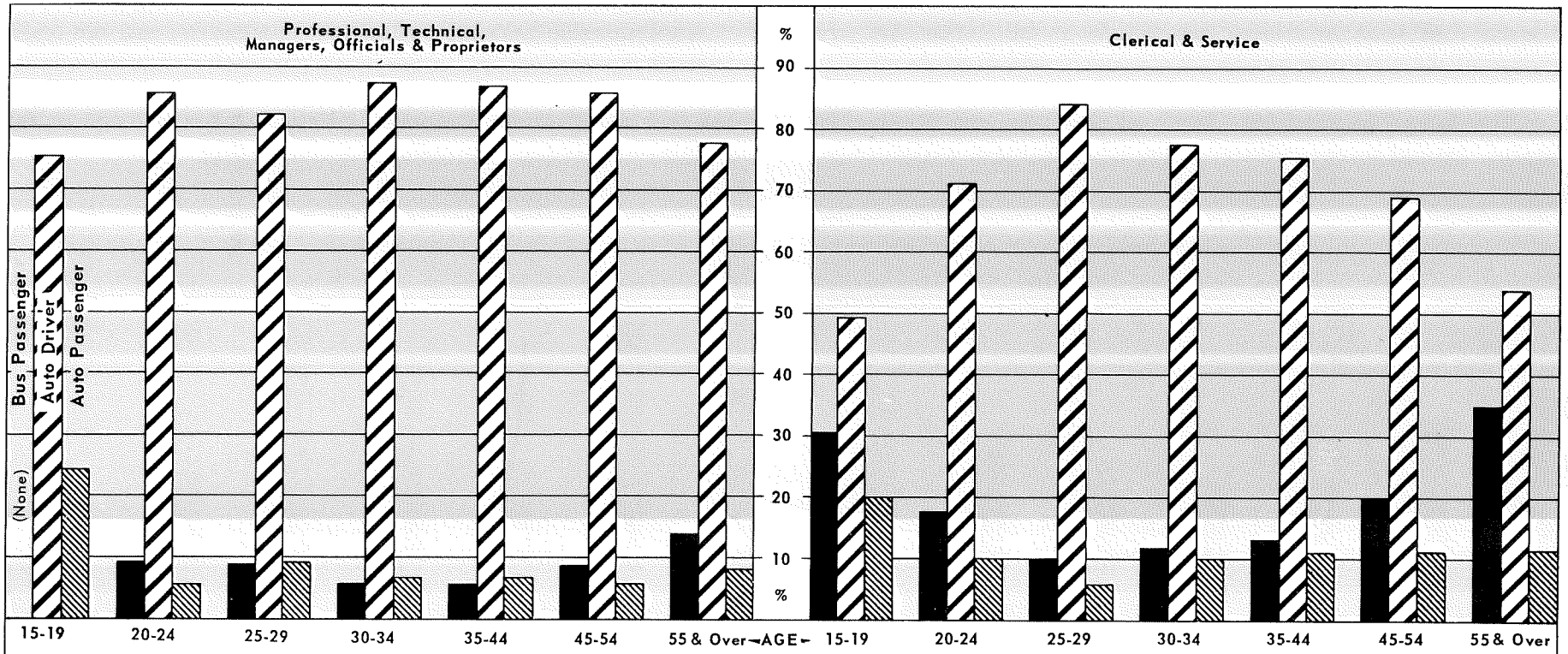



FIGURE 10. MODE OF CENTRAL CITY ORIGIN WORK TRIPS BY AGE AND SELECTED OCCUPATION GROUPS - MALES
(Home-Origin Trips Only)

in the low income group. Changes in the mode of travel are somewhat less responsive to changes in the age of male tripmakers engaged in occupations in the high income group than those engaged in occupations in the low income group.

The difference in mode of travel of persons of similar age but of different occupations can also be seen in Figures 10 and 11. This difference is particularly pronounced in the case of trips by females. For example, in each of the age groups the percent of trips accounted for by auto drivers is consistently and substantially higher for females engaged in an occupation in the high income group than for females engaged in an occupation in the low income group. This difference is less marked in the case of trips by males, particularly in all except the age groups at the ends of the range (15-19 and 55 and over).

The foregoing analyses show that age, sex and occupation are all related to the mode of travel of work trips. Furthermore, the differences in mode of travel in different occupations suggest that income may be a factor acting through occupation, since persons in the higher income occupations tend to make more of the work trips as auto drivers and less as bus passengers. Moreover, the higher bus utilization by women is likely due in part to the lower general level of income prevailing for women.

The effect of age and sex upon mode of travel of trips for the combined purposes of shopping, social-recreation and personal business has also been analyzed and is shown in Figure 12. This graph is based on trips by persons of all occupations. (See Appendix, Table 25, for detailed trip data.)

A relationship between the age of the tripmaker and the mode of travel of trips for the combined purposes of shopping, social-recreation and personal business is apparent, and this relationship is similar to the one which exists between the age of the tripmaker and the mode of travel of trips to work.

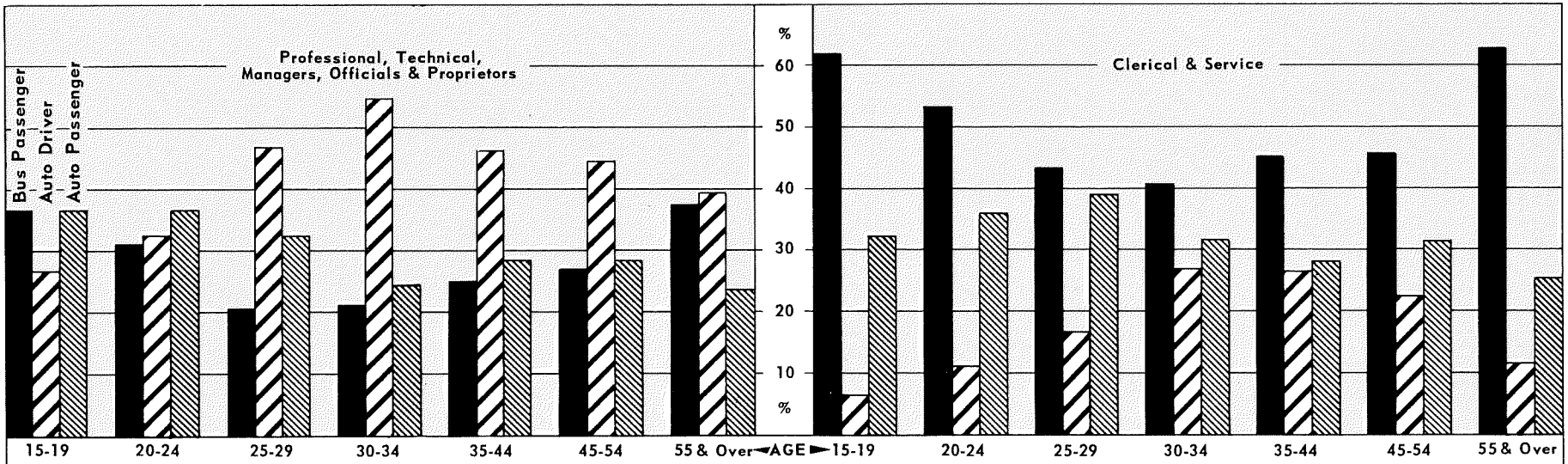



FIGURE 11. MODE OF CENTRAL CITY ORIGIN WORK TRIPS BY AGE AND SELECTED OCCUPATION GROUPS - FEMALES

(Home-Origin Trips Only)

When comparing the mode of travel of work trips by females with the mode of travel for the combined purposes of shopping, social-recreation and personal business, it is evident that bus passengers account for a much larger proportion of the work trips. On the other hand, auto passengers account for a much larger proportion of the female trips for the combined purposes.

Trips for the purposes of shopping and social-recreation are likely to involve family and group movements. As a result, a great number of such trips, particularly those by the very young and by women, are made as auto passengers riding with male auto drivers. This accounts for the switch to auto passenger as a mode of travel of trips for these purposes. Because of the nature of shopping, social-recreation and personal business trips, the significance of the relationship between mode of travel of trips for these purposes and the age, sex and occupation of the tripmaker is reduced. For that reason, major emphasis has been directed to the analysis of work trips.

## Bus Usage as it Relates to Automobile Ownership

The great relative decline in the use of mass transit facilities in the 1949-1958 period was accompanied by a rapid in-

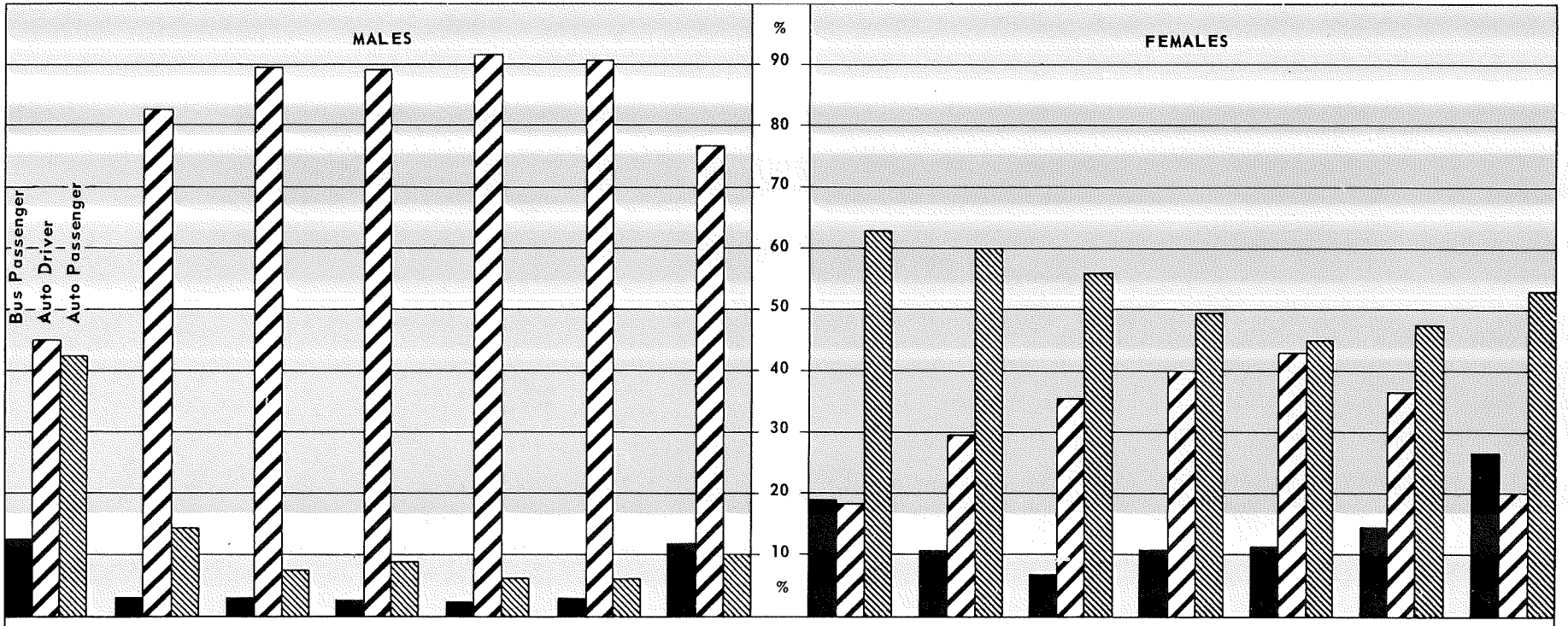



FIGURE 12. MODE OF CENTRAL CITY ORIGIN SHOPPING, SOCIAL-RECREATION, AND PERSONAL BUSINESS TRIPS BY AGE, MALE AND FEMALE

(Home-Origin Trips Only)

crease in automobile ownership. This increase, outstripping population gains, was area-wide, rather than just in suburban areas.

A study of the relationship between bus usage and the level of auto ownership, based on 49 Study Area districts receiving reasonably adequate TCRT service (districts with a low level of bus service were excluded), shows a pronounced correlation. The 49 districts are located in and near the central cities. Specifically, the variables analyzed are the level of auto ownership in a district, in terms of number of autos per 100 dwelling units, and the proportion of its home-origin trips carried by bus (trips to school excluded), as shown in Figure 13. The two variables have a correlation coefficient of −.89. The method of least squares was used to fit the line to the data for the 49 districts. (See Appendix, Table 26, for detailed data.)

Over 24% of the nonschool home-origin trips in one district, located immediately southwest of the Minneapolis CBD, are made by bus. The level of auto ownership in this district is less than 60 cars per 100 dwelling units. Conversely, bus accounts for less than 4% of the nonschool home-origin trips in the seven districts with auto ownership of 130 or more cars per 100 dwelling units. The higher the rate of auto ownership, then, the lower the usage of the bus. In view of the substantial increase in the rate of auto ownership over the past decade, the marked relative decline in bus usage is not surprising.

*No-Car Households.* Despite the 1949-1958 increase in the overall rate of automobile ownership, 69,000 of the Study Area's 408,000 dwelling units are without a car. As would be expected, these households, equaling almost 17% of the total, are concentrated near the CBDs.

The occupants of these households are one of the major sources of bus patronage; they account for 91,000, or 36%, of the 252,500 daily nonschool trips by bus passengers.

In many of the central cities districts, trips by persons of no-car households account for one-half or more of all home-origin bus passenger trips. In the district immediately southwest of the Minneapolis CBD, 71% of the home-origin bus passenger trips are made by persons of no-car households.

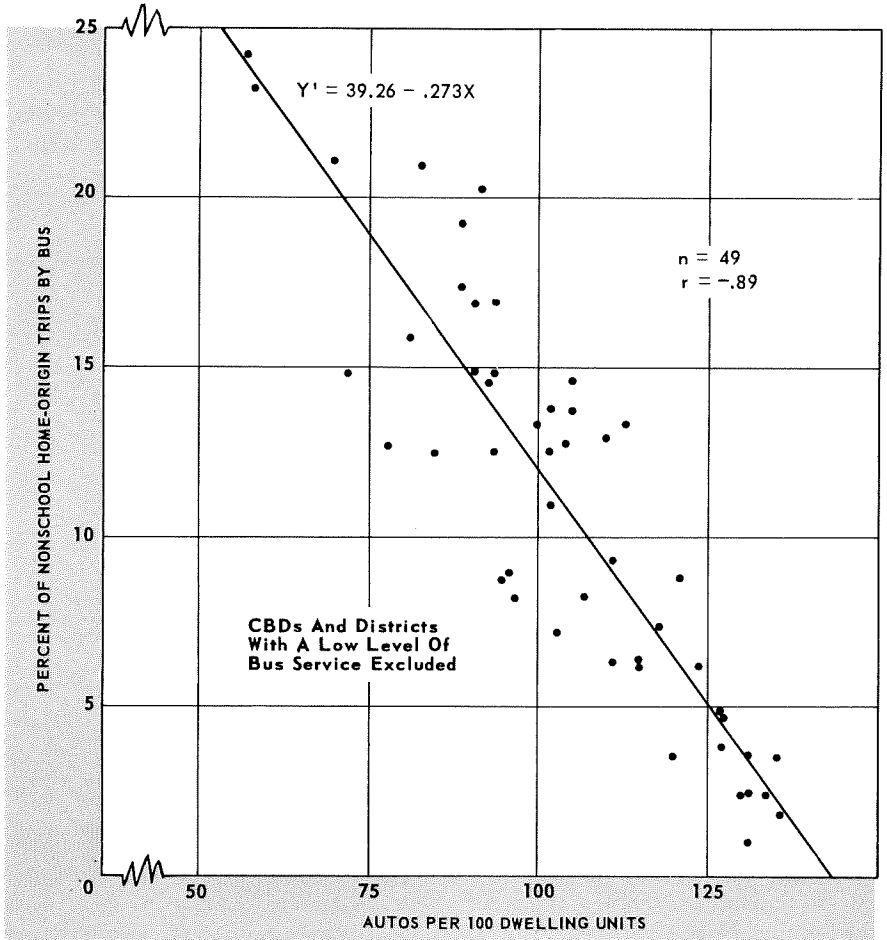



FIGURE 13. RELATIONSHIP OF BUS USAGE TO AUTO OWNERSHIP

Of the 168,000 daily nonschool trips made by persons of no-car households, 54% are by bus; 69% of the 33,700 work trips by this group are by bus. These percentages are in sharp contrast with their counterparts for the entire population of the Study Area: 8.1% and 12.1%, respectively.

Almost 40% of the nonschool trips by persons of no-car households are made by persons over 55; 67% are made by women.

In summary, it is interesting to note that while this is a "captive" group, almost half of its trips are made by modes other than bus. Furthermore, almost two-thirds of the daily nonschool bus passenger trips are made by persons from households with one or more cars; however, included in this group are likely to be many persons making trips at a time when the car is unavailable.

In the following discussion, emphasis is directed toward conditions or factors related to the mode of travel which result from the location and general setting of trips.

## GENERAL FACTORS INFLUENCING MASS TRANSIT USAGE

Among the factors related to travel mode which arise out of the general setting of the trip are level of service, intensity of land use, trip length, trip purpose, and cost.

### Level of Service

One factor which influences mode of travel is the level of bus service available. Service availability for a particular trip is not only a function of bus headways (the interval between buses) but also a function of the location of the bus line or route which must be followed with respect to the origin and destination of any particular trip. Service availability is, in short, a measure of the degree to which an individual can get where he wants to go, when he wants to go. Trips which require transfers or long walks at the origin or destination end are less likely to be made by bus, particularly if the transfers require movement into one of the CBDs and out again. By bus, such trips are likely to be very time consuming. On the other hand, trips originating close to a bus route and going into one of the CBDs, or trips with origin and destination connected more or less directly by a bus route, find the level of bus service much better. Most of the bus routes radiate outward from the CBDs, and hence CBD movements are favored relative to crosstown movements.

The frequency of buses is an important factor in the level of service. Long headways impose two specific problems with regard to the rigidity of scheduling on the part of bus passengers. One is that long headways result in an inefficient use of time on the part of bus passengers. For instance, a bus passenger may have to take a bus which gets him to his destination considerably ahead of time because taking the following bus would result in his being late.

The second problem imposed by long headways is the greater consequence of missing a bus. The auto driver who starts out two minutes late will arrive at his destination two minutes late; the bus passenger who misses his bus may be 15 minutes late at his destination. To the extent that headways are long, the bus passenger must put increased emphasis on maintaining a rigorous schedule.

Service availability may affect the mode of travel of one particular trip or it may affect the mode of travel of a series of trips. For example, many of the midday trips are diffused, and since persons making such trips by bus would not have a high level of service available, considerable time would be required. Furthermore, a destination may be involved which cannot be reached by bus. Thus an individual who makes trips of this nature during the day is much less likely to make the work trip in the morning by bus, since bus would not adequately meet his travel needs throughout the day.

## Intensity of Land Use

Intensity of land use at both the origin and destination of trips is a factor related to travel mode. There are various indicators of the intensity of land use, one of which is the number of dwelling units per net residential acre. This indicator will be used to show the relationship between mode of travel of home-origin trips with nonschool destinations and the intensity of land use at the origin.

The relationship is analyzed on a district basis; hence, the number of dwelling units per residential acre represents an average for an entire district. Similarly, the reported percentages of home-origin trips accounted for by bus passengers represent entire districts. (See Appendix, Table 27, for detailed data.)

In Figure 14, the relationship between these two variables is shown as it exists in 45 districts which are served by TCRT buses. The number of dwelling units per residential acre in the 45 districts varied from three to 20. Bus passengers accounted for 21% of the nonschool home-origin trips in one district and only 1% in another.

As shown by the plotted points, the percentage of trip origins accounted for by bus passengers responds to small changes in the number of dwelling units per net residential acre. The regression line shown indicates that an increase of one dwelling unit per acre (as an average for a district) is associated with an increase of 1.3 percentage points in the percentage of home origins accounted for by bus passengers.

The correlation coefficient between the two variables is .87, indicating that they are quite closely related within the range considered - three to 20 dwelling units per net residential acre.

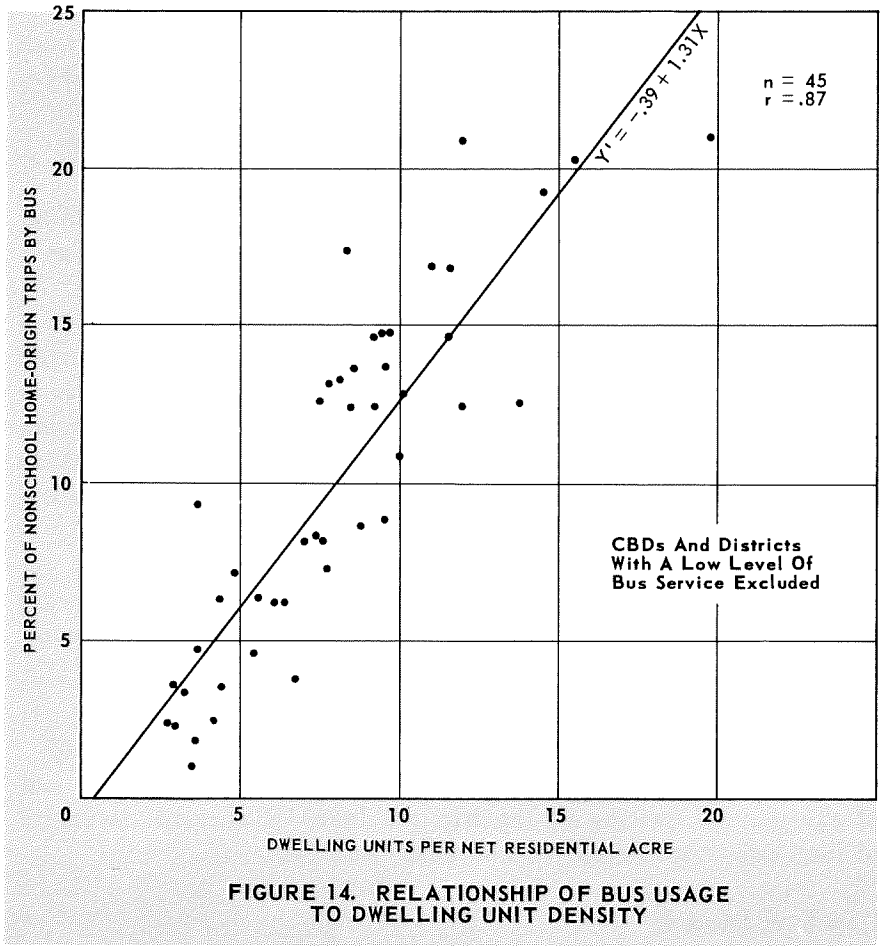



**FIGURE 14. RELATIONSHIP OF BUS USAGE TO DWELLING UNIT DENSITY**

In areas with residential densities exceeding 20 dwelling units per net residential acre, the relationship between the two variables is speculative. Excluding the CBDs, only four districts in the Study Area have densities of this magnitude. The densities of these districts ranged up to 40, and four districts spread over this extreme range are inadequate for establishing a relationship between the variables within this range. They were therefore omitted. However, on the basis of the four districts it appears

that the percentage of origins accounted for by bus does not continue to increase in a linear pattern but levels off at around 25%.

Such a leveling off might be expected. Work trips in areas of very high density can be made by walking, since these areas are generally close to major employment centers. Also, many retired people live in such areas, and this reduces the number of work trips. Since work trips tend to be made more by bus than trips for other purposes (almost 40% of the trips to work were made by bus in one of the four districts of heavy density), a reduction in the number of work trips relative to total trips would tend to pull down the percentage of origins by bus passengers.

The land use intensity at trip destinations is also related to travel mode. This is exemplified by the comparatively high ratio of bus passenger to total trip destinations in the CBDs. Twenty-seven and one-half percent of all trips with destination in the CBDs, for trips with destination purposes other than school or home, are made by bus passengers, while only 7.3% of such destinations in the entire Study Area are accounted for by the bus mode.

The higher level of bus service to the CBDs certainly accounts in part for the higher percentage of destinations by bus passengers, but the intense land use, bringing about the time, cost and inconvenience of parking a car, also favor use of the bus.

Some interesting general comparisons can be made with Chicago regarding the relationship between residential density and bus utilization. The recent Chicago Area Transportation Study indicates that intense bus usage is fairly well restricted to areas having population densities exceeding 12 families per residential acre. In Chicago, density drops to that level at about eight to ten miles from the loop whereas in the Twin Cities area such densities are generally found only two or three miles from the CBDs. Thus the bus must operate in the Twin Cities area almost exclusively in densities below those in which bus is considered as intensely used in Chicago. And not only is the high-density area considerably greater in Chicago, but maximum densities reach a much higher level. Both of these conditions are favorable to mass transportation, and this is reflected in the greater bus usage in Chicago. It is interesting to note, though, that bus usage rates in areas of similar density are not greatly different. The higher bus usage rates in the Chicago area, then, appear to be associated primarily with the greater densities.

## Trip Length

There is a logical basis for expecting the bus to compare less favorably with the auto for very long trips than for the medium-length or short trips. Bus travel speeds are slower than auto, and, other things being equal, time savings by auto over bus are a function of the length of a trip. Thus, the longer the trip, the greater the time savings by auto.

One of the important time components of many trips is terminal time needed for parking and walking at the destination - particularly for trips to the CBDs. This component can weigh heavily in the total time needed to make short trips. And it is conceivable that medium-length or short-length trips to the CBDs by bus may compare very favorably with auto in terms of total time when terminal times of parking and walking at the destination are considered. This, of course, depends upon the circumstances of individual trips. The longer the trip, however, the more likely it is to be made by auto, even if a substantial terminal time is required. This is because on-the-road time savings by auto increase relative to terminal time with the length of the trip. Thus the auto is particularly favored over the bus for very long trips. This is likely to be the case whether or not the trips are to the CBDs. The conclusion reached in this paragraph is modified in those instances where express bus service is available.

The case is not quite so clear for shorter trips. If such trips are to the CBDs and substantial terminal time is required for parking, the bus may compare very favorably with the auto. On the other hand, short trips which do not involve terminal time for parking are likely to take considerably longer by bus, particularly if headways are long.

Trip Purpose

Another factor relating to travel mode is trip purpose. Social-recreation trips and trips which involve small group movements are less likely to be made by bus. In such cases, costs may be a consideration since several fares would be required by bus. But more important, such trips are more likely to be made by auto because of the nature of the trip. At the other extreme are work trips, which generally do not involve a group. Such trips are somewhat more likely to be made by bus than are social and recreation trips.

Perhaps the notion can best be described as one in which certain trips are strictly a means to an end, such as in the case of work trips, whereas social-recreation trips are, in many cases, somewhat an end in themselves.

Cost

Establishment of the relationship between mode of travel and cost is complex because of the difficulty in assessing the appropriate overall cost of a trip. Even the establishment of a demand schedule showing the relationship between the quantity of bus service demanded at various price levels (bus fares) would be extremely difficult because of the multitude of factors included. Despite the absence of such empirical data in this report, application of economic theory to known facts, particularly those relating to the captive group, leads us to conclude that bus usage is not likely to respond greatly to moderate fare changes.

Bus fares are 25¢ in Minneapolis and St. Paul. The fare drops to 22½¢ when tokens are purchased four at a time. A trip originating in one of the central cities and ending in the other requires two fares. The double fare limits intercity bus movement, particularly for short trips which do not involve the CBDs. Trips originating in one of the central cities and ending in a suburban community require an additional fare of from 5¢ to 30¢ depending on the area. Trips beginning and ending within a suburb cost from 5¢ to 15¢. Thus, some attempt has been made to base fares on trip length and reduce subsidization of service to some areas at the expense of others.

An average bus passenger trip is about 3.5 miles and an average nonschool fare around 23¢. Thus, the average per mile cost is about 6½¢ - not greatly different from the variable costs of operating an auto.

The greatest impact of fare changes in the short run would result from adjustments by those who are in a position to make day to day decisions regarding mode of travel. Those who live near a bus line and own an auto or have access to a family auto are in such a position and could be expected to react rather quickly. Furthermore, people so disposed can choose between modes for each trip during the day, depending on the nature of the trip. At a given fare, a trip to the CBD may be cheaper by bus, depending on parking costs and the number of people going. On the other hand, trips to other areas may be cheaper by auto.

However, the number of persons really having such alternatives is not likely very large. A large proportion of bus passenger trips are likely to be made in the absence of an alternative mode. In order for a fare change to produce any substantial effect on the number of riders, there would have to be a large number of people making trips who have a choice of mode and who are operating just at or near a point of indifference between auto and bus. This is not likely to be the case; con-

sequently, moderate fare changes are not likely to affect ridership greatly, at least in the short run. The likely case is that revenue would go up if fares were increased, down if fares were decreased. In either case, the change in revenue caused by the change in fares would more than offset the change in revenue caused by the change in ridership.

In the longer run, fare changes are likely to have a somewhat greater effect because of the changes induced with regard to auto ownership and the decision as to where a person will live, but the effect of fare changes upon these decisions is also likely to be very small. In choice of mode, trip time and parking fees would, in many instances, also overshadow any change in bus fares.

Individuals weigh the costs and benefits of alternative places to live and work and of different modes of travel and choose among the combinations of alternatives accordingly. However, once a basic decision is made as to where a person lives and works, a choice of mode may no longer exist. The person who has moved to a suburb and is not served by mass transit is no longer concerned with fares as he has no alternative to the auto - just as a person who must make a trip when no auto is available has no alternative to the bus.

Although bus fares have been increasing and ridership decreasing, it is likely that increased fares are a symptom of decreased ridership, not a cause. Decreases in ridership are brought about by changes in such factors as auto ownership, living standards, and living and working areas. These factors are more significant in influencing mass transportation usage than are fare changes. In general, fare increases reflect efforts to maintain revenue in the face of decreasing ridership.

While costs of transportation are important, such costs are not just a matter of bus fares versus costs of operating an auto. Time savings, convenience, and choice of a place to live and work are also considerations. Therefore, a simple comparison between bus fares and costs of auto operation does not take account of the multitude of considerations which have a bearing on the mode of travel ultimately selected. Furthermore, increased incomes have made possible a shift toward the automobile and its use even if costs are greater.

In the following section, attention is focused on population shifts within the central cities. These shifts are to some extent a reflection of the effect of increased use of the automobile.

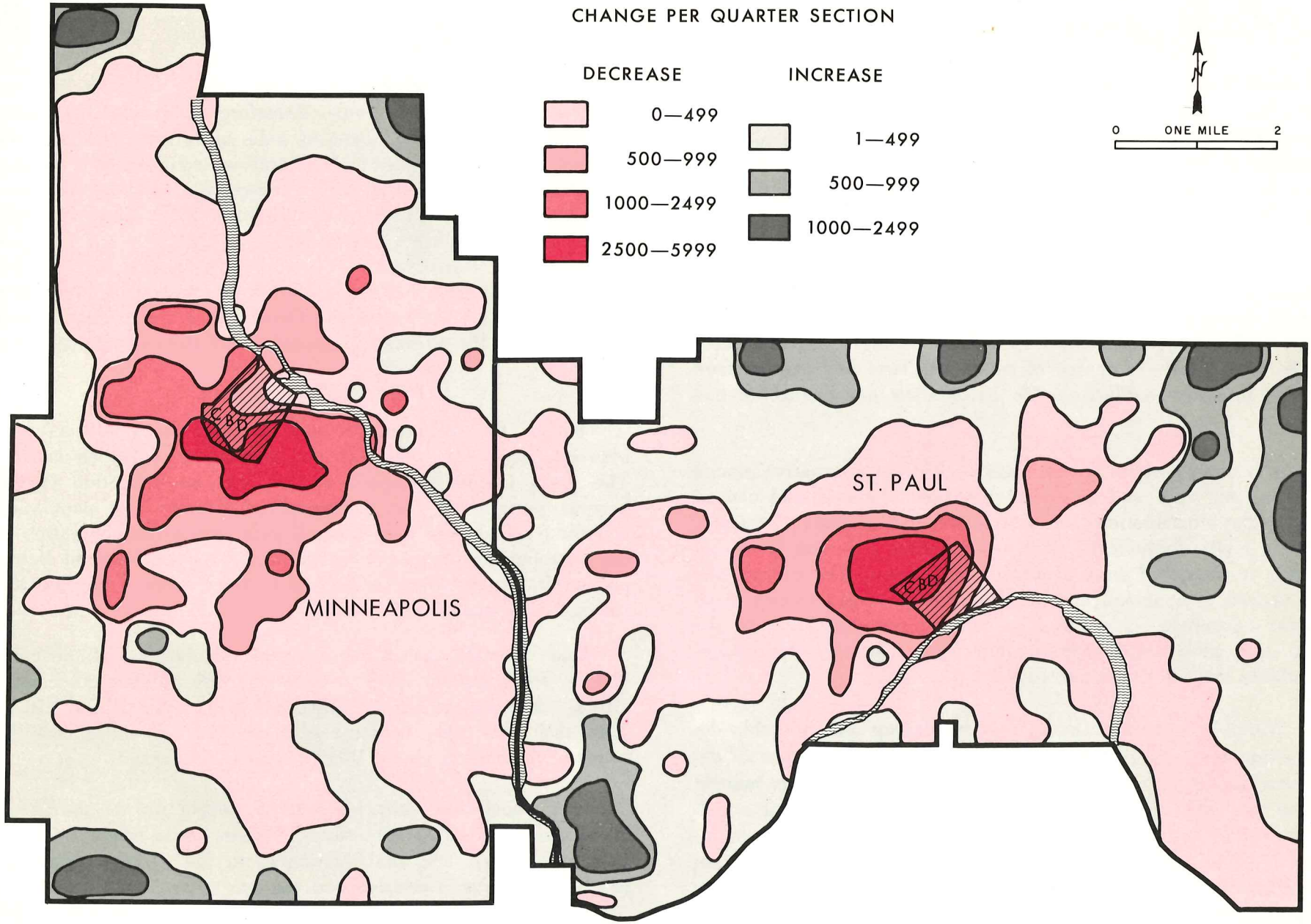
## POPULATION SHIFTS

One of the dominant features of large metropolitan areas between 1950 and 1960 was the tremendous suburban growth. The Twin Cities metropolitan area was no exception to the general pattern. In fact, Minneapolis actually lost population and St. Paul showed only a small gain, while the population of the metropolitan area as a whole (based on the Standard Metropolitan Statistical Area, as defined by the Bureau of the Census) increased by almost 29%.

Aside from the change in the overall population of Minneapolis and St. Paul and the large suburban growth outside the central cities, there was a definite movement within the central cities. This shift was from areas close to the CBDs to areas near the edges of the central cities. Map 22 shows this change.

This population shift has moved people out of the areas most easily and adequately served by bus, areas where ridership was very heavy, and has contributed to the overall decline in bus usage - both in relative and absolute terms.

To some extent, this shift is the result of people choosing where they will live and work. On the other hand, an unlimited choice is not always available. Decisions must be made from




MAP 22 - 1950-1960 POPULATION CHANGE IN THE CENTRAL CITIES

the available alternatives. When central areas become fairly saturated with a combination of single- and multiple-family dwelling units, only more and higher multiple dwellings can provide additional living space in these areas.

Such provisions have not always been forthcoming. Additional housing has appeared in the outlying areas due to many factors, including attractive financing provisions and land availability. The automobile has made such growth possible. Once movement is made to such areas, the automobile is relied on. In many cases, bus service is not available. Moreover, this decentralization makes adequate and economical bus service increasingly difficult to provide.

The personal and family characteristics, and the general factors related to travel mode, change with time. Income and auto ownership levels, land use intensity, and locations of employment and residential areas, are changing, and these changes are reflected in population shifts.

Thus population shifts are also symptomatic of the basic changes made possible by increased auto ownership and usage. These changes have been to the disadvantage of bus, as is manifested in declining utilization.

## SUMMARY

As noted at the beginning of this section, isolation of factors which affect the mode of travel, and determining the degree of influence exerted by each factor, is quite complex due to the interrelationships among many of the factors.

Auto ownership is a function of age, sex, occupation and income, intensity of land use, and perhaps the level of bus service available. Concerning age, the young cannot always afford cars and the old may no longer want to drive. Then too, persons of certain age, occupation and sex tend to locate in areas of more intense land use and areas with better bus service, particularly if auto ownership and use are not feasible or desired by such individuals. Because of these interrelationships, intensity of land use and auto ownership are highly associated with bus usage.

However, age, sex, occupation and income, where people work, the value placed on convenience and time savings, and the general attitude toward bus usage may be very important factors in the decision as to where people live. These factors then appear in the guise of other factors: auto ownership and residential density.

Many of the bus trips in the Study Area are made by "captives." For these persons, many of the factors discussed above are of little consequence. However, the significance of some of the factors, such as age, sex, occupation, and general attitude toward mass transit is that these factors are related in many cases to whether or not individuals will be captives. If older people decide to dispose of an auto and use the bus, age is a factor in their "choice" to become a captive.

Recognition of the effects of all factors is therefore necessary in order to fully understand and explain the usage of mass transit. It is particularly important to recognize and consider all factors if projections are being made as to future utilization or if a mass transportation program is being planned.

# CHAPTER IV

## Changes in Metropolitan Area Travel, 1949 to 1958

A Twin Cities area origin-destination study conducted in 1949 by the Minnesota Department of Highways makes it possible to review changes in metropolitan area travel characteristics in the 1949-1958 period.

The 200-square-mile area surveyed in 1949 is shown in Map 23 superimposed on the 890-square-mile 1958 Study Area. While the two areas are not of comparable size, many valid comparisons can be made nonetheless. Furthermore, it is possible to present 1958 data for the area corresponding to the 1949 study area, thus permitting several direct comparisons.

In the first part of this chapter, changes in travel in the 1949-1958 period will be subject to a general review. In the second part, changes in CBD travel will be examined.

To illustrate these changes, three types of comparisons are made between the 1949 and 1958 data. The first type of comparison is of an overall nature, without regard for the difference in size of the two areas. Changes uncovered in these comparisons might be ascribed not only to general changes in travel characteristics in the 1949-1958 period, but also to the effects of the greater suburban area in the 1958 Study Area. The second and third types of comparisons reveal the changes that took place within identical areas, and therefore observed changes cannot be attributed to added suburban area. The second type consists of matching the 1949 survey data against data collected from the same area in 1958. The third type is between 1949 and 1958 central cities travel.

Home destination trips have been excluded from some of the 1949-1958 comparisons, but their exclusion has no special significance as the proportion of home destinations was about the same in 1949 and 1958.

### GENERAL CHANGE

#### Overall Comparisons

While the study area of 1949 had a daily total of 431,000 mass transit trips,[1] which equalled 26% of the total daily trips by all modes, the 1958 Study Area has 416,000, and these equal only 12% of the total daily trips. Thus, in the nine-year period daily mass transit travel showed not only a relative decline, which might be expected because of the greater proportion of suburban area in the 1958 Study Area, but also an absolute decline despite a large increase in school trips.

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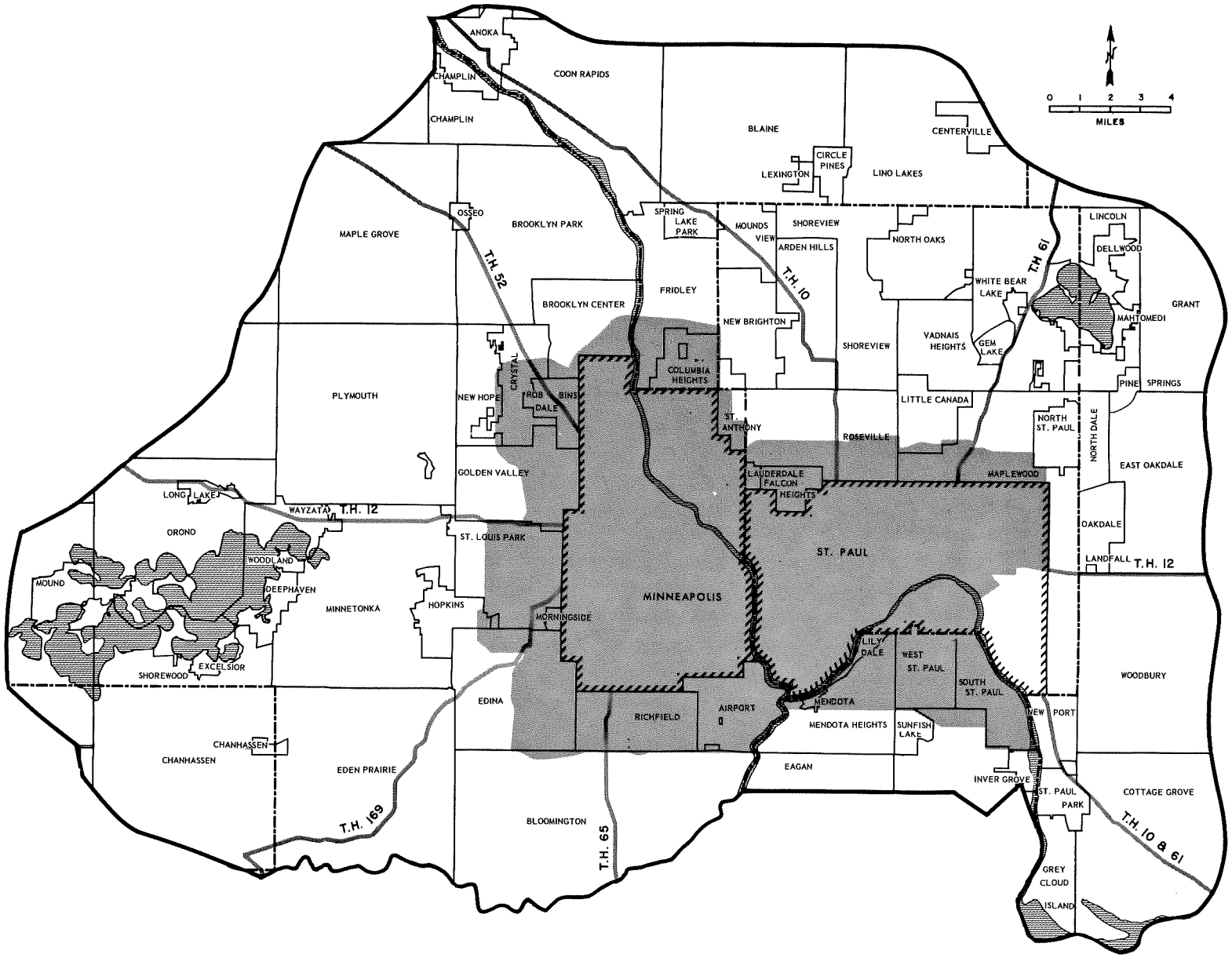
[1] In 1949, the Twin City Rapid Transit Company facilities consisted of streetcars (operating on rails) as well as buses.




MAP 23 - STUDY AREAS--1949 AND 1958

The area surveyed in 1949 was limited to the central cities and immediately surrounding suburbs; the 1958 Study Area encompasses considerable suburban area.

Tables 10 and 11 show total person trips for the two surveys by mode and purpose. An examination of these tables shows the much greater dependence of mass transit on school trips in 1958. In fact, if school trip movements (trips to or from school) are excluded, the 1958 survey shows only 252,500 daily trips against almost 400,000 in 1949.

Except for school trips, bus passenger trips declined as a percent of the total trips in each purpose category. The increase in the percent of school trips by bus - from 53% in 1949 to 63% in 1958 - is a reflection of suburban growth. While some of this increase was in trips on TCRT buses, most of it was in school bus trips. Another major change seen in Tables 10 and 11 is the sharp drop in bus's share of shopping trips - from 28% in 1949 to 6% in 1958. This too is the result of suburban development, both residential and commercial.

**TABLE 10. 1958 PERSON TRIPS IN THE 1958 STUDY AREA BY MODE AND PURPOSE**

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 123,423 | 15,491 | 12.6 | 30,091 | 24.4 | 77,841 | 63.0 |
| Work | 576,172 | 426,947 | 74.1 | 79,581 | 13.8 | 69,644 | 12.1 |
| Shop | 362,898 | 216,476 | 59.6 | 122,636 | 33.8 | 23,786 | 6.6 |
| Social-Recreation and Ride | 406,296 | 159,670 | 39.3 | 229,886 | 56.6 | 16,740 | 4.1 |
| Eat | 66,441 | 41,953 | 63.2 | 22,747 | 34.2 | 1,741 | 2.6 |
| Personal Business | 273,379 | 167,666 | 61.3 | 84,080 | 30.8 | 21,633 | 7.9 |
| Serve Passenger | 198,760 | 192,777 | 97.0 | 5,983 | 3.0 | - | - |
| Change Mode | 14,759 | 3,200 | 21.7 | 6,770 | 45.9 | 4,789 | 32.4 |
| Totals Except Home | 2,022,128 | 1,224,180 | 60.5 | 581,774 | 28.8 | 216,174 | 10.7 |
| Home | 1,344,791 | 738,843 | 54.9 | 405,762 | 30.2 | 200,186 | 14.9 |
| Totals | 3,366,919 | 1,963,023 | 58.3% | 987,536 | 29.3% | 416,360 | 12.4% |

**TABLE 11. 1949 PERSON TRIPS IN THE 1949 STUDY AREA BY MODE AND PURPOSE**

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus or Streetcar Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 31,903 | 6,070 | 19.0 | 8,744 | 27.4 | 17,089 | 53.6 |
| Work | 370,063 | 202,125 | 54.6 | 43,836 | 11.9 | 124,102 | 33.5 |
| Shop | 118,989 | 53,954 | 45.4 | 31,330 | 26.3 | 33,705 | 28.3 |
| Social-Recreation and Ride | 241,137 | 85,221 | 35.3 | 126,612 | 52.5 | 29,304 | 12.2 |
| Eat | 19,944 | 12,924 | 64.8 | 5,210 | 26.1 | 1,810 | 9.1 |
| Personal Business | 87,522 | 50,821 | 58.1 | 16,206 | 18.5 | 20,495 | 23.4 |
| Serve Passenger | 90,462 | 86,248 | 95.3 | 3,932 | 4.4 | 282 | .3 |
| Change Mode | 8,687 | 723 | 8.3 | 4,162 | 47.9 | 3,802 | 43.8 |
| Totals Except Home | 968,707 | 498,086 | 51.4 | 240,032 | 24.8 | 230,589 | 23.8 |
| Home | 663,822 | 285,156 | 43.0 | 177,554 | 26.7 | 201,112 | 30.3 |
| Totals | 1,632,529 | 783,242 | 48.0% | 417,586 | 25.6% | 431,701 | 26.4% |

**TABLE 12. 1958 PERSON TRIPS INTERNAL TO THE 1949 STUDY AREA BY MODE AND PURPOSE**

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 70,739 | 12,643 | 17.9 | 23,498 | 33.2 | 34,598 | 48.9 |
| Work | 447,589 | 319,628 | 71.4 | 61,264 | 13.7 | 66,697 | 14.9 |
| Shop | 259,606 | 150,246 | 57.9 | 86,951 | 33.5 | 22,409 | 8.6 |
| Social-Recreation and Ride | 283,437 | 111,433 | 39.3 | 156,923 | 55.4 | 15,081 | 5.3 |
| Eat | 49,957 | 31,239 | 62.5 | 17,011 | 34.1 | 1,707 | 3.4 |
| Personal Business | 211,281 | 126,198 | 59.7 | 64,480 | 30.5 | 20,603 | 9.8 |
| Serve Passenger | 154,362 | 149,825 | 97.0 | 4,537 | 2.9 | - | - |
| Change Mode | 10,421 | 2,121 | 20.4 | 4,473 | 42.9 | 3,827 | 36.7 |
| Totals Except Home | 1,487,392 | 903,333 | 60.7 | 419,137 | 28.2 | 164,922 | 11.1 |
| Home | 988,997 | 548,449 | 55.5 | 291,518 | 29.5 | 149,030 | 15.0 |
| Totals | 2,476,389 | 1,451,782 | 58.6% | 710,655 | 28.7% | 313,952 | 12.7% |

In absolute terms, the number of work trips by bus dropped from 124,100 to 69,600 in the nine-year period, and shopping trips from 33,700 to 23,800. School trips by bus increased from 17,100 to 77,800. It should be noted that for each of the work and shopping trips lost a trip home was probably lost also.

## Change Within the 1949 Study Area

By comparing Table 12 with Table 11, 1949-1958 changes within the area surveyed in 1949 may be seen. While total person trips in the area increased from 1,632,000 to 2,476,000 in the nine-year period, bus passenger trips decreased from 431,700 to 313,900. Thus bus's share of daily travel in the area dropped from 26.4% in 1949 to 12.7% in 1958, despite the fact that school trips by bus doubled.

The foregoing review, based on nine-year changes within the 1949 survey area, illustrates the actual and relative decline in bus passenger travel more effectively than data based on different-sized areas having different proportions of suburban area.

**TABLE 13. 1958 PERSON TRIPS INTERNAL TO THE CENTRAL CITIES BY MODE AND PURPOSE***

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 45,882 | 9,644 | 21.0 | 18,960 | 41.3 | 17,278 | 37.7 |
| Work | 343,653 | 238,476 | 69.4 | 46,419 | 13.5 | 58,758 | 17.1 |
| Shop | 172,264 | 94,045 | 54.6 | 57,786 | 33.5 | 20,433 | 11.9 |
| Social-Recreation and Ride | 201,112 | 79,251 | 39.4 | 109,125 | 54.3 | 12,736 | 6.3 |
| Eat | 37,591 | 23,124 | 61.5 | 12,881 | 34.3 | 1,586 | 4.2 |
| Personal Business | 157,500 | 91,687 | 58.2 | 47,284 | 30.0 | 18,529 | 11.8 |
| Serve Passenger | 113,758 | 110,708 | 97.3 | 3,050 | 2.7 | - | - |
| Change Mode | 6,809 | 1,253 | 18.4 | 2,690 | 39.5 | 2,866 | 42.1 |
| Totals | 1,078,569 | 648,188 | 60.1% | 298,195 | 27.6% | 132,186 | 12.3% |

*Home Destinations Excluded*

**TABLE 14. 1949 PERSON TRIPS INTERNAL TO THE CENTRAL CITIES BY MODE AND PURPOSE***

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus or Streetcar Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 25,136 | 5,067 | 20.2 | 7,423 | 29.5 | 12,646 | 50.3 |
| Work | 313,042 | 164,993 | 52.7 | 34,728 | 11.1 | 113,321 | 36.2 |
| Shop | 97,632 | 42,036 | 43.1 | 24,351 | 24.9 | 31,245 | 32.0 |
| Social-Recreation and Ride | 183,133 | 64,263 | 35.1 | 92,886 | 50.7 | 25,984 | 14.2 |
| Eat | 17,009 | 10,974 | 64.5 | 4,305 | 25.3 | 1,730 | 10.2 |
| Personal Business | 72,699 | 41,293 | 56.8 | 12,436 | 17.1 | 18,970 | 26.1 |
| Serve Passenger | 73,688 | 70,496 | 95.7 | 2,970 | 4.0 | 222 | .3 |
| Change Mode | 6,796 | 543 | 8.0 | 2,996 | 44.1 | 3,257 | 47.9 |
| Totals | 789,135 | 399,665 | 50.6% | 182,095 | 23.1% | 207,375 | 26.3% |

*Home Destinations Excluded*

The following analyses, showing a further degree of refinement, are based on 1949-1958 changes in travel within the central cities.

## Change Within the Central Cities

Only those trips having both the origin and destination within the central cities are considered under this heading. The purpose and mode of travel of such trips, except those having destinations at home, are shown in Tables 13 and 14 for 1958 and 1949, respectively.

Upon comparing the trip data for the two different time periods, it can be seen that 26.3% of the trip destinations (excluding home destinations) were accounted for by bus passengers in 1949, and 12.3% in 1958. This compares with 23.8% and 10.7% (excluding home destinations) for the entire 1949 and 1958 study areas, respectively. Thus, a change in mode of travel took place within the central cities, and this change is similar to the change in mode of travel between 1949 and 1958 for the two entire study areas.

The following discussion analyzes 1949-1958 change in CBD travel.

## CHANGE IN THE MODE OF TRAVEL OF TRIPS TO THE CBDs

The first part of this section deals with a comparison of trips to the CBDs for the two study areas. The second part deals with trips to the CBDs from within the 1949 study area, and the third part deals with trips to the CBDs from within Minneapolis and St. Paul. Home destinations are excluded, but such trips to the CBDs are minor.

### Overall Comparisons

When comparing trip destinations in the CBDs in 1949 and 1958, it is interesting to note the relatively small change in total destinations by all modes, in addition to the change in mode of travel. As shown in Table 15, the 1958 Study Area produced a daily total of 285,700 trips to the CBDs (home destinations excluded). Slightly less than 28% of these trips were made by bus passengers. The 1949 survey showed 263,000 CBD trips, 45% of which were made by bus, as shown in Table 16.

**TABLE 15. 1958 PERSON TRIPS WITH CBD DESTINATIONS BY MODE AND PURPOSE FOR TRIPS ORIGINATING WITHIN THE 1958 STUDY AREA**

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 3,123 | 804 | 25.7 | 927 | 29.7 | 1,392 | 44.6 |
| Work | 127,224 | 67,082 | 52.7 | 20,792 | 16.4 | 39,350 | 30.9 |
| Shop | 52,099 | 16,454 | 31.6 | 14,378 | 27.6 | 21,267 | 40.8 |
| Social-Recreation and Ride | 22,946 | 7,829 | 34.1 | 11,691 | 51.0 | 3,426 | 14.9 |
| Eat | 6,386 | 3,497 | 54.8 | 2,163 | 33.9 | 726 | 11.3 |
| Personal Business | 46,206 | 22,174 | 48.0 | 12,032 | 26.0 | 12,000 | 26.0 |
| Serve Passenger | 25,545 | 24,716 | 96.8 | 829 | 3.2 | - | - |
| Change Mode | 2,215 | 374 | 16.9 | 874 | 39.5 | 967 | 43.6 |
| Totals* | 285,744 | 142,930 | 50.0% | 63,686 | 22.3% | 79,128 | 27.7% |

**Home Destinations Excluded*

The percentage of trips accounted for by bus passengers declined for each of the purposes. The pattern was similar for both the Minneapolis and St. Paul CBDs and, therefore, the data for the two were combined.

### Change Within the 1949 Study Area

A comparison of Tables 16 and 17 shows 1949-1958 changes in trips to the CBDs originating in the area surveyed in 1949. While the total number of such trips shows only a slight decrease, the decrease in the number made by bus is substantial.

### Change Within the Central Cities

Bus passenger trips to the CBDs from within the Minneapolis and St. Paul city limits showed a substantial decline in the 1949-1958 period, both in absolute and relative terms. Tables 18 and 19 show trip data for such trips, by mode and purpose, for 1958 and 1949 respectively.

The 1958 survey showed a daily total of 69,800 bus passenger trips with origins in the central cities and destinations in the CBDs. These trips accounted for 31.2% of all trips to the CBDs with central cities origins. In 1949 the number of such trips by bus was 111,100, which accounted for 46.2% of the total by all modes.

The percentage of trips accounted for by bus passenger declined for each of the purposes. Bus passenger trip destinations for work purpose alone showed a decline of over 25,000.

Thus, there was a substantial change in the mode of travel of trips with origins in the central cities and destinations in the CBDs. And this change is very similar to the change in the mode of travel of trips to the CBDs for the two entire study areas.

TABLE 16. 1949 PERSON TRIPS WITH CBD DESTINATIONS BY MODE AND PURPOSE FOR TRIPS ORIGINATING WITHIN THE 1949 STUDY AREA

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus or Streetcar Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 3,100 | 727 | 23.4 | 482 | 15.6 | 1,891 | 61.0 |
| Work | 124,712 | 46,377 | 37.2 | 13,624 | 10.9 | 64,711 | 51.9 |
| Shop | 47,141 | 10,387 | 22.0 | 8,487 | 18.0 | 28,267 | 60.0 |
| Social-Recreation and Ride | 31,027 | 8,791 | 28.3 | 13,564 | 43.7 | 8,672 | 28.0 |
| Eat | 4,245 | 2,374 | 55.9 | 1,066 | 25.1 | 805 | 19.0 |
| Personal Business | 32,498 | 14,261 | 43.9 | 5,087 | 15.6 | 13,150 | 40.5 |
| Serve Passenger | 17,969 | 17,007 | 94.6 | 862 | 4.8 | 100 | .6 |
| Change Mode | 2,350 | 100 | 4.3 | 1,005 | 42.7 | 1,245 | 53.0 |
| Totals* | 263,042 | 100,024 | 38.0% | 44,177 | 16.8% | 118,841 | 45.2% |

*Home Destinations Excluded*

TABLE 17. 1958 PERSON TRIPS WITH CBD DESTINATIONS BY MODE AND PURPOSE FOR TRIPS ORIGINATING WITHIN THE 1949 STUDY AREA

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 2,764 | 694 | 25.1 | 798 | 28.9 | 1,272 | 46.0 |
| Work | 113,181 | 57,373 | 50.7 | 17,846 | 15.8 | 37,962 | 33.5 |
| Shop | 47,206 | 14,287 | 30.3 | 12,901 | 27.3 | 20,018 | 42.4 |
| Social-Recreation and Ride | 21,202 | 7,043 | 33.2 | 10,868 | 51.3 | 3,291 | 15.5 |
| Eat | 5,894 | 3,334 | 56.6 | 1,869 | 31.7 | 691 | 11.7 |
| Personal Business | 42,685 | 20,119 | 47.1 | 10,994 | 25.8 | 11,572 | 27.1 |
| Serve Passenger | 23,412 | 22,689 | 96.9 | 723 | 3.1 | - | - |
| Change Mode | 1,967 | 323 | 16.4 | 789 | 40.1 | 855 | 43.5 |
| Totals* | 258,311 | 125,862 | 48.7% | 56,788 | 22.0% | 75,661 | 29.3% |

*Home Destinations Excluded*

TABLE 18. 1958 PERSON TRIPS WITH CBD DESTINATIONS BY MODE AND PURPOSE FOR TRIPS ORIGINATING WITHIN THE CENTRAL CITIES

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 2,582 | 604 | 23.4 | 706 | 27.3 | 1,272 | 49.3 |
| Work | 97,856 | 47,877 | 48.9 | 15,076 | 15.4 | 34,903 | 35.7 |
| Shop | 41,384 | 12,314 | 29.7 | 10,504 | 25.4 | 18,566 | 44.9 |
| Social-Recreation and Ride | 18,312 | 6,025 | 32.9 | 9,228 | 50.4 | 3,059 | 16.7 |
| Eat | 5,070 | 2,871 | 56.6 | 1,573 | 31.0 | 626 | 12.4 |
| Personal Business | 36,918 | 16,715 | 45.3 | 9,630 | 26.1 | 10,573 | 28.6 |
| Serve Passenger | 20,089 | 19,432 | 96.7 | 657 | 3.3 | - | - |
| Change Mode | 1,649 | 233 | 14.1 | 592 | 35.9 | 824 | 50.0 |
| Totals* | 223,860 | 106,071 | 47.4% | 47,966 | 21.4% | 69,823 | 31.2% |

*Home Destinations Excluded*

TABLE 19. 1949 PERSON TRIPS WITH CBD DESTINATIONS BY MODE AND PURPOSE FOR TRIPS ORIGINATING WITHIN THE CENTRAL CITIES

| Purpose at Destination | Total by All Modes | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto, Taxi, Truck or Rail Passenger | | Bus or Streetcar Passenger | |
| | | Trips | Percent | Trips | Percent | Trips | Percent |
| School | 2,878 | 624 | 21.7 | 442 | 15.3 | 1,812 | 63.0 |
| Work | 114,031 | 41,577 | 36.5 | 12,038 | 10.5 | 60,416 | 53.0 |
| Shop | 42,924 | 9,402 | 21.9 | 7,162 | 16.7 | 26,360 | 61.4 |
| Social-Recreation and Ride | 28,755 | 8,107 | 28.2 | 12,560 | 43.7 | 8,088 | 28.1 |
| Eat | 4,003 | 2,252 | 56.3 | 1,026 | 25.6 | 725 | 18.1 |
| Personal Business | 30,032 | 12,957 | 43.1 | 4,568 | 15.2 | 12,507 | 41.7 |
| Serve Passenger | 15,946 | 15,205 | 95.4 | 661 | 4.1 | 80 | .5 |
| Change Mode | 2,090 | 61 | 2.9 | 844 | 40.4 | 1,185 | 56.7 |
| Totals* | 240,659 | 90,185 | 37.5% | 39,301 | 16.3% | 111,173 | 46.2% |

*Home Destinations Excluded*

## SUMMARY

The decline in bus passenger trips between 1949 and 1958 is not peculiar to any particular part of the Twin Cities metropolitan area. Declines are noted in the absolute number of bus passenger trip destinations as well as the proportion of trip destinations carried by bus. These declines are noted in the trips to the CBDs as well as throughout the area. Furthermore, the declines are apparent for trips within the Minneapolis and St. Paul city limits - where virtually no change took place in the areas served in the 1949-1958 period - as well as within the area surveyed in 1949.

The only exception to the general decline is in trips for school purpose. Such trips by bus passenger increased, both relative to such trips by all modes and in absolute terms. This trend is expected to continue for some time in the future.

# CHAPTER V

## Summary and Conclusions

Bus, the only form of mass transportation in the Twin Cities metropolitan area, carries over 416,000, or 12.4%, of the area's 3,367,000 daily internal person trips. The bus mode comprises three distinct systems: school buses, suburban bus companies, and the Twin City Rapid Transit Company.

Almost 40% of the daily bus passenger trips are either to or from school. About one-fourth of the daily school trips by bus are carried by the TCRT system. Bus accounts for only 8.1% of the nonschool trips.

Many analyses, particularly those relating to choice of travel mode, are made more meaningful by the exclusion of school trips. On the other hand, school trips could not be discounted entirely because of the substantial number of such trips carried by TCRT buses.

Nonschool bus passenger travel is concentrated in the central cities, particularly in and around the CBDs. About 85% of the daily nonschool trips are internal to the central cities and about two-thirds are either to or from the CBDs. Very few bus passenger trips have origin in one of the central cities and destination in the other. In general, bus usage increases with proximity to the CBDs.

While bus carries only 8.1% of the Study Area's total daily nonschool trips, it carries about 28% of the daily trips to and from the CBDs. Bus accounts for almost half of the trips between the CBDs and some of the close-in districts. The proportion of CBD trips carried by bus remains fairly stable throughout the daylight hours at about 30%. After 7 p.m. it drops sharply.

Bus passenger trips are more concentrated into the morning and evening peak traffic periods and into the daylight hours than are trips by other modes. About 90% of the daily bus passenger trips take place between 6 a.m. and 7 p.m. while only 70% of the daily trips by other modes take place in this period.

The median duration of bus passenger trips is 28 minutes - almost twice as long as the median time of auto driver trips. However, the median trip length for both modes is 2.1 miles (straight-line distance from origin to destination). Bus passenger trips are concentrated more closely around the median trip length than are the auto driver trips.

Except for school and home, work is the major destination purpose of bus passenger trips. The bus mode accounts for almost 70,000, or about 12%, of the Study Area's daily work trips. Of this number, about 39,000 are in the CBDs, which is equal

to 31% of the total CBD work trip destinations. Of the 23,500 daily shopping trips by bus, 21,000 have CBD destinations, and this number represents almost 41% of the total daily shopping trips with destinations in the CBDs.

About half of the 416,000 daily bus passenger trips have destinations at residential land. This reflects the great tendency of bus passenger trips to be home-based. The public buildings land use class, in which school trips are categorized, ranks next in order. Commercial land uses, particularly in the CBDs, also generate a substantial number of bus passenger trips.

On the average, the travel speed of bus outbound from the CBDs during the evening peak is approximately two-thirds as fast as auto. This means a saving by auto of about five minutes on a trip of slightly less than three miles, or a six- to seven-minute saving on a four-mile trip. These savings in "on the road" time are usually insignificant relative to other considerations - such as, waiting, walk time, parking time, transfers required, convenience and rigidity of scheduling.

The ratio of bus speed to auto speed is lowest in the area just outside the CBDs, where heavy passenger unloading occurs.

Less than 25% of the bus service offered daily is actually used. The percentage varies throughout the day, reaching a high of slightly over 30% during the evening peak traffic period and a low of about 5% between midnight and 6 a.m. This variation exists despite drastic adjustments in the level of service: over 600 TCRT buses are operated during the evening peak period and only 27 after midnight. Trip concentrations into certain time periods and a widely dispersed population are factors contributing to the difficulty of achieving high efficiency.

Mode of travel is related to a complex of factors. The young and old are more prone to use the bus, as are women and those engaged in low income occupations.

Automobile ownership and bus usage are negatively related. Intensity of land use and bus usage are positively related. The level of service available for a particular trip is an important factor. Also related to bus usage are the length and purpose of the trip. Cost is a factor, but perhaps not so much in terms of fares as in terms of time and parking.

Over the past decade, population shifts from the densely populated areas have contributed to the decline in bus usage.

Persons residing in no-car households, which are concentrated around the CBDs, account for over one-third of all nonschool bus passenger trips. Over half of the trips made by persons living in no-car households are by bus.

Between 1949 and 1958, the number of daily person trips in the metropolitan area increased sharply, but bus travel actually declined in absolute as well as relative terms. The loss is particularly pronounced if school trips are not considered. Because the growth in the nine-year period was suburban, an increase in bus trips proportional to total trips would not be expected. However, the decline in usage was area-wide - that is, it was exhibited in CBD travel and travel internal to the central cities; hence the overall relative decline is not entirely attributable to the addition of suburban area.

The decline of mass transit is not peculiar to any particular city, but has been reflected, generally, on a nation-wide scale. While declines typically are noted in the proportion of total person trips accounted for by passengers on mass transit, in many instances declines have been in absolute terms.

The diminution in mass transit usage is not an unaccountable phenomenon. Fundamental changes within urban areas underlie the decline. Foremost among these changes are increased ownership and usage of the automobile, which, in turn, are reflections of a higher standard of living. The shift to the auto has made

possible and tends to perpetuate dispersed land development - residential, commercial and industrial - because of the large area made accessible. Symptomatic of these changes is the increased proportion of urban population residing in suburban areas.

There is some feeling that the decline in mass transit usage is attributable to a reduction in the quantity and quality of service. While the level of service is certainly important, the decline in ridership is too general to be accounted for by this factor.

A successful plan for improving the position of mass transit must be made with recognition of the fundamental changes which have occurred, but even more important, the plan must be in harmony with the patterns of land development and urban structure of the future. Between 1949 and 1958, only a minor change took place in the number of trips to the CBDs, despite a great increase in trips in the metropolitan area as a whole. This, of course, is a symptom of the tremendous suburban growth during this period.

If dispersed and low-density development is expected to continue (and in many cases this type of development is planned), the mass transit plan must be devised accordingly. On the other hand, if higher population densities develop in the future, and if commercial and employment areas become more concentrated - as they might, for example, as a result of CBD redevelopment programs - the role of mass transit will be quite different.

One of the most important elements in travel today is convenience - the ability of a person to get where he wants to go, when he wants to go. This is the reason for the popularity of the automobile. Mass transit must become more competitive in this respect.

Obviously, high residential densities and concentration of commercial and employment centers enhance the ability of mass transit to provide such convenience on a par with the automobile, and at a reasonable level of cost.

A unique feature of the Twin Cities metropolitan area is the existence of two major CBDs. Both are of substantial size, which tends to reduce the concentration of trip movement. Furthermore, growth has taken place generally in all directions from both CBDs, since it has not been impeded by any major physical barriers. This too has contributed to a dispersed population and makes it more difficult and costly to provide attractive mass transit service.

Despite the fact that no appreciable change in the number of daily CBD trips took place in the 1949-1958 period, when the total number of daily trips in the metropolitan area increased sharply, the CBDs remain the major cores of trip generation, especially of bus travel.

Because of the high cost of the roadway and parking facilities needed to handle large numbers of automobiles, and also the space required, bus has particular advantages in carrying CBD trips. A great opportunity exists for increasing the role of bus in CBD travel, and this opportunity can be expected to increase with increased CBD activity.

A mass transit plan, to be successful, must be designed to serve in certain roles under certain conditions. A plan satisfactory for one metropolitan area is likely to fail in another. Disappointment is also likely if mass transit is viewed as a panacea for all transportation problems.

An attempt to provide all areas with mass transit service will result in areas of high usage subsidizing areas of low usage.

While this type of subsidization is not uncommon in the operation of public and quasi-public utilities, the practice might prove undesirable in the case of mass transit. The expense of subsidizing the service to low-usage areas might be better incurred in improving the service in areas of high usage. Gains in high-usage areas might more than make up for losses in previously served low-usage areas. Other means of transportation, an expanded taxi service, perhaps, could serve where there is no privately owned automobile and bus service is not feasible because of spatial and temporal dispersion of trip origins and destinations.

The captive group, mass transit users who do not have the alternative of automobile travel at their command, is too small to support a mass transit system, and with the rate of auto ownership increasing, it is likely to remain small. Therefore, the service level of mass transit must be high enough so that it competes for the travel of those who do have recourse to auto travel.

To promote maximum efficiency in mass transit usage, the area of a person's residence should be related to the type of transportation he expects to use. As stated previously, a high level of mass transit service in low-density areas at some distance from the CBDs is beyond economic attainment. Conversely, areas of high population densities near the CBDs are ideal from the standpoint of mass transportation.

As metropolitan areas grow and cover more area, the number of potential living sites, employment centers, and commercial areas increases. This sets the stage for an almost infinite number of possible trip desires. But mass transit facilities can only be provided in optimal locations, and those depending on or desiring its usage must decide the locations of their residences accordingly.

The role mass transit plays in the future transportation network will be directed and modified by socio-economic considerations and political decisions. It is hoped that the data and analyses in this report provide the basis for a better understanding of the conditions under which mass transit operates, and that this understanding will facilitate the planning and establishment of the future role of mass transit within the overall metropolitan area transportation network.

# APPENDIX

## TABLE 20. DWELLING UNITS, POPULATION AND RESIDENTIAL ACREAGE BY DISTRICT

| District | Dwelling Units | Population | Residential Land (Acres) |
|---|---|---|---|
| 10 | 7,079 | 23,738 | 743.0 |
| 11 | 13,628 | 41,387 | 674.2 |
| 12 | 9,999 | 35,484 | 1,290.5 |
| 13 | 7,867 | 29,615 | 2,093.0 |
| 14 | 11,455 | 34,139 | 972.2 |
| 15 | 5,646 | 21,721 | 1,728.9 |
| 16 | 10,775 | 34,672 | 1,353.0 |
| 17 | 8,369 | 26,318 | 864.1 |
| 18 | 6,998 | 22,129 | 693.7 |
| 19 | 1,727 | 8,277 | 742.9 |
| 20 | 2,038 | 6,512 | 145.8 |
| 21 | 4,095 | 14,798 | 480.1 |
| 22 | 4,204 | 13,456 | 468.0 |
| 23 | 4,188 | 13,671 | 436.3 |
| 24 | 3,479 | 13,735 | 703.0 |
| 25 | 5,865 | 22,130 | 1,517.1 |
| 26 | 3,403 | 13,871 | 1,403.7 |
| 27 | 5,759 | 23,048 | 1,850.4 |
| 28 | 3,519 | 14,852 | 946.4 |
| 29 | 2,084 | 8,753 | 690.1 |
| 30 | 3,940 | 14,565 | 357.2 |
| 31 | 2,423 | 8,016 | 305.0 |
| 32 | 6,091 | 22,632 | 861.6 |
| 33 | 3,536 | 12,848 | 815.9 |
| 34 | 820 | 3,453 | 324.0 |
| 35 | 845 | 3,110 | 306.5 |
| 36 | 833 | 3,225 | 339.0 |
| 50 | 9,250 | 21,861 | 429.1 |
| 51 | 6,233 | 21,075 | 519.2 |
| 52 | 2,086 | 7,345 | 206.9 |
| 53 | 5,712 | 18,054 | 580.3 |
| 54 | 4,932 | 17,872 | 777.0 |
| 55 | 4,589 | 18,153 | 798.2 |
| 56 | 2,906 | 11,694 | 828.2 |
| 57 | 6,027 | 24,891 | 2,027.8 |
| 60 | 9,467 | 22,160 | 218.7 |
| 61 | 4,629 | 14,723 | 194.9 |
| 62 | 12,476 | 38,533 | 844.4 |
| 63 | 6,798 | 22,506 | 737.8 |
| 64 | 11,170 | 32,857 | 1,222.8 |
| 65 | 3,728 | 10,961 | 448.2 |
| 66 | 10,016 | 32,267 | 1,363.6 |
| 67 | 3,335 | 13,562 | 791.0 |
| 68 | 114* | 114 | 40.0 |
| 69 | 2,985 | 11,961 | 998.6 |
| 70 | 14,349 | 29,171 | 358.0 |
| 71 | 18,316 | 49,738 | 1,167.3 |
| 72 | 14,606 | 47,543 | 1,781.7 |
| 73 | 13,545 | 50,682 | 2,438.2 |
| 74 | 8,209 | 34,461 | 2,798.1 |
| 75 | 8,950 | 31,734 | 1,311.1 |
| 76 | 7,092 | 25,554 | 2,288.9 |
| 77 | 7,470 | 28,425 | 2,446.8 |
| 78 | 666 | 3,147 | 595.0 |
| 79 | 4,390 | 16,106 | 1,765.9 |
| 80 | 10,027 | 34,150 | 846.6 |
| 81 | 7,148 | 23,507 | 588.1 |
| 82 | 7,825 | 25,956 | 889.6 |
| 83 | 4,756 | 16,207 | 635.8 |
| 84 | 7,356 | 29,096 | 2,388.3 |
| 85 | 6,150 | 23,958 | 2,833.1 |
| 86 | 5,303 | 18,933 | 1,972.9 |
| 87 | 4,549 | 18,560 | 994.2 |
| 88 | 5,267 | 19,718 | 859.1 |
| 89 | 4,969 | 19,475 | 1,235.0 |
| Totals | 408,061 | 1,376,865 | 66,326.0 |

**Nurses' Quarters at Veterans Hospital*

## TABLE 22. TOTAL DAILY BUS PASSENGER TRIPS BY PURPOSE

| FROM (ORIGIN) | TO (DESTINATION) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Home | Work | Shop | School | Social-Recreation | Eat | Personal Business | Serve Pass. | Change Mode | Ride | Totals |
| Home | 19 | 65,492 | 20,099 | 75,798 | 11,947 | 717 | 18,011 | - | 1,095 | 437 | 193,615 |
| Work | 68,391 | 555 | 1,234 | 177 | 879 | 341 | 936 | - | 1,918 | 25 | 74,456 |
| Shop | 20,543 | 50 | 544 | - | 596 | 74 | 577 | - | 550 | - | 22,934 |
| School | 82,668 | 701 | 187 | 528 | 1,072 | 417 | 457 | - | 522 | 53 | 86,605 |
| Social-Recreation | 9,665 | 178 | 336 | 262 | 634 | 46 | 226 | - | 237 | - | 11,584 |
| Eat | 756 | 202 | 25 | 392 | 135 | - | 86 | - | 22 | - | 1,618 |
| Personal Business | 16,671 | 437 | 691 | 175 | 647 | 112 | 854 | - | 353 | - | 19,940 |
| Serve Passenger | 16 | 42 | 29 | - | - | - | - | - | - | - | 87 |
| Change Mode | 1,029 | 1,943 | 641 | 481 | 315 | 34 | 380 | - | 92 | - | 4,915 |
| Ride | 428 | 44 | - | 28 | - | - | 106 | - | - | - | 606 |
| Totals | 200,186 | 69,644 | 23,786 | 77,841 | 16,225 | 1,741 | 21,633 | - | 4,789 | 515 | 416,360 |

## TABLE 23. CENTRAL CITY ORIGIN WORK TRIPS BY AGE AND MODE, MALE AND FEMALE - HOME ORIGINS ONLY

| Age | Total | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto Passenger | | Bus Passenger | |
| | | Trips | % of Total | Trips | % of Total | Trips | % of Total |
| **MALES** | | | | | | | |
| 15-19 | 6,369 | 2,711 | 42.6 | 2,292 | 36.0 | 1,366 | 21.4 |
| 20-24 | 13,400 | 9,375 | 70.0 | 2,661 | 19.8 | 1,364 | 10.2 |
| 25-29 | 19,310 | 15,696 | 81.3 | 2,373 | 12.3 | 1,241 | 6.4 |
| 30-34 | 20,033 | 16,851 | 84.1 | 1,793 | 9.0 | 1,389 | 6.9 |
| 35-44 | 40,117 | 33,235 | 82.8 | 3,814 | 9.6 | 3,068 | 7.6 |
| 45-54 | 36,138 | 28,784 | 79.7 | 3,332 | 9.2 | 4,022 | 11.1 |
| 55 and over | 32,169 | 22,595 | 70.3 | 3,291 | 10.2 | 6,283 | 19.5 |
| Not reported | 4,858 | 3,820 | 78.6 | 570 | 11.7 | 468 | 9.7 |
| Totals | 172,394 | 133,067 | 77.2% | 20,126 | 11.7% | 19,201 | 11.1% |
| **FEMALES** | | | | | | | |
| 15-19 | 7,731 | 568 | 7.3 | 2,541 | 32.9 | 4,622 | 59.8 |
| 20-24 | 12,050 | 1,942 | 16.1 | 4,243 | 35.2 | 5,865 | 48.7 |
| 25-29 | 6,639 | 1,697 | 25.6 | 2,395 | 36.1 | 2,547 | 38.3 |
| 30-34 | 6,833 | 2,387 | 34.9 | 2,103 | 30.8 | 2,343 | 34.3 |
| 35-44 | 16,667 | 4,789 | 28.7 | 5,497 | 33.0 | 6,381 | 38.3 |
| 45-54 | 18,063 | 4,240 | 23.5 | 6,043 | 33.4 | 7,780 | 43.1 |
| 55 and over | 13,537 | 2,420 | 17.9 | 3,570 | 26.4 | 7,547 | 55.7 |
| Not reported | 2,270 | 529 | 23.3 | 786 | 34.6 | 955 | 42.1 |
| Totals | 83,790 | 18,572 | 22.2% | 27,178 | 32.4% | 38,040 | 45.4% |

## TABLE 24. CENTRAL CITY ORIGIN WORK TRIPS BY BUS AND BY ALL MODES BY OCCUPATION, MALE AND FEMALE - HOME ORIGINS ONLY

| Occupation | All Modes* | Bus | Percent |
|---|---|---|---|
| **MALES** | | | |
| Managers, Officials and Proprietors | 24,777 | 1,529 | 6.2 |
| Professional, Technical | 22,335 | 2,429 | 10.9 |
| Sales | 15,565 | 994 | 6.4 |
| Craftsmen, Foremen | 33,891 | 2,185 | 6.4 |
| Clerical | 19,175 | 3,476 | 18.1 |
| Operatives | 25,362 | 2,735 | 10.8 |
| Service | 14,005 | 3,167 | 22.6 |
| Other | 17,284 | 2,686 | 15.5 |
| Totals | 172,394 | 19,201 | 11.1% |
| **FEMALES** | | | |
| Managers, Officials and Proprietors | 3,756 | 1,174 | 31.3 |
| Professional, Technical | 10,198 | 2,681 | 26.3 |
| Craftsmen, Foremen | 2,310 | 789 | 34.2 |
| Clerical | 35,299 | 17,010 | 48.2 |
| Operatives | 9,327 | 3,914 | 42.0 |
| Sales | 6,347 | 3,922 | 61.8 |
| Service | 9,350 | 5,595 | 59.8 |
| Other | 7,203 | 2,955 | 41.0 |
| Totals | 83,790 | 38,040 | 45.4% |

**Trips by rail, truck and taxi excluded*

## TABLE 25. CENTRAL CITY ORIGIN SHOPPING, SOCIAL-RECREATION AND PERSONAL BUSINESS TRIPS BY AGE AND MODE, MALE AND FEMALE - HOME ORIGINS ONLY

| Age | Total | MODE OF TRAVEL | | | | | |
|---|---|---|---|---|---|---|---|
| | | Auto Driver | | Auto Passenger | | Bus Passenger | |
| | | Trips | % of Total | Trips | % of Total | Trips | % of Total |
| **MALES** | | | | | | | |
| 15-19 | 15,093 | 6,775 | 44.9 | 6,462 | 42.8 | 1,856 | 12.3 |
| 20-24 | 15,140 | 12,482 | 82.5 | 2,184 | 14.4 | 474 | 3.1 |
| 25-29 | 15,666 | 14,057 | 89.7 | 1,192 | 7.6 | 417 | 2.7 |
| 30-34 | 15,244 | 13,552 | 88.9 | 1,308 | 8.6 | 384 | 2.5 |
| 35-44 | 30,620 | 28,081 | 91.7 | 1,753 | 5.7 | 786 | 2.6 |
| 45-54 | 25,239 | 22,832 | 90.5 | 1,666 | 6.6 | 741 | 2.9 |
| 55 and over | 38,922 | 30,260 | 77.7 | 3,937 | 10.1 | 4,725 | 12.2 |
| Not reported | 4,295 | 3,606 | 84.0 | 556 | 12.9 | 133 | 3.1 |
| Totals | 160,219 | 131,645 | 82.2% | 19,058 | 11.9% | 9,516 | 5.9% |
| **FEMALES** | | | | | | | |
| 15-19 | 15,906 | 2,876 | 18.1 | 10,093 | 63.4 | 2,937 | 18.5 |
| 20-24 | 15,818 | 4,708 | 29.8 | 9,471 | 59.9 | 1,639 | 10.3 |
| 25-29 | 16,506 | 5,866 | 35.5 | 9,396 | 56.9 | 1,244 | 7.6 |
| 30-34 | 17,777 | 7,141 | 40.2 | 8,780 | 49.4 | 1,856 | 10.4 |
| 35-44 | 37,549 | 16,262 | 43.3 | 17,017 | 45.3 | 4,270 | 11.4 |
| 45-54 | 31,675 | 11,852 | 37.4 | 15,242 | 48.1 | 4,581 | 14.5 |
| 55 and over | 44,477 | 8,866 | 20.0 | 23,679 | 53.2 | 11,932 | 26.8 |
| Not reported | 5,551 | 1,881 | 33.9 | 2,851 | 51.3 | 819 | 14.8 |
| Totals | 185,259 | 59,452 | 32.1% | 96,529 | 52.1% | 29,278 | 15.8% |

## TABLE 26. AUTO OWNERSHIP AND THE PERCENT OF HOME-ORIGIN NONSCHOOL TRIPS MADE BY BUS - BY DISTRICT

| District | Passenger Cars Per 100 Dwelling Units | Percent of Origins by Bus |
|---|---|---|
| 10 | 94 | 14.8 |
| 11 | 70 | 21.0 |
| 12 | 107 | 8.1 |
| 13 | 136 | 1.9 |
| 14 | 93 | 14.6 |
| 16 | 118 | 7.3 |
| 17 | 102 | 13.7 |
| 18 | 102 | 10.9 |
| 20 | 78 | 12.6 |
| 21 | 94 | 12.4 |
| 22 | 95 | 8.7 |
| 23 | 91 | 14.8 |
| 24 | 103 | 7.1 |
| 25 | 111 | 9.3 |
| 27 | 135 | 3.4 |
| 28 | 127 | 4.7 |
| 29 | 131 | 3.5 |
| 30 | 91 | 16.9 |
| 31 | 100 | 13.2 |
| 32 | 97 | 8.1 |
| 33 | 111 | 6.3 |
| 50 | 72 | 14.9 |
| 51 | 85 | 12.4 |
| 52 | 110 | 12.8 |
| 53 | 96 | 8.9 |
| 54 | 115 | 6.1 |
| 55 | 115 | 6.2 |
| 56 | 131 | 1.0 |
| 60 | 58 | 23.2 |
| 61 | 81 | 15.8 |
| 62 | 89 | 19.2 |
| 63 | 102 | 12.4 |
| 64 | 105 | 14.7 |
| 65 | 89 | 17.3 |
| 66 | 121 | 8.8 |
| 67 | 131 | 2.4 |
| 70 | 57 | 24.1 |
| 71 | 92 | 20.2 |
| 72 | 113 | 13.2 |
| 73 | 127 | 4.6 |
| 74 | 134 | 2.4 |
| 75 | 127 | 3.8 |
| 77 | 130 | 2.3 |
| 80 | 94 | 16.9 |
| 81 | 83 | 20.9 |
| 82 | 105 | 13.6 |
| 83 | 104 | 12.7 |
| 87 | 120 | 3.5 |
| 88 | 124 | 6.1 |

## TABLE 27. DWELLING UNITS PER RESIDENTIAL ACRE AND THE PERCENT OF HOME-ORIGIN NONSCHOOL TRIPS BY BUS - BY DISTRICT

| District | Dwelling Units Per Residential Acre | Percent of Origins by Bus |
|---|---|---|
| 10 | 9.4 | 14.8 |
| 11 | 19.9 | 21.0 |
| 12 | 7.6 | 8.1 |
| 13 | 3.7 | 1.9 |
| 14 | 11.6 | 14.6 |
| 16 | 7.8 | 7.3 |
| 17 | 9.6 | 13.7 |
| 18 | 10.0 | 10.9 |
| 20 | 13.9 | 12.6 |
| 21 | 8.4 | 12.4 |
| 22 | 8.9 | 8.7 |
| 23 | 9.5 | 14.8 |
| 24 | 4.9 | 7.1 |
| 25 | 3.8 | 9.3 |
| 27 | 3.1 | 3.4 |
| 28 | 3.7 | 4.7 |
| 29 | 3.0 | 3.5 |
| 30 | 11.0 | 16.9 |
| 31 | 7.9 | 13.2 |
| 32 | 7.0 | 8.1 |
| 33 | 4.3 | 6.3 |
| 51 | 12.0 | 12.4 |
| 52 | 10.1 | 12.8 |
| 53 | 9.6 | 8.9 |
| 54 | 6.3 | 6.1 |
| 55 | 5.7 | 6.2 |
| 56 | 3.5 | 1.0 |
| 62 | 14.6 | 19.2 |
| 63 | 9.1 | 12.4 |
| 64 | 9.1 | 14.7 |
| 65 | 8.3 | 17.3 |
| 66 | 7.3 | 8.8 |
| 67 | 4.1 | 2.4 |
| 71 | 15.6 | 20.2 |
| 72 | 8.1 | 13.2 |
| 73 | 5.5 | 4.6 |
| 74 | 2.9 | 2.4 |
| 75 | 6.9 | 3.8 |
| 77 | 3.0 | 2.3 |
| 80 | 11.7 | 16.9 |
| 81 | 12.0 | 20.9 |
| 82 | 8.7 | 13.6 |
| 83 | 7.5 | 12.7 |
| 87 | 4.5 | 3.5 |
| 88 | 6.1 | 6.1 |