

# **CLEVELAND AREA HOME INTERVIEW TRAVEL SURVEY**

## **FINAL REPORT**

*Prepared for*

**Northeast Ohio Areawide Coordinating Agency and  
Greater Cleveland Regional Transportation Authority**

*Prepared by*

**Barton-Aschman Associates, Inc.**

**January 1995**

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# Contents

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Chapters		Page
	Executive Summary	vii
1	Introduction	1
2	Survey Design	3
3	Sample Selection	29
4	Training Procedures	42
5	Conduct of the Survey	44
6	Pretest Results	62
7	Survey Results	65
8	Survey Weighting	95
9	Survey Geocoding	115
10	Survey Data Sets	118

## Appendices

Appendix A: Final Master Household File HHOLD94.DAT
Appendix B: Final Master Person File PERS94.DAT
Appendix C: Final Master Vehicle File VEH94.DAT
Appendix D: Final Master Unlinked Trip File TRPUNL94.DAT
Appendix E: Final Master Linked Trip File TRPLNK94.DAT
Appendix F: Final Combined Work File
Appendix G: Vehicle Make and Model Codes

## Tables

ES-1	Trips by Mode for Greater Cleveland	xiii
ES-2	Average Trip Rates for Greater Cleveland	xiv
1	Expected and Observed Overall Household Trip Rate Accuracy Levels (95 Percent Confidence Level)	4
2	Sample Size Requirements for Selected Relative Errors, Confidence Levels of 90%, 95%, and 98%, and Coefficient of Variation Equal to 0.9	7
3	1990 Households by Income Group for Study Area	11
4	Estimated 1990 Distribution of Households by Income Group and Household Size for the Five-County Area	12
5	Estimated 1990 Distribution of Households by Auto Availability and Household Size for the Five-County Modeling Area	13
6	Expected Distribution of Surveyed Households by Income Group and Household Size for the Five-County Area	14

## Contents (Continued)

---

Tables (Continued)	Page
7 Expected Distribution of Households by Auto Availability and Household Size for the Five-County Modeling Area	14
8 Expected Distribution of Surveyed Households by County	15
9 Recommended Data Items for Travel Survey	17
10 T-Scores Comparing Trip Rates for Households With and Without Telephones—1990 San Juan Data	30
11 Estimated Impact of Not Sampling Non-Telephone Owning Households	31
12 Telephone Ownership and Listing Status in the Cleveland Survey Area for 1990	34
13 Supplemental Samples for Cleveland Area Census Tracts With High Percentages of Low-Income Households	37
14 Disposition of Recruiting Calls From Albuquerque and St. Louis Surveys	39
15 Identified Survey Problems and Resolutions	63
16 Disposition of Surveyed Telephone Numbers	66
17 Households by Income Group and Sample Type	67
18 Chi-Square Test of Statistical Significance of the Difference in Surveyed and Expected Distributions of Households	72
19 Distribution of Surveyed Households by Travel Day	73
20 Geographic Distribution of Households	73
21 Respondents Interviewed and Using Diary	74
22 Number of Total Person Trips by All Modes Reported by Travelers	75
23 Households by Trip Frequency	77
24 Percent of Sampled Households Making No Trips on Specified Travel Day in Selected U.S. Cities	77
25 Trips by Purpose	78
26 Percent of Trips by Purpose in Selected U.S. Cities	80
27 Trips by Mode	83
28 Trips by Purpose and Auto Occupancy as Reported by Auto Drivers	84
29 Households by Autos per Licensed Driver	85
30 Trip Rates by Purpose with Confidence Levels	86
31 Average Trips Made in Motorized Vehicles per Person per Day for Selected U.S. Cities	86
32 Initial Total Trip Rates and Percent Error by Income Group and Household Size—Trips Made by All Modes	87
33 Initial Total Trip Rates and Percent Error by Income Group and Household Size—Trips Made in Motorized Vehicles	87
34 Initial Total Trip Rates and Percent Error by Auto Availability and Household Size—Trips Made by All Modes	88
35 Initial Total Trip Rates and Percent Error by Auto Availability and Household Size—Trips Made in Motorized Vehicles	88

## Contents (Continued)

---

Tables (Continued)	Page
36 Average Reported Travel Times by Trip Purposes	91
37 Vehicles by Age and Trip Usage	92
38 Vehicles by Total Miles per Day and Age of Vehicle	93
39 Vehicle Trips by Age and Trip Purpose	94
40 Estimated Households by Income Group and Household Size (1990) for the Five-County Region	95
41 Estimated Households by Income Group and Household Size (1990) for Lake County	97
42 Estimated Households by Income Group and Household Size (1990) for Lorain County	98
43 Estimated Households by Income Group and Household Size (1990) for Cuyahoga County	98
44 Estimated Households by Income Group and Household Size (1990) for Medina County	99
45 Estimated Households by Income Group and Household Size (1990) for Geauga County	99
46 Surveyed Households by Income Group and Household Size (1990) for the Five-County Region	100
47 Surveyed Households by Income Group and Household Size (1990) for Lake County	100
48 Surveyed Households by Income Group and Household Size (1990) for Lorain County	101
49 Surveyed Households by Income Group and Household Size (1990) for Cuyahoga County	101
50 Surveyed Households by Income Group and Household Size (1990) for Medina County	102
51 Surveyed Households by Income Group and Household Size (1990) for Geauga County	102
52 Final Expansion Factors by Income Group and Household Size for Lake County	103
53 Final Expansion Factors by Income Group and Household Size for Lorain County	103
54 Final Expansion Factors by Income Group and Household Size for Cuyahoga County	104
55 Final Expansion Factors by Income Group and Household Size for Medina County	104
56 Final Expansion Factors by Income Group and Household Size for Geauga County	106
57 Estimated Households by Available Automobiles and Household Size (1990) for the Five-County Region	108
58 Estimated Households by Available Automobiles and Household Size (1990) for Lake County	108

## Contents (Continued)

---

Tables (Continued)	Page
59 Estimated Households by Available Automobiles and Household Size (1990) for Lorain County	110
60 Estimated Households by Available Automobiles and Household Size (1990) for Cuyahoga County	110
61 Estimated Households by Available Automobiles and Household Size (1990) for Medina County	111
62 Estimated Households by Available Automobiles and Household Size (1990) for Geauga County	111
63 Surveyed Households by Available Automobiles and Household Size (1990) for Lake County	112
64 Surveyed Households by Available Automobiles and Household Size (1990) for Lorain County	112
65 Surveyed Households by Available Automobiles and Household Size (1990) for Cuyahoga County	113
66 Surveyed Households by Available Automobiles and Household Size (1990) for Medina County	113
67 Surveyed Households by Available Automobiles and Household Size (1990) for Geauga County	114
68 Final Expansion Factors by Available Automobiles and Household Size (1990) for Lake County	114
69 Final Expansion Factors by Available Automobiles and Household Size (1990) for Lorain County	115
70 Final Expansion Factors by Available Automobiles and Household Size (1990) for Cuyahoga County	115
71 Final Expansion Factors by Available Automobiles and Household Size (1990) for Medina County	116
72 Final Expansion Factors by Available Automobiles and Household Size (1990) for Geauga County	116
73 Sources of Data for Linked Trip Records	121
74 Mode Priority System	123

# Contents (Continued)

---

Figures	Page
ES-1 Distribution of Households by Income Level and Household Size	viii
ES-2 Distribution of Households by Auto Availability and Household Size	ix
ES-3 Trips by Purpose in Selected U.S. Cities	xi
ES-4 Daily Trips by Mode	xii
ES-5 Average Daily Trips Made in Motorized Vehicles for Selected U.S. Cities	xv
ES-6 Vehicle Trips by Age and Trip Purpose	xvii
ES-7 Vehicle Miles Traveled by Vehicle Age	xviii
1 Survey Area	2
2 Household Data Form	21
3 Travel Diary (Front)	22
4 Travel Diary (Back)	23
5 Travel Diary—Additional Trips (Front)	24
6 Travel Diary—Additional Trips (Back)	25
7 Household, Person, and Vehicle Data Collection Form	26
8 Travel Diary Collection Form	27
9 Travel Diary Data Collection Form—Additional Trips	28
10 Percentage of Low-Income Households	38
11 Screener Sheet (Front)	46
12 Screener Sheet (Back)	47
13 Cover Letter	49
14 Travel Day Reminder Sheet	50
15 Travel Survey Instructions	51
16 Example Travel Diary	52
17 Percent Error of Proportion at 95 Percent Confidence Level (Based on 1,408 Samples)	81
18 Trips by Time-of-Day (Trips by All Modes)	90

# Executive Summary

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## Background

In 1994, the Greater Cleveland Regional Transit Authority (GCRTA) and the Northeast Ohio Areawide Coordinating Agency (NOACA) conducted a home-interview travel survey to update information on current travel patterns and trip characteristics in the Northeast Ohio area. The travel survey was the first such comprehensive effort since 1963. The survey was administered during the Spring of 1994 to 1,651 households, or about 0.2 percent of the households included in the five-county area of Northeast Ohio shown in Figure ES-1. The survey included 1,056 households from Cuyahoga County.

The travel survey was administered using a telephone-based data collection technique. A list of random telephone numbers was selected to be representative of households in the region. Households agreeing to participate in the travel survey were assigned a travel day (Monday through Friday only) and mailed a household survey form and travel diaries for each household member five years old or older. Each household member of age five or older was asked to complete a travel diary, providing detailed information about each trip that he or she made on the travel day. One member of each household, usually the head, was asked to complete the household survey form. Following the assigned travel day, the household was telephoned and the household and travel data were collected.

The survey was continually monitored to ensure that the households included in the survey adequately represented the different income groups and the different household sizes in the area. The number of surveys collected by household size and income group, and by household size and autos available for the survey area are depicted in Figures ES-1 and ES-2, respectively.

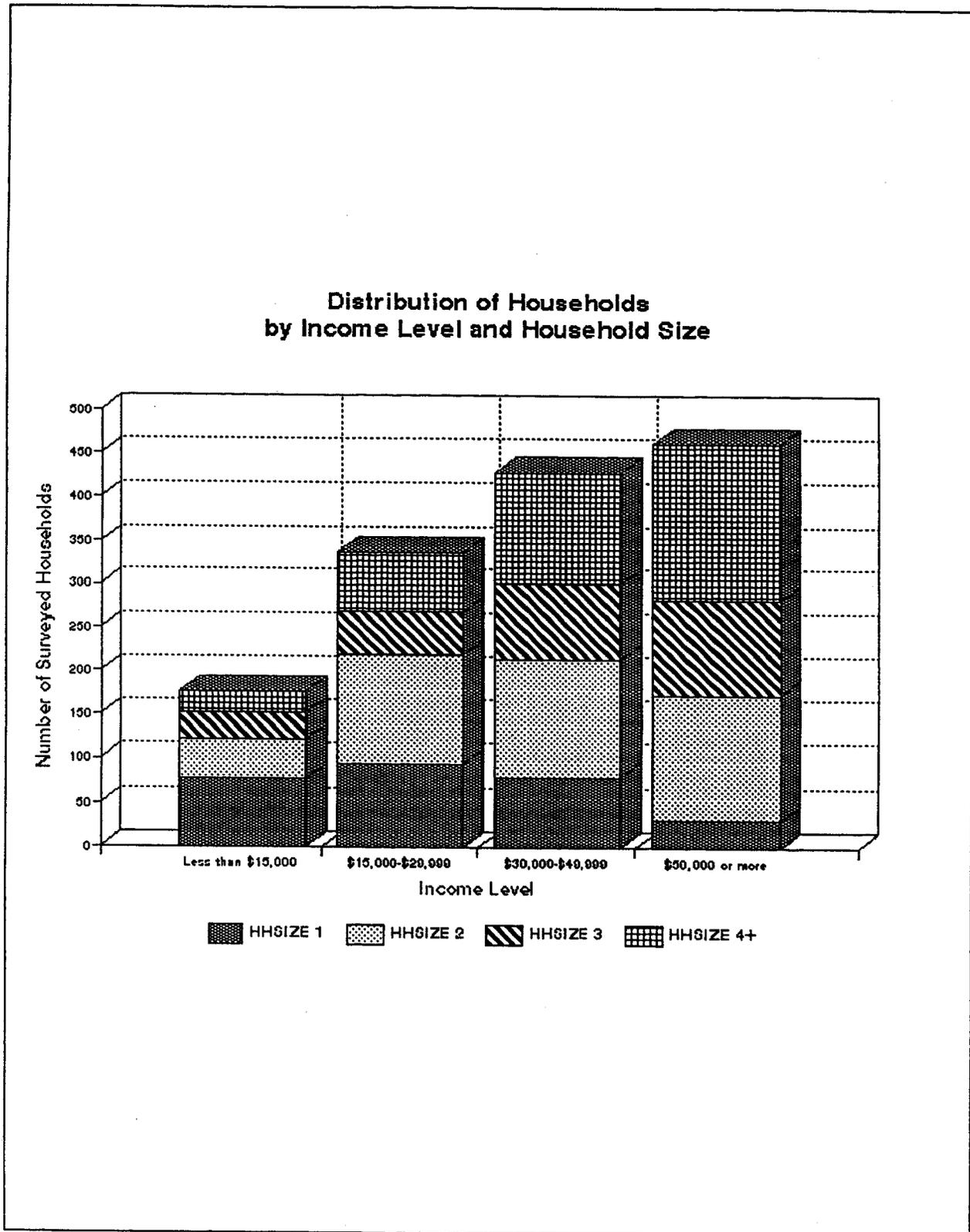


Figure ES-1

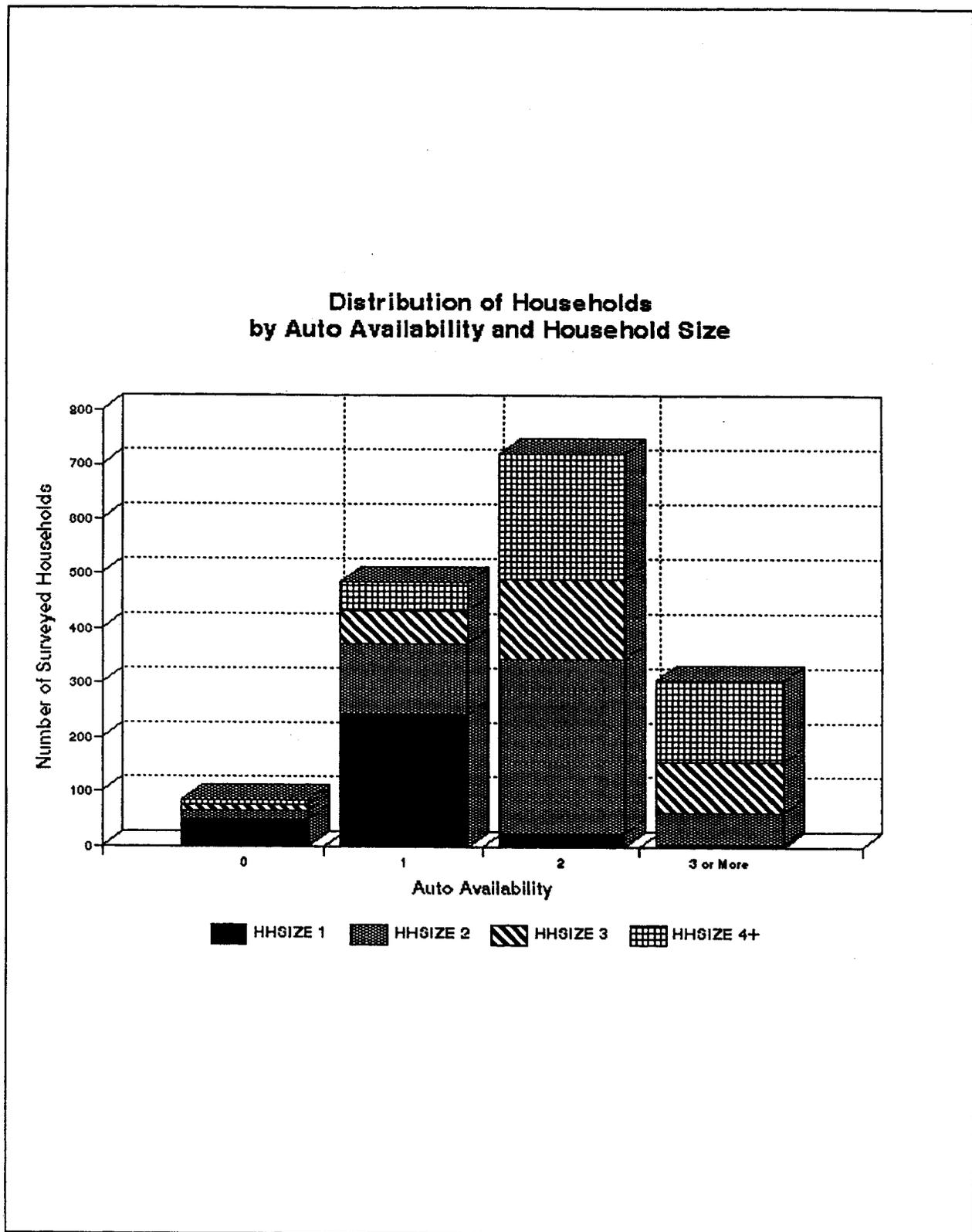


Figure ES-2

A final step performed after the collection of the survey was the development of expansion factors for the survey data. These factors provide the means to summarize regional estimates of the data collected in the survey. Each household represents between 141 and 1,426 households depending on the socioeconomic characteristics and county of residence for the household. On the average, each household represents 490 households.

## Survey Results

The travel survey has provided a snapshot of travel in the Northeast Ohio region. On an average weekday, 7,739,900 trips are made by all modes by residents of the five-County Northeast Ohio Area. Of the 7,739,900 trips, 7,061,600, or 91.2 percent of the total trips, are made in motorized vehicles.

Trips are defined as one-way travel made by a resident of or out-of-area overnight visitor to the region (age five or older). For example, if a ten year old child rides a school bus to school in the morning and walks home in the afternoon, two trips have resulted: one by a motorized mode and one by a non-motorized mode. In another example, a trip home from work, with a stop enroute to buy milk results in two trips having been made. Trips have been further stratified by trip purpose. Three general purposes have been used in the summaries included in this document: home-based work (HBW), home-based non-work (HBNW), and non-home-based (NHB). Furthermore, all trips summarized in this section have been linked. Trips made to drop off or pick up passengers for whatever purpose were linked as long as the duration of the stop was five minutes or less. Home-based work trips include all trips where one end of the trip is the traveler's home and the activity at the other end of the trip is work. Both trips from home to work and from work to home are included as long as no intermediate stops were made. Home-based non-work trips include trips made for all other purposes (e.g., school, shop, doctors visit, social, etc.) as long as one end of the trip was at the traveler's home. Non-home-based trips include trips made for any purpose where neither end of the trip was the traveler's home.

### *Trips by Trip Purpose*

Figure ES-3 shows the percents of trips by trip purpose for the Northeast Ohio Area, St. Louis, Northern New Jersey, and Albuquerque. The percentages of trips by purpose that result for the Northeast Ohio Area, 17 percent home-based work trips, 54 percent home-based non-work trips, and 29 percent non-home based trips, are reasonable ranges for a major U.S. city.

### *Trips by Mode*

The number of trips by generalized mode and trip purpose are depicted in Figure ES-4. Overall, the non-motorized modes are utilized very little, and appear to be least popular with the home-based work trips. Table ES-1 summarizes trips by mode and purpose for the Northeast Ohio Area. The data summarized in the table

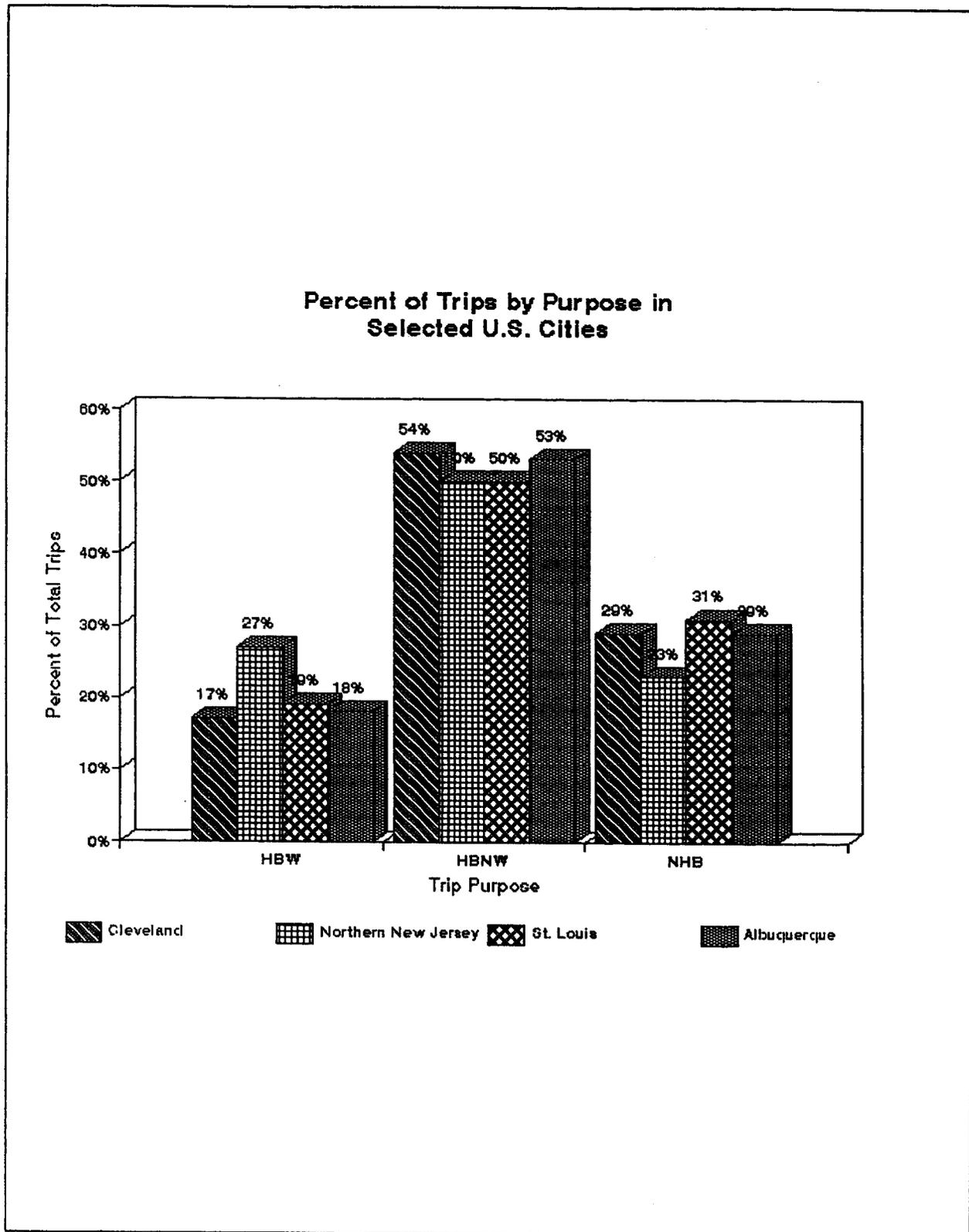


Figure ES-3

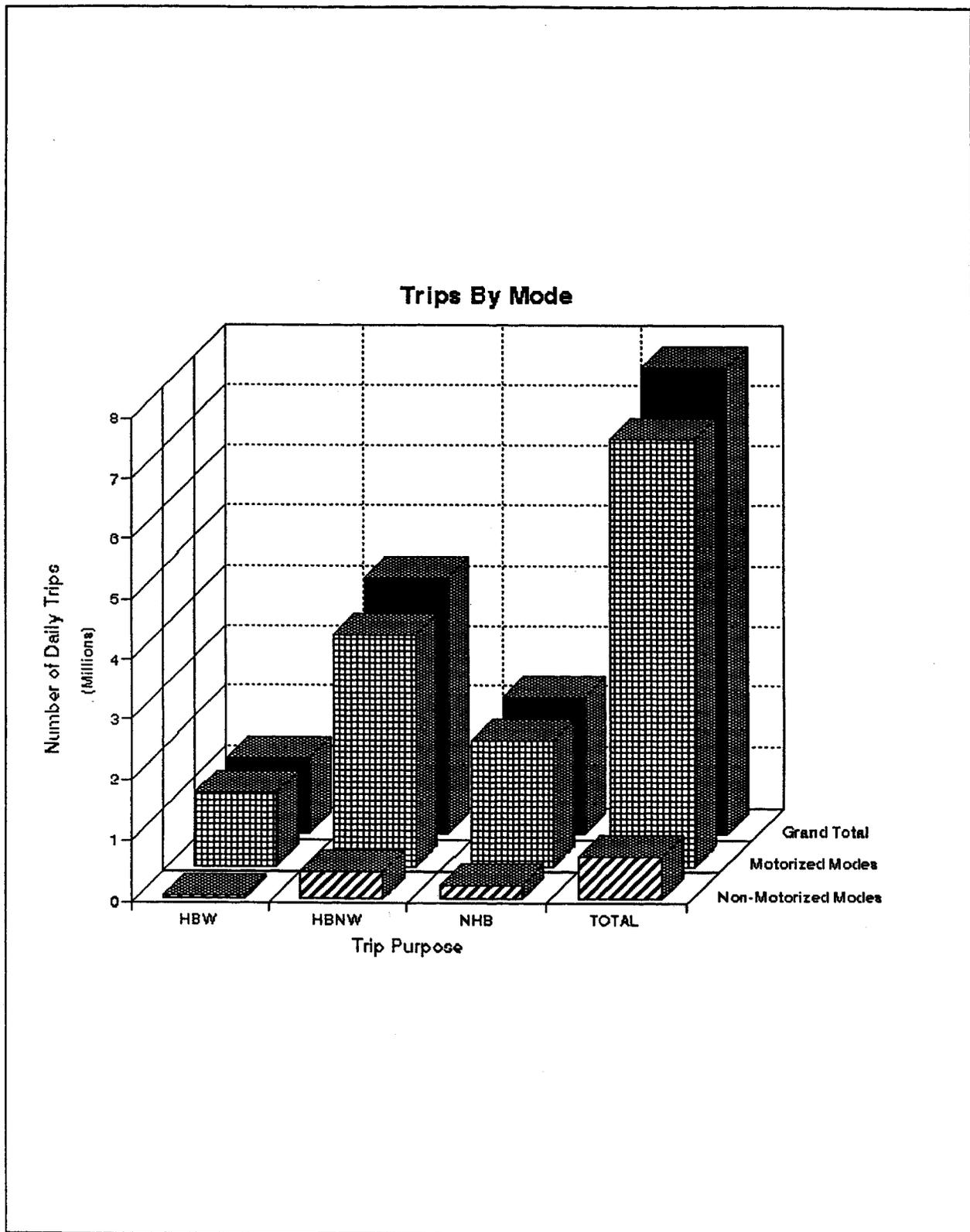


Figure ES-4

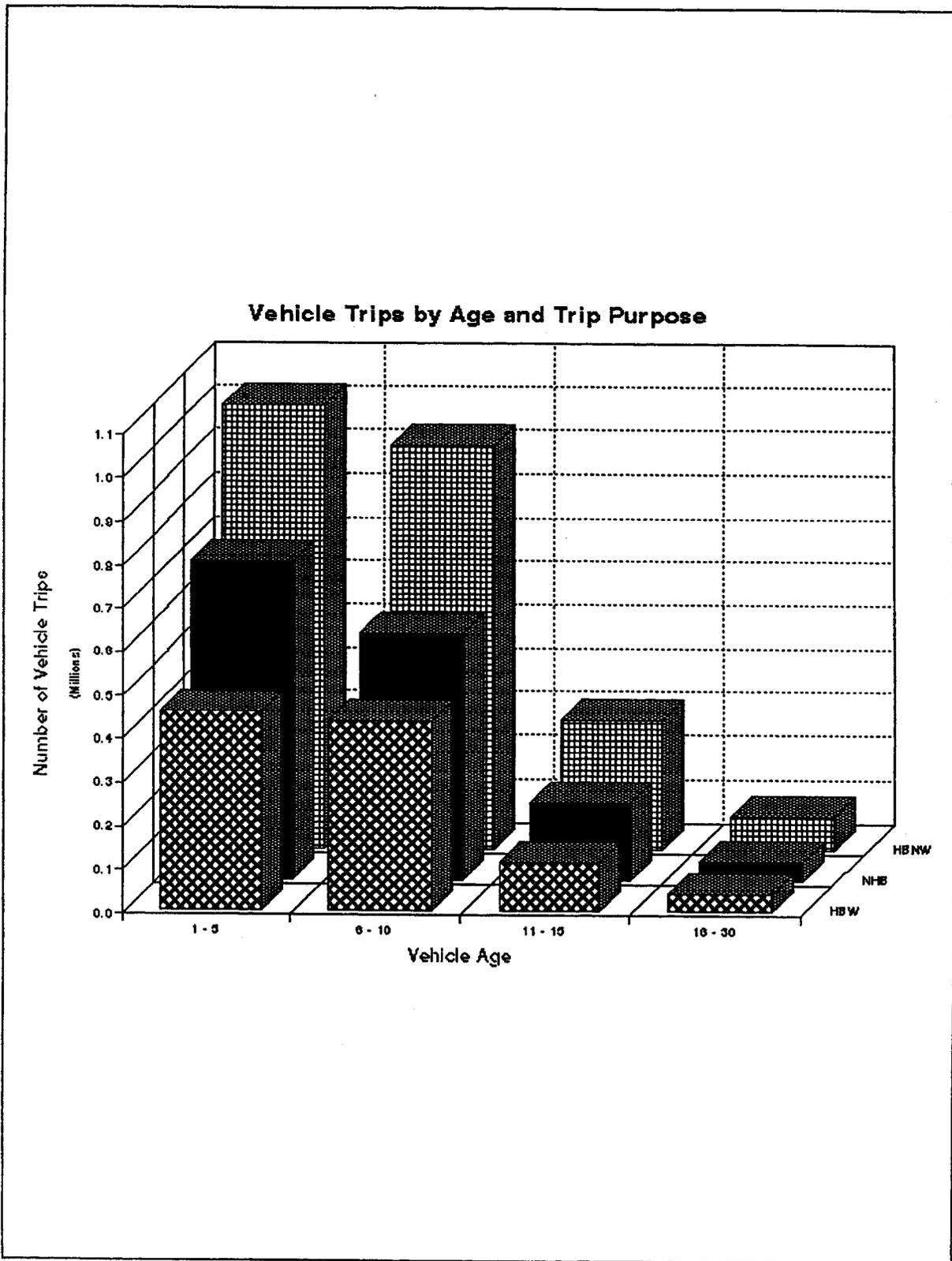
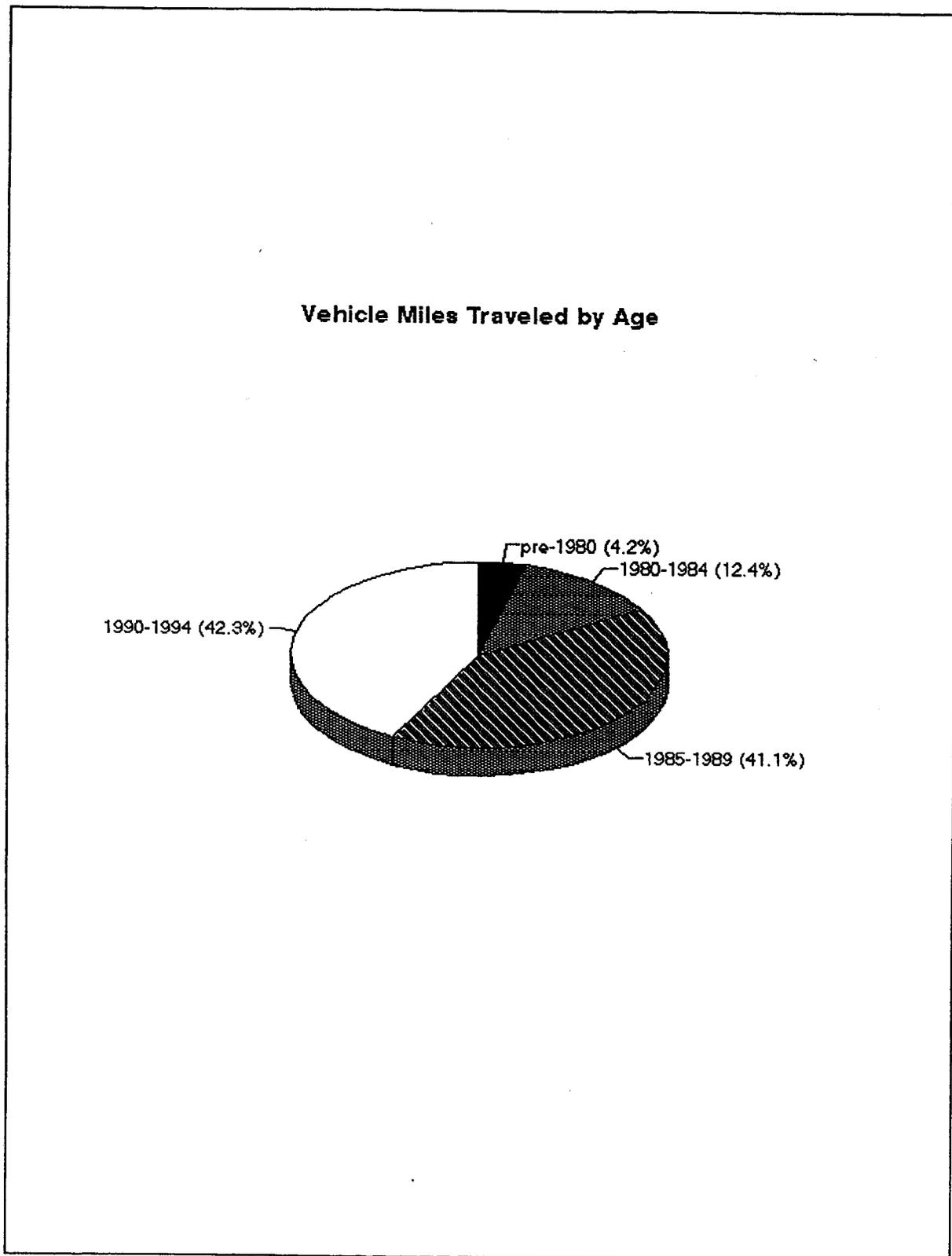


Figure ES-6



**Figure ES-7**

# 1. Introduction

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This report documents the design and conduct of a telephone home interview travel survey of more than 1,600 households performed in the Spring of 1994 for the Cleveland Area. The area surveyed (see Figure 1) included the northeastern Ohio Counties of Cuyahoga, Lake, Lorain, Geauga, and Medina. The survey was performed for the Greater Cleveland Regional Transportation Authority (GCRTA) and the Northeast Ohio Areawide Coordinating Agency (NOACA) by Barton-Aschman Associates, Inc. (BA) with assistance from Catherine Bryant and Associates (CB&A). This report contains a narrative summary of the survey and a preliminary summary of the survey results.

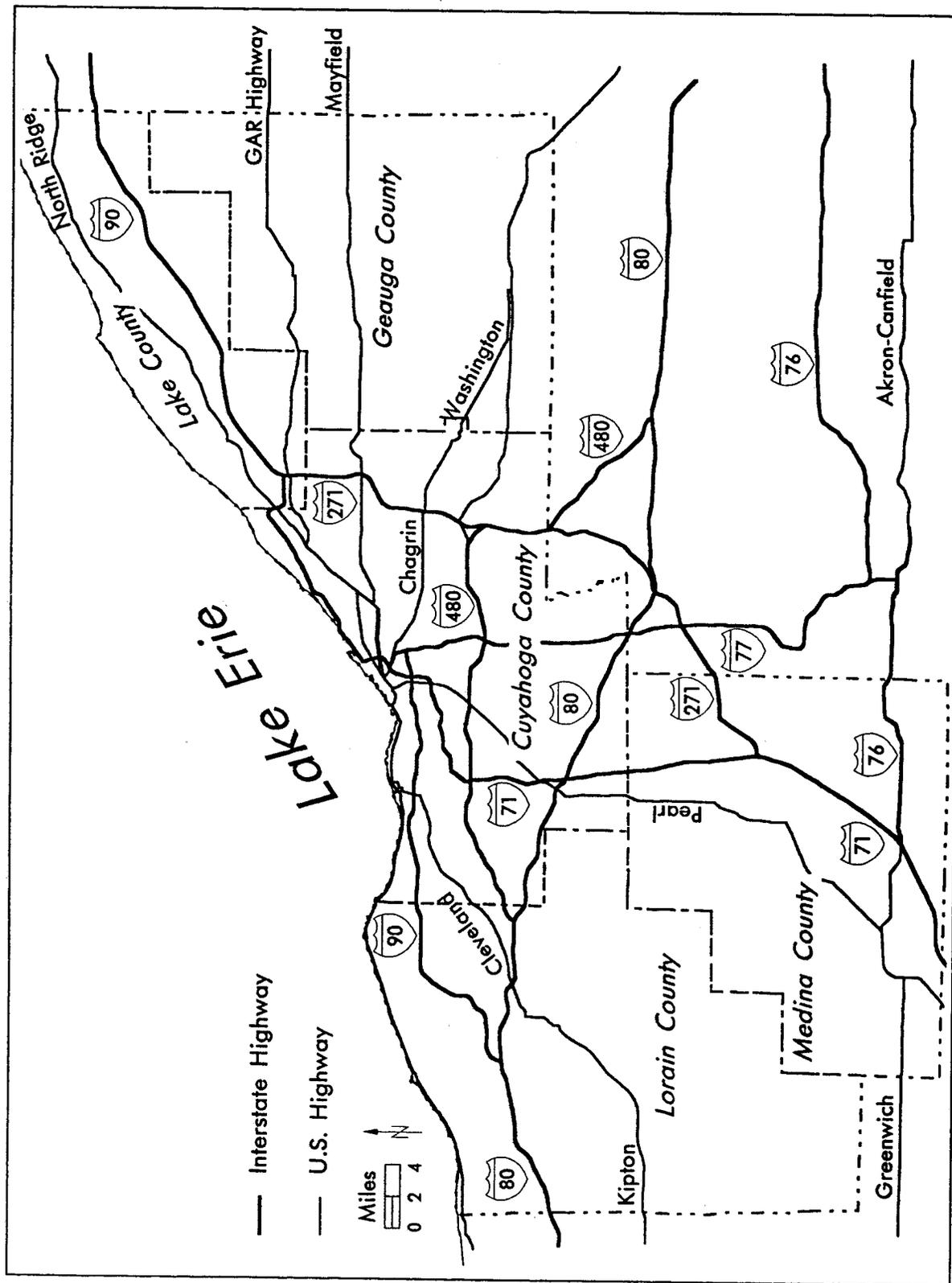


Figure 1  
Survey Area

**Table ES-1  
Trips by Mode for Greater Cleveland<sup>1</sup>**

Mode	Home-Based Work		Home-Based Non-Work		Non-Home Based		Total	
	Trip	Percent	Trips	Percent	Trips	Percent	Trips	Percent
Auto Driver-Drive Alone	994,639	80.2%	1,554,514	36.7%	1,096,640	48.4%	3,645,793	47.1%
Auto Drive-Shared Ride	68,164	5.5%	803,352	19.0%	467,500	20.7%	1,339,016	17.3%
Auto Passenger	79,586	6.4%	1,087,740	25.7%	400,023	17.7%	1,567,349	20.3%
RTA Bus	43,515	3.5%	80,656	1.9%	36,607	1.6%	160,776	2.1%
RTA Rapid	9,458	0.8%	10,970	0.3%	5,765	0.3%	26,193	0.3%
Other Public Transportation	1,960	0.2%	2,288	0.1%	5,863	0.3%	10,111	0.1%
Yellow School Bus	0	0.0%	266,118	6.3%	35,588	1.6%	301,706	3.9%
Taxi	1,274	0.0%	8,957	0.2%	394	0.0%	10,625	0.1%
<b>Total Motorized<sup>2</sup></b>	<b>1,198,594</b>	<b>96.7%</b>	<b>3,814,595</b>	<b>90.0%</b>	<b>2,048,380</b>	<b>90.5%</b>	<b>7,061,569</b>	<b>91.2%</b>
Bicycle	9,603	0.8%	42,618	1.0%	1,770	0.1%	53,991	0.7%
Walk	31,495	2.5%	375,284	8.9%	210,995	9.3%	617,774	8.0%
Other	0	0.0%	3,934	0.1%	2,628	0.1%	6,562	0.1%
<b>Total Non-Motorized<sup>2</sup></b>	<b>41,098</b>	<b>3.3%</b>	<b>421,836</b>	<b>10.0%</b>	<b>215,393</b>	<b>9.5%</b>	<b>678,327</b>	<b>8.8%</b>
<b>Total<sup>2</sup></b>	<b>1,239,692</b>	<b>100.0%</b>	<b>4,236,431</b>	<b>100.0%</b>	<b>2,263,773</b>	<b>100.0%</b>	<b>7,739,896</b>	<b>100.0%</b>

<sup>1</sup> Expanded trips based on 1,408 households reporting incomes.

<sup>2</sup> Percentages might not sum to values shown due to rounding error

confirm the emphasis within the region on the auto as the primary mode of transportation. About 85 percent of the total trips made on a daily basis are made in an auto, either as a driver or a passenger. Of the 7,061,600 trips made in motorized vehicles, 6,552,200 or 93 percent, are made in autos and 190,100 trips, or about three percent, are made by public transportation.

## Average Trip Rates

Table ES-2 summarizes the average number of trips made each day by a typical household in the Northeast Ohio Area. Two sets of rates are shown: the average rate for all trips and the average rate for trips made in motorized vehicles.

**Table ES-2**  
**Average Trip Rates for Greater Cleveland**

Trip Purpose	Household Trip Rates All Trips <sup>1</sup>	Household Trip Rates Trips Made in Vehicles <sup>1</sup>
Home-Based Work	1.5	1.5
Home-Based Non-Work	5.2	4.6
Non-Home-Based	2.8	2.5
Total	9.6	8.7

<sup>1</sup> Based on 1,408 households reporting income.

Figure ES-5 summarizes average trip rates for trips made in motorized vehicles for various cities in the U.S. The trip rates have been stated as trips per person per day to minimize the effect of different average household sizes for the cities. As shown in Figure ES-5, the average total trip rate per person for trips made in motorized vehicles for the Northeast Ohio Area is similar to trip rates observed in other urban areas of varying sizes.

## Vehicle Usage

The summarized survey data yield some interesting observations with respect to the vehicles owned by those households and the uses of those vehicles. Relationships and trends were analyzed between vehicle age and vehicle trip frequency, and vehicle age and daily vehicle mileage.

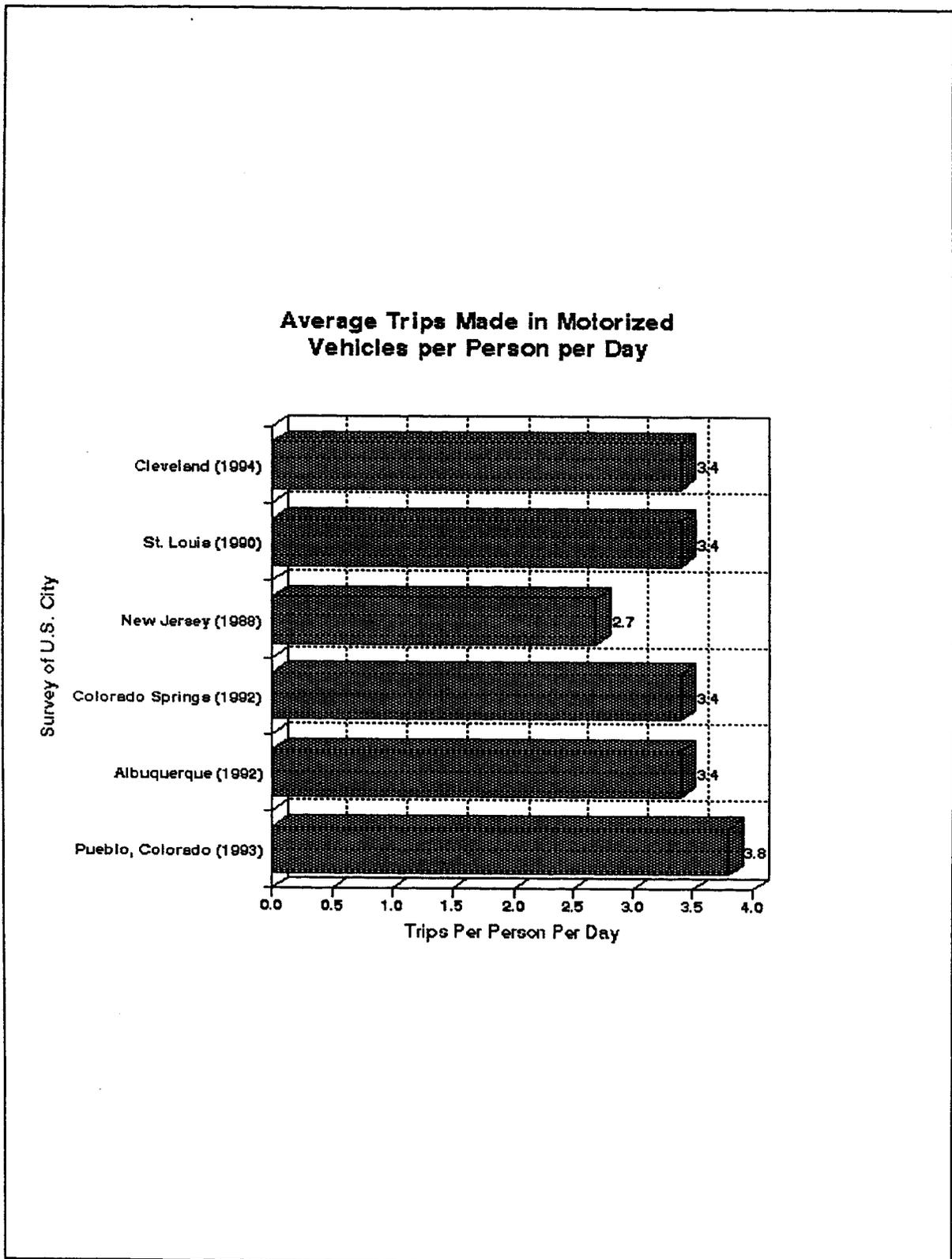


Figure ES-5

The surveyed household vehicles were grouped, by age into four categories: zero to five years old, six to ten years old, eleven to fifteen years old, and sixteen or more years old. The tabulated number of trips made using the vehicles showed that, as would be expected, more trips were made with newer automobiles than with older ones.

The total number of daily trips by vehicle age category is plotted in Figure ES-6. As vehicles increase in age, fewer trips tend to be made with them, regardless of the trip purpose. However, it is interesting to note that almost as many home-based work trips are made in six to ten year old vehicles as are made in zero to five year old vehicles. This suggests that older, "second" cars are heavily used for commuting purposes.

The percents of total vehicle miles traveled by vehicle-age are presented in Figure ES-7. The highest percent of total vehicle miles traveled is 42.3 percent for the newest automobiles, 1990 through 1994. The smallest percentage is 4.2 percent for the oldest automobiles, pre-1980.

### **Future Uses of the Travel Survey**

The information collected in the 1994 travel survey will ultimately enable more sophisticated transportation planning for the Northeast Ohio area. One of the main and immediate uses of the data will be for the structuring and calibration of mathematical models used to project future travel in the region. The travel forecasts will be used to evaluate a variety of transportation improvement alternatives and help assess future roadway requirements. In addition, the collection of vehicle information tied to trip making will enable better estimates of air quality impacts of various transportation improvements.

## 2. Survey Design

---

### Introduction

A minimum sample size of 1,600 households was recommended for the survey with a goal of 89 percent of those households, or 1,425, reporting income. This number was chosen based on three main criteria:

- The models to be calibrated using the survey.
- The statistical significance of the survey results.
- The sampling technique to be employed.

The survey will be used primarily for the calibration of trip production and trip distribution models. The information from this survey will also be used in conjunction with transit on-board survey data to calibrate mode choice and auto-occupancy models for the region. Finally, diurnal distribution factors can be developed from the data. Experience with previous model calibrations has shown that samples of about 1,300 to 1,600 households provides sufficient data to calibrate trip production and trip distribution models.

The statistical significance of data generated by the survey data was also a concern in the design of the survey size. Statistical significance is a quantification of the degree of certainty that the experimental or survey results did not occur by chance. A result is said to be significant when the likelihood of its being random falls below a certain agreed-upon level of probability, called the "accuracy level." This probability of error decreases as the size of the sample is increased, but can never be completely eliminated unless the entire universe is enumerated.

The ability to specify accuracy levels and confidence levels for the survey allows the results to conform to desired overall accuracy and enhances usefulness of the survey data. Expected accuracy levels for a given confidence level can be estimated based on

the expected sample size and an assumption of the coefficients of variation. Based on recent surveys performed in the St. Louis, Albuquerque, and Colorado Springs areas by Barton-Aschman, coefficients of variation were estimated as:

Trip Purpose	Coefficients of Variation		
	St. Louis	Albuquerque	Colorado Springs
Home-Based Work	0.93	0.95	0.91
Home-Based Non-Work	0.97	0.97	1.00
Non-Home-Based	1.28	1.26	1.21
Total Trips	0.76	0.76	0.74

Table 1 shows the expected accuracy levels at the 95 percent confidence level that were estimated for the 1994 Regional Travel Survey along with the accuracy levels actually obtained.<sup>1</sup>

**Table 1**  
**Expected and Observed Overall Household Trip Rate Accuracy Levels (95 Percent Confidence Level)**

Trip Purpose	Expected <sup>1</sup>	Observed <sup>2</sup>
Home-Based Work	2.18%	2.24%
Home-Based Non-Work	2.28%	2.22%
Non-Home-Based	3.01%	2.91%
Total Trips	1.79%	1.76%

<sup>1</sup> Expected accuracy levels are based on the assumptions of the survey size of 1,636 households and coefficients of variation from the 1990 St. Louis Region Travel Survey.

<sup>2</sup> Observed accuracy levels are based on the unweighted results for trips made in motorized vehicles from the 1994 travel survey of 1,636 households.

A total of 1,636 completed, useable household surveys were obtained for the survey area. Based on 1990 summaries of census data, the area sampled encompassed

<sup>1</sup>The accuracy levels shown in Table 1 are for "unweighted" survey results. The survey results are actually more accurate if the distribution of households by income group and household size are accounted for. This analysis will be discussed in subsequent sections of this report.

808,706 households. Thus, the sample rate was about 0.2 percent or, in other words, each sampled household represented about 494 households.

The remainder of this chapter focuses on the details of the design of the sample for the Cleveland area home interview survey. The discussion concerns three aspects of sample design: specification of the sample frame, specification of the sample size, and specification of the sample stratification.

## Sample Size

A survey of 1,675 households was performed. Of these, 1,636 surveys were completed, usable surveys for statistical analysis with the exception that not all households necessarily reported their incomes.

A goal of obtaining 1,425 households reporting income (i.e., 89 percent of the total households in the sample) was set for the survey; final results show that 1,409 households actually reported incomes. This sample size was deemed sufficient to provide estimates of regional trip rates per household within  $\pm 5$  percent error at the 95 percent confidence level.

Error level, or precision, and confidence level should be defined. The issue of precision is simply the accuracy of a sample estimate. For example, if the average household generates 10 person trips per weekday, the sample estimate is mean person trips per household. Since the estimate is based on a sample, we expect the sample mean to be inexact as a measure of the mean for the entire population of households. If this sampling error is limited, to say, 5 percent, the precision is said to be  $\pm 5$  percent, or  $\pm 0.5$  trips per household. Thus, this precision would yield an estimate for mean trips per household between 9.5 and 10.5 trips per day for this example.

This brings us to the second issue, level of confidence. How confident can we be that the average trips per household of all households is actually bounded by the stipulated accuracy range derived from our sample? It turns out that the level of confidence is a function of the number of standard errors of the mean. With one standard error on either side of the mean, the level of confidence is about 68 percent; two standard errors (1.96 to be exact) yields 95 percent confidence; three standard errors gives 98 percent confidence.

The following is meant by confidence: if 100 random surveys were conducted, the sample means from 68 of the surveys would fall within the range defined by plus or minus one standard error of the mean. In the hypothetical case defined above, that would be  $\pm 0.5$  trips per household. If a higher level of confidence is desired, say 95 percent, 1.96 standard errors on either side of the mean would be required. The hypothetical estimate from the above sample would range between 9.02 (10 minus 0.98, where  $0.98 = 1.96 \times 0.5$ ) and 10.98 (10 plus 0.98).

Mathematically, confidence levels, relative errors, and sample sizes are related as follows. The standard error the estimate is:

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} \quad (1)$$

where:

$\sigma_{\bar{x}}$  = the standard error of the estimate of the mean,  $\bar{x}$ ,

$\sigma$  = the standard deviation of the sample calculation

$$= \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

$n$  = number of households sampled,

$x_i$  = a sampled household,

$\bar{x}$  = the sample mean calculated as  $\frac{\sum_{i=1}^n x_i}{n}$

Now if both sides of equation (1) are divided by the mean, we obtain:

$$\frac{\sigma_{\bar{x}}}{\bar{x}} = \frac{\sigma}{\bar{x}\sqrt{n}} \quad (2)$$

since the term  $\sigma / \bar{x}$  is equal to the coefficient of variation,  $cv$ , the relative error of the mean,  $e$ , is given by:

$$e = \frac{\sigma}{\bar{x}\sqrt{n}} = \frac{cv}{\sqrt{n}} \quad (3)$$

and:

$$n = \frac{cv^2}{e^2} \quad (4)$$

Additionally, if the number of standard errors (the level of confidence) is specified as  $z$ ,

$$n = \frac{z^2 cv^2}{e^2} \quad (5)$$

From the equation (5) above, we can estimate the overall sample size necessary for a given precision and desired level of confidence, if the cv (coefficient of variation) is known. Alternative, we can rearrange the above equation to estimate the relative error at a desired level of confidence given the coefficient of variation and the sample size:

$$e = \frac{z(cv)}{\sqrt{n}} \quad (6)$$

Based upon a large number of home interview studies in the United States since 1960, 0.9 is a good approximation of the coefficient of variation based on mean household trip rates. Table 2 below has been constructed based on an assumed value of 0.9 for the coefficient of variation, a level of confidence of 90 percent, 95 percent, or 98 percent, and selected relative percent errors. Table 2 dramatically illustrates the impact of precision and level of confidence required on sample size. Increases in each are bought with large increases in sample size. Conversely, small changes in sample size have a less than proportional effect on the precision and confidence level of sample estimates.

**Table 2**  
**Sample Size Requirements for Selected Relative Errors,**  
**Confidence Levels of 90%, 95%, and 98%, and Coefficient of**  
**Variation Equal to 0.9**

Percent Relative Error	Confidence Level		
	90%	95%	98%
1%	21,786	31,117	72,900
2%	5,446	7,779	18,225
3%	2,420	3,457	8,100
4%	1,362	1,945	4,556
5%	872	1,245	2,916
6%	605	864	2,025
8%	340	486	1,339
10%	218	311	729
15%	97	139	324

If only overall regional trip rates were desired from a survey, 1,100 households would be a reasonable number of samples to collect. However, state-of-the-practice trip generation models are generally stratified by a measure of wealth (e.g., income group) and household size. Thus the number of samples for each cell is substantially less

than 1,600, generally in the range 30 - 300. Models for other regions have been successfully calibrated using sample sizes of 1,600.

## Sample Stratification

One of the main uses of the survey will be the recalibration of the trip production models of the five-county modeling area. The trip production models will probably be stratified by a measure of wealth variable (such as income group or auto availability) and household size. Stratification of households into different socioeconomic groups is accepted practice in travel models used to simulate or forecast travel behavior. Two common stratification schemes used are:

- Households by income group and household size
- Households by auto availability and household size

Stratification is important in modeling because it groups households according to socioeconomic characteristics. Travel behavior of households within a group tends to be relatively homogeneous; between groups, travel behavior can be quite different. Stratification makes the model's estimation of travel more precise, especially if the geographic distribution of households is not random with respect to these variables.

Stratification also provides the means to selectively weight the sample responses so accurate estimates of regional travel can be made. If the sample is completely unbiased, the total number of households in the region can simply be divided by the number of sampled households to calculate a sample weight. For the Cleveland survey, this weight is  $808,706/1,636$ , or 494. In other words, on the average, each sample will represent 494 households. However, experience has shown that there is typically a bias in the sample unless heroic quota sampling techniques are used. Specifically, low-income households are typically under-represented, even with the oversampling of low-income census tracts. In addition, it is likely that one-person households have been under-sampled.

Summaries of the number of households by the various sample strata for the region were required. The joint distribution of households and by auto availability and household size were available in the 1990 Census Transportation Planning package (CTPP) data. Unfortunately, the CTPP data did not include a distribution of households by income group and household size, so this distribution had to be estimated from two other tables from the CTPP. The following process was used:

- The joint distribution of households by income group and auto availability was used with the joint distribution of households by autos available and household size to estimate a preliminary joint distribution of households by income group and house size.

- The number of households in each income group was adjusted to account for inflation between 1989 (the year used to report income for the 1990 Census) and 1993 (the year used to report income for the 1994 Cleveland Area Travel Survey).
- The preliminary joint distribution was "balanced" to match the 1990 marginal distributions of households by income group and households by household size.

The adjustment for inflation requires more explanation. Inflation, as measured by the consumer price index-urban consumers (CPI-U) has occurred in the Cleveland area between 1989 and 1993. While there is no guarantee that changes in incomes have matched the changes in the CPI-U values, that assumption has been used as a basis for the income adjustments due to lack of data to the contrary. Several sources were checked to verify or refute this assumption including NOACA, the Department of Commerce, the U.S. Census Bureau, the Federal Building in Chicago, the Bureau of Economic Analysis, and the City of Cleveland Planning Department.

Finally, the Ohio Bureau of Employment Statistics (OBES) provided information on "personal per capita incomes" for all Ohio counties for 1987 through 1992 along with Cleveland-specific CPI values through June 1994. Since per capita income information is not yet available for 1993, they provided statewide median incomes for 1992 and 1993. The pertinent data for the five counties in the Northeast Ohio area are shown below:

Year	County-Specific Per Capita Income in "Current Year" Dollars				
	Cuyahoga	Geauga	Lake	Lorain	Medina
1989	\$19,855	\$20,178	\$18,030	\$15,441	\$17,261
1992	\$23,128	\$22,355	\$20,450	\$17,436	\$19,080

Source: Ohio Bureau of Employment Statistics

In the above table, "Current Year" dollars implies that 1989 incomes are in 1989 dollars and 1992 incomes are in 1992 dollars.

In 1992, the Ohio statewide median household income was \$32,344 and in 1993, the median household income was \$31,285. Both income levels are expressed in 1993 dollars.

Staff at the OBES suggested that the CPI values be used to convert the county-specific per capita incomes to constant year dollars. The 1989 average CPI for Cleveland was 122.7, and the 1992 average CPI was 136.8; these CPI figures resulted in an inflation

adjustment factor of 1.115. If this factor is used to adjust the incomes to constant dollars, the following county-specific incomes result:

Year	County-Specific Per Capita Income in Constant 1989 Dollars				
	Cuyahoga	Geauga	Lake	Lorain	Medina
1989	\$19,855	\$20,178	\$18,030	\$15,441	\$17,261
1992	\$20,744	\$20,050	\$18,342	\$15,639	\$17,113
1992/1989 Ratio	1.04	0.99	1.01	1.02	0.99

A ratio of 1.0 for 1992 to 1989 incomes implies that income growth has exactly matched inflation. Thus based on the above table, the growth in income between 1989 and 1992 closely matched the growth in inflation for the five-county area.

Between 1992 and 1993, there was a 3.27 percent loss in real income at a statewide level based on statewide median incomes. If this loss in income is assumed for the five Northeast Ohio counties, the following ratios of 1993 to 1989 incomes would result.

Year	County-Specific Ratio of 1993 to 1989 Constant Dollar Incomes				
	Cuyahoga	Geauga	Lake	Lorain	Medina
1993/1989 Ratio	1.01	0.96	0.98	0.99	0.96

Based on the above table, it is possible that the growth in incomes has lagged *slightly* behind the growth in inflation for the five-county area. However, the difference is small. Thus, the use of CPI values to adjust income ranges is reasonable. The CPI-U values for the Cleveland area were 122.7 for 1989 and 140.3 for 1993.

In order to adjust for inflation, each of the 10 individual income group ranges defined for the travel survey was factored by the ratio of the 1993 CPI-U value to the 1989 CPI-U value, or 1.143. The 1990 distribution of households by income group was then assigned to the newly defined ranges. Finally, households were "moved" between income groups, assuming a uniform distribution within each income group, to match the definitions of the income groups used for the 1994 travel survey. The resulting distribution represents 1990 households in the region adjusted to match 1993 income

levels. Table 3 shows the adjustment and the resulting estimates of 1990 households by income group defined for the 1994 Cleveland area travel survey.

**Table 3**  
**1990 Households by Income Group for Study Area**

Income Group	1990 Census			1994 Travel Survey			
	Income Range in 1989 \$	Income Range in 1993 \$	Number of Households	Income Range in 1993 \$	From Previous Range	To Next Range	Estimated Households
1	Less than \$5,000	Less than \$5,717	54,811	Less than \$5,000	0	6,876	47,935
2	\$5,000 - \$9,999	\$5,717 - \$11,433	71,228	\$5,000 - \$9,999	6,876	17,872	60,232
3	\$10,000 - \$14,999	\$11,434 - \$17,150	67,203	\$10,000 - \$14,999	17,812	25,294	59,781
4	\$15,000 - \$19,999	\$17,152 - \$22,868	68,980	\$15,000 - \$19,999	25,294	34,618	59,656
5	\$20,000 - \$24,999	\$22,869 - \$28,585	67,834	\$20,000 - \$24,999	34,618	42,554	59,898
6	\$25,000 - \$29,999	\$28,586 - \$34,302	65,039	\$25,000 - \$29,999	42,554	48,961	58,632
7	\$30,000 - \$39,999	\$34,302 - \$45,736	123,011	\$30,000 - \$39,999	48,961	61,729	110,243
8	\$40,000 - \$49,999	\$45,737 - \$57,171	94,479	\$40,000 - \$49,999	61,729	59,265	96,944
9	\$50,000 - \$74,999	\$57,172 - \$85,757	126,042	\$50,000 - \$74,999	59,265	47,435	137,871
10	\$75,000 or more	\$85,758 or more	70,079	\$75,000 or more	47,435		117,514
Total			808,706				808,706

Table 4 shows the estimate of 1990 households by income group and household size and Table 5 shows 1990 households by auto availability and household size. The percents of households by income group and household size and by auto availability and household size shown in Tables 4 and 5 were used to estimate the number of samples by the various strata that were obtained in the survey. Table 6 shows the desired distribution of sample households by income group and household size for 1,600 samples. Table 7 shows the distribution of sample households by auto availability and household size. As can be seen in Tables 6 and 7, fewer than 30 samples were expected for a number of strata. Quota sampling of households in those strata could have been performed to obtain a minimum number of samples. However, such quota sampling would have been costly and was not used.

Table 8 shows the number of households by county (from the 1990 Census) along with the expected number of samples from the survey.

**Table 4**  
**Estimated 1990 Distribution of Households by Income Group and Household Size for the Five-County Area**

Number of Households	Household Size				Total
	1 Person	2 Persons	3 Persons	4+ Persons	
Income Group (\$1993)	1 Person	2 Persons	3 Persons	4+ Persons	Total
Less than \$5,000	25,809	10,882	4,937	6,307	47,935
\$5,000 - \$9,999	31,168	14,726	6,349	7,990	60,232
\$10,000 - \$14,999	27,554	16,489	6,927	8,811	59,781
\$15,000 - \$19,999	24,655	17,670	7,525	9,805	59,656
\$20,000 - \$24,999	21,508	18,716	8,374	11,300	59,898
\$25,000 - \$29,999	17,906	19,117	9,010	12,599	58,632
\$30,000 - \$39,000	25,820	37,174	19,246	28,003	110,243
\$40,000 - \$49,999	15,949	33,183	19,156	28,657	96,944
\$50,000 - \$74,999	15,806	45,623	29,869	46,573	137,871
\$75,000 or more	<u>10,728</u>	<u>37,094</u>	<u>26,371</u>	<u>43,321</u>	<u>117,514</u>
Total	216,903	250,674	137,764	203,365	808,706

Percent of Households	Household Size				Total
	1 Person	2 Persons	3 Persons	4+ Persons	
Income Group (\$1993)	1 Person	2 Persons	3 Persons	4+ Persons	Total
Less than \$5,000	3.2%	1.3%	0.6%	0.8%	5.9%
\$5,000 - \$9,999	3.9%	1.8%	0.8%	1.0%	7.4%
\$10,000 - \$14,999	3.4%	2.0%	0.9%	1.1%	7.4%
\$15,000 - \$19,999	3.0%	2.2%	0.9%	1.2%	7.4%
\$20,000 - \$24,999	2.7%	2.3%	1.0%	1.4%	7.4%
\$25,000 - \$29,999	2.2%	2.4%	1.1%	1.6%	7.3%
\$30,000 - \$39,000	3.2%	4.6%	2.4%	3.5%	13.6%
\$40,000 - \$49,999	2.0%	4.1%	2.4%	3.5%	12.0%
\$50,000 - \$74,999	2.0%	5.6%	3.7%	5.8%	17.0%
\$75,000 or more	<u>1.3%</u>	<u>4.6%</u>	<u>3.3%</u>	<u>5.4%</u>	<u>14.5%</u>
Total	26.8%	31.0%	17.0%	25.1%	100.0%

**Table 5**  
**Estimated 1990 Distribution of Households by Auto Availability**  
**and Household Size for the Five-County Modeling Area**

Number of Households	Household Size				Total
	1 Person	2 Persons	3 Persons	4+ Persons	
Auto Availability					
No Vehicles	61,346	19,767	10,710	14,295	106,118
1 Vehicle	135,763	81,716	28,853	31,475	277,807
2 Vehicles	16,477	124,817	59,524	95,157	295,975
3 or more Vehicle	<u>3,317</u>	<u>24,374</u>	<u>38,677</u>	<u>62,438</u>	<u>128,806</u>
Total	216,903	250,674	137,764	203,365	808,706

Percent of Households	Household Size				Total
	1 Person	2 Persons	3 Persons	4+ Persons	
Auto Availability					
No Vehicles	7.6%	2.4%	1.3%	1.8%	13.1%
1 Vehicle	16.8%	10.1%	3.6%	3.9%	34.4%
2 Vehicles	2.0%	15.4%	7.4%	11.8%	36.6%
3 or more Vehicle	<u>0.4%</u>	<u>3.0%</u>	<u>4.8%</u>	<u>7.7%</u>	<u>15.9%</u>
Total	26.8%	31.0%	17.0%	25.1%	100.0%

**Table 6**  
**Expected Distribution of Surveyed Households by Income Group and Household Size for the Five-County Area**

Income Group	Household Size				Total
	1 Person	2 Persons	3 Persons	4+ Persons	
1	45	19	9	11	84
2	55	26	11	14	106
3	49	29	12	16	105
4	43	31	13	17	105
5	38	33	15	20	105
6	32	34	16	22	103
7	45	65	34	49	194
8	28	58	34	50	171
9	28	80	53	82	243
10	<u>19</u>	<u>65</u>	<u>46</u>	<u>76</u>	<u>207</u>
Income not Reported	47	55	30	44	176
Total	429	496	273	402	1,600

**Table 7**  
**Expected Distribution of Households by Auto Availability and Household Size for the Five-County Modeling Area**

Number of Households Auto Availability	Household Size				Total
	1 Person	2 Persons	3 Persons	4+ Persons	
No Vehicles	121	39	21	28	210
1 Vehicle	269	162	57	62	550
2 Vehicles	33	247	118	188	586
3 or more Vehicles	<u>7</u>	<u>48</u>	<u>77</u>	<u>124</u>	<u>255</u>
Total	429	496	273	402	1,600

**Table 8**  
**Expected Distribution of Surveyed Households by County**

County	Number of Households	Expected Surveys
Cuyahoga	563,303	1,115
Geauga	26,931	53
Lake	80,563	159
Lorain	96,059	190
Medina	<u>41,850</u>	<u>83</u>
Total	808,706	1,600

Several different sampling techniques can be considered for household travel surveys:

- Simple Random Sampling
- Quota Sampling
- "Optimal Sampling"

Simple random sampling has the benefit of being easy to apply and cost effective. To apply this method, the sample is drawn from the universe—all households for the Cleveland survey. The drawback to this process is that sample error can easily be introduced. For example, some households will refuse to participate in the survey. If for example, relatively more low-income or high-income households refuse to participate in the survey than middle-income households, a bias will be introduced. Likewise, a bias can be introduced by an imperfectly specified sampling procedure. The Cleveland survey used random listings of telephone numbers as a *proxy* for all households. Some bias was introduced by not including non-telephone owning homes in the sample list.

Some of the possible bias introduced through simple random sampling can be mitigated through quota sampling. Quota sampling pre-specifies the number of samples that must be obtained for certain strata through the random sampling process. For the household survey, quotas could be specified for, say, socioeconomic groups such as households by income group and household size or by geographic area. While this process provides more control over the survey, it is more difficult and costly to apply. Once a quota is filled, additional samples in that the quota are discarded. In addition, households in some quotas might be difficult to find (e.g., low-income, one-person household) resulting in increased cost to find and recruit those households.

A third sampling technique, optimal sampling, has been used for some surveys. This technique considers the variation of the mean for a stratum along with the relative frequency with which samples for the stratum occur in the universe. For example, the variation in the mean trip rate for high-income, five or more persons household is relatively high. The optimal technique would, as a result, increase the number of

samples for the cell. At the same time, if there are relatively few households in this cell the optimal technique would decrease the number of samples for the cell.

While the optimal technique is good for reducing the overall variation (sampling error) in the sample, it is much more costly and difficult to apply. It can exacerbate the difficulties outlined for quota samples since the process is in fact, applied as a quota sampling technique. At the same time, it is affected by the variation in the selected variable being measured. In other words, the optimal sample based on the mean home-based work trip rate might be different than the optimal sample for the mean home-based other trip rate. Finally, the development of the optimal strategy requires an estimate of the variation of the variable being measured for each stratum.

The recommended sampling strategy was a "modified" simple random sample. A number of household surveys have shown that low-income strata tend to be undersampled using a simple random sample based on telephone listings. To mitigate the undersampling, a supplemental sample of several low-income census tracts was selected to increase the number of low-income samples. The specification of this sample is described in Chapter 3.

Note that supplemental samples could have been drawn to oversample other segments of the population. For example, a supplemental sample of the empowerment area could have been drawn, or supplemental samples of outlying counties could have been drawn. The special samples, however, were not recommended. One of the primary purposes of the regional travel survey is the calibration of the regional travel model. The collection of the modified simple random sample provided the necessary data without increasing costs or data collection time due to more difficult sampling techniques.

## Survey Methodology

### *Determination of Data Items to be Sought in the Survey*

Based on previous survey and model development efforts in other cities, a set of data items to be collected in the travel survey was recommended. Table 9 lists the data items along with a brief explanation of the purpose or use of each data item. The data items were subdivided into questions that were asked during the recruiting phase of the survey and, for the actual survey, household questions, person questions, vehicle questions, and trip questions.

**Table 9**  
**Recommended Data Items for Travel Survey**

Data Item	Purpose or Use
<b>Recruiting Questions</b>	
Name and address	Mailing and geocoding
Is household a dormitory or barracks?	Delete these household types from survey
Number of household members	Household size
Number of household members 5 or older	Determination of number of travel diaries
Number of expected out-of-area visitors on travel day	Determination of number of travel diaries
Number of autos, vans, and pickups of one-ton capacity or less available for use by household	Preliminary estimate of household wealth
<b>Household Questionnaire Questions</b>	
Verify name and address	Geocoding
Verify number of household members	Household size for trip generation, data expansion
Verify number of household members 5 or older	Information for logic tests of survey data
Verify number of out-of-area visitors	Ensure trip data from all household members (even temporary) collected
Verify number of autos, vans, and pickups of one-ton capacity or less available for use by household	Possible measure of wealth for trip generation, data expansion
Housing type	Possible effect on trip generation
Total 1993 household income for all members	Measure of wealth for trip generation, data expansion
<b>Person Questionnaire Questions</b>	
Relationship	Information to aid collection of data
Sex	Information to aid collection of data
Age	Information for logic tests of survey data
Driver's License	Information for logic tests of survey data
Employment Status	Information for logic tests of survey data
Went to job on travel day?	Information for logic tests of survey data
Made trips while at work?	Information for logic tests of survey data
Made other trips on travel day?	Information for logic tests of survey data
Personally interviewed? (Surveyor Observation)	Analysis of possible biases in trip rates
Used travel diary? (Surveyor Observation)	Analysis of possible biases in trip rates

**Table 9**  
**Recommended Data Items for Travel Survey (Continued)**

Data Item	Purpose or Use
<b>Vehicle Questionnaire Questions</b>	
Vehicle manufacture year	Vehicle age for air quality, fleet mix
Vehicle make	Air quality information, fleet mix
Vehicle model	Air quality information, fleet mix
Fuel type	Air quality information, fleet mix
Odometer reading at beginning and end of day	Air quality information, estimate of annual VMT
<b>Travel Diary Questions</b>	
Start of day location	Trip distribution, trip attraction models
"Where did you go next?"	Trip distribution, trip attraction models
Kind of place at destination	Possible trip attraction modeling
Trip purpose	Trip stratification, trip linking
Start time of trip	Trip-length frequency distribution verification, time-of-day models
End time of trip	Trip-length frequency distribution verification, time-of-day models
Mode of travel	Mode choice
Auto occupancy	Auto occupancy, mode choice
Parking cost, transit fare, and payment method	Mode choice
Vehicle used for trip	Air quality modeling

### ***Determination of Survey Procedures and Instruments***

A mail-out, telephone-collection survey methodology was used for the Cleveland area travel survey. The methodology included the following steps and characteristics:

- A random sample of listed and unlisted telephone numbers was drawn as a proxy for the households in the region.
- The telephone numbers were called and households were recruited for the survey. Several informational questions were asked and a travel day was assigned during this call.

- A travel packet of travel diaries, a household and person questionnaire, and instructions were mailed to the households agreeing to participate in the survey.
- Households were called one or two days after their travel day and the household, person, and travel data were collected over the telephone.
- The data was edited, coded, and keyed to computer data base files. The origin-destination and household data were geocoded to x,y coordinates.

The mail-out telephone-collection survey methodology was selected since the methodology is cost-effective and it was possible to collect high-quality data using the methodology. Interviewers had personal contact with the respondents and could clarify unclear responses. The methodology was effective for reducing under reporting of trips since interviewers could probe for easily forgotten trips.

The last point is very important. Experience in past surveys found that there was a statistically significant under-reporting of trips in a survey performed in Bexar County (San Antonio), Texas, when the results of self-administered, mail-back surveys are compared to the results of data collected via the telephone.<sup>2</sup> In that survey, the mail-out, telephone-collection method was employed. However, after collecting the data from the respondents, the respondents were sent a return envelope and were asked to return their travel diaries. Based on 729 returned diaries, the household trip rate reported on the diaries was 0.70 less than the trip rate for the same households based on the telephone collection procedures. Based on a paired t-test of the data, the difference in trip rates was significant at the 0.001 level.

## Questionnaire Design

The survey instrument consisted of four parts: a household data questionnaire that obtained data on characteristics of the household and the members of the household, a person data questionnaire (characteristics of household members), a vehicle data questionnaire (characteristics of vehicles of a household) and a travel diary that collected travel data for each trip made by a household member (aged five and older) on the travel day. Figure 2 shows the household data form, and Figures 3 and 4 show the front and back of the travel diary. One travel diary (Figures 3 and 4) was sent for each household member age 5 or older. The number of additional trip diaries (Figures 5 and 6) sent was dependent on the household size. Note that the forms are designed to be as user friendly as possible through the use of "check-off" boxes for many of the questions. The household data form was printed on white 8-1/2" x 11" paper. The travel diary was printed on blue 8-1/2" x 11" card stock.

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<sup>2</sup>Karen Manges, Mark Douglas, and John Stesney, "A Comparison of Household Interview Travel Survey Methodologies," presented at the Conference on Travel Forecasting Methodologies, Austin, Texas, 1990.

The survey data were collected by interviewers on data collection questionnaires (see Figures 7 through 9). The check-off boxes were replaced by numbers that made the collection forms largely self-coding. In addition, in the person data section of the household questionnaire, questions regarding whether the person went to their job on the travel day, whether or not trips were made at work, whether or not other trips were made on the travel day, whether or not the person was interviewed, and whether or not the person used the travel diary were added to the data collection forms. These questions were completed by the interviewer. The household data collection form also included a trip summary section (Section V) that was completed by the interviewer at the end of a survey and an administrative section used to record the progress of the interview. The survey data collection forms were printed on white 11" x 17" inch card stock.



HOUSEHOLD DATA

Please answer the following questions about your household:

1. Is this your correct address? \_\_\_\_\_
2. How many people live in this household? \_\_\_\_\_
3. How many people are 5 years old or older? \_\_\_\_\_
4. How many overnight visitors from outside of the area are staying with you on your travel day? \_\_\_\_\_

5. How many vehicles (cars, vans, light trucks, and motorcycles) are kept at home for use by members of your household? \_\_\_\_\_

6. Is your home:
  - A 1-Family House Detached From Any Other House
  - A Multi-Unit Building (Duplex/apartment/townhouse)

7. What was the combined income from all sources for all members of your household in 1993? (Please circle the appropriate letter.)

- A. Under \$5,000
- B. \$ 5,000 - \$9,999
- C. \$10,000 - \$14,999
- D. \$15,000 - \$19,999
- E. \$20,000 - \$24,999
- F. \$25,000 - \$29,999
- G. \$30,000 - \$39,999
- H. \$40,000 - \$49,999
- I. \$50,000 - \$74,999
- J. \$75,000 or more

Complete one line below for each member of your household. Each line of the table begins with a person number. Please be sure that the person number on this form matches the person number on each persons travel diary.

PERSON NUMBER	RELATIONSHIP				AGE	SEX	LICENSED TO DRIVE?	ARE YOU EMPLOYED: (Check only one box)					ARE YOU A STUDENT IN:				
	Spouse/ Partner	Child	Other Household Member	Out-of-Area Visitor				Full Time	Multiple Jobs	Part Time	Retired	No	Elem / Middle School	High School	Post-High School	Other	
01	Head of Household					<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
02	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
03	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
04	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
05	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
06	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
07	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
08	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
09	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/> M <input type="checkbox"/> F	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please complete one line below for each vehicle kept at home for use by members of your household (include cars you own or lease, company cars, rental cars, motorcycles, etc.). Please be sure that you record the correct vehicle ID number on the travel diaries if one of the vehicles listed below is used for any trips made during your travel day.

VEHICLE ID NUMBER	MODEL YEAR	MAKE (Ford, Oldemobile, Jeep, ...)	MODEL (Taurus, Ciera, Cherokee, ...)	TYPE OF FUEL (Check one)			ODOMETER READINGS ON TRAVEL DAY (Please record to nearest mile)	
				Gas	Diesel	Other	Beginning	Ending
1				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
2				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
3				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
4				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
5				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
6				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
7				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

This completes the household information needed. Please complete the attached travel diaries for all travel on your travel day. Thank you for your cooperation!

Figure 2 Household Data Form



WHERE did you go?	What kind of place was it? (home, bank, restaurant, ...)	WHY did you go there? (Check one)	WHEN did your trip start and end? (Check AM, PM, Noon, Midnight)	HOW did you travel? (Check one)	If you were in a car/van/pickup... Number in Vehicle (include yourself) _____ Vehicle Used (ID #) _____ Parking cost at destination: \$ _____	If in TRANSIT, how did you get to the stop? <input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
4 When I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		
5 Then I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		
6 Then I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		
7 Then I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		
8 Then I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		
9 Then I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		
10 Then I went To: Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social- <input type="checkbox"/> Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> Noon <input type="checkbox"/> PM <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Walk <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus		

Figure 4  
Travel Diary (Back)



TRAVEL DIARY-ADDITIONAL TRIPS

WHERE did you go?		What kind of place was it? (home, bank, restaurant, ...)	WHY did you go there? (Check one)	WHEN did your trip start and end? (Check AM, PM, Noon, Midnight)	HOW did you travel? (Check one)	If you were in a car/van/pickup... (Number in Vehicle include yourself) (ID #)	If in TRANSIT, how did you get to the stop?
Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Home <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational	<input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Other Transit <input type="checkbox"/> Walk <input type="checkbox"/> Yellow School <input type="checkbox"/> Bus	Vehicle Used (ID #) _____ Parking cost at destination: \$ _____ Fare Paid: \$ _____	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Home <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational	<input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Other Transit <input type="checkbox"/> Walk <input type="checkbox"/> Yellow School <input type="checkbox"/> Bus	Vehicle Used (ID #) _____ Parking cost at destination: \$ _____ Fare Paid: \$ _____	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Home <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational	<input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Other Transit <input type="checkbox"/> Walk <input type="checkbox"/> Yellow School <input type="checkbox"/> Bus	Vehicle Used (ID #) _____ Parking cost at destination: \$ _____ Fare Paid: \$ _____	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Home <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational	<input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Other Transit <input type="checkbox"/> Walk <input type="checkbox"/> Yellow School <input type="checkbox"/> Bus	Vehicle Used (ID #) _____ Parking cost at destination: \$ _____ Fare Paid: \$ _____	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
Name of Place _____ Address or Intersecting Streets _____ City, State, Zip Code _____		<input type="checkbox"/> Home <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational	<input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Bicycle <input type="checkbox"/> Other Transit <input type="checkbox"/> Walk <input type="checkbox"/> Yellow School <input type="checkbox"/> Bus	Vehicle Used (ID #) _____ Parking cost at destination: \$ _____ Fare Paid: \$ _____	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____

11 Then I Went To:

12 Then I Went To:

13 Then I Went To:

14 Then I Went To:

15 Then I Went To:

16 Then I Went To:

Figure 5 Travel Diary—Additional Trips (Front)



**NOACA**

**SECTION I: HOUSEHOLD DATA**

Please answer the following questions about your household:

- Is this your correct address?
- How many people live in this household?
- How many people are 5 years old or older?
- How many overnight visitors from outside of the area are staying with you on your travel day?

**HOUSEHOLD DATA**

**SAMPLE NUMBER** \_\_\_\_\_

5. How many vehicles (cars, vans, light trucks, and motorcycles) are kept at home for use by members of your household? \_\_\_\_\_

6. Is your home:

- A 1-Family House Detached From Any Other House
- A Multi-Unit Building (Duplex/apartment/townhouse)

7. What was the combined income from all sources for all members of your household in 1993? (Please enter the appropriate number—use "99" for refused.) \_\_\_\_\_

(1) A. Under \$5,000	(6) F. \$25,000 - \$29,999
(2) B. \$ 5,000 - \$9,999	(7) G. \$30,000 - \$39,999
(3) C. \$10,000 - \$14,999	(8) H. \$40,000 - \$49,999
(4) D. \$15,000 - \$19,999	(9) I. \$50,000 - \$74,999
(5) E. \$20,000 - \$24,999	(10) J. \$75,000 or more

**SECTION V. TRIP SUMMARY**

A. Total Vehicle Trips \_\_\_\_\_

B. Persons age 5 and older making trips \_\_\_\_\_

C. Persons age 5 and older not making trips \_\_\_\_\_

D. Complete or incomplete interview code \_\_\_\_\_

**SECTION II: PERSON DATA**

Complete one line below for each member of your household. Each line of the table begins with a person number. Please be sure that the person number on this form matches the person number on each persons travel diary.

PERSON NUMBER	RELATIONSHIP				AGE	SEX	LICENSED TO DRIVE?	ARE YOU EMPLOYED: (Check only one box)					ARE YOU A STUDENT IN:				WENT TO JOB ON TRAVEL DAY?			TRIP MADE AT HOME?	TRIP MADE AT WORK?	TRIP MADE AT SCHOOL?	TRIP MADE AT OTHER?
	Spouse/ Partner	Child Member	Other Household Member	Out-of-Area Visitor				Full Time	Multiple Jobs	Part Time	Retired	No	Elem / Middle School	High School	Post-High School	Other	1 YES	2 NO	3 WORKED @ HOME				
01	①					1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
02	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
03	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
04	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
05	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
06	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
07	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
08	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
09	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			
10	2	3	4	5		1 M 2 F	1 YES 2 NO	1	2	3	4	5	1	2	3	4	1 YES 2 NO 3 WORKED @ HOME	1 YES 2 NO	1 YES 2 NO	1 YES 2 NO			

**SECTION III. VEHICLE DATA**

Please complete one line below for each vehicle kept at home for use by members of your household (include cars you own or lease, company cars, rental cars, motorcycles, etc.). Please be sure that you use the correct vehicle ID number if one of the vehicles listed below is used for any trips made during your travel day.

VEHICLE ID NUMBER	MODEL YEAR	MAKE (Ford, Oldsmobile, Jeep, ...)	MODEL (Taurus, Civic, Cherokee, ...)	TYPE OF FUEL (Check one)			ODMETER READINGS ON TRAVEL DAY (Please record to nearest mile)	
				Gas	Diesel	Other	Beginning	Ending
1				1	2	3		
2				1	2	3		
3				1	2	3		
4				1	2	3		
5				1	2	3		
6				1	2	3		
7				1	2	3		

**Section VI. Administrative**

A. Telephone contacts:

Date	Time	Outcome	Initials
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

B. Completed interview submitted:

Date: \_\_\_\_\_ By: \_\_\_\_\_

I certify that all the information on this form is correct and true.

\_\_\_\_\_  
Signature of Interviewer

C. If interview submitted incomplete, give reasons:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

D. First edit: FAIL PASS

Date: \_\_\_\_\_ Initials: \_\_\_\_\_

E. Final edit: FAIL PASS

Date: \_\_\_\_\_ Initials: \_\_\_\_\_

**Figure 7**  
**Household, Person, and Vehicle Data Collection Form**



SECTION IV - TRIP DATA

SAMPLE NUMBER \_\_\_\_\_

TRIPS FOR PERSON NUMBER: \_\_\_\_\_  
(Use person number from household data form)

NOTES: \_\_\_\_\_

NAME: \_\_\_\_\_

TRAVEL DAY: \_\_\_\_\_

At 4:00 AM on the travel day, I was at:		Place Code:
<input type="checkbox"/> Home <input type="checkbox"/> Other location as shown below (if not home)		
Name of Place	Kind of Place	Trip Purpose:
Address or Intersecting Streets		
City, State, Zip Code		

WHERE did you go?	WHAT kind of place was it? (home, bank, restaurant, ...)	WHY did you go there? (Check one)	WHEN did your trip start and end? (Check AM, PM, Noon, Midnight)	HOW did you travel? (Check one)	If you were in a car/van/pick-up...		If in TRANSIT, how did you get to the stop?
					Number in Vehicle (include yourself)	Vehicle Used (ID #)	
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							
Name of Place		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick up Passenger 3 Shop 9 Other 4 Eat Meal 5 Social-Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdnt	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Address or Intersecting Streets			End: _____ 1 AM 3 Noon 2 PM 4 Mdnt				Parking cost at destination: \$ _____
City, State, Zip Code							

Figure 8  
Travel Diary Data Collection Form



TRAVEL DIARY-ADDITIONAL TRIPS

WHERE did you go?	What kind of place was it? (home, bank, restaurant, ...)	WHY did you go there? (Check one)	WHEN did your trip start and end? (Check AM, PM, Noon, Midnight)	How did you travel? (Check one)	If you were in a car/van/pickup...		If in TRANSIT, how did you get to the stop?
					Number in Vehicle (Exclude yourself)	Vehicle Used (ID #)	
11 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
12 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
13 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
14 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
15 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
16 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
17 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
18 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
19 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
20 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
21 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
22 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		
23 This I went to		0 Go Home 6 Bank/doctor ... 1 Go to Work 7 Work Related 2 School 8 Drop off/Pick 3 Shop up Passenger 4 Eat Meal 9 Other 5 Social- Recreational	Start: _____ 1 AM 3 Noon 2 PM 4 Mdn End: _____ 1 AM 3 Noon 2 PM 4 Mdn	1 Driver (Auto/Van/Pick-up/...) 2 Passenger (Auto/Van/Pick-up/...) 3 RTA Bus 7 Taxi 4 RTA Rapid 8 Bicycle 5 Other Transit 9 Walk 6 Yellow School 10 Other Bus			1 Walked 2 Bicycled 3 Drove & Parked 4 Dropped off Fare Paid: \$ _____
Name of Place	Address or Intersecting Streets	City, State, Zip Code			Parking cost at destination: \$ _____		

Figure 9  
Travel Diary Data Collection Form—Additional Trips

### 3. Sample Selection

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The sample selection involved the discussion and resolution of important issues such as defining the proper sample frame to minimize any biases, the acquisition of the sample list to achieve the goals of the sample frame, and the use of areawide replicates to utilize the sample list in a consistent manner with the requirements of the sample frame.

#### Sample Frame

The sample frame for the Cleveland Travel Survey was specified as all households with telephones in the modeling area as shown in Figure 1 (Cuyahoga, Lake, Lorain, Geauga, and Medina Counties). Households with telephones were chosen as a proxy for the actual desired sample frame—all households in the study area. Based on 1990 census data, approximately 96.5 percent of the households in the area had telephones. The exclusion of households without telephones introduced a bias into the survey. To solve this problem, non-telephone owning households could have been identified and surveyed using personal, in-home interviewing techniques. However, the cost of performing this type of survey is generally considered disproportionately high in terms of the benefits it yields.

The bias introduced by excluding non-telephone owning households should be small since it reflects, to a large degree, income level. Non-telephone owning households generally represent the "poorest of the poor" households in the region. Households that can afford telephones, but chose not to have them, have trip rates similar to telephone-owning households. Since the survey collected data on household size and income group, it was possible to minimize the effect of the non-telephone owning households on the travel models, especially the trip rates, if the models are stratified by income level.

Data from the 1990 San Juan, Puerto Rico, travel survey were used to analyze these hypotheses. In the San Juan travel survey, a small supplementary sample of non-

telephone owning households was taken. The t-scores for the differences between trip rates for households with and without telephones stratified by income level, auto availability, and household size for San Juan are shown in Table 10 (for cells where sufficient samples existed to compute t-scores). In Table 10, positive t-scores imply that the trip rate for households with telephones was greater than the trip rate for households without telephones; negative t-scores imply that the households without telephones had a higher trip rate. A t-score of  $\pm 1.96$  is required for significance at the 0.05 significance level and the 95 percent confidence level. Thus, the only cells where there were statistically significant differences between in the trip rates for telephone owning and non-telephone households were for the lowest income group and for the lower-middle income, one auto, five or more person households. As can be seen in Table 10, there were statistically significant differences between trip rates for telephone owning and non-telephone owning households in San Juan, even when the households were stratified by income group, auto availability, and household size. However, these differences tend to occur mainly for the "poorest of the poor."

**Table 10**  
**T-Scores Comparing Trip Rates for Households With and Without Telephones—1990 San Juan Data**

Autos Available	Household Size				
	1	2	3	4	5+
Low Income Level (less than \$5,000 per year)					
0	0.28	5.08	3.40	2.47	1.57
1	N/A	3.23	2.52	1.42	1.09
Lower-Middle Income Level (\$5,000 to \$9,999 per year)					
0	N/A	-0.35	1.42	0.00	1.53
1	N/A	-0.76	N/A	N/A	3.78

While there might be statistically significant differences between trip rates for telephone owning and non-telephone households in Cleveland, the potential impact of these differences and overall trip rates should be analyzed.

In Cleveland, only 3.5 percent of the households did not have telephones according to 1990 Census data. Assuming that the non-telephone owning households make trips at one-half the rate of telephone owning households, the effect of not sampling those households on overall trip rates can be hypothesized using existing typical trip generation models. Table 11 shows this analysis based on data collected from non-telephone-owning households in San Juan. As can be seen in Table 11, the number of trips for the low-income households might be overestimated by as much as five percent. However, the overall trip rate for all households will probably be overestimated by less than one percent.

**Table 11**  
**Estimated Impact of Not Sampling Non-Telephone Owning**  
**Households**

Income Group	Percent of Households	Unadjusted 2010 Results		Adjusted 2010 Results		Ratio of Unadjusted/ Adjusted
		Trip Rate	Trips	Trip Rate	Trips	
Low-No Telephone	3.5%	2.4	8.40	1.2	4.20	} 1.055
Low-Telephone	29.8%	2.4	71.52	2.4	71.52	
Middle	33.3%	6.0	199.80	6.0	199.80	
High	<u>33.4%</u>	<u>8.5</u>	<u>283.90</u>	<u>8.3</u>	<u>283.90</u>	1.000
Total	100.0%	—	563.62	—	559.42	1.008

Few recent surveys are known to have included no-telephone households in the survey. In addition to the San Juan survey, a survey is being performed in North Carolina that will collect information on no-telephone households. This survey will provide a second "data point" regarding the effect of excluding no-telephone households from the survey.

The North Central Texas Council of Governments anticipates spending \$900,000 on a home-interview survey for the Dallas-Fort Worth region. However, due to the cost of surveying no-telephone households and the relatively few households in their region that do not have telephones (about six percent as compared to 3.5 percent for the Northeast Ohio region), they do not anticipate surveying no-telephone households. They do anticipate summarizing data from the 1990 Census Public Use Micro-Data Sample (PUMS) to help determine the characteristics of no-telephone households.

In summary, due to the difficulty in finding and the cost of surveying households without telephones, most surveys, including the Cleveland area survey, have excluded no-telephone household from the sample frame. It would be possible to summarize PUMS data to determine the socioeconomic characteristics of no-telephone households to provide guidance regarding the likely impact of no-telephone households on travel in the region. This can be done as part of the model calibration.

### Over-Representation of Households With Multiple Telephone Lines

As part of the recent Portland survey, households were asked a question regarding the number of telephone lines they had that were not permanently connected to a facsimile machine or computer modem. The results were as follows:

Number of Phone Lines	Percent of Households Reporting	
	Recruiting Stage	Completed Survey
1	88.8%	89.4%
2	8.9%	8.6%
3	1.4%	1.2%
4 or more	0.9%	0.8%

Assuming the Northeast Ohio area has the same distribution of households by number of telephone lines, it is possible that one telephone-line households are under-represented by about 13 percent, two telephone-line households are over-represented by about 75 percent, three telephone-line households are over-represented by about 162 percent, and four or more telephone line households are over-represented by about 267 percent.

While the under- and over-representation of households by number of telephone lines is somewhat large, the important issue is whether the travel characteristics of households by number of telephone lines are different. The Portland data have not yet been analyzed to determine the difference in travel characteristics. If the travel characteristics are, in fact, different, two possibilities exist for accounting for these differences in the travel models:

- Adjusting overall travel characteristics (e.g., increasing or decreasing trip rates as appropriate).
- Including the number of telephone lines as an explanatory variable and projecting households by number of telephone lines on a small area basis.

The implementation of the second solution is unlikely. Thus, an overall adjustment of trip rates is the likely correction. If the Portland data show that the number of telephone lines does, in fact, impact the travel characteristics of households, it might be possible to match households against Northeast Ohio telephone listings to determine multiple line households (at least where the multiple telephones lines are listed). The analysis of the results, stratified by the number of telephone lines, could be used to adjust the travel models during model calibration.

### Exclusion of Group Quarters

The household survey was, by definition, a survey of households. The exclusion of group quarters is appropriate in order to prevent biasing the household survey results. If travel characteristics of group quarters are a major concern, a special survey of the

group quarters is appropriate. The survey would probably be similar in many aspects to the workplace survey since it might be difficult to get the agreement of every resident of the group quarters to participate in the survey. For example, one can imagine the difficulty of obtaining the cooperation of all residents of a college dormitory. Only about one percent of the region's population lives in group quarters.

## **Under-Representation of Frequent Travelers**

The discussion concerns two issues. The first issue is when one member of a household is a frequent traveler and not available when the surveyor calls. The survey procedures were designed to maximize the likelihood of reaching frequent travelers through multiple calls, with call-backs being scheduled to coincide with periods when even the frequent traveler should be home. In addition, if it was not possible to reach the frequent traveler directly, travel data were collected from a completed travel diary from another responsible household member.

The second issue occurs when the entire household travels frequently. Up to five call-backs were made to each telephone number when there was no answer to an initial call. The first call-back was made on the same day as the initial call at a later time (if feasible), and subsequent call-backs were made on succeeding days at different hours of the day (i.e., rather than making all calls to a particular household between 5:00 PM and 8:00 PM on multiple days, calling times were varied). This procedure is frequently used in surveys to try to contact "busy" households. However, the limit on call-backs is typically set at five or six calls in order to contain surveying costs. Even with this call-back limit, the procedure reduces the problem of undersampling high-travel households.

The impact of undersampling high travel households can be investigated using the data collected as part of the travel survey. Specifically, trip rates can be determined for households stratified by the number of calls required to recruit the household. A per-person, household-based trip rate might be estimated to reduce the effect of household size. To do this, the number of trips made by a household would be divided by the household size. The per-person trip rates could be compared for common income groups (or auto ownership levels) across the number of calls required to recruit the household. This analysis, which should be considered as part of the model calibration, would provide information on the magnitude of the problem of undersampling high-travel households. A global adjustment factor might then be determined for household trip rates based on the proportion of households that were repeatedly called but never answered the telephone.

## Acquisition of Sample List

As mentioned above, the sample frame was all households with telephones in the modeling area. Based on October 1993 telephone company information,<sup>1</sup> 70.1 percent of the telephones in the Cleveland region have listed telephone numbers. The actual breakdown for the modeling area is shown in Table 12. The sample telephone list was drawn to be representative of the total number of listed and unlisted telephone numbers in the region. Based on a sample size of 1,600, approximately 1,130 households were expected to have listed telephone numbers and 470 of the households were expected to have unlisted telephone numbers.

Note that telephone numbers are unlisted for two main reasons:

- Privacy (i.e., by request)
- Mobility

Households that have specifically requested the telephone company not to list their telephone number in the local telephone directory are "privacy" unlisted numbers. Mobility unlisted numbers include telephone numbers for households that have moved since the last publishing of the telephone directory. Households in this category do not necessarily want their telephone numbers to be unlisted. Rather, they are unlisted because of telephone directory publishing guidelines.

**Table 12**  
**Telephone Ownership and Listing Status in the Cleveland Survey Area for 1990**

County	Number of Households <sup>1</sup>	Households With Telephones Percent	Household With Telephones Numbers	Percent Listed <sup>2</sup>	Numbers Listed
Cuyahoga	563,303	96.4%	543,024	69.3%	376,316
Geauga	26,931	95.3%	25,665	80.2%	20,584
Lake	80,563	98.4%	79,274	78.5%	62,230
Lorain	96,059	95.2%	91,448	67.6%	61,819
Medina	<u>41,850</u>	<u>97.7%</u>	<u>40,887</u>	<u>76.6%</u>	<u>31,320</u>
Total	808,706	96.5%	780,401	70.7%	552,269

<sup>1</sup> Source: 1990 Census, STF - 3A, Table 32

<sup>2</sup> Source: Survey Sampling, Inc., Fairfield, CT.

<sup>1</sup> Provided by Survey Sampling, Inc. (SSI). SSI was the vendor that provided the sample telephone list for the Cleveland area home-interview survey.

Three lists of random telephone numbers were selected to represent the universe of households with telephones in the region:

- A primary list of listed telephone numbers for the region.
- A primary list of unlisted telephone numbers for the region.
- A supplemental list of listed telephone numbers for households in low-income census tracts in the region.

Results from a travel survey performed Albuquerque in 1992 suggested that stratifying the sample by listed and unlisted telephone numbers would not greatly affect the results of the survey. Results from that survey showed that the trip rates for households with unlisted telephones were not statistically significantly different from trip rates for households with listed telephones when the rates are stratified by income group and household size. While this might also be true in Cleveland, substantial numbers of households are included in both the listed and unlisted categories (as shown in Table 12) and efforts were made to ensure that the sample was representative of listed and unlisted telephone numbers. In addition, the use of listed numbers was more efficient for surveying (as opposed to random digit dialing) since more recruiting calls resulted in a contact with a potential survey participant. Thus, the generation of primary lists of listed telephone numbers and unlisted telephone numbers were used for the survey.

The sample acquisition implicitly accounts for households with unlisted telephone numbers due to a recent move. The listed telephone sample obtained from Survey Sampling, Inc. (SSI), was generated from the data base used to generate telephone directories for the region. SSI updates their data base at least annually. Random unlisted telephone numbers were generated by SSI and compared to the listed telephone numbers and business numbers. The remaining unlisted telephone numbers include both "true" unlisted numbers (for privacy purposes) and unlisted numbers due to recent moves. Thus, there should be no bias against households with unlisted telephone numbers due to recent moves. A similar procedure will be used in the upcoming household survey of the North-Central Texas Area.

The supplemental list of telephone numbers was drawn since, based on experience in past surveys, there is a tendency to undersample low-income households. Based on St. Louis and Albuquerque data, sampled low-income households were only 70 percent of the expected number of low-income households. Assuming that a 30 percent undersample would likewise be experienced in the Cleveland home-interview survey led to an attempt to oversample low-income households. This was done by supplementing the sample of telephone numbers with extra telephone numbers drawn from low-income census tracts. Thirty-three tracts were identified in the region with 50 percent or more of the households in the lowest income group category from the 1990 census.<sup>2</sup>

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<sup>2</sup>Source: 1990 Census, STF 3A, Table 19.

For survey purposes, low income was defined as the lowest two income groups (less than \$10,000 per year). For the Cleveland survey, of 1,600 households, this resulted in a group of 214 households. In a simple random sample, the tendency to undersample would result in samples of  $214 \times 0.70 = 150$  low-income samples. Thus, an extra 64 samples were needed from the low-income census tracts noted above. The supplemental low-income samples were spread equally across the 33 census tracts.

The supplementary sample was marked with a special code. In this way, if the undersampling of low-income households was not as severe in the Cleveland area as in other regions, the oversampling of the low-income census tracts could easily be suspended during the course of the survey. Table 13 summarizes the low-income census tracts and the number of samples that were drawn from each of the tracts. Figure 10 shows the geographic distribution of the oversampled tracts. The supplemental samples were drawn from listed telephone numbers since it was possible to match the listed numbers with a census tract.

Not all of the telephone numbers called resulted in completed, usable samples. Outcome possibilities for the initial telephone contacts included:

- Agreement to participate
- Refusal to participate
- Disconnected telephone number
- Wrong number (for listed households) or household has moved
- Commercial telephone numbers
- Fax, modem, TTD, or other electronic equipment
- Telephone continually busy or no answer
- Households outside of the modeling area
- Other unusable (dormitories, barracks, or other group housing)

In addition, some households that did agree to participate in the survey did not result in completed, usable samples. Past experience shows that after an initial agreement is obtained, approximately 85 percent of the agreeing households typically result in completed, usable samples.

**Table 13**  
**Supplemental Samples for Cleveland Area Census Tracts With**  
**High Percentages of Low-Income Households**

County	Census Tract	Household Total <sup>1</sup>	Income <\$10,000	
			Number	Percent
Cuyahoga	502 pt	8	8	100.0%
	1139	19	19	100.0%
	1098	786	687	87.4%
	1047.01	176	135	76.7%
	1138	684	612	89.5%
	1097	1,226	1,010	82.4%
	1132	224	191	78.3%
	1033	511	428	83.8%
	1127	361	271	75.1%
	1096	304	249	81.9%
	1079	297	242	81.5%
	1131	324	229	70.7%
	1077	308	291	94.5%
	1089	641	534	83.3%
	1186.02	1,423	1,047	73.6%
	1093	495	350	70.7%
	1143	992	716	72.2%
	1189	1,291	861	66.7%
	1041	762	472	61.9%
	1186.01	455	318	69.9%
	1147	435	273	62.8%
	1123	470	369	78.5%
	1041	762	472	61.9%
	1148	399	281	70.4%
	1129	325	207	63.7%
	1133	624	380	60.9%
	1121	714	475	66.5%
1128	539	347	64.4%	
1037	462	313	67.7%	
1072	212	184	86.8%	
Lorain	223	354	251	70.9%
	238	317	176	55.5%
	708	641	370	57.7%



The actual number of telephone numbers required to produce the desired sample was calculated using the lowest completion rate information from the Albuquerque and St. Louis surveys (Table 14). In addition, the required numbers of telephone numbers in the sample lists was increased by 17.6 percent to account for the 85 percent completion rate after initial agreement, and by an additional 20 percent to provide a margin of safety and additional telephone numbers for the pretest. The original numbers of telephone numbers by sample type required and purchased are as follows:

<u>Sample Type</u>	<u>Required</u>	<u>Purchased</u>
Listed	4,080	4,100
Unlisted	3,510	3,500
Supplemental	280	280

**Table 14**  
**Disposition of Recruiting Calls From Albuquerque and St. Louis Surveys**

Outcome	Albuquerque				St. Louis			
	Listed		Unlisted		Listed		Unlisted	
	#	%	#	%	#	%	#	%
Agree	1,403	4.9%	609	18.9%	1,118	39.1	776	22.1%
Refuse	1,022	29.8%	553	17.1%	1,124	39.3	648	18.4%
Disconnect	306	8.9%	986	30.6%	234	8.2	1,116	31.8%
Moved	249	7.3%	8	0.2%	71	2.5	93	2.6%
Commercial	97	2.8%	192	6.0%	41	1.4	370	10.5%
Screen Quit	38	1.1%	379	11.7%	-	-	-	-
Busy/No Answer	273	8.0%	314	9.7%	268	9.4	505	14.4%
Out-of-Area	6	0.2%	154	4.8%	2	0.1	0	0%
Language	<u>38</u>	<u>1.1%</u>	<u>31</u>	<u>1.0%</u>	<u>3</u>	<u>0.1</u>	<u>5</u>	<u>0.1%</u>
Total	3,432	100.1%	3,226	100.0%	2,861	100.1	2,513	99.9%

Each of the above mentioned lists was purchased from SSI. The listed telephone numbers were randomly drawn from residential listings for the region. The unlisted telephone numbers were randomly generated. The unlisted numbers generated were checked against business listings to remove commercial telephone numbers, against all listed telephone numbers to remove listed numbers, and against working blocks of telephone numbers to remove non-working blocks of numbers (at least three working telephone numbers had to be found in each block of 100 telephone numbers for the block to be considered a working block of telephone numbers). SSI performed these checks when they developed the sample lists of telephone numbers.

During the course of the survey, a significantly low response rate of households agreeable to participate, was observed, requiring that more households be contacted than could be accommodated by the initial lists purchased from SSI. Consequently, a supplementary sample of telephone numbers was purchased from SSI, consisting of 5,500 random listed and unlisted telephone numbers in the five counties and a sample of 500 listed telephone numbers from selected low-income census tracts (refer to Table 13). All numbers were checked against the original purchase, to avoid duplicates.

There was some likelihood that a portion of the telephone numbers in the sample lists were not actual households that could be used in the survey (especially in the case of unlisted telephone numbers). Some possibilities included:

- Commercial telephone numbers
- Dormitories and barracks
- Other group housing (e.g., nursing homes)

Screening questions were asked during the recruiting call to remove non-usable households and telephone numbers in commercial establishments or group housing from the survey.

### **Use of Areawide Replicates to Avoid Geographic Biases**

The telephone numbers included in the two primary samples were geographically representative of the region assuming they were all used. The supplementary list was not geographically representative of the region since it was drawn from 33 specifically identified census tracts. However the desire to be representative of the socioeconomic distribution for the region outweighed the small amount of bias that the supplemental sample introduced into the geographic distribution over the region.

If the required number of samples was obtained before all of the households represented by the 7,350 telephone numbers were contacted, calling the additional numbers would have been costly. In order to insure representative results for the survey if only a portion of the telephone numbers in the list were called, a replicate system was used. The replicate system also provided the means for using some of the numbers for the pretest without biasing the full survey.

Each of the three sample lists were stratified into 50 (40 for the second sample) replicates. To do this, the 1st, 51st, 101st, ... telephone numbers were assigned to replicate one, the 2nd, 52nd, 102nd, ... telephones numbers were assigned to replicate two; the 3rd, 53rd, 103rd, ... telephone numbers were assigned to replicate 3, and so on. This procedure resulted in 50 replicates for each of the three sample types. The number of telephone numbers in each replicate was as follows:

	<u>Original Sample</u>	<u>Second Sample</u>
Listed:	82	-
Unlisted:	70	-
Supplemental:	5	12

The second primary sample was purchased as a combination of listed and unlisted numbers. The three sample types were combined to form one sample list with 50 replicates for each sample type. Each composite replicate in the original sample included 157 or 158 telephone numbers. Each replicate in the second sample included 150 telephone numbers. Note that replicates 49 and 50 were used for the pretest.

The sample type was included on the combined sample list. This provided the means to discontinue the use of the supplemental list if a sufficient number of low-income households were obtained prior to the completion of the survey. It also provided an option to use additional samples from the supplemental list of telephone numbers from low-income census tracts if it appeared that the "quota" of low-income households in the survey was not being met.

Each replicate was, in effect, a mini-random sample of the survey area and was representative of the survey area, provided that the replicate was completely used. Telephone assignments were distributed to survey recruiters one replicate at a time. Each replicate was completely exhausted once it was opened. In other words, all required call-backs for each telephone number in the replicate were made in the recruiting stage of the survey once the replicate was opened.

## 4. Training Procedures

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The market research firm of Catherine Bryant & Associates (CB&A) had performed travel surveys with BA prior to the Cleveland survey, and, thus, had experienced surveyors and survey management staff available for the Cleveland Home Interview Survey. Nevertheless, training of the surveyors was not taken lightly.

A key element of the training program was the preparation of two detailed training manuals: a *Home Interview Survey Interviewer/Recruiter Manual* and a *Home Interview Survey Editing and Coding Manual*. The following chapters comprised the interviewer and recruiter manual:

- The **Introduction** provided general background information on the Cleveland Area being surveyed as well as general background regarding the survey.
- **Instructions to Interviewers** provided information on specific interviewer responsibilities.
- **Conducting the Interview** provided detailed instructions regarding the conduct of the actual data collection interview.
- **How to Fill Out the Survey Forms** provided detailed instructions on how to record the survey information on the two survey forms as well as detailed information for each question including allowable responses and codes.
- The **Appendices** described the initial telephone contact procedures for survey respondent recruiters, defined terms used in the travel survey, defined land-use codes, provided an example travel survey packet that would be mailed to participating households, and provided an example work packet of materials for a surveyor.

The final document was entitled, *Home-Interview Survey Interviewer and Recruiter Manual* prepared for the GCRTA and NOACA by Barton-Aschman Associates, Inc., and dated April 1994.

The *Editing and Coding Manual* contained useful information on procedures to edit and code the forms so that the data could be efficiently entered into the appropriate data bases by data entry personnel. The chapters of the manual were as follows:

- The **Introduction** provided general information on the importance of editing the data and why it is necessary.
- **Editing Instructions** provided instructions on checking the survey forms for omissions and legibility of data as well as inconsistencies amongst responses.
- **Coding Instructions** provided very detailed information on codes to be used for each data item and their meanings. The chapter was divided into sections representing each type of survey form.
- The **Appendices** of the manual included a set of procedures for keying the survey data, including the specific file formats of the survey data files, a set of land use codes that are used in the coding of the trip diaries, and a set of vehicle make and model codes.

A training session for interviewers was held at the CB&A offices in Clemmons, North Carolina, prior to the survey pretest. The training session included a practice session with role playing of recruiting calls and the data collection telephone survey.

## **5.**

# **Conduct of the Survey**

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### **Procedural Overview**

A Management Information System is central to the implementation and management of a regional travel survey. It is viewed metaphorically as a machine that is fueled by telephone recruiting data, sample data, and household interview data, and produces survey implementation materials, progress reports, and check lists.

Each aspect of the survey required interaction with a central database file. This data base file contained the random sample of households for the survey area acquired from SSI (see Chapter 4). Continual updates to the central data base file was key to the success of accurately tracking the status of the various households.

The process also included a survey editing/checking program (SURVCHK) that was customized for use in the Cleveland Home Interview Survey. SURVCHK performed checks on the travel data that were collected and keyed into dBASE IV data base files. The following types of checks were performed:

- Range checks on household data.
- Range checks on person data.
- Range checks on vehicle data
- Range checks on trip data.
- Inter-record checks comparing trip information to household and person data.

### **Recruiting Calls**

Recruiting calls were made to households included in the random sample of listed and unlisted telephone numbers purchased for this survey. The objectives of the recruiting calls were as follows:

- Introduce the household to the purpose of the travel survey and the fact that the survey was being conducted on behalf of the GCRTA and NOACA.
- Enlist the cooperation and agreement of the members of the sample household to take part in the travel survey including the recording of travel on the travel diaries.
- Set the travel date for the household members to record their travel.
- Determine the number of people in the household, the number of household members five years old and older, and the number of vehicles available to the household.
- Obtaining the name and address of the party answering the telephone (more reliable than verifying the information included in the sample database).

The screener sheet was used to record the results of the recruiting calls. It also was a script sheet for the interviewer. An example form is shown in Figures 11 and 12. The form accommodated multiple callbacks to households if the initial calls resulted in no answer or a busy signal. If a household was willing to participate in the survey, the interviewer selected the travel day for the household.

At the end of each day's recruiting session, the telephone interview coding forms were collected and separated into three groups:

- An acceptance group for households agreeing to participate.
- A "dead" group for refusals, disconnected numbers, commercial numbers, busy or no answer on six attempts, or other (e.g., language) problems.
- A call-back group for those telephone numbers that were busy or there was no answer for less than five continuous days.

The acceptance and dead groups were turned over to the data entry staff for input into the central database file. After input, the forms were placed into a file for storage. The call-back group was used in the following recruiting session.

CB&A # 94-073  
April/May 1994

**SCREENER**

CLEVELAND HOME INTERVIEW SURVEY

NAME: Mr./Ms. \_\_\_\_\_ HH ID #: \_\_\_\_\_ REP #: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

CITY: \_\_\_\_\_ TRAVEL DATE: \_\_\_\_\_

ZIP: \_\_\_\_\_ PHONE: ( ) \_\_\_\_\_ DATE: \_\_\_\_\_ INTV: \_\_\_\_\_

---

ASK TO SPEAK WITH MALE OR FEMALE HEAD OF HOUSEHOLD. Hello, my name is \_\_\_\_\_. I'm calling on behalf of the Northeast Ohio Areawide Coordinating Agency and the Greater Cleveland Regional Transportation Authority. We are conducting a travel survey of randomly selected families who reside in the Northeast Ohio area. Your family has been selected in the sample, and we would really like your help on this important survey.

IF PERSON ASKS PURPOSE OF SURVEY: NOACA and GCRTA are studying traffic patterns and travel habits so that travel options such as roads and the transit system can be improved and it will be easier to travel in the area. To do this, we need to find out about how people get around in the area. The information from your household will be combined with similar information from 1,600 other households to make a detailed picture of the travel patterns in your area.

IF SCREENING CALLBACK APPOINTMENT NEEDED, ENTER DATE/TIME: \_\_\_\_\_

1. First, please tell me the county where this household is located?

Cuyahoga >> City of Cleveland	-1
Cuyahoga >> Not inside City	-2
Geauga	-3
Lake	-4
Lorain	-5
Medina	-6

NOT ANY LISTED COUNTY [ ] >>> (Thank and Term)

2. How many automobiles, pickup trucks, vans, or motorcycles are kept at home for use by members of your household?  
Write in number: \_\_\_\_\_

3. Including yourself, how many people live in this household?  
Write in number: \_\_\_\_\_

4. And how many people in this household are five years old or older?  
Write in number: \_\_\_\_\_

5. We need information regarding weekday travel by households such as yours and we would like your cooperation in this study. You would be sent a packet of one day travel diaries. We would like you and other members of your household and out-of-town guests to make entries on these diaries for any travel performed next (weekday/date). You will also receive a letter from the Executive Director explaining the need for your help, and an example of the filled out travel diary. It really is quite simple, and will help us study the way people get around in the Northeast Ohio area. May we count on your household to take part in this study?

Yes >>> CONTINUE

No >>> THANK/TERM

6a. Great! That will really help us. Let me get your name and address so I can send you the travel survey materials. (RECORD NAME/ADDRESS AND TRAVEL DATE AT TOP OF SCREENER) We'll send enough diaries for each overnight guest and member of your household who is at least 5 years old. (VERIFY Q4-NUMBER IN HOUSEHOLD AGE 5 OR OLDER -- CORRECT Q4 RESPONSE IF NECESSARY)

6b. In addition to those household members, are you expecting any out of town guests who will stay overnight in your household next (TRAVEL DAY/DATE)?

No >>> CONTINUE

Yes >>> Enter # >>> \_\_\_\_\_

7. Thanks again for helping with the survey. We'll call you the day before your travel day to remind you about the study and to be sure you got your diaries, and then again a day or two after the travel day to collect the information. We'd like to speak directly to each member of your household who is at least 16 years old. What time of day would be best for us to call you back? (READ LIST)

Morning	-1	Afternoon	-2	Evening	-3
---------	----	-----------	----	---------	----

Figure 11  
 Screener Sheet (Front)

8. Since your household will be representing hundreds of households in your area, it is important to remember that each household member or out of town guest who is five years old or older needs to fill out a travel diary next (TRAVEL DAY/DATE).

Would you please let everyone in your household know as soon as possible about the study so that the packet we send you tomorrow won't be misplaced? If you have questions before you receive the packet, you can call us toll free at 1-800-779-8966.

Thanks again. Have a good day/evening/night.

**Initial and Date as Each Completed:**

Recruit Completed: \_\_\_\_\_

Entered into Database: \_\_\_\_\_

Diaries Mailed: \_\_\_\_\_

Reminder Made: \_\_\_\_\_

Callback 1: \_\_\_\_\_ Result: \_\_\_\_\_ Entered: \_\_\_\_\_

Callback 2: \_\_\_\_\_ Result: \_\_\_\_\_ Entered: \_\_\_\_\_

Callback 3: \_\_\_\_\_ Result: \_\_\_\_\_ Entered: \_\_\_\_\_

Callback 4: \_\_\_\_\_ Result: \_\_\_\_\_ Entered: \_\_\_\_\_

Callback 5: \_\_\_\_\_ Result: \_\_\_\_\_ Entered: \_\_\_\_\_

Callback 6: \_\_\_\_\_ Result: \_\_\_\_\_ Entered: \_\_\_\_\_

**Figure 12**  
 **Screener Sheet (Back)**

As earlier mentioned, a telephone patter or script printed directly on the screener sheet was used in conjunction with the recruiting calls. The script standardized the information given to the household respondent and explained the purpose of the survey. However, telephone recruiters were allowed to modify the script slightly so that they were more comfortable with the wording. This made the script flow more smoothly and sound more natural to the respondent.

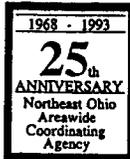
There were seven possible outcomes each time a candidate telephone number was dialed. The possible outcomes were as follows:

- Complete, household agreed to participate.
- Refused, household declined to participate.
- Disconnected telephone/TTD/Computer/Fax Machine.
- Commercial number (from unlisted telephone numbers).
- "Screening" Quit (e.g., group housing)
- Busy or no answer (a total of six attempts were made; busy also counted as an attempt).
- Language Problems.

## **Mail Information Packets**

When a household agreed to participate in the survey, it was sent a packet of forms including a cover letter signed by the Executive Director of NOACA, Howard Maier, an instruction sheet for the survey, an example travel diary, a travel day reminder card, a set of questionnaires regarding household data, person data, and vehicle data, and travel diaries. The household's travel day and date were stamped on the travel diaries and the reminder card prior to the compilation of a packet to be mailed to a household. The number of travel diaries required by the household was estimated based on the number of persons five years old and older and the number of visitors living in the household. Examples of the household data questionnaires and the travel diary are shown in Figures 2, 3, and 4. Figures 13 to 16 show examples of the other forms sent in the mail-out packet.

This task employed four sets of mailing labels: one for the envelope of the mail information packet, a second for the screener sheet, a third for the household data questionnaire form (included in the mail information packet), and a fourth for the household data collection form. In addition, mailing check lists, reminder check lists and call-back dialing records were prepared. All households for a specific travel day were listed on the mailing check list. As the travel packets were prepared, they were checked-off on the mailing check list. When a packet was mailed, the household was checked-off on the travel day check list. Packets were mailed to participants six to nine days before their travel day. This procedure ensured that each household received its packet of information for the survey in a timely manner, was reminded of its travel day on the previous day, and was called the day after the travel day to collect the data.



**NORTHEAST OHIO AREAWIDE COORDINATING AGENCY**

Serving all county, municipal and township governments in Cuyahoga, Geauga, Lake, Lorain and Medina Counties

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Ohio Department of Transportation - District 12
- Bill Stowroszek  
Chief, Northeast District Office  
Ohio Environmental Protection Agency



Dear Northeast Ohio Area Resident:

Thank you for agreeing to participate in the Household Travel Survey being conducted by the Northeast Ohio Area-wide Coordinating Agency (NOACA) in cooperation with the Greater Cleveland Regional Transit Authority. Cooperation from you and the other members of your household is essential to planning improvements to transit and highway facilities to ease highway congestion and improve traffic conditions.

The travel data gathered during the telephone interview with you will be used to identify short-term and long-range transportation needs in the NOACA area which includes Cuyahoga, Geauga, Lake, Lorain, and Medina Counties. Catherine Bryant & Associates, Inc. (CB&A), a firm specializing in transportation surveys, has been retained to assist in the collection of travel data.

As the CB&A interviewer mentioned on the telephone, 1,600 households have been randomly selected as a representative sample of the five county area. The information obtained from each household will be used to establish the region's current travel patterns and characteristics. Materials and instructions for providing this information are included in the packet accompanying this letter. Please be assured that your responses will remain strictly confidential.

If you have any questions about the instructions or the purpose of this survey, please call CB&A toll-free at 1-800-779-8966. If you have any further questions or comments about this survey, please call Mr. Joe Cole of the Northeast Ohio Area-wide Coordinating Agency at 241-2414 (Ext. 280).

Thank you again for your time and cooperation.

Sincerely,

Howard R. Maier  
Executive Director

888 Euclid Avenue, Atrium Office Plaza, Cleveland, Ohio 44114-3000 (216) 241-2414 Fax (216) 621-3024  
(Printed on Recycled Paper)

Figure 13  
Cover Letter



# Reminder

**Your Travel Day is:**

**4:00 a.m. of travel day to 4:00 a.m. of next day**

**Remember, a separate travel diary should be used to record all trips for every member of your household age five and older!**

**Thank you for your help  
in this very important study!**

**For further information call 1-800-779-8966**

**Figure 14  
Travel Day Reminder Sheet**



CLEVELAND AREA TRAVEL SURVEY  
INSTRUCTIONS

This survey has two parts:

**Household Data** contains information about you and your household. Some information has already been filled in based on our telephone conversation with a member of your household.

**Travel Diaries** are forms for each member of your household and out-of-area visitor to your household to record travel on, for your travel day. The travel diaries are provided for each person to use to keep an accurate record of his/her trips throughout the day. They will also speed up the telephone interview when we call to collect the travel data for your household.

Please ask each member of your household and out-of-area visitor to your household to carry a travel diary with him/her on the travel date and to record each trip when it is made (even if the trip is made with another member of the household). Be sure to record the person's name and person number (from the Household Data section) on the travel diary. Please keep a travel diary for the household members and visitors age five or older who are unable to fill out the diary themselves.

Extra travel diary forms have been provided. A person should use extra diaries if one is not enough.

Record all trips that you make during the day, including walk and bicycle trips, as long as they cross a street from where you start the trip. For example, if you are at work and walk across the street for lunch, record the trip. However, if you walked next door for lunch without crossing the street, the trip would not be recorded as a trip.

If you make a trip in a vehicle that is kept at home for use by members of your household, please record the vehicle identification number from the household data form on your travel diary.

The start time for a trip made in a vehicle is when you first put your car in motion. The end time for the trip is when you have finished parking your car at your destination. For walking trips, the start time is when you leave the building or place where your trip starts and the end time is when you arrive at the building or place where your trip ends.

A sample trip diary for the trips in the following example has been included in the packet:

**Example:**

- (1) You leave home in vehicle 1 at 7:21 AM and drive your child to a daycare center, arriving at 7:32 AM
- (2) You leave the daycare center in vehicle 1 at 7:41 AM to drive to work, arriving at 7:59 AM
- (3) You ride to lunch with your boss in her car, leaving at noon and arriving at 12:11 PM
- (4) You walk to a meeting, leaving at 1:17 PM and arriving at 1:23 PM
- (5) You ride the bus back to work, leaving at 3:34 PM and arriving at 3:48 PM
- (6) You leave work in vehicle 1 at 5:03 PM to drive to the daycare center to pick up your child, arriving there at 5:24 PM
- (7) You and your child leave the daycare center in vehicle 1 at 5:27 PM, and stop at McDonald's drive-up window to buy supper, arriving there at 5:37 PM
- (8) You leave the McDonald's drive-up window at 5:44 PM, and arrive home at 5:47 PM

If you have any questions, please call the Travel Survey Office toll-free at 1-800-779-8966.

For your convenience, we will call you within three days after your travel day to collect your information. All of your answers are strictly confidential. **THANK YOU**

Figure 15  
Travel Survey Instructions



TRAVEL DIARY

TRIPS FOR PERSON NUMBER: 1  
(Use person number from household data form)

NAME: David

TRAVEL DAY: Tuesday, April 26

INSTRUCTIONS:

- Record trips in the order you make them.
  - Include the specific information requested for each trip.
  - Record each trip even if made with another household member.
  - Record walking and bicycle trips only if you leave the block you start the trip from (that is, if you cross a street).
  - If a vehicle kept at your home for use by members of your household is used for a trip, record the correct vehicle ID number from the household data form for that trip.
  - At the end of your travel day, leave all completed diaries in a convenient place at home so they will be available when the interviewer calls.
- Use the back of the form and an extra card, if necessary. If you have any questions about completing this travel diary, please call our toll-free number: 1-800-779-8966

At 4:00 AM on the travel day, I was at:  
 Home  
 Other location as shown below (if not home)

Name of Place \_\_\_\_\_ Kind of Place \_\_\_\_\_  
 Address or intersecting Streets \_\_\_\_\_  
 City, State, Zip Code \_\_\_\_\_

WHERE did you go?	WHAT kind of place was it? (home, bank, restaurant, ...)	WHY did you go there? (Check one)	WHEN did your trip start and end? (Check AM, PM, Noon, Midnight)	HOW did you travel? (Check one)	If you were in a car/van/pick-up...		If in TRANSIT, how did you get to the stop?
					Number in Vehicle (include yourself)	Vehicle Used (ID #)	
1 Name of Place: <u>Little Rascals</u> Address of intersecting Streets: <u>Lee &amp; Mayfield</u> City, State, Zip Code: <u>Cleveland Heights, OH</u>	<u>Daycare</u>	<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational <input checked="" type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input checked="" type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: <u>7:27</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: <u>7:32</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input checked="" type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus	2 1	Parking cost at destination: \$ <u>0.00</u>	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input checked="" type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
2 Name of Place: <u>Euclid Consultants</u> Address of intersecting Streets: <u>2930 Euclid Avenue</u> City, State, Zip Code: <u>Cleveland, OH 44115</u>	<u>Office Building</u>	<input checked="" type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: <u>7:57</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: <u>7:57</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input checked="" type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus	1 1	Parking cost at destination: \$ <u>0.00</u>	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input checked="" type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____
3 Name of Place: <u>Shirazi's</u> Address of intersecting Streets: <u>Tower City</u> City, State, Zip Code: <u>Wesland, OH</u>	<u>Restaurant</u>	<input type="checkbox"/> Go Home <input type="checkbox"/> Go to Work <input type="checkbox"/> School <input type="checkbox"/> Shop <input checked="" type="checkbox"/> Eat Meal <input type="checkbox"/> Social-Recreational <input type="checkbox"/> Bank/doctor ... <input type="checkbox"/> Work Related <input type="checkbox"/> Drop off/Pick up Passenger <input type="checkbox"/> Other	Start: <u>12:00</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt End: <u>12:11</u> <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM <input type="checkbox"/> Noon <input type="checkbox"/> Mdnt	<input checked="" type="checkbox"/> Driver (Auto/Van/Pick-up/...) <input type="checkbox"/> Passenger (Auto/Van/Pick-up/...) <input type="checkbox"/> RTA Bus <input type="checkbox"/> RTA Rapid <input type="checkbox"/> Other Transit <input type="checkbox"/> Yellow School Bus	2 2 2	Parking cost at destination: \$ <u>1.50</u>	<input type="checkbox"/> Walked <input type="checkbox"/> Bicycled <input checked="" type="checkbox"/> Drove & Parked <input type="checkbox"/> Dropped off Fare Paid: \$ _____

Figure 16 Example Travel Diary

## Reminder Calls

During the evening before each travel day, households were called and reminded that their travel day was the next day. A reminder call check list of the telephone number, travel day, name of addressee, number of travel diaries required, and a check-off box with result of call was used by the interviewers.

## Data Collection Calls

The actual telephone interviews were conducted one to three days after the household's travel day. For each interview session, all telephone interviewers were given the necessary material to complete the interviews including:

- The original screener sheet.
- The call-back dialing record.
- The household data collection form on which to record the household, person, and vehicle data.
- Blank trip diaries to record the trip data collected on the phone.

The call-back dialing record form (one per household) was used by the interviewer to record his or her daily progress for an assigned interview. The interviewers separated the dialing record from the household data collection form only when the survey was completed. The interviewer filled out the summary information for each completed interview (number of trips, completion code, and income group) on the household data collection form at the end of every complete interviewing session. The information on the dialing record was entered into the central data base file after every interview session to keep track of the progress of the survey.

At the end of every interviewing session, the interview materials were collected and separated manually into three groups:

- Completed interview group.
- An incomplete survey group.
- A survey reassignment group.

The completed interview group consisted of successful interviews and interviews that were unsuccessful due to household refusal or other reasons. This group was turned over to the editing and coding staff for immediate processing. Any interviews that required a call-back were placed in the incomplete group and were used in the following interview session. Note that if households needed to be rescheduled, a new travel date was selected for the household and entered into the central data base file.

There were five possible outcomes from each survey:

- *Complete.* A completed survey.
- *Refused.* The household refused to participate in the survey (after initial agreement in the recruiting call).
- *No Answer/Busy or Answering Machine After Repeated Calls.* No contact could be made with the household after at least six callbacks.
- *Language Problem.* Data could not be collected from all members of the household due to language problems.
- *Telephone Number no Longer in Service.* The household's telephone number was disconnected between the initial recruiting call and the data collection call. This was identified by the recording, "I'm sorry, that number is no longer in service."

Note that data collection calls could have taken several days to complete. Attempts were made to personally interview all members of the household over 15 years of age (information from younger children was collected from an adult member of the household based on the child's travel diary). This required callbacks to households when not all family members were present during an interviewing session. If an absent member of the family (on the survey data collection day) had completed a travel diary, the information on the travel diary was collected in lieu of a personal interview as a last resort.

Interviewers were trained to ask questions and probe for additional information and trips without suggesting possible answers to the respondents. Some general phrases that were used to get the additional information without leading the respondent were:

- "Please explain that a little more."
- "Could you be more specific?"
- "I'm not sure I understand. Would you explain that again?"
- "On the last trip you said you made yesterday from your office to your house, did you make a stop for any reason along the way?"
- "And where did you go next?" was asked after each trip that was enumerated by the respondent.
- "And did you stop anywhere along the way?" was asked before the interviewer recorded the trip.

Interviewers were also trained to look at the reasonableness of a pattern of trips to ensure that trips were not missed. For example, if a trip was made to work, the interviewer made sure that a trip was made from work (unless there were mitigating circumstances such as a very long work day to meet a deadline or working outside of the survey area).

## Data Editing, Coding, and Keying

Completed surveys were edited, coded, and keyed to computer data files during this task. Initial editing and coding of the survey data were performed manually. The surveyor made an initial check to ensure that all information was obtained for the survey, that the information was logical, and that the information was clearly written on the household and trip collection forms. The survey forms were then given to editing staff for a double check of the information recorded on the survey forms. The editing of a survey could have required a follow-up phone call to the household by an editor and/or supervisor to resolve any problems detected with the collected information.

The data collection forms were, to a large extent, self-coding. Surveyors circled numbers or letters of responses or recorded a letter or number as a response. However, three items required coding by the editing staff. Specifically, the income code was a letter designation on the household data collection form. This information was converted to a numeric designation by the editors. On the travel data collection form, surveyors recorded a description of the land use at the destination of the trip. Editors converted this information to a one-digit land use code. Finally, to streamline the entry of vehicle makes and models, a series of three-digit codes were used by editors to designate both the make and model of the vehicle. This code was entered instead of the alphanumeric information.

After a sample passed the initial editing and coding procedure, it was passed to data entry personnel for keying into dBASE files. Four different record types were keyed: household data (record type 1), person data (record type 2), vehicle data (record type 3), and trip data (record type 4). There was one household data record for each sample number, one person record for *each* member in the household age five years and older, one vehicle record for each vehicle, and at least one trip record (the zero trip record) for each member of the household age five years and older.

After key entry, the data were input to the TSMIS editing program, SURVCHK. The program performed range edits on individual fields, intra-record checks (e.g., to ensure that the starting time of a trip was not after the ending time for the trip), and inter-record checks (e.g., to ensure that there are the correct number of person records for the number of people listed in the household). The edit checks performed by SURVCHK are shown below:

### **Household Data Range and Intra-Record Checks**

The following lists the range and intra-record checks performed on the household data:

- Sample type must be 1, 2, 3, 4, 5, or 6 (primary listed telephone number, primary unlisted telephone number, telephone number from supplementary list for low-income census tracts, supplemental; both listed and unlisted telephone number, or supplemental; telephone number from low-income census tract)
- Family size must be in range 1 - 20
- Family size in the range 10 - 20 (warning only)
- Family size for age five and above must be in range 1 - 20
- Family size for age five and above in the range 10 - 20 (warning only)
- Family size for age five and above must be less than or equal to family size
- Number of visitors must be in the range 0 - 10
- Number of autos must be in range 0 - 20
- Number of autos in the range 10 - 20 (warning only)
- Structure type must be in the range 1 - 2
- Income code must be 99 (unreported) or in the range of 1 - 10
- Travel day must be a valid travel date
- The number of people making trips plus the number of people not making trips must equal the number of household members age five and above plus the number of visitors

### **Person Data Range and Intra-Record Checks**

The following lists the range and intra-record checks performed on the person data:

- Person number must be numbered in increasing order with no gaps (e.g., the person record for person 2 would be in error if no person number 1 was found)
- Relationship code must be in the range 1 - 5
- Age must be 0 (not coded) or in the range 5 - 99
- Sex must be 1 (male) or 2 (female)
- Drivers license must be 1 (yes) or 2 (no)
- If drivers license is 1 (yes), age must be 0 (not reported), or 16 or older (note, 15 year olds with learners' permits were allowed to pass edits)-warning only
- Employment status must be in the range 1 - 5
- Student status must be in the range 1 - 4 or 9 (not a student)
- If age is in the range 5 - 13, student status should not be 2 (High School)
- If age is in the range 16 - 99, student status should not be 1 (Elementary School)
- If age is in the range 21 - 99, student status should not be 2 (High School)
- If age is in the range 5 - 16, student status should not be 3 (Post High School) or 4 (Other School)

- If age is in the range 6 - 14, student status should not be 9 (not a student)
- Went to job on travel day code must be in the range 1 - 3
- If went to job on travel day is 1 (yes) or 3 (worked at home), employment status must be 1 (employed full time), 2 (employed multiple jobs), or 3 (employed part time)
- Trips made at work code must be 1 (yes) or 2 (no)
- If trips made at work code is 1 (yes), went to job on travel day code must be 1 (yes) or 3 (worked at home)
- Made other trips on travel day code must be 1 (yes) or 2 (no)
- Interviewed code must be 1 (yes) or 2 (no)
- Used diary code must be 1 (yes) or 2 (no)

### ***Vehicle Data Range and Intra-Record Checks***

- The vehicle number must be in increasing order with no gaps (a gap implies a missing or duplicate vehicle)
- The vehicle make and model code must have a corresponding entry in the vehicle list data base
- A household with no vehicles should not have any corresponding records in the vehicle file
- The vehicle year must be in the range of 1900 - 1994 or (0 - 94)
- The fuel type code must be either 1 (Gas), 2 (Diesel), or 3 (Other)
- The beginning odometer reading must be less than or equal to the end odometer reading
- Vehicle mileage should be in the range of 2500 - 25000 per year (warning only)
- The vehicle mileage accrued in one day should be less than or equal to 100 (warning only)

### ***Trip Data Range and Intra-Record Checks***

The following lists the range and intra-record checks performed on the trip data:

- Person number and trip number must be in increasing order with no gaps within each household (a gap implies a missing trip record or records)
- Address coding type must be in the range 1 - 4
- If address coding type is 1 (actual address), street number and street name must be coded
- If address coding type is 1, the fields for the second street name, street direction, and street type must be blank.
- If address coding type is 2 (intersecting streets), the two intersecting street names must be coded
- If address coding type is 2, the field for the street number must be blank

- If address coding type is 3 (place name) or 4 ("home"), street number and street name information must be blank
- If address coding type is 3 (place name), the place name information must be non-blank
- If address coding type is 4 ("home"), the place name information must be coded as "home" or blank
- If address coding type is 1 - 3, city information must be non-blank
- Kind of place code must be in the range 0 - 9
- If address coding type is 4, kind of place code must be 0
- Trip purpose code must be in the range 0 - 10 or 14 - 19
- If trip purpose code is 10 (other), trip purpose comment must be non-blank
- If trip purpose code is not 10 (other), the trip purpose comment must be blank
- If trip purpose code is 0 (return home), address coding type must be 4
- If trip purpose code is not 0, address coding type must be in the range 1 - 3
- If the trip is the "00" trip record, all information for beginning and ending time, mode, auto occupancy, parking cost or fare, and parking or fare payment method must be 0 or blank
- Trip start time must be in the range 0 - 1200
- Trip start am-pm code must be in the range 1 - 4 (am, pm, noon, or midnight)
- If trip start time am-pm code is 3 or 4, start time must be 1200
- Trip end time must be in the range 0 - 1200
- Trip end am-pm code must be in the range 1 - 4 (am, pm, noon, or midnight)
- If trip end time am-pm code is 3 or 4, end time must be 1200
- Trip starting time must be before trip ending time (unless the trip starts at or after 4:00 am and ends between midnight and 3:59 am the next day)
- Mode code must be in the range 1 - 9
- If mode code is 9 (other), mode code comment must be non-blank
- If mode code is 1 (auto driver), 2 (auto passenger), or 6 (motorcycle), auto occupancy should be in the range 1 - 9 (warning if auto occupancy greater than 9)
- If mode code is 3 - 10, auto occupancy must be 0
- If the mode code is not 10, "other," the mode comment field must be blank
- If mode is 1 (auto driver), 2 (auto passenger), or 7 - 10, the transit arrival mode must be 0
- If the mode code is 3 - 6, the transit arrival code must be in the range 1 - 4.

In addition to the above checks, kind of place codes are cross-tabulated against trip purpose for logic checking.

### **Inter-Record Checks**

The following lists the inter-record checks performed on the household, person, and trip data:

- A person record must be found for each person aged five or older and each visitor
- The highest person number must be equal to the sum of the number of persons aged five or older plus the number of visitors
- A "00" trip record must be found for each person
- A person without a drivers license (on a person record) must not be an auto driver for a trip (warning only)
- Work or work related trips (on a trip record) must not be made by non-employed persons (on a person record)
- School trips (on a trip record) must not be made by non-students (on a person record)
- Persons who went to their job on the travel day (on a person record) must have at least one trip to work (on a trip record)
- Persons who did not go to their job on the travel day (on a person record) must have zero trips to work (on their trip records)
- Persons who made trips while at work (on a person record) must have at least 2 trips to work (on their trip records)
- A person who left home during the day must have their last trip as a "go home" trip (warning only)
- A person who made a trip to work must leave work during the day (warning only)
- The sum of trips made in motorized vehicles (modes 1 - 7) from the trip records must equal the number of vehicle trips coded on the household record
- The number of trip makers summarized from the trip records must match the number of trip makers recorded on the household record
- Each sample number found on a person or trip record must have a household record
- Each household record must have a record in the TSMIS sample file
- The number of vehicles available to a household (on a household record) must equal the number of vehicles described in the VEHSDATA.DBF file for that household
- A non-zero vehicle ID# used for a trip must have a corresponding vehicle record

Samples that completely passed the editing were copied into the final data files. Samples that failed the editing were copied to a "reject" file for correction. Rejections could have been caused by keying errors or problems missed in the initial editing and coding step.

Several documents more fully explain the conduct of the survey and the survey editing:

- *Home-Interview Survey Interviewer and Recruiter Manual*, prepared for the GCRTA and NOACA, Barton-Aschman Associates, Inc., April 1994.
- *Home Interview Survey Editing and Coding Manual*, prepared for the GCRTA and NOACA by Barton-Aschman Associates, Inc., April 1994.
- *SURVCHK User Documentation*, prepared for the GCRTA and NOACA by Barton-Aschman Associates, Inc., April 1994.

## Survey Monitoring Process

Catherine Bryant & Associates (CB&A) used quality control staff, completely separate from the data collection staff, to monitor the survey and assure the maintenance of high quality data. The quality control staff monitored selected interviewer telephone calls, and performed the editing described above. Supervisors (1 per 10 interviewers) continually monitored the surveyors by spot-checking the data they collected.

For the recruiting calls, the quality control staff monitored recruiter calls for thoroughness and clarity. Quality control staff monitored selected telephone calls for each recruiter to determine whether or not the recruiter followed the script as written, how well they explained the purpose of the study, how well they listened to the respondent, the thoroughness of their probing for names and addresses, the level of interest of the recruiter, and the tonal quality of the recruiter. Monitoring of recruiters was "blind"—recruiters did not know when quality control staff were monitoring their calls. Any deviations or problems were noted on a validation form and verbally related to the recruiter either by the quality control staff or by the recruitment supervisor.

CB&A also monitored recruiter productivity. Specifically, they monitored the number of households recruited per dialing hour by each recruiter as well as the recruiter's number of dialings per hour. This was compared with the number of households retained throughout the process. Recruiters were retrained or reassigned if they did not meet a minimum level of productivity or if they could not retain the households through the data collection process.

CB&A also monitored interviewers collecting the travel survey data. Several types of checks were performed. First, completed interviews were checked in the field data collection section (the group actually making the telephone calls). Problems noted were returned to interviewers for immediate clarification or correction. The field unit supervisor monitored whether specific interviewers had an inordinate number of surveys returned for clarification.

As surveys were edited in the field unit, they were passed to quality control staff for the editing described in the Data Editing, Coding, and Keying section above. As with

the field unit checks, if an interviewer had an inordinate number of surveys that required problem correction, the field supervisor was notified so the interviewer could be retrained or reassigned. Surveys requiring call-backs as determined by the editors, were returned to the supervisor/interviewer for immediate attention. Much of the interviewing and editing occurred simultaneously.

As with the survey recruiters, quality control staff monitored selected interviews for each interviewer throughout the survey. Particular attention was paid to probing for address information (for trip destinations), the tone of voice used by the interviewer, and the overall flow and pace of the interview.

CB&A monitored the productivity of the interviewers on a daily basis. Productivity was evaluated by the number of surveys completed, the productivity of each interviewer (in completed surveys per hour worked), and the average number of trips per household collected by the interviewer. CB&A used the individual reports to determine underproductive interviewers and interviewers that seemed to be missing trips due to lack of probing. These interviewers were retrained or reassigned.

Summary reports were sent to BA for review. BA monitored the average overall trip rates and the distribution of households by income group and household size for reasonability. The status of the survey was discussed with the CB&A survey manager weekly.

## 6. Pretest Results

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A sample file of 180 listed and unlisted telephone numbers for the area was used for the pretest. The sample file was the last two replicates of the 4,500 telephone numbers originally purchased for the survey from Survey Sampling, Inc. (SSI). These two replicates were *not* reused in the full survey. The sample file was transmitted to CB&A for use in the TSMIS program.

Three members of the GCRTA and three members of NOACA staff volunteered to participate in the survey pretest. All of the telephone numbers for the volunteers were entered into TSMIS as unlisted telephone numbers. The identity and existence of the volunteers was known only by the CB&A project manager; survey recruiters and interviewers were not informed about the volunteer participants. Volunteer participants did not identify themselves as such to recruiters or interviewers during the survey.

CB&A generated recruiting assignments and made recruiting calls on April 4, 1994. The assigned travel day was Monday, April 11. Based on the 112 households contacted, 40 (including five of the six volunteers) agreed to participate in the survey. Although this agreement rate was substantially less than that experienced in other surveys, this number was deemed sufficient to collect between 30 and 40 pretest samples, so recruiting was stopped. Under normal survey procedures, the entire replicate would have been called during the recruiting to ensure proper geographic representation of the sample. However, in the pretest, the geographic representation of the sample was not the focus, so the premature suspension of recruiting was reasonable. The results of the recruiting calls were entered into TSMIS for survey tracking purposes.

Travel survey packets were mailed to recruited households on Tuesday, April 5. Reminder calls were made on Sunday, April 10. Survey data were collected from 31 households on April 12 and 13. Six households dropped out of the survey. Several callbacks were made to households after April 13 for "public relations" purposes.

Under normal survey procedures, concentrated efforts would have been made subsequent to the initial call-back period to complete more surveys.

Several comments were received from CB&A and from the local volunteers of GCRTA and NOACA regarding the pretest. Data collection procedures were reviewed extensively between BA, staff members of the GCRTA and NOACA, and CB&A. This allowed the opportunity to revise and reprint the survey forms in time for the full survey.

Table 15 outlines several problems identified with survey procedures and forms, and the resolutions of those problems. Most of the problems were identified by the GCRTA and NOACA volunteers, although CB&A recruiting and interview personnel also identified several difficulties.

**Table 15**  
**Identified Survey Problems and Resolutions**

Comment	Suggested Action
<b>Recruiting Calls</b>	
1. A midday trip to home (from work, for example, for the purpose of lunch) was coded as a home-based work trip.	1. Special purpose codes were set up for midday trips made from work to home, if traveler returned to work. Code this as a "work to home to eat meal" trip.
2. The introduction was too wordy; the entire recruiting call was too long.	2. The suggested patter was revised to be more concise and to have better flow.
3. The purpose of the study was not clear.	3. The suggested patter was revised to provide a slightly stronger message about the purpose of the study. Recruiters were coached to be mindful of including this.
4. There was some confusion about whether the travel information was to be returned via U.S. Mail.	4. Recruiters were coached to clearly explain to participants how the data would be collected.

**Table 15**  
**Identified Survey Problems and Resolutions (Continued)**

Comment	Suggested Action
5. Printing the travel diaries on card stock made them difficult to carry and a nuisance; one person carried small pieces of paper to record trips and then transferred them to the diary.	5. No action suggested—see comment 6.
6. Using card stock for the travel diaries made them easier to use	
7. The spouse of one volunteer agreed to be personally interviewed only at the insistence of the interviewer.	7. The interviewer conducted the interview according to specifications. No change is suggested.
8. One data collection call was made at 5:30 PM rather than 7:30 PM as specified by the volunteer during the recruiting call.	8. CB&A will be more careful in making scheduled call-backs.
9. There was some confusion reported by the interviewers regarding the reporting of transit access—there could be a tendency to collect too much data.	9. No change is suggested—collecting too much detail is better than collecting insufficient detail.
10. There was some confusion reported by the interviewers regarding one trip made on more than one transit vehicle.	10. Interviewers are instructed to collect individual legs of transit trips if the information is available. The trip purpose for intermediate stops will be recorded as "Other" with an explanation that the purpose of the trip is "change mode." Editors will convert the purpose to "change mode," even though this purpose is not listed on the travel diaries.

## **7. Survey Results**

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### **Survey Problems/Resolutions**

The corrections made to the survey process and survey forms based on the pretest resulted in a survey with very few problems from an administrative standpoint. Several problems were, however, encountered in the conduct of the actual travel survey. These problems and their solutions are summarized below:

- A small number of respondents called the GCRTA and NOACA with complaints regarding the conduct of the survey—interviewers were too aggressive, interviewers were confusing, the survey is an invasion of my privacy, etc. These calls were dealt with on an individual basis by GCRTA and NOACA personnel. When appropriate, Catherine Bryant & Associates was informed of the complaints so that a briefing session could be held to remind interviewers of proper surveying procedures and etiquette.
- The agreement rate for participation was unusually low. CB&A personnel were instructed to be more persuasive when households attempted to drop out of the survey. In addition, a second sample of telephone numbers was purchased to supplement the original sample.

### **Disposition of Telephone Calls**

In total, 12,600 different telephone numbers were called during the travel survey. The 12,600 calls resulted in 1,651 completed, usable surveys. In other words, 13.1 percent of the initial telephone calls resulted in usable surveys. Table 16 shows the final disposition of all telephone numbers called during the course of the survey.

**Table 16**  
**Disposition of Surveyed Telephone Numbers**

Disposition	Telephone Numbers Called	
	Number	Percent
<b>Recruiting Calls</b>		
Agreements	2,734	21.7%
Refusals	5,002	39.7%
Disconnected Numbers	3,059	24.3%
Commercial	1,203	9.5%
Group Housing	5	0.0%
Continually Busy/No Answer	484	3.8%
Out of Survey Area	113	0.9%
Total <sup>1</sup>	12,600	100.0%
<b>Data Collection Calls</b>		
Complete	1,651	63.9%
Refused	769	28.1%
Timed Out	194	7.1%
Number No Longer Working	24	0.9%
Other	96	1.0%
Total <sup>1</sup>	2,734	100.0%

<sup>1</sup> Percentages might not sum to total shown due to rounding error.

These completion percentages suggest a significantly higher refusal rate than has been typically encountered on previous home interview surveys. Overall, 22.6 percent or 1,747 of the 7,736 households where a potential respondent was actually contacted by a recruiter (i.e., 2,734 "agreements" plus 5,002 "refusals") resulted in a completed, usable survey. This result is partially explained by the observation that the Cleveland area tends to be surveyed heavily relative to other metropolitan areas in the nation.

As discussed in Chapter 3, the supplemental sample of households from low income census tracts was drawn to increase the number of responses from low income households. Table 17 shows the distributions of households by income group for each household size. As shown in Table 17, 39.7 percent of the supplemental sample households had 1993 household incomes less than \$15,000. In comparison, only 7.9 percent of the households from the primary listed sample and 9.7 percent of the households from the random-digit dialing sample had 1993 household incomes less than \$15,000.

**Table 17**  
**Households by Income Group and Sample Type**

Income Group	Primary Listed		Primary Unlisted		(Low Income) Supplemental Listed		(Additional) Supplemental Listed & Unlisted		Total Sample	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent <sup>2</sup>
Refusals	99	13.4%	33	15.3%	21	33.3%	88	13.9%	241	14.7%
Less than \$5,000	10	1.4%	7	3.2%	10	15.9%	12	1.9%	39	2.4%
\$ 5,000 - \$ 9,999	17	2.3%	16	7.4%	10	15.9%	18	2.9%	61	3.7%
\$10,000 - \$14,999	31	4.2%	10	4.6%	5	7.9%	31	4.9%	77	4.7%
\$15,000 - \$19,999	39	5.3%	13	6.0%	3	4.8%	33	5.2%	88	5.3%
\$20,000 - \$24,999	56	7.6%	20	9.3%	3	4.8%	46	7.3%	125	7.6%
\$25,000 - \$29,999	57	7.8%	14	6.5%	1	1.6%	54	8.6%	126	7.6%
\$30,000 - \$39,999	102	13.9%	35	16.2%	7	11.1%	76	12.0%	220	13.6%
\$40,000 - \$49,999	84	11.4%	29	13.4%	2	3.2%	89	14.1%	204	12.4%
\$50,000 - \$74,999	138	18.8%	23	10.6%	1	1.6%	109	17.3%	271	16.5%
\$75,000 or more	101	13.8%	16	7.4%	0	0.0%	75	11.9%	192	11.6%
Total <sup>1</sup>	734	100.0%	216	100.0%	63	100.0%	631	100.0%	1,644	100.0%

<sup>1</sup> Percentages might not sum to total shown due to rounding error.

<sup>2</sup> Total sample results shown in this table are before cleaning and geocoding of survey responses. Some samples were deleted from the final survey data during this process. Thus, the totals shown in this table might not match totals shown in other tables.

It is interesting to note that unlisted telephones are relatively more prevalent among lower income households. Based on Table 17, 18.0 percent of the households with unlisted telephone numbers had 1993 incomes less than \$15,000 (as opposed to 9.1 percent for households with listed telephone numbers). One contributing factor to this phenomenon is the definition of unlisted. The unlisted numbers are, for survey purposes, actually unpublished numbers. Numbers might be unpublished either by request or due to mobility. If a household moves and their new telephone number is not assigned in time to be published in the current telephone directory, the number is, for practical purposes, unpublished. Since lower income households are probably more likely to rent homes or apartments rather than own their own homes, they are probably more mobile than higher income families.

Three hundred and seventy-two of 1,651 surveyed households, or 22.5 percent, list the City of Cleveland as their address. The City of Cleveland has 199,800, or 24.7 percent, of the 808,700 households in the survey area. Thus, the home-interview survey was roughly proportionate to the regional share of Cleveland households.

## Results

Results from the travel survey are summarized in the following sections. Both weighted and unweighted results are shown, as appropriate.

Before the survey results can be interpreted, the definition of several basic terms used in the travel survey must be understood. These terms are as follows:

**Household.** Generally, a household was considered to be the entire group of persons living in one dwelling unit. A household could have been just one person living alone or several persons living together. The household usually consisted of a family with a head (e.g., a father or mother) and all of his or her relatives living in the dwelling unit. The household also may have included members such as roommates, lodgers, visitors, and maids. In order to determine whether a person was a member of the household or not, two general rules were applied.

1. Was the person's usual place of residence, at the time of the interview, in the household?

The usual place of residence was where a person normally slept and where there were living quarters for that person to return to any time he or she wanted to. It was not just a mailing address. It could have been a temporary place of residence where a person was staying while looking for permanent living quarters.

2. Was the person from outside the Northeast Ohio area and visiting the household at the time of the interview?

A visitor from outside the area was considered a member of the household for the survey and his or her trips were recorded. A visitor who lived within the

Northeast Ohio area was not considered a member of the household and his or her trips were not included.

**Travel Mode.** The means used to travel including auto, pickup, van, rapid, bus, school bus, taxi, bicycle, and walk.

**Trip.** A trip was considered to be one-way travel from one point to another which took the person outside the block he or she started the trip in. Travel must have been made by one of the designated modes of travel. Trips made by both motorized and non-motorized modes were included in the survey.

Trips made by truck drivers (dump truck, delivery truck, or semitrailer) during their working day were not counted; information on truck trips should be collected in a separate survey. Also, trips made during the working day by persons whose regular job was making deliveries of any type of vehicle were not counted.

A continuous round trip was considered as two separate trips. The destination of the first trip and the origin of the second were the farthest point that was reached on the round trip. For example, if a person traveled to a park, drove around the park without getting out of the car, and returned home, it was counted as two trips. The destination of the first trip was the park, and the origin of the second trip was the park.

Travel had to begin or end in the survey area to be included as a trip. For example, travel from Cleveland to Akron within the travel day was included as a trip. However, if the traveler continued his or her journey with a trip from Akron to Toledo, the second trip was not included as a trip.

The travel day, for the purpose of this survey, was the designated day of travel for the household, which began at 4:00 AM that morning and ended at 4:00 AM the next day. The trip had to begin or end during that period to be counted.

**Trip Purpose.** The primary reason for making any given trip was considered to be the trip purpose. Trips were categorized into the following trip purposes:

*Return Home*

A trip to a person's usual place of residence was a return home trip.

*Go to Work*

A work trip was travel to a person's place of employment or business, such as an office, factory, or store. Some people had more than one job, and travel to each place of employment was considered a work trip. Also, some persons visited different locations during the day in performing their work, such as doctors and salespeople. The purpose of each of these work-related stops was work-related (see below).

*School*

Travel by a student to school or college was a school trip. Travel by a teacher or school employee to a school was a work trip.

*Shop*

Travel to shop or to purchase things was classified as a shopping trip.

*Personal*

This category included trips made for transactions that were not considered to be a part of a person's primary or secondary employment, and were made to obtain services—not purchase goods. Trips to a bank, to the post office, to a doctor or dentist, and to a barber were personal trips. Trips made to have an item repaired, such as a car or radio, or to have clothes cleaned, were also personal trips.

*Social/Recreation*

Travel made for social or recreation purposes during which no business was transacted, either work-related or personal business, were social/recreational trips. These trips included trips made for:

- |                                      |                 |
|--------------------------------------|-----------------|
| Parties                              | Golfing         |
| Social meetings                      | Fishing         |
| Lectures                             | Movies          |
| Cultural events                      | Athletic events |
| Visits to friends                    | Tennis          |
| Church activities (social in nature) |                 |

Trips made to regularly scheduled church services were recorded as Personal.

*Work Related*

Some people, such as salespeople and repair persons, traveled to different locations during the day in performing their work. The purpose of the work-related stops they made was work-related.

*Eat Meals*

These were trips made to eat a regular meal. Stops for snacks or refreshments were better classified as social/recreational. A trip home to eat a meal (e.g., a person came home from shopping to eat lunch and returned to shopping) was classified as an "eat a meal" trip. A trip that was specifically made from work to home in order to eat a meal was considered a work-home-work sequence, described below.

*Pickup/Drop-Off Passenger*

This category included trips or stops to pick up someone from or deliver someone to a specific location.

*Change Travel Mode*

This category included trips made from one point to another simply to change travel modes and continue the journey. For example, if a child was driven to a school bus stop and then took the school bus to school, the child would have recorded his/her first trip as an auto passenger with the purpose "change mode" and the second trip as a school bus passenger with the purpose "school." This choice was not provided on the questionnaire, but instead was deduced by the telephone interviewer.

*Other*

Other includes any other trip purpose that cannot be placed in one of the above categories. Respondents were questioned regarding the purpose of the trip and an explanation was coded.

*Work-Home-Work Sequence*

A trip made while at work to the home, for the purpose of (1) social/recreational activity, (2) personal business, (3) eating a meal, (4) work-related activity, (5) serving a passenger, or (6) other activity; followed by a trip made starting at the home back to the work place.

**Distribution of Households by Income Group and Household Size**

The distribution of households by income group and household size was discussed in Chapter 2, "Survey Design," under the section on sample stratification. Tables 6 and 22 show the expected and the surveyed distributions of households by income group and household size while Table 7 shows the expected distribution of households by autos available and household size. The surveyed distributions are different from the expected distributions, but the differences should not cause problems in the calibration of trip production models. Note, however, that if regional average trip rates are calculated, the survey data should be weighted to reflect the regional distribution of households by income group and household size. The development of survey weights is discussed in Chapter 9, "Survey Weighting."

A chi-square test of statistical significance comparing the expected distributions of households to the surveyed distributions of households was performed. The chi-square statistic was calculated using the following formula:

$$\chi^2 = \sum \frac{f_o^2}{f_e} - N$$

where:

$f_o$  is the observed number of households in the cell

$f_e$  is the expected number of households in the cell

$N$  is the total number of observed households.

Table 18 shows the results of the chi-square test for the income group by household size distribution. Only the 1,408 households that reported their incomes were considered. As shown in Table 18, the surveyed distribution of households is statistically significantly different from the expected distribution of households at the 0.05 level. Thus, for regional averages and summaries, it will be necessary to use the weighted data.

**Table 18**  
**Chi-Square Test of Statistical Significance of the Difference in Surveyed and Expected Distributions of Households**

Distribution	Number of Households	Chi-Square Statistic	Degrees of Freedom	Significantly Different at 0.05 Level?
Income by Household Size	1,408	100.0	27	Yes

### ***Distribution of Households by Travel Day***

The travel survey was designed to collect an equal number of surveys for each weekday over the survey period. As shown in Table 19, the surveyed number of households was relatively evenly split between the five travel days. Monday and Wednesday were slightly undersampled while Tuesday and Thursday were slightly oversampled.

**Table 19**  
**Distribution of Surveyed Households by Travel Day**

Travel Day	Number of Households	Percent of Households
Monday	319	19.3%
Tuesday	350	21.2%
Wednesday	312	18.9%
Thursday	338	20.5%
Friday	332	20.1%

Based on the chi-square test, the distribution of households by day is not statistically significant from an equal distribution over the week at the 0.05 significance level ( $\chi^2 = 2.8$ ).

### ***Geographic Distribution of Households***

Table 20 shows the expected and surveyed distributions of households by zip code for the Northeast Ohio urban area. The zip codes included for the summary shown in Table 20 do not cover the entire study area. However, they do cover most of the urbanized area.

**Table 20**  
**Geographic Distribution of Households**

Zip Code	Expected Households <sup>1</sup>		Surveyed Households	
	Number	Percent <sup>2</sup>	Number	Percent <sup>2</sup>
Cuyahoga	1,115	69.7%	1,056	66.0%
Geauga	53	3.3%	76	4.8%
Lake	159	9.9%	190	11.9%
Lorain	190	11.9%	191	11.9%
Medina	83	5.2%	90	5.6%
Total	1,600	100.0%	1,603	100.2%

<sup>1</sup> The expected households are based on distributions of households by zip code for 1990 provided by Survey Sampling, Inc.

<sup>2</sup> Percentages based on 1,600 surveyed households.

As shown in Table 20, there are some variations in the surveyed and expected households by county. The chi-square statistic comparing the surveyed and expected distributions is 25.7, which means that the distributions are statistically significantly different at the 0.05 level.

Because of the inherent diversity of the five counties of Northeast Ohio, adjustments to the survey weighting process (see Chapter 9) were recommended. In addition, the weighting process was implemented by individual county and adjusted for socioeconomic biases (e.g., household size and income group). In many cases, the data were aggregated in order to get sufficient surveyed households in the strata used for the weighting process.

### ***Respondents Interviewed and Using Diary***

Table 21 shows a cross tabulation of the number of people who were interviewed and who used their travel diary. As shown in Table 21, about half of the household members were not personally interviewed. This number is somewhat misleading, however, since 780 of the 2,191, or 36 percent of the household members who were not interviewed were under 16 years old. If only household members 16 years of age and older are considered, 1,967 out of 3,388 persons, or 58 percent, were personally interviewed.

**Table 21**  
**Respondents Interviewed and Using Diary**

Interviewed	Used Diary		Total
	Yes	No	
Yes	1,766	201	1,967
No	1,748	443	2,191
Total	3,514	644	4,158

About 85 percent of the respondents used their travel diary. Note that travel diary use was not asked. Interviewers inferred the answer to this question based on the speed and confidence that the interviewer had in reporting travel. The use of travel diaries was stressed in the survey design and in the instructions to survey participants as a means to record *all* trip making. Table 22 summarizes the reported number of trips by all modes per person based on whether or not the person was interviewed and whether or not the person used a travel diary. As can be seen in Table 22, the numbers of trips reported for travelers vary substantially depending on whether or not the person was interviewed and whether or not the person used the travel diary. However, it is not possible to conclude from the results presented in Table 22 that trips were, in fact, unreported if diaries were not used or persons were not interviewed. It is quite

**Table 22  
Number of Total Person Trips by All Modes Reported by Travelers**

Number of Trips	Interviewed Used Diary		Interviewed Did Not Use Diary		Not Interviewed Used Diary		Not Interviewed Did Not Use Diary	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
0	105	5.9%	63	31.3%	94	5.4%	174	39.3%
1	22	1.2%	5	2.5%	29	1.7%	7	1.6%
2	319	18.1%	42	20.9%	495	28.3%	132	29.8%
3	202	11.4%	20	10.0%	195	11.2%	31	7.0%
4	287	16.3%	34	16.9%	355	20.3%	52	11.7%
5	220	12.5%	8	4.0%	180	10.3%	18	4.1%
6	189	10.7%	10	5.0%	160	9.2%	13	2.9%
7	131	7.4%	5	2.5%	81	4.6%	8	1.8%
8	91	5.2%	5	2.5%	60	3.4%	3	0.7%
9	74	4.2%	1	0.5%	39	2.2%	2	0.5%
10+	126	7.1%	8	4.0%	60	3.4%	3	0.7%
Total <sup>1</sup>	1,766	100.0%	201	100.0%	1,748	100.0%	443	100.0%

<sup>1</sup> Percentages might not sum to totals shown due to rounding error.

likely that some respondents did not use a diary because they made very few or no trips on their travel day. Additional analysis could be performed to learn more about the possible under-reporting of trips by non-diary users and persons who were not interviewed. For example, the socioeconomic status of zero trip makers could be analyzed to determine if higher percentages of "frequent" travelers (e.g., 16-20 year old from upper-middle income families) are included in the non-interviewed or non-diary user groups than in the groups that were interviewed or used diaries.

### ***Households by Trip Frequency***

Table 23 summarizes the number of households by the number of trips made. As shown in Table 23, 4.6 percent of the households surveyed did not make trips by any mode during their assigned travel day. The percentage of households making no trips during the travel day was very reasonable, compared to what has been found in several recent surveys. If only trips made in motorized vehicles are included in the summary, 90 households, or 5.5 percent, made no trips in motorized vehicles during the travel day. Table 24 summarizes the percent of zero trip making households for several cities. It is interesting to note that average per person trip rates in the Northeast Ohio Area are higher than the rates for the other cities, though the percent of zero trip-making households is in the middle of the range noted for the other cities. Note that the percent of zero trip making households will be affected by the weighting of the survey data.

The percent of households making only one trip per day was very low, as should be expected. The few households making only one trip during the day either left (or returned to) the region.

About four percent of the surveyed households made more than 25 total trips per day. The highest number of trips made on the travel day was 78. One three-person household reported this level of trip making on the travel day. Further analysis of the data showed that 58 of the 67, or 86.6 percent, households making 26 or more trips per day were four or more person households. Thus, the households with high numbers of trips do not indicate a problem with collecting "traveling salesman" trips.

**Table 23**  
**Households by Trip Frequency**

Trip Frequency <sup>1</sup>	Trips Made by All Modes		Trips Made in Vehicles	
	Number of Households	Percent of Households	Number of Households	Percent of Households
0	76	4.6%	90	5.5%
1	4	0.2%	11	0.7%
2	122	7.4%	143	8.7%
3	51	3.1%	63	3.8%
4	154	9.3%	164	9.9%
5	103	6.2%	113	6.8%
6	142	8.6%	136	8.2%
7	85	5.2%	91	5.5%
8	121	7.3%	118	7.2%
9	75	4.5%	75	4.5%
10	102	6.2%	97	5.9%
11-15	297	18.0%	277	16.8%
16-20	176	10.7%	152	9.2%
21-25	75	4.5%	74	4.5%
26 or more	67	4.1%	46	2.8%

<sup>1</sup> Trips included in this summary have been linked.

**Table 24**  
**Percent of Sampled Households Making No Trips on Specified Travel Day in Selected U.S. Cities**

City	Year of Survey	Percent of 0 Trip Households <sup>1</sup>		Percent of Households with <\$10,000 Income <sup>2</sup>	Average Per Person Trip Rate <sup>3,5</sup>
		Trips Made by All Modes	Trips Made in Motorized Vehicles		
St. Louis	1990	N/A	4.9%	32.8% <sup>4</sup>	3.4
Albuquerque	1992	2.4%	N/A	13.5%	3.4
Colorado Springs	1992	4.7%	5.3%	10.4%	3.4
Pueblo	1993	9.4%	11.2%	24.0%	3.8
Cleveland	1994	4.6%	5.5%	13.4%	4.1

<sup>1</sup> Based on unexpanded survey results.

<sup>2</sup> Based on 1990 census data.

<sup>3</sup> Trips made in motorized vehicles

<sup>4</sup> Percent of households with income less than \$20,000 for St. Louis

<sup>5</sup> Based on unlinked and unexpanded trips.

### Trip Purpose

Table 25 shows the expanded trips by detailed trip purpose summarized from the survey. Based on trips made in motorized vehicles, about 17 percent of the total trips were home-based work, about 54 percent were home-based non-work, and about 28 percent were non-home based. The home-based work trips made during the middle of the day (i.e., the work-home-work sequence) were considered home-based non-work trips for this summary. These shares are fairly typical of what has been observed in other U.S. cities, although the home-based work share is at the low end of the typical range. Table 26 shows some results from recent surveys.

It should be noted that the shares listed in Table 25 are based on sample data. Because of this, there is sampling error that is associated with the data. The amount of error can be determined as follows:

$$\sigma_p = \sqrt{\frac{pq}{n}}$$

where:

- $\sigma_p$  is the standard error of the proportion, p
- p is the proportion of the sampled items have a specific attribute
- q is the proportion of the sampled items *not* having the specific attribute, or 1-p
- n is the number of sampled elements

For example, based on 1,408 samples, the largest standard error occurs when  $p = 0.5$ :

$$\begin{aligned}\sigma_p &= \sqrt{\frac{0.5 \times 0.5}{1,408}} \\ &= 0.0133\end{aligned}$$

For one standard error of the estimate, the level of confidence is about 68 percent. For 95 percent confidence, the standard error must be multiplied by 1.96. So, for our example, if the proportion of the sample having the specific attribute is 0.5, we can say with 95 percent confidence that the proportion is in the range:

$$\begin{aligned}0.5 \pm 1.96 * \sigma_p \\ \text{or } 0.5 \pm .0261\end{aligned}$$

Converting the error estimate to a percentage of the mean gives us the results:

$$0.5 \pm 5.2\%$$

**Table 25**  
**Trips by Purpose<sup>1</sup>**

Trip Purpose	All Trips		Trips Made in Motorized Vehicles	
	Number <sup>1</sup>	Percent	Number <sup>1</sup>	Percent
Home-Based Work	1,239,692	16.0%	1,198,594	17.0%
Home-Based Work Midday	84,839	1.1%	79,173	1.1%
Home-Based School	779,317	10.1%	641,832	9.1%
Home-Based Shop	921,512	11.9%	868,551	12.3%
Home-Based Personal	834,581	10.8%	782,354	11.1%
Home-Based Social-Recreational	988,519	12.8%	847,615	12.0%
Home-Based Work Related	115,415	1.5%	111,553	1.6%
Home-Based Eat	283,176	3.7%	274,351	3.9%
Home-Based Serve-Passenger	172,529	2.2%	165,730	2.3%
Home-Based Other	56,543	0.7%	43,436	0.6%
Non-Home-Based Work Related	726,878	9.4%	629,320	8.9%
Non-Home-Based Other	<u>1,536,895</u>	<u>19.9%</u>	<u>1,419,060</u>	<u>20.1%</u>
Total <sup>2</sup>	7,739,896	100.0%	7,061,569	100.0%

<sup>1</sup> Expanded trips shown are based on 1,408 households reporting income. Trips have been linked. Trips shown include trips made to locations outside of the study area (i.e., internal-external trips).

<sup>2</sup> Percentages might not sum to total shown due to rounding error.

**Table 26**  
**Percent of Trips by Purpose in Selected U.S. Cities**

City	Year of Survey	Home-Based Work	Home-Based Non-Work	Non-Home-Based
St. Louis <sup>1</sup>	1990	19%	50%	31%
Northern New Jersey <sup>3</sup>	1986	27%	50%	23%
Denver <sup>1</sup>	1985	26%	47%	27%
Dallas-Fort Worth <sup>2</sup>	1984	27%	48%	25%
Seattle <sup>2</sup>	1985-88	18%	52%	30%
San Diego <sup>1</sup>	1986	13%	51%	36%
San Juan, PR <sup>3</sup>	1991	18%	58%	24%
Albuquerque <sup>3,4</sup>	1992	18%	53%	29%
Colorado Springs <sup>3,4</sup>	1992	20%	51%	29%
Pueblo <sup>3,4</sup>	1993	16%	57%	27%
Cleveland <sup>3,4,5</sup>	1994	17%	54% <sup>5</sup>	29%

<sup>1</sup> Shares based on unlinked trips. Trip linking would probably increase home-based work shares and decrease other shares.

<sup>2</sup> Unknown whether trips summarized are linked or unlinked.

<sup>3</sup> Shares based on linked trips.

<sup>4</sup> Shares are based on trips made in motorized vehicles.

<sup>5</sup> Home-based work trips made during the middle of the day were considered home-based non-work trips, the notion being that behavior associated with this type of trip is more similar to home-based non-work trips than home-based work trips. Note that each of these trips was identified as part of a work-home-work sequence.

The relationship between the percent error and the proportion of the sample having the specific attribute is shown on Figure 17. Although it is not entirely statistically correct,<sup>1</sup> the errors of the shares shown in Table 25 can be estimated from Figure 17.

<sup>1</sup>There are two problems with using this estimate. First, the proportions shown in Table 7-10 are based on the weighted survey data rather than the raw survey results. Second, there is a "cluster effect" that would increase the confidence interval. The proportions shown in Table 7-10 are based on trips which were "clustered" by household. Although the households were randomly selected, in the survey, the actual trips were "cluster sampled" from the universe of all trips.

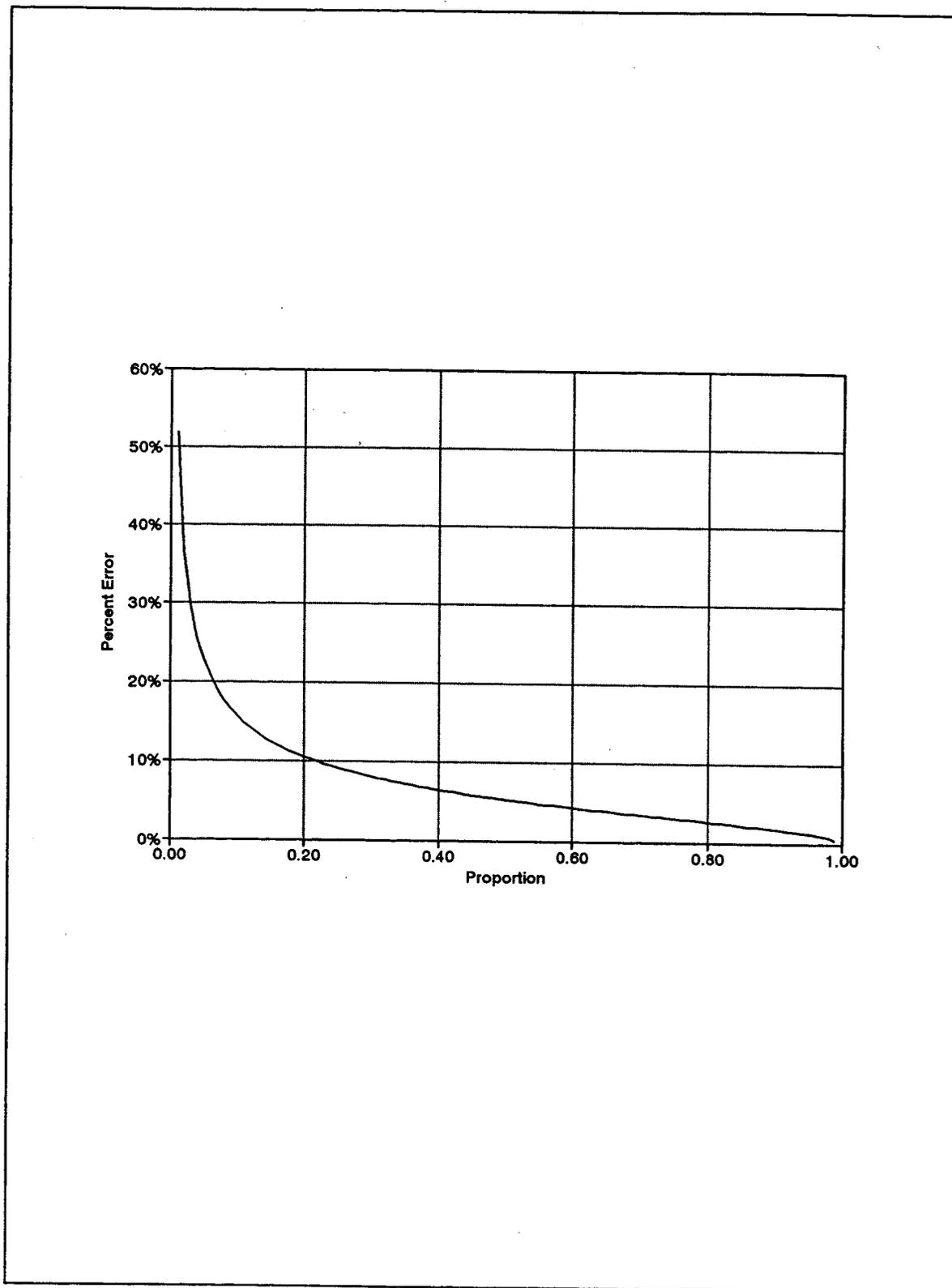


Figure 17  
Percent Error of Proportion at 95 Percent Confidence Level (Based on 1,408 Samples)

### ***Trips by Mode***

Table 27 shows the shares of trips by travel mode for the general trip purposes. The auto-oriented nature of travel in Northeast Ohio is obvious in Table 26. About 85 percent of all trips are made by private auto. If only trips in vehicles are considered, 93 percent of the trips are made by private vehicles either as a driver or passenger.

As with the shares of trips by purpose discussed previously, the shares of trips by mode are subject to sampling error. Again, the information shown in Figure 17 can be used to estimate the 95 percent confidence intervals for the shares shown in Table 27. For example, the estimated proportion of home-based work trips made by RTA bus is  $0.035 \pm 5.2\%$  at the 95 percent confidence level. Thus, the share is between 0.0089 and 0.0611 at the 95 percent confidence level.

### ***Average Auto Occupancy***

Table 28 shows the numbers of trips by auto occupancy and trip purpose as reported by the auto driver. Table 28 also shows an estimated average auto occupancy for each trip purpose and total. The average auto occupancies by trip purpose should be considered estimates. Although the auto driver accurately reported the number of people in the auto, the passengers were not necessarily traveling for the same purpose. For example, a parent might take two children to school on his or her way to work. The parent's trip (the auto driver) would be reported as home-based work and the auto occupancy would be reported as 3. However, the two passengers were actually making home-based non-work trips, not home-based work trips. Thus, reporting the home-based work auto occupancy as 3 for this trip is a misstatement of fact.

Note that for total trips this classification error does not occur. Thus, the total average auto occupancy reported in Table 28 is a true estimate of the average auto occupancy. No statistical confidence levels have been calculated for the data summarized in Table 28.

**Table 27  
Trips by Mode<sup>1</sup>**

Mode	Home-Based Work		Home-Based Non-Work		Non-Home-Based		Total	
	Trips	Percent	Trips	Percent	Trips	Percent	Trips	Percent
Auto Driver	1,062,803	85.7%	2,357,866	55.7%	1,564,140	69.1%	4,984,809	64.4%
Auto Passenger	79,586	6.4%	1,087,740	25.7%	400,023	17.7%	1,567,349	20.3%
RTA Bus	43,515	3.5%	80,656	1.9%	36,607	1.6%	160,776	2.1%
RTA Rapid	9,458	0.8%	10,970	0.3%	5,765	0.3%	26,193	0.3%
Other Public Transportation	1,960	0.2%	2,288	0.1%	5,863	0.3%	10,111	0.1%
Yellow School Bus	0	0.0%	266,118	6.3%	35,588	1.6%	301,706	3.9%
Taxi	1,274	0.0%	8,957	0.2%	394	0.0%	10,625	0.1%
<b>Total Motorized<sup>2</sup></b>	<b>1,198,594</b>	<b>96.7%</b>	<b>3,814,595</b>	<b>90.0%</b>	<b>2,048,380</b>	<b>90.5%</b>	<b>7,061,569</b>	<b>91.2%</b>
Bicycle	9,603	0.8%	42,618	1.0%	1,770	0.1%	53,991	0.7%
Walk	31,495	2.5%	375,284	8.9%	210,995	9.3%	617,774	8.0%
Other	0	0.0%	3,934	0.1%	2,628	0.1%	6,562	0.1%
<b>Total Non-Motorized<sup>2</sup></b>	<b>41,098</b>	<b>3.3%</b>	<b>421,836</b>	<b>10.0%</b>	<b>215,393</b>	<b>9.5%</b>	<b>678,327</b>	<b>8.8%</b>
<b>Total<sup>2</sup></b>	<b>1,239,692</b>	<b>100.0%</b>	<b>4,236,431</b>	<b>100.0%</b>	<b>2,263,773</b>	<b>100.0%</b>	<b>7,739,896</b>	<b>100.0%</b>

<sup>1</sup> Expanded trips based on 1,408 households reporting incomes.

<sup>2</sup> Percentages might not sum to values shown due to rounding error.

**Table 28**  
**Trips by Purpose and Auto Occupancy as**  
**Reported by Auto Drivers<sup>1</sup>**

Auto Occupancy	Home-Based Work	Non Home-Based	Home-Based Non-Work	Total Trips
1	994,639	1,096,640	1,554,514	3,645,793
2	52,085	330,914	533,471	916,470
3	10,609	88,247	175,540	274,396
4	4,461	33,320	58,495	96,276
5	0	10,986	25,065	36,051
6	533	1,384	5,621	7,538
7	0	2,253	1,334	3,587
8	0	0	3,826	3,826
9	0	0	0	0
10	476	0	0	476
11 +	0	396	0	396
<b>Total</b>	<b>1,062,803</b>	<b>1,564,140</b>	<b>2,557,866</b>	<b>4,984,809</b>
<b>Average Auto Occupancy</b>	<b>1.09</b>	<b>1.43</b>	<b>1.40</b>	<b>1.40</b>

<sup>1</sup> Expanded trips shown are based on 1,408 households reporting income. Trips have been linked. Trips shown include trips made by residents to or from locations outside of the study area (i.e., internal-external trips).

### ***Autos Per Licensed Driver***

Table 29 is a cross-tabulation of the number of households by autos available and number of licensed drivers. Based on the data used to create Table 29, approximately 643,287 of the 808,712, or 80 percent, households in the region have at least one auto available for each licensed driver. On a household basis, an average of 1.0 autos were available per licensed driver in the region (excluding households with no licensed drivers). This estimate is  $\pm 17.8$  percent at the 95 percent confidence level.

**Table 29**  
**Households by Autos per Licensed Driver<sup>1</sup>**

Autos Available	Number of Licensed Drivers in Household			
	0	1	2	3+
0	36,205	25,132	831	1,492
1	2,870	200,532	65,974	4,196
2	0	22,492	282,861	27,625
3+	0	6,231	52,636	78,535

<sup>1</sup> Based on 1,408 households reporting income.

### **Trip Rates**

Table 30 shows average household trip rates for the three major trip purposes. Overall, each household in the region makes 8.7 trips per day in a motorized vehicle. This rate corresponds to 3.4 trips per person per day. The average trip rate per person is comparable to that of other cities with similar characteristics. Table 31 summarizes average trip rates per person for several cities that have performed travel surveys recently.

Table 30 shows percent error levels associated with the household trip rates. Two sets of error levels and trip rates are shown: unweighted and weighted. The unweighted trip rates are based on the mean trips per household for all sampled households. The unweighted error levels are based on the variation in trip rates for all sampled households.

The weighted trip rates and error levels account for the fact that the underlying distribution of households by income group and household size is known. Based on this knowledge, the "within group" variation in trip rates for each income group-household size stratification can be separated from the "between group" variation. The "between group" variation is caused by the fact that low income, one person households have a different trip rate than high income, five or more person households. Since we know the underlying distribution of households, we can account for the between group variation. Since the proportion of each group of the whole is also known, a weighted mean can also be calculated.

**Table 30**  
**Trip Rates by Purpose with Confidence Levels**

Trip Purpose	All Trips				Trips in Motorized Vehicles			
	Trips/Household <sup>1</sup>		Percent Error <sup>2</sup>		Trips/Household		Percent Error <sup>2</sup>	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Home-Based Work	1.7	1.5	±4.9%	±4.6%	1.5	1.5	±5.0%	±4.6%
Home-Based Non-Work	5.6	5.2	±5.0%	±4.1%	4.6	4.7	±5.1%	±4.3%
Non-Home-Based	<u>3.0</u>	<u>2.8</u>	±6.4%	±6.2%	<u>2.5</u>	<u>2.5</u>	±6.8%	±6.5%
Total	10.2	9.6	±3.9%	±3.2%	8.7	8.7	±4.0%	±3.3%

<sup>1</sup> Trip rates are based on the 1,408 households that reported incomes.

<sup>2</sup> Percent error is at 95 percent confidence level.

**Table 31**  
**Average Trips Made in Motorized Vehicles per Person per Day for Selected U.S. Cities**

City	Year of Survey	Average Trips per Person per Day	Trips Linked?
Dallas-Fort Worth	1984	3.4	N/A
Denver	1985	3.0	No
Seattle	1985-88	4.2	N/A
San Diego	1986	3.9	No
Northern New Jersey	1986	2.7	Yes
St. Louis	1990	3.4	No
San Juan, PR	1991	2.5	Yes
Albuquerque	1992	3.4	Yes
Colorado Springs	1992	3.4	Yes
Pueblo Urbanized Area	1993	3.8	Yes
Cleveland	1994	3.4	Yes

Tables 32 and 33 show total trip rates stratified by income group and household size and Tables 34 and 35 show the trip rates stratified by auto availability and household size. The tables clearly show the within-group and between-group variation discussed above. For example, in Table 32, the household trip rates for the entire survey area vary from 3.8 trips per household for low income, one person households to 17.2 for high income, four or more person households. This variation is the between-group variation that lends credence to the underlying stratification scheme. The within-group variation is shown by the percent error listed for each cell.

**Table 32**  
**Initial Total Trip Rates and Percent Error by Income Group and Household Size—Trips Made by All Modes<sup>1</sup>**

Income Group	Item	Household Size			
		1	2	3	4+
Low (less than \$15,000)	Mean	3.8	7.3	7.0	12.2
	% Error <sup>2</sup>	±18.1%	±22.7%	±27.9%	±23.4%
Low-Medium (\$15,000 - \$29,999)	Mean	4.7	7.6	9.5	14.1
	% Error <sup>2</sup>	±12.6%	±11.2%	±17.3%	±13.1%
Medium-High (\$30,000 - \$49,999)	Mean	5.0	7.8	10.6	17.0
	% Error <sup>2</sup>	±11.9%	±10.0%	±17.3%	±9.8%
High (\$50,000 or more)	Mean	6.1	8.7	12.4	17.2
	% Error <sup>2</sup>	±21.4%	±8.8%	±9.4%	±6.8%

<sup>1</sup> Based on 1,408 households reporting income.

<sup>2</sup> Percent error at 95 percent confidence level.

**Table 33**  
**Initial Total Trip Rates and Percent Error by Income Group and Household Size—Trips Made in Motorized Vehicles<sup>1</sup>**

Income Group	Item	Household Size			
		1	2	3	4+
Low (less than \$15,000)	Mean	3.1	6.8	5.4	8.9
	% Error <sup>2</sup>	±18.9%	±24.9%	±29.7%	±28.1%
Low-Medium (\$15,000-\$29,999)	Mean	4.3	7.1	8.8	13.0
	% Error <sup>2</sup>	±13.5%	±11.8%	±18.1%	±14.3%
Medium-High (\$30,000 - \$49,999)	Mean	4.5	7.4	10.0	15.6
	% Error <sup>2</sup>	±13.1%	±10.5%	±18.3%	±9.9%
High (\$50,000 or more)	Mean	5.5	8.1	11.0	16.0
	% Error <sup>2</sup>	±24.0%	±9.1%	±9.5%	±6.9%

<sup>1</sup> Based on households reporting income.

<sup>2</sup> Percent error at 95 percent confidence level.

**Table 34**  
**Initial Total Trip Rates and Percent Error by Auto Availability and Household Size—Trips Made by All Modes**

Autos Available	Item	Household Size			
		1	2	3	4+
0	Mean	3.1	5.1	5.4	11.4
	% Error <sup>1</sup>	±29.5%	±38.9%	±52.2%	±46.6%
1	Mean	4.8	7.2	8.1	14.8
	% Error <sup>1</sup>	±7.6%	±12.8%	±15.9%	±13.9%
2	Mean	4.6	8.2	9.9	15.0
	% Error <sup>1</sup>	±22.6%	±6.2%	±8.5%	±7.4%
3+	Mean	4.6	8.4	13.3	17.4
	% Error <sup>1</sup>	±53.2%	±12.7%	±14.0%	±7.2%

<sup>1</sup> Percent error at 95 percent confidence level.

**Table 35**  
**Initial Total Trip Rates and Percent Error by Auto Availability and Household Size—Trips Made in Motorized Vehicles**

Autos Available	Item	Household Size			
		1	2	3	4+
0	Mean	1.8	3.6	3.0	6.2
	% Error <sup>1</sup>	±29.8%	±47.3%	±61.2%	±72.7%
1	Mean	4.5	6.6	7.0	11.6
	% Error <sup>1</sup>	±8.0%	±13.7%	±16.8%	±14.9%
2	Mean	4.0	7.9	9.3	14.1
	% Error <sup>1</sup>	±23.0%	±6.3%	±8.5%	±7.3%
3+	Mean	4.6	8.0	12.8	16.5
	% Error <sup>1</sup>	±53.2%	±13.3%	±14.4%	±7.3%

<sup>1</sup> Percent error at 95 percent confidence level.

As shown in Table 30, the weighted percent errors are generally lower than the unweighted percent errors. This is because a portion of the variation, the between-group variation, has been isolated from the calculation of the error. Since the weighted percent errors are more difficult and time consuming to calculate, unweighted error levels have generally been shown in this report. This will tend to result in less confidence in the results than is actually warranted.

Tables 32 through 35 also show that the trip rates exhibit reasonable patterns. The rates tend to increase as household size increases and as income level or auto availability increases. The percent errors for each of the cells are substantially higher than the percent error in the average overall trip rates shown in Table 30. This is due to the fact that the trip rates for each cell are based on substantially fewer observations than the average overall trip rate.

### ***Trips by Time of Day***

Figure 18 shows the diurnal distribution of trips by purpose and total in the Northeast Ohio region. Trips made by all modes, including non-vehicular modes, are summarized on Figure 18. In addition, the composition of the trip types by time-of-day is shown. The time-of-day of travel shown on Figure 18 is based on the start time of the trip and trips have been aggregated by one-half hour time period. Thus, the trips shown for 7:30 AM include all trips with reported starting time between 7:30 AM and 7:59 AM. Some of the trips shown for the 7:30 AM time period might be completed by 7:59 AM and some might be completed (but not shown) in later time periods.

Two peak periods are clearly evident on Figure 18. Home-based work and home-based non-work trips are the main components of the morning peak period. The main afternoon peak period occurs at around 5:00 PM as might be expected. Smaller peaks can be noted at noon and 3:00 PM. The noon peak is typical of U.S. cities and is related to noon-time errands and lunch trips. The 3:00 PM peak is related to home-based non-work trips. These trips could also be school related.

### ***Reported Average Travel Time by Trip Purpose***

Table 36 summarizes the average reported travel times by trip purpose for trips made in motorized vehicles. The average travel times were estimated from the reported starting and ending time of trips. These reported travel times could be used with some caution since travelers have a tendency to round their starting and ending times to the nearest five-minute increment.

Trips that were greater than or equal to 90 minutes in duration were excluded from the summaries reported in Table 36. The long duration trips are generally trips to or from locations outside of the study area and would skew the reported average travel time.

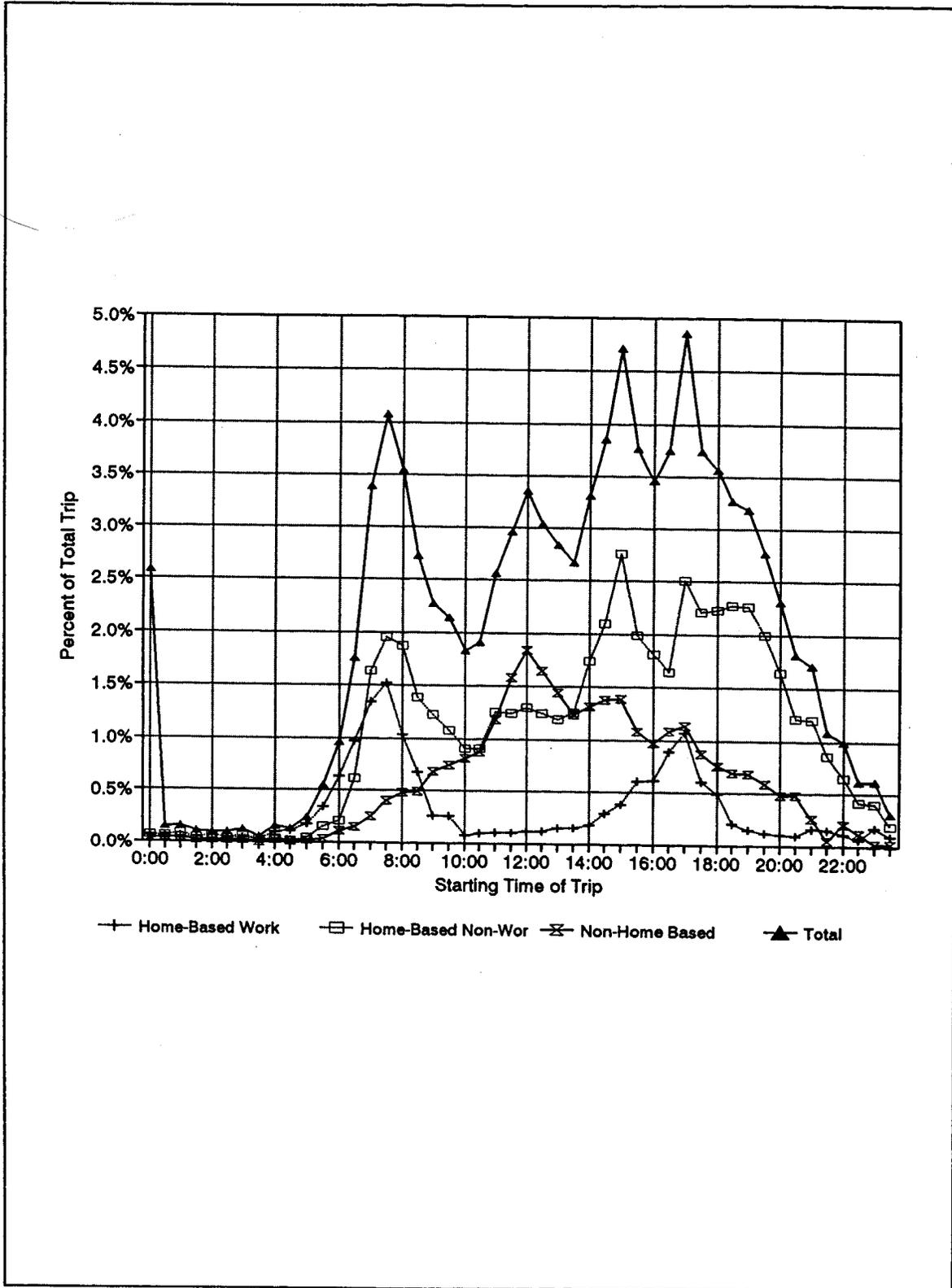


Figure 18  
Trips by Time-of-Day (Trips by All Modes)

**Table 36**  
**Average Reported Travel Times by Trip Purposes**

Trip Purpose	Reported Average Travel Time (minutes) <sup>1</sup>		
	Pueblo, Colorado Urbanized Area	Colorado Springs	Cleveland
Home-Based Work	15.5	19.8	23
Home-Based School	12.2	17.2	20
Home-Based Shop	10.8	13.0	14
Home-Based Other	12.1	15.1	18
Non-Home-Based Work Related	11.9	14.1	17
Non-Home-Based Other	11.0	13.9	16

<sup>1</sup> Based on expanded trips made in motorized vehicles, excluding trips with reported travel times of 90 minutes or more.

The reported average travel time show a reasonable variation by trip purpose. As is typically found in urban areas, home-based work trips are the longest trips. Table 36 also compares average trip lengths for Cleveland to those for Pueblo, Colorado, (a small urban) and Colorado Springs (a mid-size urban area). Average trip lengths for Cleveland are about two to three minutes longer than trips for comparable purposes in Colorado Springs and about three to seven minutes longer than trips for comparable purposes in Pueblo. This might be expected due to the difference in the size of the cities, with Pueblo being the smallest and Cleveland the largest.

Home-based school trips have the second longest average travel time. School trips might be expected to be short due to neighborhood elementary schools. However, the trips used to estimate travel times exclude walking and bicycle trips. The travel times are somewhat skewed since they mainly include trips made on school buses, trips to high schools, and trips to the various universities.

### **Automobile Usage**

The average miles per trip made by auto drivers is 10.8 with a percent error or 4.1% at the 95% confidence level. Mileage amount per trip exceeding 100 were excluded from the calculation. The frequency of auto driver trips by year of vehicle is shown in Table 37. As shown in the table, the average trips made per vehicle is highest (4.7) for automobiles in the "1990-1994" category, and lowest (3.4) for automobiles in the "pre-1980" category.

**Table 37**  
**Vehicles by Age and Trip Usage**

Trip Frequency	Year of Automobile				Total
	pre 1980	1980-1984	1985-1989	1990-1994	
1	631	1,975	13,850	5,434	21,890
2	16,745	34,996	126,678	111,764	290,813
3	6,049	17,930	58,730	61,090	143,799
4	5,332	29,179	74,116	83,153	191,780
5	6,411	14,762	48,543	61,054	130,770
6	4,082	12,937	51,499	48,315	116,833
7	329	5,548	22,432	31,090	59,399
8	1,674	5,794	16,840	22,152	46,460
9	0	3,226	11,441	15,256	29,923
10	1,887	400	7,595	6,777	16,659
11-15	0	5,355	10,382	18,706	34,443
16-20	0	0	1,253	2,063	3,316
21-25	0	0	651	0	651
Total	43,140	132,102	444,010	466,854	1,086,106
Average Trips/Veh.	3.4	4.4	4.3	4.7	4.5

The frequency of auto-driver trips by total daily mileage level and age of vehicle is shown in Table 38. The average daily miles per vehicle was highest (34.4) for automobiles in the "1990-1994" category, and lowest (20.7) for automobiles in the "pre-1980" category.

The vehicle trips made by auto drivers were stratified by vehicle age and trip purpose, and the results are presented in Table 39. The average vehicle age per trip is 6.6 years for home-based work trips, 6.6 for home-based non-work trips, and 6.4 for non-home-based trips.

**Table 38**  
**Vehicles by Total Miles per Day and Age of Vehicle**

Daily Mileage	Year of Automobile				Total
	pre 1980	1980-1984	1985-1989	1990-1994	
1-9	9,034	26,534	66,412	39,294	141,274
10-19	10,380	28,097	71,477	89,875	199,829
20-39	18,089	40,752	136,710	133,200	328,751
40-59	4,940	19,702	80,626	103,690	208,958
60-79	510	6,545	53,998	51,677	112,730
80-99	0	5,846	14,385	18,461	38,692
Total	42,953	127,476	423,608	436,197	1,030,234
Average Daily Miles/Veh.	20.7	27.4	32.5	34.4	33.8

**Table 39**  
**Vehicle Trips by Age and Trip Purpose**

Vehicle Age	Trip Purpose			Total
	HBW	HBNW	NHB	
1	61,971	153,260	98,343	313,574
2	110,351	226,603	160,744	497,698
3	75,812	223,589	176,812	476,213
4	101,839	187,846	132,869	422,554
5	104,054	223,823	160,859	488,736
6	108,432	207,143	124,530	440,105
7	104,933	212,419	116,198	433,550
8	63,646	165,952	85,165	314,763
9	91,397	177,020	130,030	398,447
10	65,269	164,068	107,726	337,063
11-15	108,474	295,352	174,749	578,575
16-20	29,697	64,955	36,376	131,028
21-25	5,719	6,636	5,016	17,371
26-30	3,244	3,244	1,089	7,577
Total	1,034,838	2,311,910	1,510,506	4,857,254
Average Age/Trip.	6.6	6.6	6.4	6.6

## 8. Survey Weighting

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As was noted in Chapter 7, "Survey Results," there were differences in the surveyed distribution of households and the estimated distribution of the universe of households by socioeconomic, geographic, and listed/unlisted telephone strata. The differences in the sample distribution of households were corrected before any aggregate results of the data were reported. For example, when the average home-based work trip rate for the region was calculated and reported, the reported rate was adjusted to account for the under-sampling of the low income households and subsequent oversampling of the other income households. If the aggregate rates had been developed from unfactored data, they would have had a tendency to overstate the average trip rate since the low trip-making, low income households would not have been fully represented in the region.

The conventional technique for calculating expansion factors, or weights, is to use the ratio of the number of elements in the universe to the number of sample elements for each stratum:

$$W_h = \frac{M_h}{N_h}$$

Where:

$W_h$  is the expansion factor for stratum h.

$M_h$  is the number of elements in the universe for stratum h; e.g., the number of households in an income group/household size stratum.

$N_h$  is the number of sampled households in stratum h.

Two sets of survey weights were developed, one based on households stratified by household size and income group, and by county of residence; and the second based on households stratified by household size and auto ownership and by county of residence. No weighting was performed to adjust for the bias in listed and unlisted telephones. The listed/unlisted adjustment was dispensed with for three main reasons:

- The strata already selected finely divided the sampled households. Based on the household size, income group, and county of residence, a number of the cells had fewer than 10 surveyed households and had to be combined with adjacent, similar cells.
- An “observed” regional distribution of households by the four dimensions was not available.
- The difference in trip-making characteristics between households with listed telephones and households with unlisted telephones was expected to be substantially less than the differences in trip-making characteristics between groups in the other strata (e.g., between one-person and two-person households).

By weighting the survey using the third dimension of county of residence, the geographic bias that might otherwise have been introduced was offset.

The “observed” distributions of households used to calculate the weights were developed from several sources. The 1990 Census data provided this information. The Census Transportation Planning Package provided distributions of households in the region, and by the five individual counties, by income group and household size, and by auto availability and household size. It should be noted that the current release of the CTPP did not have the distribution of households by income group and household size for the region nor for the five individual counties. As an interim measure, the bivariate distributions were estimated using the sample distribution summarized from the 1990 Census Public Use Micro-Data Sample (PUMS) factored to match the marginal distributions of households by income group, auto availability, and household size from the 1990 Census. The marginal distributions were available as part of the STF-3 data released by the Census Bureau in 1992.

Table 40 shows the resulting estimates of the distribution of households by income group and household size for the region. The estimated distributions for the five counties—Lake, Lorain, Cuyahoga, Medina, and Geauga—are presented in Tables 41 through 45, respectively.

The surveyed households were tabulated by the same strata shown in Tables 40 through 45. The distributions of surveyed households are shown in Tables 46 through 51. Expansion factors were then calculated by dividing the observed households by the surveyed households for each stratum. When the observed number of households was less than 10 in a cell, the cell was combined with an adjacent cell. This aggregation was performed across income group strata. Note that the 242 households that refused to report income are shown for information purposes only. They were not included in the calculation of the expansion factors. The final expansion factors are shown in

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Tables 52 through 56. The countywide income-based expansion factors are applied for only the 1,373 households that reported income and whose county of residence could be determined based on the ability to geocode the address corresponding to the households.

**Table 40**  
**Estimated Households by Income Group and Household Size (1990) for the Five-County Region**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	25,723	10,898	4,993	6,323	47,937
\$5,000 - \$9,999	31,178	14,722	6,340	7,983	60,223
\$10,000 - \$14,999	27,551	16,443	6,902	8,888	59,784
\$15,000 - \$19,999	24,608	17,622	7,491	9,937	59,658
\$20,000 - \$24,999	21,522	18,626	8,301	11,451	59,900
\$25,000 - \$29,999	17,957	19,034	8,914	12,729	58,634
\$30,000 - \$39,999	25,839	37,026	19,053	28,324	110,242
\$40,000 - \$49,999	16,035	33,062	18,919	28,929	96,945
\$50,000 - \$74,999	15,842	45,691	29,840	46,498	137,871
\$75,000 or more	10,649	37,551	27,013	42,305	117,518
Total	216,904	250,675	137,766	203,367	808,712

**Table 41**  
**Estimated Households by Income Group and Household Size (1990) for Lake County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	959	449	154	165	1,727
\$5,000 - \$9,999	1,937	932	322	355	3,546
\$10,000 - \$14,999	2,255	1,382	507	595	4,739
\$15,000 - \$19,999	2,194	1,632	651	824	5,301
\$20,000 - \$24,999	1,965	1,841	790	1,066	5,662
\$25,000 - \$29,999	1,671	2,027	945	1,344	5,987
\$30,000 - \$39,999	2,446	4,212	2,211	3,294	12,163
\$40,000 - \$49,999	1,544	3,918	2,282	3,495	11,239
\$50,000 - \$74,999	1,634	5,721	3,814	5,921	17,090
\$75,000 or more	1,031	4,044	3,146	4,892	13,113
Total	17,636	26,158	14,822	21,951	80,567

**Table 42**  
**Estimated Households by Income Group and Household Size (1990) for Lorain County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	2,347	1,221	550	762	4,880
\$5,000 - \$9,999	2,932	1,660	715	981	6,288
\$10,000 - \$14,999	2,729	2,038	902	1,296	6,965
\$15,000 - \$19,999	2,296	2,219	1,047	1,573	7,135
\$20,000 - \$24,999	1,913	2,326	1,185	1,843	7,267
\$25,000 - \$29,999	1,617	2,381	1,288	2,044	7,330
\$30,000 - \$39,999	2,241	4,540	2,702	4,402	13,885
\$40,000 - \$49,999	1,388	4,029	2,705	4,487	12,609
\$50,000 - \$74,999	1,454	5,357	4,115	6,886	17,812
\$75,000 or more	1,013	3,475	2,771	4,632	11,891
Total	19,930	29,246	17,980	28,906	96,062

**Table 43**  
**Estimated Households by Income Group and Household Size (1990) for Cuyahoga County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	21,783	8,884	4,141	5,121	39,929
\$5,000 - \$9,999	25,057	11,389	5,005	6,124	47,575
\$10,000 - \$14,999	21,267	12,027	5,053	6,244	44,591
\$15,000 - \$19,999	18,941	12,613	5,259	6,634	43,447
\$20,000 - \$24,999	16,582	13,220	5,715	7,467	42,984
\$25,000 - \$29,999	13,767	13,190	5,944	8,043	40,944
\$30,000 - \$39,999	19,745	25,057	12,306	17,356	74,464
\$40,000 - \$49,999	12,157	22,195	12,073	17,629	64,054
\$50,000 - \$74,999	11,642	29,836	18,559	27,707	87,744
\$75,000 or more	7,676	25,513	17,688	26,693	77,570
Total	168,617	173,924	91,743	129,018	563,302

**Table 44**  
**Estimated Households by Income Group and**  
**Household Size (1990) for Medina County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	484	244	104	147	979
\$5,000 - \$9,999	868	454	192	278	1,792
\$10,000 - \$14,999	869	640	296	442	2,247
\$15,000 - \$19,999	762	719	352	556	2,389
\$20,000 - \$24,999	669	784	404	665	2,522
\$25,000 - \$29,999	562	897	478	822	2,759
\$30,000 - \$39,999	820	1,955	1,143	2,031	5,949
\$40,000 - \$49,999	549	1,803	1,201	2,143	5,696
\$50,000 - \$74,999	697	2,935	2,159	3,857	9,648
\$75,000 or more	471	2,277	1,845	3,278	7,871
Total	6,751	12,708	8,174	14,219	41,852

**Table 45**  
**Estimated Households by Income Group and**  
**Household Size (1990) for Geauga County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	150	101	44	127	422
\$5,000 - \$9,999	384	287	108	245	1,024
\$10,000 - \$14,999	431	357	145	312	1,245
\$15,000 - \$19,999	415	440	182	350	1,387
\$20,000 - \$24,999	393	456	206	411	1,466
\$25,000 - \$29,999	340	539	259	475	1,613
\$30,000 - \$39,999	587	1,262	691	1,242	3,782
\$40,000 - \$49,999	396	1,117	657	1,175	3,345
\$50,000 - \$74,999	415	1,843	1,193	2,127	5,578
\$75,000 or more	459	2,242	1,564	2,809	7,074
Total	3,970	8,644	5,049	9,273	26,936

**Table 46**  
**Surveyed Households by Income Group and Household Size (1990) for the Five-County Region**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	23	7	7	2	39
\$5,000 - \$9,999	25	16	9	11	61
\$10,000 - \$14,999	29	22	14	12	77
\$15,000 - \$19,999	33	24	13	18	88
\$20,000 - \$24,999	30	52	18	25	125
\$25,000 - \$29,999	31	49	20	26	126
\$30,000 - \$39,999	50	74	36	64	224
\$40,000 - \$49,999	29	61	52	63	205
\$50,000 - \$74,999	24	76	64	108	272
\$75,000 or more	7	67	46	72	192
Total	281	448	279	401	1,409
Refused	49	93	42	58	242

**Table 47**  
**Surveyed Households by Income Group and Household Size (1990) for Lake County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	1	0	0	0	1
\$5,000 - \$9,999	1	1	0	0	2
\$10,000 - \$14,999	4	5	0	0	9
\$15,000 - \$19,999	0	4	0	0	4
\$20,000 - \$24,999	5	6	2	3	16
\$25,000 - \$29,999	2	8	1	3	14
\$30,000 - \$39,999	7	6	4	9	26
\$40,000 - \$49,999	3	11	10	9	33
\$50,000 - \$74,999	1	15	12	15	43
\$75,000 or more	0	3	9	8	20
Total	24	59	38	47	168
Refused	1	8	5	8	22

**Table 48**  
**Surveyed Households by Income Group and Household Size (1990) for Lorain County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	2	2	2	0	6
\$5,000 - \$9,999	2	0	1	3	6
\$10,000 - \$14,999	5	1	2	2	10
\$15,000 - \$19,999	4	3	2	6	15
\$20,000 - \$24,999	1	9	4	5	19
\$25,000 - \$29,999	2	4	5	1	12
\$30,000 - \$39,999	4	9	5	4	22
\$40,000 - \$49,999	2	8	3	10	23
\$50,000 - \$74,999	0	6	9	11	26
\$75,000 or more	1	4	8	6	19
Total	23	46	41	48	158
Refused	5	17	4	7	33

**Table 49**  
**Surveyed Households by Income Group and Household Size (1990) for Cuyahoga County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	20	5	5	2	32
\$5,000 - \$9,999	20	14	6	8	48
\$10,000 - \$14,999	17	16	10	10	53
\$15,000 - \$19,999	26	16	9	9	60
\$20,000 - \$24,999	22	30	12	14	78
\$25,000 - \$29,999	25	33	14	19	91
\$30,000 - \$39,999	35	48	22	44	149
\$40,000 - \$49,999	21	35	31	35	122
\$50,000 - \$74,999	19	48	36	61	164
\$75,000 or more	4	42	21	38	105
Total	209	287	166	240	902
Refused	41	54	28	32	155

**Table 50**  
**Surveyed Households by Income Group and**  
**Household Size (1990) for Medina County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	0	0	0	0	0
\$5,000 - \$9,999	1	1	1	0	3
\$10,000 - \$14,999	0	0	2	0	2
\$15,000 - \$19,999	1	0	1	1	3
\$20,000 - \$24,999	0	5	0	1	6
\$25,000 - \$29,999	2	1	0	1	4
\$30,000 - \$39,999	0	6	4	3	13
\$40,000 - \$49,999	1	4	3	7	15
\$50,000 - \$74,999	2	4	3	8	17
\$75,000 or more	0	5	2	10	17
Total	7	26	16	31	80
Refused	2	5	2	6	15

**Table 51**  
**Surveyed Households by Income Group and**  
**Household Size (1990) for Geauga County**

Income Group	Household Size				Total
	1	2	3	4+	
Less than \$5,000	0	0	0	0	0
\$5,000 - \$9,999	1	0	0	0	1
\$10,000 - \$14,999	2	0	0	0	2
\$15,000 - \$19,999	2	1	1	1	5
\$20,000 - \$24,999	1	2	0	2	5
\$25,000 - \$29,999	0	1	0	2	3
\$30,000 - \$39,999	2	2	0	2	6
\$40,000 - \$49,999	1	2	2	1	6
\$50,000 - \$74,999	0	2	3	8	13
\$75,000 or more	1	11	5	7	24
Total	10	21	11	23	65
Refused	0	6	2	3	11

**Table 52**  
**Final Expansion Factors by Income Group and Household Size**  
**for Lake County**

Income Group	Household Size			
	1	2	3	4+
Less than \$5,000	846	440	462	510
\$5,000 - \$9,999	846	440	462	510
\$10,000 - \$14,999	846	440	462	510
\$15,000 - \$19,999	846	440	462	510
\$20,000 - \$24,999	846	276	462	510
\$25,000 - \$29,999	640	276	462	510
\$30,000 - \$39,999	640	478	462	510
\$40,000 - \$49,999	640	478	462	388
\$50,000 - \$74,999	640	542	318	395
\$75,000 or more	640	542	350	612

**Table 53**  
**Final Expansion Factors by Income Group and Household Size**  
**for Lorain County**

Income Group	Household Size			
	1	2	3	4
Less than \$5,000	793	631	400	419
\$5,000 - \$9,999	793	631	400	419
\$10,000 - \$14,999	793	631	400	419
\$15,000 - \$19,999	793	631	400	419
\$20,000 - \$24,999	963	631	400	829
\$25,000 - \$29,999	963	532	515	829
\$30,000 - \$39,999	963	532	515	829
\$40,000 - \$49,999	963	714	515	449
\$50,000 - \$74,999	963	714	405	678
\$75,000 or more	963	714	405	678

**Table 54**  
**Final Expansion Factors by Income Group and Household Size**  
**for Cuyahoga County**

Income Group	Household Size			
	1	2	3	4+
Less than \$5,000	1,089	1,067	831	1,124
\$5,000 - \$9,999	1,253	1,067	831	1,124
\$10,000 - \$14,999	1,251	752	505	624
\$15,000 - \$19,999	758	788	584	737
\$20,000 - \$24,999	754	441	476	533
\$25,000 - \$29,999	530	400	425	423
\$30,000 - \$39,999	564	522	559	394
\$40,000 - \$49,999	579	634	389	504
\$50,000 - \$74,999	840	622	516	454
\$75,000 or more	840	607	842	702

**Table 55**  
**Final Expansion Factors by Income Group and Household Size**  
**for Medina County**

Income Group	Household Size			
	1	2	3	4+
Less than \$5,000	964	438	371	545
\$5,000 - \$9,999	964	438	371	545
\$10,000 - \$14,999	964	438	371	545
\$15,000 - \$19,999	964	438	371	545
\$20,000 - \$24,999	964	438	371	545
\$25,000 - \$29,999	964	438	371	545
\$30,000 - \$39,999	964	438	371	545
\$40,000 - \$49,999	964	540	651	545
\$50,000 - \$74,999	964	540	651	396
\$75,000 or more	964	540	651	396

**Table 56**  
**Final Expansion Factors by Income Group and Household Size**  
**for Geauga County**

Income Group	Household Size			
	1	2	3	4+
Less than \$5,000	397	640	459	542
\$5,000 - \$9,999	397	640	459	542
\$10,000 - \$14,999	397	640	459	542
\$15,000 - \$19,999	397	640	459	542
\$20,000 - \$24,999	397	640	459	542
\$25,000 - \$29,999	397	640	459	542
\$30,000 - \$39,999	397	640	459	542
\$40,000 - \$49,999	397	640	459	542
\$50,000 - \$74,999	397	640	459	329
\$75,000 or more	397	204	459	329

While relatively few surveys were collected from low-income households in non-Cuyahoga Counties, the design of the survey was not directed at ensuring specific quotas of households by income group and household size by county. Rather, the survey was designed to provide a solid data base for the calibration of revised travel models for the Northeast Ohio region. A procedure was developed to increase the number of samples obtained from low-income households, without resorting to costly quota sampling techniques, in order to maximize the number of surveys collected.

While the sampling ratio is relatively small for low-income households in non-Cuyahoga County households in comparison to that for all households, it is important to clarify the concepts of survey accuracy and the sampling rate. As discussed in Chapter 2, "Survey Design," relative error and the confidence level associated with the survey is related to the number of samples collected and the variation in the statistic being measured, not the sampling rate. Also discussed in the same chapter is that models have been successfully calibrated in other regions based on 1,600 household surveys. Typically, these surveys result in 30 to 300 observations in specific stratum such as low-income, two-person households.

In fact, regional trip production models are typically limited to three to five "measure of wealth" strata, not ten strata as were used for the survey expansion. The actual stratification of households that will be used to calibrate trip production models (assuming normal cross-classification modeling techniques—the best state-of-the-practice—are used for the trip production models) will not be determined until the data are analyzed for model calibration. The survey provides more than enough samples to calibrate trip distribution models and, when combined with the "choice-

based" sample data from the transit on-board survey, should provide a high quality data set for the estimation of mode choice models for the region. It is anticipated that trip attraction models will be estimated using the work place survey data. The collection of a supplemental survey is not necessary for the calibration of travel models for the Northeast Ohio region.

It would have been possible to simply calculate expansion factors by income group (or auto ownership) and household size for the region. These expansion factors would have ignored biases in the number of surveys collected by county. However, the approach chosen was to correct for biases in the geographic distribution of the sample by calculating county-specific expansion factors. This approach led to increased effort in the calculation of expansion factors, but produced improved *regional* (expanded) summaries. The process of aggregating strata for the estimation of expansion factors is standard practice. In the home-interview survey, the collection of income data by "income groups" is, in itself, an aggregation.

A more appropriate question to ask might be whether the correct aggregations were made for the estimation of expansion factors. The specific method involved developing three-dimensional matrices of both actual and surveyed households by income group, household size, and county for the expansion of the survey data. Since insufficient observations existed in all 200 cells to estimate 200 individual expansion factors, certain cells required aggregation with other cells. A goal in this aggregation was to combine across strata with the smallest amount of inter-class variation. The approach was to aggregate across income groups within each county with the premise that there is less inter-class variation in trip rates across income groups than across household sizes, and, at the same time, to maintain the county totals for expanded households. Expanded totals of households will be correct only for the aggregated strata or aggregation of those strata. An alternative option would have been to aggregate across counties for specific income groups and household sizes. However, such an aggregation process would not have ensured correct county-specific household totals.

The estimate of the distribution of households for the region by auto availability and household size is presented in Table 57. The estimated distributions for the counties of Lake, Lorain, Cuyahoga, Medina, and Geauga are shown in Tables 58 through 62, respectively. The surveyed households were tabulated by the same strata shown in Tables 57 through 62 and are presented in Tables 63 through 67.

The procedure to calculate expansion factors was similar to that described for the income-based expansion factors, with the aggregations of cells of the matrices occurring across auto-ownership levels rather than income groups. Further, because the two sets of distributions, households by income group, household size, and county versus households by auto availability, household size, and county are different, the cell combinations are inevitably different, and would coincide only by chance.

The expansion factors are both derived from and applied to all surveyed households whose county of residence could be determined; since no household refused to reveal the number of automobiles that were available. The final expansion factors for Lake, Lorain, Cuyahoga, Medina, and Geauga Counties are shown in Tables 68 through 72, respectively.

**Table 57**  
**Estimated Households by Available Automobiles and Household Size (1990) for the Five-County Region**

Available Automobiles	Household Size			
	1	2	3	4+
0	61,346	19,767	10,710	14,295
1	135,763	81,716	28,853	31,475
2	16,477	124,817	59,524	95,157
3+	3,317	24,374	38,677	62,438

**Table 58**  
**Estimated Households by Available Automobiles and Household Size (1990) for Lake County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	2,652	658	189	154	3,653
1	12,453	6,985	2,228	1,979	23,645
2	2,139	15,051	7,056	11,365	35,611
3+	391	3,463	5,348	8,452	17,654
Total	17,635	26,157	14,821	21,950	80,563

**Table 59**  
**Estimated Households by Available Automobiles and Household Size (1990) for Lorain County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	4,328	1,283	686	893	7,190
1	12,893	8,844	3,257	4,129	29,123
2	2,186	15,165	8,168	13,846	39,365
3+	523	3,952	5,869	10,037	20,381
Total	19,930	29,244	17,980	28,905	96,059

**Table 60**  
**Estimated Households by Available Automobiles and Household Size (1990) for Cuyahoga County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	52,842	17,289	9,614	12,244	91,989
1	103,084	61,576	21,824	23,538	210,022
2	10,684	82,100	38,372	59,097	190,253
3+	2,007	12,959	21,933	34,140	71,053
Total	168,617	173,924	91,743	129,019	563,303

**Table 61**  
**Estimated Households by Available Automobiles and Household Size (1990) for Medina County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	1,019	296	84	145	1,544
1	4,571	2,620	1,109	1,238	9,538
2	970	7,585	3,652	7,096	19,303
3+	191	2,206	3,328	5,740	11,465
Total	6,751	12,707	8,173	14,219	41,850

**Table 62**  
**Estimated Households by Available Automobiles and Household Size (1990) for Geauga County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	505	241	137	859	1,742
1	2,762	1,691	435	591	5,479
2	498	4,916	2,276	3,753	11,443
3+	205	1,794	2,199	4,069	8,267
Total	3,970	8,642	5,047	9,272	26,931

**Table 63**  
**Surveyed Households by Available Automobiles and**  
**Household Size (1990) for Lake County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	1	0	0	0	1
1	22	12	2	2	38
2	2	47	22	31	102
3+	0	8	19	22	49
Total	25	67	43	55	190

**Table 64**  
**Surveyed Households by Available Automobiles and**  
**Household Size (1990) for Lorain County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	1	1	1	1	4
1	18	13	9	5	45
2	6	41	21	31	99
3+	3	8	14	18	43
Total	28	63	45	55	191

**Table 65**  
**Surveyed Households by Available Automobiles and Household Size (1990) for Cuyahoga County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	46	18	10	8	82
1	188	102	43	45	378
2	15	197	92	139	443
3+	1	24	49	80	154
Total	250	341	194	272	1,057

**Table 66**  
**Surveyed Households by Available Automobiles and Household Size (1990) for Medina County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	1	0	0	0	1
1	6	3	4	1	14
2	1	18	8	16	43
3+	1	10	6	20	37
Total	9	31	18	37	95

**Table 67**  
**Surveyed Households by Available Automobiles and Household Size (1990) for Geauga County**

Available Automobiles	Household Size				Total
	1	2	3	4+	
0	0	0	0	0	0
1	9	2	0	1	12
2	1	17	5	14	37
3+	0	8	8	11	27
Total	10	27	13	26	76

**Table 68**  
**Final Expansion Factors by Available Automobiles and Household Size (1990) for Lake County**

Available Automobiles	Household Size			
	1	2	3	4+
0	705	637	395	409
1	705	637	395	409
2	705	337	395	409
3+	705	337	281	384

**Table 69**  
**Final Expansion Factors by Available Automobiles and Household Size (1990) for Lorain County**

Available Automobiles	Household Size			
	1	2	3	4
0	906	723	394	837
1	906	723	394	837
2	301	390	389	447
3+	301	390	419	558

**Table 70**  
**Final Expansion Factors by Available Automobiles and Household Size (1990) for Cuyahoga County**

Available Automobiles	Household Size			
	1	2	3	4
0	1,149	960	961	675
1	548	604	508	675
2	793	417	417	425
3+	793	540	448	427

**Table 71**  
**Final Expansion Factors by Available Automobiles and Household Size (1990) for Medina County**

Available Automobiles	Household Size			
	1	2	3	4
0	750	500	454	499
1	750	500	454	499
2	750	500	454	499
3+	750	221	454	287

**Table 72**  
**Final Expansion Factors by Available Automobiles and Household Size (1990) for Geauga County**

Available Automobiles	Household Size			
	1	2	3	4
0	397	320	388	347
1	397	320	388	347
2	397	320	388	347
3+	397	320	388	370

## 9. Survey Geocoding

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Responses from the household survey were geocoded based on the household address of the respondent and their indicated trip destinations. The following section highlights the processes used in this effort.

To fulfill the objectives of the survey, all possible household and trip destination locations from the HHGOOD (cleaned household records) and TRIPGOOD (cleaned household records) were geocoded and assigned a specific x,y coordinate based on the address indicated by each respondent. Resulting individual data points for all geocoded household and trip destinations were aggregated and assigned to a specific five-county zone system traffic zone.

### Geographic and Data Files

Household and trip destination locations were machine geocoded using the address-matching functions within the ATLAS\*GIS software package. To facilitate this task, both digital geographic mapping files and a complete, accurate data base were required.

The geographic base was an aggregation of 1992 US Census TIGER/Line files for Cuyahoga, Lake, Lorain, Medina, and Geauga Counties—the area encompassing the Five-County Traffic Zone System. These files contain all roadways in service at the time each file was originally digitized and provide important attribute information for roadways, thus facilitating accurate geocoding (e.g., street name and type). Additionally, the files contain address ranges for both the left and right sides of most roadways. Base geographic files are enhanced by the inclusion of certain other attributes assigned to roadways through the use of geographic overlays. The city and five-digit zip code in which an individual roadway is located are also included to further augment accurate geocoding and to reduce the possibility of multiple address matches.

Data base files utilized were the HHGOOD and TRIPGOOD files along with external roadway attribute files containing the city, zip code, and address range data previously mentioned. The linkage between these data files and the geographic files provided the basis on which proper geocoding was conducted.

## Geocoding Process

With the underlying geographic files in place, accurate geocoding generally requires a "clean-up" of the data base—the HHGOOD and TRIPGOOD files being no exception. Because the file contained address information within separate fields (e.g., intersecting streets, or street numbers and street names) these fields were concatenated within a single field to enable the use of automated geocoding processes. Further, addresses given by respondents were not consistent in the definition of street names. For example, U.S. Highway 20 was denoted in response records as U.S. 20, Route 20, 20, Center Ridge, Euclid, or Mentor depending on the location of the origin along its route. However, the TIGER files list each segment as U.S. Highway 20 only. As such, all other references to this route were either manually changed to match the geographic file name or converted through use of a feature name translation file. These processes were employed for all instances in which similar problems arose on other streets and roadways. A further clean-up of the file entailed a search for improperly spelled street names and those address fields containing other non-address data. Note that all cleaning took place in special geocoding fields so that the original data were not overwritten.

With the data base "clean-up" accomplished, all household and trip destination origin addresses were compared to the street names and address ranges in the geographic file for matches on an automated basis. Those unmatched records remaining had been matched on an automated basis after further "clean-up" of the data base, assigned manually, or rejected based on a variety of considerations such as incomplete or non-existing addresses or addresses which are parallel streets.

One limitation to this process was the fact that few street types (e.g., st., ave., or rd.) or prefixes (e.g., N, S, E, or W) were given by respondents. This can result in inaccurate and multiple matched geocoding. To address these problems, additional geocoding criterion were required, such as using the origin city and origin zip code as additional address-matching fields. The additional matching requirements allowed the software to restrict the number of matching possibilities and provided more accuracy in geocoding. For instance, an intersection listed as Oak & Maple could be located in numerous cities. Moreover, the street could be Oak St., Oak Ave., Oak Rd., etc. There could then be numerous possibilities for matches using only the street names as matching fields, but probably only one Oak & Maple exists within both a particular city and within a particular zip code.

After all possible automated matches were completed, a certain amount of manual geocoding was required in cases where the TIGER file was missing the name of a roadway segment, or more often, when address ranges were missing. These anomalies

were addressed by comparing addresses to hard copy maps and manually geocoding the responses to the proper location. Further, there existed within the TRIPGOOD file, many trip destinations for which the respondent listed only a place name (e.g., McDonald's in Berea). In these instances the place name was located in the telephone directory and, when possible, discrete addresses were added to the data file and subsequently geocoded. While these records were manually geocoded they possess the same locational accuracy as automated matches. They are different only in the time required to accomplish the match.

Obtaining the x,y coordinate of individual origin locations allowed the use of GIS functions to aggregate the origins into their respective Five-County Traffic Zones. Origins outside the Five-County Traffic Zone System were manually assigned zone numbers based on where respondents were most likely to enter or exit the study area.

In summary, geocoded record contains all the informational fields included in the HHGOOD and TRIPGOOD data bases as well as the x,y coordinates in terms of both latitudinal/longitudinal position. In addition, all household and trip destination records contain the Five-County Traffic Zone number in which they are located.

## 10. Survey Data Sets

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Files have been established for the archival storage of the survey data. The formats have been established to satisfy the following criteria:

- The archival files should be in the most "transportable" format available, ASCII format. The dBASE formats for the files used during the survey are satisfactory, but there is no guarantee that dBASE files will be easy to read in the future.
- The archival files should have all data necessary to analyze the data including expansion factors to regional totals.
- A version of the archival data that can be distributed to other agencies should be available. For confidentiality reasons, this version of the data cannot include any information that allows the identification of the household included in the survey.
- The archival data for distribution should be easy to use. This suggests that all household, person, vehicle, and trip information be combined on one file.
- Although it is not an overriding concern, efforts should be made to keep the archival files reasonable sizes.

Six archival files have been developed that satisfy the criteria outlined above. Two types of files were created. *Master files* are files that will be maintained by GCRTA or NOACA and contain all original information collected in the travel survey, including the address information. These files will not be distributed so that the confidentiality promised the respondents can be preserved. *Work files* are files that include derived data or have been otherwise modified for easier analysis. Work files do not include exact address information. The file names and general descriptions are:

- **HHOLD94.DAT** This file is the *master* household data file.
- **PERS94.DAT** This file is the *master* person data file.
- **VEHS94.DAT** This file is the *master* vehicle data file.

- **TRPUNL94.DAT** This file is the *master* unlinked trip data file.
- **TRPLNK94.DAT** This file is the *master* linked trip data file. Trip expansion factors can be added after the model validation to ensure that total linked trips summarized from this data file match the modeled total trips for 1994 in the model validation.
- **COMB94.DAT** This file is the *work* file. Numerous modifications will be made to this file to make it easily usable by analysts. The file combines the household, person, vehicle, and linked trip data, converts reported times to the 24-hour clock, includes all expansion factors, and includes a number of "derived" factors. The trip information contained on each record in this file will include origin and destination information as opposed to just destination information as contained in the master trip files. Geocoded origin and destination zones are posted on the file.

Appendices A-F provide detailed descriptions of the six files described above. Full notes are provided for each file so that the sections describing the formats can be easily copied and distributed. A suggested mnemonic is listed for each data item. Of course, different mnemonics can be used when the data are input to a program. Mnemonics are not repeated in the different files unless the data contained are identical in the different files.

## Trip Linking

Standard practice has been to link trips obtained in home-interview surveys. The linking process removes incidental trips such as a parent dropping a child off at school on the way to work. For the parent (or the driver of the trip), the school location would not be the true attractor of the trip. Rather, the work location of the subsequent trip would be the attraction. Such a trip chain by the driver of the vehicle is more indicative of path choice and trip chaining behavior than of trip generation.

In the trip linking process, two or more reported trips are combined to form one trip for an individual traveler. Different levels of trip linking have been performed in past studies. The following describes the different types of trips that have been linked:

*Serve Passenger Trips.* When one traveler makes a trip to serve the needs of another traveler, the purpose is considered "Serve Passenger." In the Cleveland area survey, this trip purpose is represented by the "Pick up-Drop Off Passenger" trip purpose. Generally, the traveler making the serve passenger trip is the auto driver.

*Change Mode Trips.* These trips are generally associated with auto access trips to transit. In this case, the auto access trip is generally combined with the subsequent trip on the transit vehicle to the final destination and the combined trip is considered to be a transit trip (for trip generation and trip distribution purposes).

***Incidental Shopping Trips.*** Some studies have linked out incidental “drive-by” shopping trips. Examples of such trips are short stops made at a convenience store on the trip to or from work. Generally, this “linking” is done during the collection of the survey data by the interviewers. This technique was *not* used in the Cleveland survey.

Note that while trip linking is the state-of-the-practice, it prevents research into trip chaining behavior by travelers. It is likely that models that are more responsive to socioeconomic and transportation supply changes might be built based on full analyses of trip chaining behavior.

To provide the opportunity to investigate trip chaining in the future, two data sets of “final” travel survey data have been archived. One data set includes all cleaned trip data without any trip linking for future research into trip chaining behavior. The second data set has been linked according to the specifications outlined below.

## Linking Criteria

A moderate amount of trip linking has been performed using the following criteria:

- “Drop off-Pick up Passenger Trips” were linked if:
  - The trip was not part of a “serve passenger tour”
  - The stop at the destination was less than five minutes duration
- “Change Mode Trips” were linked

A serve passenger tour occurred when the person making the serve passenger trips started and ended their journey at the same location. For example, a driver that took another person to a store and then returned to their original location was considered a serve passenger tour and none of the trips were linked out of the travel data. If the trips were linked, a trip with identical starting and ending locations would result.

## Linked Trip Data Sources

Information from two or more trip records is combined when trips are linked. Table 73 lists the individual fields included on the final trip records along with the source of the data in the final linked records. For the source of the data, first means that the data will be taken from the first record in the sequence of trips being considered for linking and last means that the data will taken from the last record. Note that when change mode trips are linked, a priority system was used. Table 74 lists the mode priority system used. The mode with the highest priority (i.e., the lowest priority number) was the selected mode for the combined trip record.

**Table 73**  
**Sources of Data for Linked Trip Records**

Item	Description	Source
1	Record Type	First
2	Sample Number	First
3	Person Number	First
4	Trip Number	First
5	Name of Place	Last
6	Address Type	Last
7	Street Number	Last
8	Street Direction 1	Last
9	Street Name 1	Last
10	Street Type 1	Last
11	Street Direction 2	Last
12	Street Name 2	Last
13	Street Type 2	Last
14	City	Last
15	State	Last
16	Zip Code	Last
17	Kind of Place	Last
18	Place Code	Last
19	Trip Purpose	Last
20	Trip Purpose Comment	Last
21	Beginning Time of Trip	First
22	AM, PM, Noon, Midnight	First
23	Ending Time of Trip	Last
24	AM, PM, Noon, Midnight	Last
25	Mode of Travel	Highest Priority
26	Mode Comment	Based on Field 25
27	Number in Vehicle	Last
28	Vehicle Number	Last
29	Parking Cost	Last
20	Transit Arrival Mode	Last
31	Transit Fare	Last

**Table 74**  
**Mode Priority System**

Mode	Description	Priority
1	Driver	7
2	Passenger	6
3	RTA Bus	2
4	RTA Rapid	1
5	Other Transit	3
6	Yellow School Bus	5
7	Taxi	4
8	Bicycle	8
9	Walk	9