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16. Abstract The Texas Department of Transportation has a comprehensive on-going travel survey program. This research examines areas within two select travel surveys concerning quality control issues involved in data collection and sampling error in the data caused by various assumptions, survey methods, and issues such as non-response. Quality control issues, sampling errors, and non-response in external and household travel surveys conducted in Texas are identified, examined, and evaluated. The impact of these issues is quantified and evaluated relative to the use of the data in travel demand models. The state-of-the-practice in these types of surveys relative to quality control during and after the surveys are conducted and how sampling errors and non-response are treated (or corrected) in the survey analysis are reviewed and documented. The results are assessed to formulate a set of recommendations for incorporating into survey designs for the travel survey program.			
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IMPROVING ACCURACY IN HOUSEHOLD AND EXTERNAL TRAVEL SURVEYS

by

David F. Pearson, Ph.D., P.E.; Research Engineer;
Edwin Hard, Research Scientist;
Stephen Farnsworth, Associate Research Scientist;
Tim Forrest, Assistant Transportation Researcher;
Debbie Spillane, Assistant Transportation Researcher;
Mark Ojah, Assistant Research Specialist; and
Katie Womack, Senior Research Scientist, of the Texas Transportation Institute

and

Sharon A. Boxill, Ph.D., Research Associate; and
Carol A. Lewis, Ph.D., Director, of Texas Southern University

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TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

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CHAPTER 1: INTRODUCTION

BACKGROUND

The Texas Department of Transportation (TxDOT), Transportation Planning and Programming Division (TPP) funds and manages an on-going statewide travel survey program (TSP). This program collects data on travel in all major urban areas in the state of Texas. Data from these surveys are inputs to the travel demand models used by TxDOT in transportation planning and policy analyses. These data ensure the travel demand models accurately reflect travel behavior in forecasting travel demand. This is critical to making sound transportation investments. The program includes household, work place, commercial vehicle, and external surveys.

The surveys are designed and implemented following accepted state of the practice methods. There are, however, systematic issues regarding household and external surveys that warrant examination. Some inherent challenges such as non-response in household surveys are recognized nationally and internationally as potential problems in these types of surveys. Other concerns such as the inability for certain segments of the population to participate in the household survey have been specific to Texas practice. Some issues identified in external surveys have resulted from field observation and careful review of the data collected. The objective of this research is to examine these issues with respect to Texas practice, determine the extent of their impacts, develop and identify alternatives to address the concerns, and evaluate the results of recommended alternatives in actual surveys.

Objectives and Significance of Research

The previous discussions have identified a number of systematic issues related to household and external surveys in Texas. These surveys are complex efforts that measure characteristics of travel, and their validity and reliability are essential. Therefore, each issue should be addressed, and if warranted, modifications to the survey designs, methods, and quality controls should be developed in order to improve the accuracy of the estimates of travel. There are five objectives to be accomplished within the scope of this research. Those objectives include:

1. Assess the state of the practice in household and external surveys relative to non-response, sampling error, and data quality.
2. Identify the options that are available to address non-response, sampling error, and data quality.
3. Evaluate the measurable impacts of non-response, sampling error, and data quality on surveys in Texas.
4. Assess the available options to address these issues relative to their effectiveness and cost of implementation.
5. Measure and evaluate the impact of implementing the most cost effective options within actual surveys in Texas.

The significance of this research lies in its concentration on making an accurate assessment of current practices and existing data in order to ascertain significant impacts and how those impacts can be addressed in a cost effective manner. The results will be better surveys, better data, and more accurate estimates for use in travel demand models. This will result in more accurate information to decision makers for developing transportation investments.

Research Approach

The initial effort in this research is directed at identifying and carefully reviewing the practices in household and external surveys that have been implemented outside Texas. This work will concentrate on studies and research dealing with non-response, sampling error, and data quality. The result will be an overview of what other areas have done or are doing in addressing these issues, the methods employed to identify and measure these elements, and the techniques used to negate the influence of these issues.

A detailed review and evaluation of survey procedures and methods in Texas was performed to develop a better understanding of the elements of survey processes, quality controls, successes, problems, and areas of concern. How these issues relate to the different vendors that have been employed to perform household and external surveys were also explored. This work will document the differences in vendor techniques and procedures to identify those elements that work in practice, as well as those methods that are not successful.

Methods and techniques that have the potential to improve household and external surveys relative to response rates, sampling error, and data quality are identified and documented. Factors outside the surveys themselves that may impact these elements and the survey results are also documented. This research identified the non-response, sampling error, and data quality elements influencing surveys in Texas and estimated the expected impacts on survey estimates. As a result, those elements having the most impact were identified.

During the course of this research, a number of events occurred that impacted the project. Household and external surveys were delayed pending the internal review and revision of survey bid specifications. These delays prevented the accomplishment of scheduled activities intended to test and evaluate recommendations from this research. The document presents the findings and analyses, which accomplished the majority of the research in accordance with the project proposal.

ORGANIZATION OF REPORT

The research accomplished in this project was organized into specific tasks. Each task was accomplished and documented in Technical Memorandums during the course of the research. Accordingly this report is a compilation of all the Technical Memorandums produced in this research. This first chapter is followed by four chapters. The second chapter presents a discussion of survey practices in Texas specifically oriented to household and external surveys. The third chapter presents the research specific to household surveys and is composed of individual sections that present the research results for each task involving household surveys. The fourth chapter presents the research specific to external surveys and is composed of individual sections that present the research results for each task involving external surveys. The fifth and final chapter presents a summary of the research and compiles all of the recommendations for modifications and revisions to current practice in Texas household and external surveys.

CHAPTER 2:
SURVEY PRACTICES IN TEXAS

HOUSEHOLD SURVEYS

Household surveys in Texas are stratified sample surveys. A sampling plan is developed that specifies the number of households to be surveyed cross-classified by household size and household income. In some areas, the sampling stratification also includes the number of employed persons in the household. Table 1 illustrates the sampling plan used for the Austin-San Antonio household survey. The number of households to be surveyed is based on the estimated number and distribution of households in the population and the expected amount of travel that will be generated by those households. Statistically, the sampling plan is designed to achieve an overall accuracy level in the estimate of total person trips of plus or minus 10 percent at a confidence level of 90 percent.

Table 1. Austin - San Antonio Region Household Survey Sample Sizes.

Income Ranges 2000 $	Household Size				Total
	1	2	3	4+	
$0 to $19,999	181	198	93	105	577
$20,000 to $34,999	128	257	163	175	723
$35,000 to $49,999	117	198	187	193	695
$50,000 to $74,999	71	233	198	210	712
$75,000+	70	245	210	268	793
Totals	**567**	**1,131**	**851**	**951**	**3,500**

Source: 2005 Austin-San Antonio Household Survey Bid Specifications, General Services Division, Texas Department of Transportation.

The sample distribution of households is not proportional to the estimated distribution in the population, and this issue introduces a bias into the survey. This bias, however, is accounted for in the weighting and expansion of the survey data. Households are mailed letters or postcards notifying them that they will be contacted by phone, and when contacted by phone the household members are asked to participate in the survey. Those agreeing to participate in the survey are sent a package with travel and activity diaries for each member of the household. Each household member is asked to record their travel and activities over a 24-hour travel day.

The day before their scheduled travel day, participating households are called to remind them about completing their diaries. The data are retrieved by phone following the household's travel day. An attempt is made to interview each adult in the household to retrieve their travel and activity data directly, but proxy reporting is permitted. Additionally, a sub-sample of the participating households is solicited to participate in the Global Positioning System (GPS) data collection effort. Those households agreeing to participate have GPS data collection devices placed in their vehicles. The GPS devices collect vehicle movement data over the same time period that the household is recording their travel and activities.

EXTERNAL SURVEYS

External station surveys (also referred to as "roadside" or "intercept" surveys) are designed to capture travel information on trips that are made into, out of, and through urban study areas. Each study area has a defined boundary that delineates the area under study. This is the area expected to be urbanized and developed within the time frame being modeled and forecasted. External stations are those locations where streets or highways cross this boundary. These locations are where persons or vehicles may enter, leave, or travel through the urban study area. Exceptions include airports, ferries, boats, and trains. Airports are typically surveyed as part of a workplace or special generator survey.

External station surveys typically query motorists as they leave a defined study area. In order to obtain motorist travel information, a traffic control plan is setup on the outbound lane or lanes of road where they traverse the study area boundary. Vehicles exiting the study area are directed out of the main flow of traffic into a survey "station" by a trained individual. Once in the survey station, drivers are interviewed by a trained surveyor. Both commercial and non-commercial vehicles are surveyed during external surveys, but the two vehicle groups are surveyed using different survey instruments.

In addition to the survey, directional vehicle classification counts are performed at or near the survey site on the same day as the survey. The classification data are aggregated into 15-minute increments for a 24-hour period. External surveys are typically performed only during daylight hours, primarily for safety reasons. Therefore, the classification counts are used to expand the survey data to represent a 24-hour day.

SURVEY ISSUES

Potentially problematic issues identified in the conduct of household and external surveys in Texas include:

1. Response rates for household surveys;
2. Item and unit non-response within household surveys;
3. Sampling errors in household and external surveys; and
4. Quality controls in data collection.

Response Rates

Response rates for household surveys are a measure of how well a survey successfully obtains information from all eligible households. Response rates for household surveys within the United States have been declining. The rates have typically been in the range of 25 to 40 percent (*1*). The response rates for the Laredo and Tyler-Longview household surveys, computed according to the definition of the Council of American Survey Research Organizations (CASRO), were 20 and 19 percent, respectively (*2, 3*). Poor response rates may be symptomatic of other problems such as poor data quality, non-response bias, poor survey design and execution, the sample not being representative of the population, etc. While response rates in Texas have been low, the data reviews and analyses have not found any indications of poor data quality, survey design or execution problems, or other associated survey problems.

Item and Unit Non-Response

Item non-response generally refers to data elements that are incomplete in a survey (sometimes referred to as missing data). For example, a household may refuse to answer certain questions such as household income, employment status of certain individuals, and so on. In certain situations, these gaps in the data may render the entire response from a household as being non-useable in the survey. In other cases, special weighting of the data may be required. Reasons for item non-response vary from poor survey instruments, lack of good quality controls, poor survey execution, lack of interest on part of survey participants, etc. In Texas, household surveys have experienced item non-response, but this has been at very low levels and the variables involved did not affect the development of information used in travel demand models. For example, in the Laredo household survey (*2*), the five variables with the highest incidence of non-response were vehicle odometer readings (32 percent), work at second job (26 percent), parking payment method (13 percent), hours worked at main job (12 percent), and length of time without telephone service (12 percent).

Unit non-response refers to households that do not participate in a household survey (i.e., non-response households). The households considered in the non-response category include:

1. Households that could not be contacted;
2. Households that refused to participate;
3. Households in which one or more individuals refused to participate; and
4. Households that initially agreed to participate but dropped out during the survey.

Non-response is considered a major cause of systematic error in household surveys (*4*). Households that fall into this category have been shown to be from segments of the population having characteristics significantly different from those of responding households (*5*).

At the heart of the non-response issue is whether non-respondents are different from respondents in demographic characteristics, travel behavior, or both. Studies by Borg and Meyburg (*6, 7*) have found non-response households in German mail back surveys are different in demographic characteristics and travel behavior. In the 1995 Houston-Galveston household survey (*8*), a comparison was made between the households that reported household income and those that did not. Various distributions of households and persons were compared. Although some under- and over-representation in certain variables was found, when the differences in households by vehicles available were applied to the average trip rates, only a 4 percent reduction in overall average trips per household was found. This difference was considered well within the range of the survey variance and confidence. Another study, the 1997 Denver Region Travel Behavior Inventory (*9*), attempted to determine if there were any significant differences between households that responded to the survey and those that either quickly refused to participate or those that could not be contacted. Results showed some differences between the households. The study also suggested that trip rates between the two groups of households might be very similar.

With respect to travel behavior, the literature is not conclusive, but it does seem to support the finding that non-response households differ from response households in terms of demographic characteristics. There are households in Texas surveys that do not participate. Whether these households are different in travel behavior and whether this difference affects the trip rates and trip length information used in the travel demand models is unknown.

Errors in Surveys

The literature identifies two sources of error in sample surveys (*4*). The first error, sampling error, is due to the fact that the data are a sample and not the entire population. This error will always occur, and it only affects the confidence researchers can have in the sample averages. This error may be reduced only by increasing the size of the sample.

The second source of sampling error in data measurement is called sample bias. This error may result from the sampling frame (i.e., the population from which the sample is selected) chosen for the survey, sampling techniques, interviewer mistakes, survey instruments, or many other aspects of the survey. This type of error may affect the values of the estimates obtained in the survey. These are the errors that may impact household trip rates, average trip lengths, percentages of external through and external local trips, and other critical parameters used in travel demand models in Texas. Sample bias can be corrected in certain situations through the proper weighting and expansion of the survey. The areas that have been identified as potential sources of error, either sampling or bias, in Texas surveys are:

- Certain segments of the population are excluded from the sample frame in household surveys (e.g., households with no telephones or only cell phones are excluded from a telephone survey).
- Reporting of survey data by proxy in household surveys (i.e., one person in a household reports all of the travel and activity information for one or more other member(s) of the household).
- Time period for external surveys (i.e., these surveys are conducted only during daylight hours).
- External survey direction (i.e., these surveys are performed only in the outbound direction).
- Vehicle classification counts (i.e., classification counts are collected by automatic vehicle classification (AVC) machines and may not accurately reflect the true distribution of commercial and non-commercial vehicles).
- External survey sample size (i.e., current sample minimums per site are 300 non-commercial vehicles and 50 commercial vehicles).
- External survey sample distribution (i.e., sample distribution during peak periods versus non-peak periods).

Since these situations may potentially introduce errors in the estimates developed from the surveys, they were evaluated in this research.

Quality Controls

The methodology most commonly used for data retrieval in household surveys is computer-assisted telephone interviewing (CATI). The methodology typically used in external surveys is personal interview with data entry into computer tablets. Since both surveys involve data entry directly into computer files or storage devices, no paper documentation is obtained in either survey for individual respondents. These systems have proven to be superior to the traditional paper and pencil techniques. They have, however, proven to be difficult to review and evaluate with regards to the accuracy of certain data elements such as addresses used for geocoding. The survey time requirements for external surveys have made the entry of detailed address information difficult (i.e., a survey is expected to be completed within four minutes). Geocoding is the process of locating the trip origins and destinations by longitude and latitude. The locations obtained from the geocoding of these addresses are the basis for estimating trip length frequency distributions used in the travel demand models. A review of these data from previous external surveys performed in Texas has raised serious questions as to the accuracy and quality controls of vendors collecting the information.

Methods for quality control in data collection vary between vendors depending on their resources, techniques, etc. The methods employed by TxDOT and TTI in reviewing survey data utilize detailed computer programs and manual reviews. Therefore, the methods used by vendors need to be reviewed and evaluated to ensure the data meet the specifications and accuracy requirements for TxDOT. The data checks and criteria utilized by TxDOT and TTI in reviewing data submittals by vendors need to be documented as well.

CHAPTER 3: HOUSEHOLD SURVEYS

LITERATURE REVIEW

The purpose for this task was to develop a synthesis of the state-of-the-practice of household surveys by state departments of transportation (DOT), Metropolitan Planning Organizations (MPO), or their consultants since 2000. To acquire information for this task, researchers reviewed survey reports, research articles, and presentations on this topic. To augment published reports, researchers at Texas Southern University conducted telephone interviews. The findings presented here primarily come from published reports, journal articles, and other publications, rather than requests for proposals (RFP), bid specifications, or consultant-related documents.

Specific information was gathered from 12 different household surveys ranging from the National Household Travel Survey to regional, statewide, and local surveys. Table 2 presents the characteristics of interest for each survey. The discussion in this section combines information from the review of these 12 surveys with survey methodology studies found in academic publications.

Household Participation

The Council of American Survey Research Organization (CASRO) proposed a standard for reporting survey response rates that includes the following terms:

- Contact Rates: The number of eligible persons who were contacted;
- Response Rates: The proportion of completed interviews by the total number of eligible respondents;
- Cooperation Rates: The number of completed interviews by the total number of contacted eligible respondents; and
- Refusal Rates: The proportion of eligible respondents who refused to give an interview.

The review of 12 household travel surveys indicated that most reported an overall response rate, a recruitment rate, and a retrieval rate, which is a slight variation on the CASRO standard. NuStats (*10*) provides this explanation of how they calculate the overall response rate, considering the recruitment and retrieval rates.

> The response rate is the ratio between completed interviews and total eligible sample called on the telephone. The response rate is calculated for recruitment, then retrieval. The overall response rate is determined by multiplying the two resultant rates, e.g., if the recruitment rate is 43 percent, and the retrieval rate is 75 percent, the overall response rate for the study [is] 33 percent (.43%×.75%). In other words, 33 percent of all eligible households that were contacted actually completed the survey.

For the 12 studies reviewed, overall response rates ranged from 19 percent to 54 percent. Recruitment rates ranged from 15 to 59 percent, and retrieval rates ranged from 62 percent (with one low exception of 36 percent for a special test group in the Oregon survey) to 75 percent (with a high exception of 87 percent for two test groups in the Oregon survey).

Much has been written about the steep decline in telephone survey response rates, particularly over the past 10 years since the introduction of new technology such as caller identification, caller recognition and blocking, do not call lists, and increased use of answering machines. One example of the dramatic rise in access to this technology was documented by Tuckel and O'Neill who report that the proportion of households in the U.S. with caller ID grew nearly 500 percent in the 5-year period from 1995 to 2000, increasing from about 1 in 10 households to almost half of all households in the country (*11*).

While telephone survey response rates in the 1980s averaged in the 70-80 percent range, current rates more typically fall in the 40-50 percent range (*12*). Very little has been written recently that identifies what is currently considered a reasonable or even a good telephone survey response rate. A popular survey methods textbook by Babbie says " A review of the published social research literature suggests that a response rate of at least 50 percent is considered adequate for analysis and reporting. A response rate of 60 percent is good; a response rate of 70 percent is very good" (*13*). Another textbook states "it is very important to pay attention to response rates. For interview surveys, a response rate of 85 percent is minimally adequate; below 70 percent there is serious chance of bias" (*14*). The Federal government, Office of Management and Budget (OMB), as of 2004, is reluctant to approve any federally sponsored survey with an overall response rate of less than 60 percent (*15*).

Overall response rates traditionally considered as high are more difficult to achieve with household travel surveys because of the completion rate. In actual practice, the interpretation of what constitutes a complete household response varies. Some surveys, including the requirements for the National Household Travel Survey, accept 50 percent of household participation as a complete response, but others require that all members of the household participate to be considered a complete response. Furthermore, the completion rate is also affected by the degree to which each household member answers all the questions. (This is not unique to household travel surveys.) Again, the range can go from zero tolerance (all questions must be answered to be considered complete), to a completion considered for a pre-determined set of core questions, to a pre-determined percentage of the data required (such as 80 percent).

Proxy reporting is one technique used to facilitate completions. Several, but not all, of the surveys reviewed for this research described proxy reporting. As of this writing, there does not appear to be a standard for household travel surveys with regard to proxy allowances. The review of the state-of-the- practice indicates that most proxy reporting is based on age, i.e., under 16 or 12-years old, for example, may be reported on by an older household member. The age varies. A few cases were noted in which language, accessibility, and repeated failed attempts to reach individuals were listed as allowable proxy situations.

In a 2000 report published by the Transportation Research Board, *Transportation in the New Millennium,* the Standing Committee on Travel Surveys stated that there is an urgent need to merge "today's state-of-the-art with tomorrow's state-of-the-practice" (*16*). This committee asserts that "the biggest problem faced in conducting high-quality travel surveys today is nonparticipation" (*16*). They offer several state-of-the-art solutions to address the problem, which are:

1. Use of Mixed-Mode Survey Designs. This is the use of a combination of telephone, mail back, and face-to-face interviewing for data retrieval. Pointing out that some respondents respond better to mail methods, others to telephone methods, and still others to face-to-face interviewing, the authors recommend providing respondents with greater choices on how, when, and where to be interviewed. They also see layering strategies such that sub-samples are targeted for more in-depth data collection as more commonplace in the future.
2. Use of Multimedia/Internet Methods. The internet was suggested as a state-of-the-art method to give respondents greater choice of when and where to be interviewed. This technique in not currently universally beneficial; however, internet or other multimedia approaches (videotapes, CD-ROM discs, etc.) offer the potential for easier and faster surveys for a segment of the population.
3. Use of Monitoring and Remote-Sensing Technologies. The use of global positioning systems is not widespread yet, but has great potential to not only increase the accuracy of data but also to lessen respondent burden. Advances in these technologies are said to promise major improvements in tracking travel patterns (*16*).

Sampling Frames

At the core of the accuracy of the data acquired from household travel surveys is the sampling method. Indeed, "the basis for unbiased inference from relatively small observed samples to largely unobserved populations is probability sampling” (*17*). Because the universe of people of interest cannot feasibly be surveyed, a target population is identified, from which a sampling frame is defined. The target population is usually all the residents within the geographic boundaries of the travel survey area. For travel surveys the target population is further defined as residents in households. Most travel surveys limit households to non-institutional and non-group homes (such as penitentiaries, dormitories, hospitals, and nursing homes).

The sampling frame is a listing of units that includes the target population. For telephone surveys, the sampling frame usually consists of all listed residential numbers or all telephone numbers within exchanges in the survey area (*18*). Since household travel surveys seek to reach household with listed *and* unlisted numbers, a random digit dialing (RDD) procedure is used. The RDD procedure was used in all the travel surveys reviewed.

Response bias can be introduced if the sampling frame omits segments of the target population. The sampling frame for telephone surveys leaves out households without phones and households with cell phones only (no land lines). Recent reports from the Federal Communications Commission indicate that an estimated 92.9 percent of all households in the U.S. have telephone service as of November 2005 (*19*). Higher telephone subscription rates are found among households with annual incomes above $100,000 (97.7 percent); households headed by Whites (93.3 percent); households headed by a person between 65 and 69 (95.2 percent); households with four to five persons (94.1 percent); and among employed adults (94.2 percent). Conversely, lower subscription rates are found for households with annual incomes below $5,000 (79.4 percent); headed by Blacks (86.7 percent) and Hispanics (89.2 percent); headed by a person under 25 (86.1 percent); households with one person (90.0 percent); and unemployed adults (89.7 percent). However, according to the proceedings of the National Household Travel Survey Conference in 2004, the percent of households reporting no phone service in the 2000 Census was only 2–3 percent (*20*). Cell phone only households are reported to represent about 6 percent of all U.S. households. These households tend to be among the younger, more urban, and the population more likely to rent than own their dwelling (*20*).

Several techniques have been used to mitigate the problem associated with unavailable or inaccessible telephone contact. One is to use addresses. This approach was pilot tested for the continuous survey for travel modeling pilot study evaluation in Oregon (*21*). The results showed that an address-based sample performed better in reaching households of a particular geographical unit, reaching low-income and transit-user households.

Another is to use mixed mode surveys (mail, telephone, intercept, face-to-face interviews, internet). Although not common practice, adding a survey mode is sometimes done to target a difficult to reach subsample. This was also recommended in the Transportation in the New Millennium report to the Transportation Research Board (*16*).

The bias against households without telephones is often handled subsequent to data collection by weighting the data to account for the under-representation. This approach involves comparing survey results to Census data for demographic comparability and applying weights to the survey sample to more closely approximate the population of the study area. One example where this approach was used is the Delaware Regional Valley Planning Commission/South Jersey Transportation Planning Organization household survey conducted in 2001. NuStats, in cooperation with Cambridge Systematics conducted the survey. Since NuStats performs many household surveys in the U.S., the weighting procedures applied to address the sampling frame distortion caused by non-telephone households is common (even though a standard has not been set).

The review of literature, both academic and in-practice, gives evidence of a variety of sample designs and means of achieving desired representation from groups within the sampling frame. An overarching question that is often asked is how large should a sample be or what is a reasonable sample size. Stopher and James (*22*), in discussing the development of standards for transportation survey quality assert the following:

> "This is probably the single most controversial item in household travel surveys, and one on which there is virtually no agreement, as evidenced by samples ranging from a few hundred to as many as 50,000 households. There is a need to develop minimum standards for sample size, depending on the purpose of the personal travel survey…(p.14)."

The base sample size for the 2001 National Household Travel Survey was 26,038 households. For the 10 non-national, non-pilot surveys reviewed in the table below, sample sizes ranged as follows (number of households in final sample):

Thurston County	1,500
Baltimore Region	3,200
Denver Region	3,824
Puget Sound Region	4,700
Delaware Region	5,677
Atlanta Region	8,069
Southern California	16,939
California Statewide	17,040
Bay Area Region	18,068
Ohio Statewide	22,413

Non-Response

The decline in response rates over the past three decades, and particularly over the past 10 years, has been well documented (*12, 23, 24*). Attention to survey non-response has increased in recent years because of the growing problem of inability to make contact with potential respondents and a larger number of those unwilling to participate. Of course, these problems are not limited to travel surveys, and there is much in the survey methodology, opinion research, statistical studies, and even medical studies literature that addresses combating non-response.

Public Opinion Quarterly, a journal published on behalf of the American Association for Public Opinion Research, recently (2006) devoted a special issue to the topic of non-response bias in household surveys. As an introduction to the issue, Eleanor Singer notes that survey non-response is not new and that according to Tom Smith (*25*), "early research extends back to the emergence of polling in the 1930s and has been a regular feature in statistical and social science journals since the 1940s" (pp. 27-28). Singer goes on to describe the evolution of the focus on non-response, describing a three-phase period. The first period from the mid-80s to the early 90s was one in which a decline in response rates was observed and the focus was on how much and what was responsible for the decline. The second phase, from about 1992 to about 2002, was noted by a surge in research devoted to investigating ways to reduce non-contacts and refusals. This phase produced publications on list-assisted sampling, answering machine solutions, and the use of incentives. The third and current phase Singer describes as one that reflects "the reluctant recognition that despite increasingly costly efforts to make contact with designated households and persuade respondents to participate, response rates have not only continued their decline but also have done so at an increasing rate" (*17*, p. 641). During this phase, the focus is on determining how non-response relates to non-response bias. The question is, if non-response bias is correlated with non-response, then what adjustments need to be made to make accurate inferences from the sample surveyed to the population.

Several studies have found that the direct correlation between non-response and non-response bias is not a foregone conclusion. Groves reviewed and analyzed 30 research reports in which non-response bias was reported (*26*). He concluded first that non-response bias does occur; but secondly that the non-response rate of the survey is not alone an accurate predictor of the magnitude of non-response bias. A third conclusion was that the effect of increasing the response rate on the non-response bias is not easily predicted. Groves explains with an example that if the non-responders are wealthy and an effort to increase the response rate is made by introducing monetary incentives, the response may increase among non-wealthy, thus actually increasing the non-response bias. In short, "higher response rates do not necessarily reduce non-response bias for any given survey or any given estimate" (*26*, p. 663).

Groves also provides a good overview of what has been gleaned from the literature regarding who is less likely to respond to surveys. He points out that males are more likely to refuse than females, people who live alone are more often refusals, urban dwellers are more likely to refuse, while households with young children are more likely to respond. Other demographic variables are associated with response propensity, such as minority status and socioeconomic status, but these vary with types of surveys, the topic and the sponsor (*26*, p. 664). Surveys sponsored by the government are more likely to receive higher response rates than academic surveys, and academic surveys are more likely to receive higher response rates than commercial surveys (*23*). Groves also mentioned burden of response as an influencing factor in non-response. The burden has a greater effect on paper surveys—the response rate goes down with the number of pages—but the interview length of telephone surveys is not as reliable a predictor of the burden effect. In a study of incentives, interview length, and interviewer characteristics, Hansen found that changing the announced interview time at the outset of the interview from 20-to-15 minutes (irrespective of the actual interview time) resulted in a 25 percent increase in the response rate (*27*).

An examination of the effects of major efforts to increase the response rate on non-response bias was recently conducted. In this study, a "standard" survey was conducted during a five-day period in June 2003 (*28*). A "rigorous" survey was initiated at the same time using the same questionnaire. The rigorous survey continued through October 2003 (21 weeks). In the rigorous survey, advance letters were mailed, refusal conversion letters were mailed, answering machine messages were used, and some letters included a $2 incentive. A subset of "hardest to reach" was delineated and analyzed. These 494 respondents refused at least twice and/or were called 21 times before completing the interview. The standard survey yielded a 25 percent response rate. The rigorous survey yielded a 50 percent response rate. To assess respondent representativeness, a comparison of demographics was made between respondents of the two surveys and respondents to two other national surveys that achieved a higher than 90 percent response rate—the Current Population Survey and the National Health Interview Survey. The results showed that "despite its higher response rate, the rigorous sample was not closer to population parameters than the standard sample in every comparison. The topic of the survey was political, and the analysis showed little difference in question responses from the standard survey respondents and the "hardest to reach." Two important points were discussed in this paper. One points to the cost associated with the effort to reach the hardest to reach. The rigorous survey completed 1,089 interviews after 72,485 calls. The second point is that even though the non-response bias was not significant for the topic of the survey, this cannot be assumed for surveys of other topics. The authors conclude with this recommendation:

> "One practical recommendation from our research might be that the additional effort undertaken in a rigorous study be reserved for situations in which there is a strong theoretical expectation that the level of interest in the survey topic is likely to lead to non-response bias on key measures in the study" (*28*, p. 779).

De Heer presented an international overview of data quality problems in travel surveys for a workshop on respondent issues (*29*). He concludes with the following:

> "So the general conclusion is that it seems not to be very useful to try to get the highest possible response rates by all available means. It seems to be better to try to avoid design or fieldwork failures that might result in decreasing participation rates of specific subgroups and to detect particular groups among the non-respondents and to collect from them information related to the target variables to find out whether there is non-response bias or not."

Despite studies that demonstrate that the relationship between non-response and non-response bias is complex and not easily or uniformly remedied, the federal government sets forth some clear guidelines for the goal of decreasing non-response (again, minimum response rates are required to obtain OMB approval for federal surveys) and assessing non-response bias. These are:

- Prior to data collection, identify expected unit response rates at each stage of data collection, based on content, use, mode, and type of survey.
- Plan a non-response bias analysis if the expected unit response rate is below 80 percent.
- Use internal reporting systems that provide reporting of response rates and the reasons for non-response throughout the data collection.
- If response rates are low and it is impossible to conduct more extensive procedures for the full sample:
    - select a random subsample of non-respondents selected for the more intensive data collection method;
    - determine a set of required response items to obtain when a respondent is unwilling to fully cooperate; and
    - if the overall unit response rate is less than 80 percent, conduct non-response analysis using unit responses rates and assess whether the data are missing at random.
- For multi-stage collections, analyze each stage with particular attention to the "problem" stages.
- Non-response bias analyses should include:
    - comparing response rates by different subgroups;
    - comparing non-respondents and respondents on frame variables;
    - comparing respondents to known characteristics of the population from an external source; and
    - comparing initial refusers with initial respondents (*15*).

This type of response rate monitoring and non-response bias analysis was found in practice. The 2002 Southern California regional travel survey examined non-response bias, augmented the survey with mixed modes and oversampling, yet still achieved a very low response rate of 19 percent (unacceptable by federal government guidelines). In the 2000-01 California statewide travel survey, the pilot test achieved a 20 percent overall response rate and stated their goal for the full survey would be 25 percent. The contractor, NuStats, used weights for household size, income, county, and vehicle availability by own/rent status to adjust for non-response. The Oregon pilot evaluation looked at relative response rates for a dual frame sample in which respondents were randomly assigned to three groups for data collection. The demographics of responders were compared with Census data, enabling an analysis of non-response bias to be performed. In this evaluation the CATI Random Digit Dialing (RDD) method was used for the sampling frame of households with landline telephones. Additionally, an address-based sampling frame was used to draw residential addresses within a geographic area that were then matched to telephone numbers. The pilot evaluation showed that the RDD method performed better for reaching larger households and a higher overall response rate, but the address-based sample was more effective in reaching lower income and transit-using households. The Bay Area Travel Survey 2000 (BARTS 2000), conducted by MORPACE, included an extensive midpoint review of the sample and survey quality. At this midpoint, non-response by subgroups was identified and efforts were made, such as the introduction of incentives, for heavier recruitment.

Incentives

Incentives are posited as one technique to increase survey cooperation rates. Eleanor Singer has provided the survey science community with a synthesis report on the use of incentives in interview and mail surveys (*30*). She points out that sometimes incentives are offered at the outset of the survey (typically with mail questionnaires) and sometimes they are offered as a way to convert refusals. In her scan of studies that examined incentives, Singer found the following:

- Incentives improve response rates. On average, each dollar of incentive paid results in about a third of a percentage point difference between the incentive and the zero incentive condition.
- Prepaid incentives do not differ significantly from promised incentives.
- Money is more effective than a gift, even controlling for the value of the incentive.
- Increasing the burden of the interview increases the difference in response rates between an incentive and a zero-incentive condition. However, incentives have a significant effect even in low-burden studies.
- Incentives have significantly greater effects in studies where the response rate without an incentive is low. That is, they are especially useful in compensating for the absence of other motives to participate.
- Studies of lotteries as incentives have shown inconsistent results.

The review of case studies for this research revealed that incentives in household travel surveys have been used primarily for motivating harder to recruit categories of the sample (for example, large households, households with no vehicles). Of the 12 case study examples, four offered incentives in this manner.

Weighting and Expansion of Survey Data

Data expansion is used to apply results to a broader geographical area. Data weighting is needed to adjust for bias or for disproportionate sampling stratification. Almost all of the case studies reviewed included some form of weighting and/or expansion. However, they were not always described in detail in the reports made available to the general public.

Transportation Research Board (TRB) Research Circular E-C008 (*Transport Surveys: Raising the Standard)* (*29*) provides a thorough coverage of weighting procedures and guidelines, which is summarized in the following outline:

I. Schematic Description of Weighting – The weighting procedure usually should be
   a. First stage: *sample weighting* – Sample weighting corrects for unequal probabilities of selection. That could be correcting frame errors and/or requiring disproportionate samples. This stage should be compulsory for disproportionate samples.
   b. Middle stage: *unit/item weighting (non-response weighting)* – This stage may weight respondents up/down due to unit non-response; it may correct for item non-response by weighting or by the imputation of missing values.
   c. Final stage: *grossing up* – After the corrections above, overall sample characteristics may (still) not reflect the population proportions on key variables, for example, because the random sample did not give a representative sample. This stage is often done primarily for political/cosmetic reasons.

The order of the second two stages may be inverted. Whether the weighting takes place by households first, then by people, or vice versa, depends on objectives, but will rarely give the same result. This can be addressed by:

- iterative weighting; and
- weighting to cells, if population cross-tests are known.

II. Weighting: Guidelines
   a. Document the weighting procedure fully. Add weighting variables to the data sent in a manner that allows them to be easily identified. Keep them there for other users. Identify the effects the weighting has for the variance of dependent variables and how this has been taken into account (e.g., with significance testing).

   b. Keep the weighting as straightforward as possible, for example, avoid the adoption of different weighting procedures in different sections of a report—this makes it very difficult for the client to follow.

c. Weighting non-contacts (e.g., despite callbacks) is probably better used for correcting (based on data for late/difficult contacts) rather than refusals. There is little literature evidence to suggest that late/difficult contacts are similar to refusals.

III. Quality Guidelines – The difference between the weighted and non-weighted data sets is not a good quality indicator, because:
   a. The sampling could have been disproportional to allow for specific weighting of particular subgroups/cells; and
   b. This may encourage political/cosmetic weighting; one should be free to weight to the optimal sample characteristics, as far as this can be statistically justified.

Survey Techniques

Procedures for conducting household travel surveys were reasonably standard across the case studies examined. The 10 surveys for which details were available on survey procedures were conducted by three firms as prime contractors—Westat for the National Household Travel Survey; NuStats for Atlanta 2001, Delaware region, Ohio statewide, California statewide, Southern California, and Thurston County; and MORPACE for Bay Area region, Baltimore region, and Puget Sound Region.

The survey procedure is basically a 5-step process:

1. Advance Notification. This step was taken in 6 of the 10 case studies. An advance letter was mailed to addresses that could be matched to telephone numbers to introduce and describe the survey, and in the case of the National survey a pre-survey incentive was included. In two cases the mention of a survey information website was provided in the letter.
2. Recruitment Call. This step was common to all surveys. In addition to securing cooperation, respondents were assigned their travel day(s) during this call. One case study (Southern California region) reported the average length of the recruitment call was 20 minutes. The National survey was the only one that reported the number of call-backs for recruiting, which was 7 attempts.
3. Diary/Activity Log Mailings. These were usually mailed the day following the recruitment call.
4. Reminder Call. All of the survey procedures included a reminder call the night or day before the travel day(s). This was also described as an opportunity for last minute questions.

5. Retrieval Call. Retrieval calls were initiated the day after the assigned travel day. Data are retrieved during the retrieval call using Computer Assisted Telephone Interview (CATI) methods. Two studies reported the average time for data retrieval—25 minutes for Atlanta and 26 minutes for Southern California. The National survey was the only one that reported the number of call-backs for data retrieval, which was 8 attempts. MORPACE allowed respondents to mail back their diary information in some situations, particularly with larger households who might drop out of the survey due to the increased household burden.

With regard to number of contacts, Stopher reports that his analysis and the results of previous studies indicate that more than six call attempts does not result in a significant reduction in non-response bias. Therefore, in his proposed standards and guidelines for household travel surveys, he recommends that "the number of call-back attempts for household travel surveys be limited to five (or possibly six), and that these callback attempts be made at different times on different days of the week" (*31*).

Quality Control

Survey quality is enhanced through the use of pilot tests, interviewer training, monitoring results, and mid-survey reviews. Reports for five of the case studies mentioned full pilot tests. NuStats described the Atlanta pilot test as a "dress rehearsal" and a way to debrief respondents on the survey materials and the survey experience (*32*). The completed sample size was 53. A pilot survey was conducted in the California statewide survey, allowing for a "full evaluation of the survey materials from the recruitment phase to the data processing phase prior to the implementation of the full survey." The sample size was 209 (*33*). The Delaware region survey also included a complete run-through pilot survey with a sample size of 97 (*10*). Additionally, MORPACE conducted a full pilot study for the Bay Area Travel Survey (BATS) 2000. The sample size was 402. The script and procedures were changed as a result of the pilot study, and a second pilot study was conducted with a sample size of 21. The second pilot study resulted in a decrease in the length of the survey instrument from 25 to 19 minutes. The BATS 2000 survey effort also included a midpoint evaluation to check survey data and adjust the sample (*34*). MORPACE also conducted a pilot study for the Puget Sound survey, with a sample size of 30 (*35*).

Interviewer skill is a key to recruitment and quality data. NuStats reports to have the largest permanent interviewer staff in the U.S. trained in household travel survey interviews.

They also report developing project-specific training manuals to train for the nuances of each survey (*33*).

Westat used 345 interviewers and 58 supervisors for the 2001 National Household Travel Survey. Each new interviewer completed at least eight hours of interviewing and CATI training, in addition to the 24 hours of project specific training that all interviewers received (*36*).

MORPACE provides its training manual and interviewer handbook for the BATS 2000 survey online at www.abag.gov/pub/mtc/planning/BATS/BATS2000 (Volume II). The training is extensive. The manual states that "during a typical interviewing shift, the ratio of interviewers to supervisors is 15:2. The staff assigned to every 15 interviewers consists of a supervisor or assistant supervisor and a call monitor. The call monitor/supervisor routinely view via CRT and listen to/evaluate 15 percent of each interviewer's calls during an interviewing shift" (*37*, p.10).

Survey Geocoding

The Household Travel Surveys Standards and Guidelines mentioned above describes the state-of-the-practice for geocoding as an "expensive and problematic activity in most household travel surveys," (*31*, p. 26) despite advances in technology. Basically, "geocoding is identifying the geographic location of a trip end and coding a number, such as a traffic analysis zone (TAZ), Census tract or block, or latitude and longitude, to represent that location" (*38*). The recommendations made for standards and guidelines are:

- information about frequently visited locations be collected and geocoded in the recruitment stages of a survey to maximize the opportunity to re-contact households to check addresses that cannot be matched;
- geocoding for non-household and non-habitually visited locations be performed within a few days of data retrieval, also to allow households to be re-contacted if necessary;
- respondents be asked for the names of cross streets and/or landmarks during data retrieval; and
- interviewers should have a good knowledge of the survey area, or have access to gazetteers containing accurate addresses for shopping centers and schools. On-line address directories (e.g., www.infoseek.com, www.usps.com), should be used to locate addresses in situations where supplementary information is not available (*31*, p. 26).

As Table 2 shows, geocoding was done for each of the case study surveys. The software most often used was ArcView. Geocode matches were high. In several cases, new technology was used to collect GIS information: GeoLogger (an individual tracking system) was used in the

California statewide survey and in the Oregon pilot evaluations; and an in-vehicle GPS system was used in the Puget Sound region survey.

Table 2. Household Survey Practices.

Element	National HH Travel Survey—2001	Delaware Regional Valley Planning Commission/South Jersey Transportation Planning Organization
Sampling Frame	All non-institutionalized households. All members of household eligible, including under five years. Random digit dialing RDD telephone sampling.	HH in 14 counties of Pennsylvania, and Southern New Jersey. All members of HH eligible
Response Rates	69,817 individuals in 26,038 households, plus 43,779 add-ons. 50% adult participation considered a responding HH. Overall—41% HH screener rate—58% Useable HH rate—71%	Recruitment rate—43% Retrieval rate—75% Overall response rate—33%
Non-Response	7 callbacks. Refusal conversion specialists.	Examined by comparing responders to 1990 census data and to registered vehicle data set. Item non-response provided in report.
Incentives	$5 for New York HHs and $2 for Wisconsin HHs.	None
Proxy Reporting	Proxies requested for subjects under age 16. 4 other cases in which proxies were allowed: impairment or language barrier; subject unavailable for six days; subject refused and interviewee knowledgeable on subject's travel; three days of unsuccessful callbacks.	Not mentioned
Diary Use	71.1% completed 24-hour, 1 day travel diary	1-day, 24-hour travel diary
Data Expansion/Weighting	Weighting applied to sample for households, persons, trips, and travel periods.	Each HH that participated in the survey represented 133 HH when expanded. Use of HH-level weights.
Address Coding/Geocoding	O&D geocodes for all trip purposes and modes	Took place throughout the survey, beginning with home address, then to habitual addresses, then to trip ends. Used ArcView software.
Report Reference/Website	http://www.bts.gov/programs/ national_household_travel_survey/	http://www.sjtpo.org/ htsrpt.pdf

Table 2. Household Survey Practices (continued).

Element	Denver Regional Travel Behavior Inventory--1997	Baltimore Household Survey—2001
Sampling Frame	8-county Denver Regional survey; listed and unlisted phone numbers	Baltimore Area—telephone households; list-assisted RDD
Response Rates	54%	Add-on to National Travel Survey
Non-Response	Small HHs Urban core HHs (apts.) Low income HHs Very high income HHs ESL HHs	Add-on to National Travel Survey
Incentives	Not on full survey, but included in non-responder follow-up	No
Proxy Reporting	Not mentioned	Yes—as described for NTS
Diary Use	Place-to-place activity one day diary;	One-day, 24-hour
Data Expansion/Weighting	3 Steps—weighting of 5 selections of random HH telephone numbers; then ―mean of means" used to calibrate HH characteristics; then samples were calibrated to alternative estimates of the region's HHs using 8 tests. Sample then expanded to region.	Weights assigned at household, person, and trip level using known Census 2000 population distributions.
Address Coding/Geocoding	Individual geocoding; used relaxed match	Performed by contractor for all addresses
Report Reference/Website	http://www.drcog.org/documents/ DRCOG%20TDR%20Report.pdf	http://www.baltometro.org/reports/ HHsurvey2001.pdf

Table 2. Household Survey Practices (continued).

Element	2001 Atlanta Household Travel Survey	2001-2003 Ohio Statewide Household Travel Survey
Sampling Frame	Telephone households in 13-county non-attainment area of Atlanta	All Ohio telephone households (with exceptions of Cleveland, Columbus, and Cincinnati)
Response Rates	Recruitment rate: 44.8% Retrieval rate: 67.8% Overall response rate: 30.4%	Recruitment rate: 41% Retrieval rate: 73.6% Overall response rate: 30%
Non-Response	Higher among low income and minority HHs	Non-response items were filled in with —data imputation.”
Incentives	None	None
Proxy Reporting	Not mentioned	Not mentioned
Diary Use	48-hour period	24-hour weekday period
Data Expansion/Weighting	Weights applied for net residential density level, county, income, household size, race, ethnicity, and vehicle ownership. 2000 Census data was used to expand to 13-county level.	Weights applied based on household size, income, and vehicle ownership by housing own/rent status using 2000 Census data. Expanded to county level representation.
Address Coding/Geocoding	Latitude and longitude geocoding for all addresses performed by contractor.	Took place throughout the survey, beginning with home address, then to habitual addresses, then to trip ends. Used ArcView software.
Report Reference/Website	http://www.atlantaregional.com/cps/rde/xbcr/arc/ HouseholdTravelSurvey.pdf	http://www.dot.state.oh.us/urban/ Download/Ohio%20HTS_Final%20Tech%20Memo%200811 .pdf

Table 2. Household Survey Practices (continued).

Element	Bay Area Travel Survey—2000	2000-2001 California Statewide Travel Survey
Sampling Frame	9 county Bay Area. RDD of telephone households	California telephone households stratified in 17 regions. Listed and unlisted RDD numbers.
Response Rates	At mid-point period: Recruitment rate: 14.9% Completion rate: 43.2%	Recruitment rate: 28% Retrieval rate: 72% Overall response rate: 20%
Non-Response	7% item non-response for income; 2% item non-response for race	Analysis on non-response rate said to be out of scope of survey project.
Incentives	$20 to 4-person HHs; $30 to 5-person HHs; option for United Way donation	None
Proxy Reporting	Not mentioned	Not mentioned
Diary Use	2-day diaries; Diary for each HH member and HH summary sheets	24-hour weekday or 48-hour weekend diary period
Data Expansion/Weighting	Weights applied at —superdistrict" level.	Weighted by 4 weight factors: own/rent status by vehicle availability, households by county distribution, household size and income. 3 expansion factors: weekday, weekend, and 7-day variables.
Address Coding/Geocoding	99.9% of home addresses geocoded to the street address or intersection level. 86% of activity addresses geocoded to the street address level and 8% to the intersection level	Performed by contractor throughout survey. Used GPS tracking system (GeoLogger)
Report Reference/Website	ftp://ftp.abag.ca.gov/pub/mtc/planning/ BATS/BATS2000/BATS%20Final%20Report/ Executive%20Summary%20and%20TOC/execsum.pdf	www.dot.ca.gov/hq/tsip/otfa/mtab/ Travel-Survey/2000_Household_Survey.pdf

Table 2. Household Survey Practices (continued).

Element	Oregon Continuous Survey for Modeling—10/05	2000 Southern California Regional Household Travel Survey
Sampling Frame	Pilot evaluation survey used RDD method for telephone households combined with address-based sampling. Sample was divided into 3 groups for evaluation purposes. Statewide sample frame.	Telephone households in Counties of Imperial, Los Angeles, Orange, San Bernardino, Riverside, and Ventura. Intercept surveys used for mode augment
Response Rates	Recruitment rate: 35% for Groups 1 & 2; 16% for Group 3 Recruit to eligible rate: 87% for Groups 1& 2; 36% for Group 3	Recruitment rate: 29% Overall response rate: 19%
Non-Response	Studied in great detail, comparisons across groups	Higher non-response from larger HHs (5+ persons, zero-vehicle HHs, and low income HHs.
Incentives	No	None mentioned
Proxy Reporting	Only for under 12 years of age	For children under 12
Diary Use	Trip logs + GeoLogger (assigned to Groups 2 & 3 based on age).	Activity-focused travel logs—24 hour weekday & 48 hour weekend samples. Subsample used GPS technology
Data Expansion/Weighting	Not applicable—pilot testing the method and sample selection	Data weighted to compensate for HH size and vehicle availability.
Address Coding/Geocoding	Uses GPS monitoring devices to record movement by HH members. Rates were very high—100% for home & school; 98% for work and 95% for trip ends.	Geocoding on a continuous basis by contractor
Report Reference/Website	www.oregon.gov/ODOT/TP/ docs/TMR/OLPS/pilot.pdf	www.scag.ca.gov/travelsurvey/ pdf/MainSurveyResults.pdf

Table 2. Household Survey Practices (continued).

Element	1998-1999 Thurston County Household Travel Survey	Puget Sound 2006 Household Activity Survey
Sampling Frame	Telephone households in Thurston County, Washington. RDD of 1500 HHs.	Counties in the Puget Sound region, Washington, subset for GPS collection, subset for transit and toll alternatives. Included stated preference survey.
Response Rates	Recruitment rate: 59% Completion rate: 62% Overall response rate: 36%	Recruitment rate: 36.7% Overall participation rate: 54.1%
Non-Response	Analyzed by comparison of respondent HH to 1990 Census data	GPS used to address missing trip item non-response
Incentives	None reported	$20-$30 for 0 vehicle HH's and 4+ person HHs if all HH members completed survey
Proxy Reporting	Not mentioned	Discouraged except for those under 16, but accepted from adult HH member. 20% proxy reporting for those over 18.
Diary Use	48-hour period for all members of HH	48-hour diaries
Data Expansion/Weighting	Used household survey data for those who completed survey compared to those recruited but not completed to calculate expansion factors	Weighting at the county level for regional estimates
Address Coding/Geocoding	Digital mapping	Not discussed in detail but used to compare travel diary reports with GPS data from equipped vehicles.
Report Reference/Website	www.trpc.org/resources/ 19981999thurstoncountyhouseholdtravelsurveyfindings .pdf	www.psrc.org/datapubs/data

TEXAS PRACTICE

The purpose of this section is to examine household travel survey practice in Texas and contrast that practice with those practices reviewed in the literature review (i.e., previous section). Three household surveys in Texas were reviewed in this effort, Laredo, Tyler-Longview, and Cameron-Hidalgo Counties (i.e., referred to as the Valley). Specific information on the three surveys done in Texas was obtained from documentation provided by the vendors that performed the surveys and from examination of the data that resulted from the surveys (*39, 40, 41*).

Household Participation

The review of the survey documentation for the three surveys found that two of the three vendors reported survey response rates. The third survey (in the Valley) did provide enough information to estimate the response rate. Table 3 presents the results for each survey.

Table 3. Recruitment, Response, and Retrieval Rates in Texas Transportation Institute.

Survey Area	Recruitment Rate	Retrieval Rate	Response Rate
Laredo	45.0%	71.0%	31.0%
Tyler-Longview	76.0%	51.9%	39.4%
Valley	31.2%	83.5%	26.1%

In the surveys reviewed in the literature review, recruitment rates ranged from 15 to 59 percent, retrieval rates ranged from 62 to 75 percent, and overall response rates ranged from 19 to 54 percent. The surveys in Texas are consistent with the data reported for surveys in other parts of the country.

As noted in the previous section, overall response rates are impacted by what is considered a complete household response. In Texas, a complete household is considered one that each person in the household completes the survey. In the Laredo survey, only members of the household age five and older were expected to complete the survey. This requirement was modified after that survey to include all members of the household regardless of age. It was noted that in some surveys, only 50 percent of the household members had to participate to constitute a complete household. This variation implies that the response rates from all surveys may not be comparable.

Proxy reporting is a means of improving survey completions because it relaxes the requirement that each person in the household be interviewed to retrieve their travel and activity information. In practice, it is recognized that this requirement is simply not always practical, especially for younger household members and members that may be gone a lot. There is not a standard for household surveys in terms of allowable use of proxies. The review of the state of the practice found that most proxy reporting is based on age, e.g., under 16 or 12 years of age. In those cases, a proxy is typically allowed to report the data. In Laredo, a proxy was allowed to report for individuals under the age of 12 (*39*). In Tyler-Longview, proxies were allowed for persons less than 16 years of age (*40*) whereas in the Valley, proxies were allowed for minors (the age was not given) (*41*). In all three surveys, proxies were allowed for persons not available at the time of data retrieval or for whom call backs could not be arranged. These practices appear to be consistent with those followed in other surveys around the nation.

Sampling Frames

The sampling frame for a household survey is a listing of units that includes the target population for the survey. For telephone surveys, the sampling frame consists of all residential numbers within the telephone exchanges in the area being surveyed. The review of surveys in the literature review found that a random digit dialing method was used in all of the surveys. The sampling frame for each area surveyed in Texas consisted of all households with working telephone numbers (as is typical for all telephone surveys). Institutional and group homes such as penitentiaries, dormitories, hospitals, and nursing homes are excluded from the survey.

Since the sampling frame consists of households with working telephone numbers, households without phones and households with only cell phones are not included in the frame. This is believed to introduce some response bias. Nationwide, the percent of households reporting no phone service in the 2000 census was 2–3 percent. The percent of households (based on the 2000 census) without phone service in Laredo was 6.1 percent, in Tyler-Longview was 2.8 percent, and in the Valley was 6.8 percent.

The bias introduced by sampling only households with telephones is typically handled by weighting the survey data to account for the under representation. This weighting is done in

Texas based on the population of households (telephone and non-telephone) stratified by household size and income. Since the Laredo household survey (done in 2001), an additional weighting has been applied to the survey data to account for under/over representation of individuals by sex and age. This weighting is applied to person data collected in the survey and includes trips and activities. The underlying assumption in weighting the survey data is the surveyed households and population are representative of the groups that were not included in the sampling frame.

Nationwide, sample size in household travel surveys varies considerably depending on the size of the area. For example, the national household survey was 26,038 households, the California statewide survey was 17,040, and the Ohio statewide survey was 22,413. The Thurston County survey was 1,500 households and the Baltimore region survey was 3,200. There are no current standards for how large (or small) the sample size should be in household travel surveys. In Texas, the sample size is based on a desired accuracy of ±10 percent in total person trips with a confidence level of 90 percent. For Laredo, the sample size was 2,000 households, Tyler-Longview it was 2,000 households, and in the Valley it was 2,400 households. These samples were stratified by size and income in each area. Given the size of the areas, surveys in Texas appear to be consistent with other areas in the nation relative to sample size.

Non Response

Review of the research literature on non-response found that this issue has been a concern for a long period of time and that response rates have continued to decline despite efforts to reverse the trend. Non-response households may be grouped into three categories: 1) those that cannot be contacted, 2) those that are contacted but refuse to participate, and 3) those that agree to participate but do not complete the initial interview and/or the survey. The response rate typically reported for household travel surveys is based on the combined recruitment rate and retrieval rate. For purposes of this research, the non-response category of interest are those that are contacted but refused to participate and those that agree to participate but drop out during the course of the interview and/or survey. In the Laredo household survey, out of the eligible households, 52 percent refused to participate. In the Tyler-Longview survey, 12 percent of the eligible households refused. In the Valley survey, an estimated 69 percent refused (this is an estimate since the eligible number of households was not reported). In Laredo, the partial completes were 3.3 percent and in Tyler-Longview, the partial completes were 4.4 percent. This number could not be determined for the Valley. These numbers are not considered inconsistent with national trends because the overall non-response rates in Texas were consistent. The numbers do raise the question of whether their non-participation introduces bias into the survey results and how that bias may affect the overall results.

Incentives

Incentives are one of the options frequently mentioned as a means to improve response rates in household travel surveys. Review of surveys around the nation found that incentives were largely used to improve response rates in hard to recruit categories of households. Of the 12 surveys reviewed, four offered incentives in this manner. In Texas, there have not been any consistent efforts to provide incentives. This has been left to the individual vendor. For example, no incentives were reported as being offered in the Laredo household survey. In the Tyler-Longview survey, incentives of $20 were offered to two or more person households with an annual income of less than $10,000 and incentives of $20 were offered to three or more person households with an annual income less than $10,000. A $30 incentive was offered to all households that completed the GPS portion of the survey. In the Valley survey, incentives of $50 to $100 were paid to participants in the GPS portion of the survey. The amount was dependent on the number of vehicles available to the household. No specific data exist on the effectiveness of these incentives but it can be assumed based on the literature that the incentives did help the vendor meet their survey goals.

Weighting and Expansion of Survey Data

Survey data are weighted (or expanded) to produce estimates of survey parameters for the entire population. Weighting provides a means to correct for under/over representation of specific survey elements as well as produce estimates for the entire population. In the surveys reviewed in the literature, almost all of them included some form of weighting and/or expansion. Unfortunately, the documentation reviewed for those did not include details on how the weighting and expansion was done. The Laredo household survey data were weighted based on the number of surveyed households and the population of households stratified by household size and income. This weighting resulted in estimates of the survey data that were representative of the population of all households in the study area. The survey data in Tyler and Longview and in the Valley were first weighted based on the number of surveyed households and the population of households stratified by household size and income. A second weighting factor was computed for each individual based on their age and sex. This weighting was applied only to person variables (such as trips and activities). This weighting corrected for under/over representation in the survey data of individuals by age and sex.

Review of the findings in the literature indicated that weighting may also be applied to unit/item non-response in the survey data. This may correct for item non-response or be applied to impute missing values. This type of weighting is not done in Texas.

Survey Techniques

As noted in the literature review, procedures for conducting household travel surveys are fairly standard. They typically involve the following five steps:

1. Advance Notification,
2. Recruitment Call,
3. Diary/Activity Log Mailings,
4. Reminder Call, and
5. Retrieval Call.

Each of the surveys done in Texas used these steps in conducting the survey.

Quality Control

Survey quality control is exercised through several methods including pilot tests, interviewer training, monitoring results, and in some cases mid-survey reviews. In the 12 surveys reviewed in the literature, five conducted full pilot tests. The sample sizes for these pilot tests ranged from 30 to over 400. In Texas, full pilot surveys were conducted in Laredo, Tyler-Longview, and the Valley with respective sample sizes of 51, 62, and 50 households. These pilot surveys tested each step in the survey process and served as training exercises and full scale tests of survey questions, scripts, and processes.

In all the surveys reviewed in the literature and those in Texas, extensive training of interviewers is maintained by the vendors performing the surveys. Several surveys monitor results as the surveys were being done and in one case, a mid-survey review was conducted. Surveys in Texas are monitored closely by the vendors to track how well the survey quotas are being matched since the samples are stratified by size and income. Extensive review and evaluation of survey results are not typically done in Texas surveys during the course of the survey. When the data are submitted, they are examined closely to identify problems in unit responses and data quality prior to being accepted for payment to the vendor.

Survey Geocoding

Geocoding is the process of identifying a location relative to its position such as a census tract, transportation analysis zone, or longitude and latitude. Locations typically geocoded include household addresses, trip ends, and work locations. The process of geocoding can be time consuming and expensive as well as problematic. Every survey reviewed included geocoding. This is also true in Texas. The Texas survey data were reviewed to determine the success rate for geocoding to longitude and latitude. Longitude and latitude are considered the most critical since they are the basis for geocoding to census tracts and transportation analysis zones. In the Laredo survey, a 99 percent match rates was achieved for geocoding to longitude and latitude. In the Tyler-Longview survey, the match rate was 87 percent and in the Valley survey, the match rate was 99 percent. Table 4 describes Different systems used to achieve these results.

Summary

Table 4 presents a summary of the household survey practice in Texas. In reviewing that practice and the findings in the literature review, household surveys in Texas are consistent with those being done in other parts of the nation and are considered to be state of the practice.

Table 4. Summary of Texas Household Survey Practice.

Element	Laredo (39)	Tyler/Longview (40)	Valley (41)
Sampling Frame	All households with working telephone. 2000 census reported 6.14% of households without phone service. Collect travel data for each person 5 yrs of age and older	All households with working telephone. 2000 census reported 2.83% of households without phone service. Collect travel data for each person in household regardless of age.	All households with working telephone. 2000 census reported 6.75% of households without phone service. Collect travel data for each person in household regardless of age.
Response Rates	18,806 telephones called Recruitment rate – 45% Retrieval rate – 71% Response rate – 31%	56,297 telephones called Recruitment rate – 76.0% Retrieval rate – 51.9% Response rate – 39.4%	10,000 telephones called Recruitment rate – 31.2% Retrieval rate – 83.5% Response rate – 26.1%
Non-Response	3,185 Eligible Refused (52%)	686 Eligible Refused (12%)	6,877 Refused (69%); Number is estimated since vendor did not report specifically total refusals out of number eligible.
Incentives	None reported	$20 to households with <$10k income and 2+ persons $20 to households with <$20k income and 3+ persons $30 to all households that completed GPS portion of survey	$50 to $100 paid to participants in GPS portion of survey. Amount depended on number of vehicles in household
Survey Participants	Persons in household that were 5 or more years in age	All persons in household	All persons in household
Proxy Reporting	Proxy allowed for persons 12 and under and for persons not available at time of data retrieval	Proxy allowed for persons less than 16 years of age and for persons in household for whom call backs could not be arranged	Proxy allowed for minors in household and for household members that were not available
Pilot Survey	Yes 51 households	Yes 62 households	Yes 50 households
Diary Use	70% of persons reported not using diary	18% of persons reported not using diary	0% of persons reported not using diary
Data Expansion/Weighting	Expansion based on stratified population of households by household size and income	Expansion based on stratified population of households by household size and income with person data weighted based on population of persons by gender and age cohort.	Expansion based on stratified population of households by household size and income with person data weighted based on population of persons by gender and age cohort.
Address Coding/Geocoding	Arc-View software used to geocode electronically. Addresses not geocoded electronically were manually geocoded. 99% match rate achieved for geocoding to longitude/latitude.	MapInfo MapMarker Plus geocoding software used to geocode electronically. 87% of all locations geocoded to street level or nearest intersection longitude/latitude	TransCAD, ArcView, Manifold GIS and custom geocoding software used to geocode. Unmatched records were manually geocoded. 99% of all locations geocoded to longitude/ latitude

HOUSEHOLD SURVEY SAMPLING FRAME

Questions have been raised periodically about the household survey methodology used in Texas relative to how households are recruited for participation. Specifically, households without phones are excluded because the recruitment method specified in the contracts is phone. Using data from the 2004 household survey in Cameron and Hidalgo Counties (the Valley), the potential range of impacts that households without a phone may have on the survey results is analyzed.

Introduction

Texas practice is to request participation of a random sample of households by calling the households on a telephone. The sampling frame for household surveys consists of the population of households that have a telephone. The desired sampling frame is all households in the study area with a sampling methodology that ensures each household has an equal random probability of being selected to participate in the survey. In actuality, the use of telephones as the method for contacting and soliciting participation in the survey precludes the participation of households that do not have a phone. It is recognized that there are a certain number of households within every urban area that do not have phones. The assumption has been made in the past that households within the sampling strata (i.e., household size and income groups) are assumed to behave the same as households with phones in the same strata. The purpose of this task is to examine the potential impact of households without phones on the survey results under certain assumptions.

Methodology

Using data from the household survey done in 2004 in the Valley, the potential impact of the estimated households without phones are examined. The 95 percent confidence limits for the total person trips stratified by household size and income are determined based on the average person trips per household and the observed variances in the trip rates. Using data from the 2000 census for the Valley, estimates of the households with and without phones are developed stratified by household size and income. Assumptions are made to develop worst case scenarios and estimates of the total person trips prepared for each scenario. These are then compared to the estimates developed for the 95 percent confidence levels. This comparison provides a basis to evaluate the maximum impact households without phones may have on the estimates of person trips.

Description of Data

In 2004 and 2005, a comprehensive household travel survey was conducted in the Valley. Three individual Metropolitan Planning Organizations are located in the two county area included in the survey. The household survey was designed to measure the amount of household travel and the characteristics of travel for a typical Monday through Friday weekday during the school year. The sampling plan required households to be randomly selected based on a two way stratification of households by size and income. Table 5 presents the number of households that were to be surveyed in the Valley. The number of households in the two way stratification was to achieve an overall accuracy of ±10 percent at a confidence level of 90 percent. Table 6 presents the actual number of households that were surveyed. The sampling plan specified the number of households to be surveyed and only used four categories of household size. The number of household size categories is increased to five in the data analysis and development of trip rates for travel demand modeling. The survey collected information on the number, purpose, activity, and location of trips made by every person in the household during a 24-hour period. These data were expanded to produce estimates of internal travel in the Valley.

Table 5. Household Survey Sampling Plan.

Household Income 2004 Dollars			Household Size				Total
			1	2	3	4+	
0	To	$9,999	62	101	135	240	538
$10,000	To	$19,999	50	98	60	260	468
$20,000	To	$34,999	39	104	67	270	480
$35,000	To	$49,999	30	82	60	259	431
$50,000		Plus	30	110	78	265	483
Total			**211**	**495**	**400**	**1,294**	**2,400**

Table 6. Distribution of Surveyed Households.

Household Income 2004 Dollars			Household Size					Total
			1	2	3	4	5+	
0	To	$9,999	74	111	122	100	121	528
$10,000	To	$19,999	58	109	67	105	134	473
$20,000	To	$34,999	50	132	78	109	140	509
$35,000	To	$49,999	41	111	72	116	119	459
$50,000		Plus	45	200	115	148	130	638
Total			**268**	**663**	**454**	**578**	**644**	**2,607**

Using Public Use Micro Sample (PUMS) data from the 2000 census, estimates of the number of households in the Valley stratified by household size and income were developed for households with and without phones. Tables 7 and 8 presented these estimates. It was estimated in 2000 that approximately 6.2 percent of the households did not have phones. Since the household survey was designed to solicit participation by phone, these households could not participate in the survey. It is assumed that the use of 2000 data for the analysis in this task represents the same result as if 2004/05 data were used. While the magnitude of the estimates would be different using 2004/05 data, the relative impact of the differences may be expected to be the same.

Table 7. 2000 Census Households with Phones in the Valley.

Household Income[1] 2004 Dollars			Household Size					Total
			1	2	3	4	5+	
0	To	$9,999	11,352	7,517	5,157	4,903	7,363	36,292
$10,000	To	$19,999	7,032	11,773	8,456	8,541	13,220	49,022
$20,000	To	$34,999	4,542	12,319	9,408	11,392	17,728	55,389
$35,000	To	$49,999	3,594	8,398	6,218	6,461	11,033	35,704
$50,000		Plus	3,563	15,377	9,717	11,097	15,723	55,477
Total			**30,083**	**55,384**	**38,956**	**42,394**	**65,067**	**231,884**

[1] Source: Census PUMS Data.

Table 8. 2000 Census Households without Phones in the Valley.

Household Income[1] 2004 Dollars			Household Size					Total
			1	2	3	4	5+	
0	To	$9,999	1,633	907	770	967	1,274	5,551
$10,000	To	$19,999	864	619	844	850	1,650	4,827
$20,000	To	$34,999	195	713	396	714	1,316	3,334
$35,000	To	$49,999	138	214	261	150	393	1,156
$50,000		Plus	24	147	105	75	150	501
Total			**2,854**	**2,600**	**2,376**	**2,756**	**4,783**	**15,369**

[1] Source: Census PUMS Data.

Data Analysis

Table 9 presents the average person trips per household as observed in the survey. Table 10 presents the standard deviation of the average trips per household. Using the number of households surveyed and the standard deviation, a confidence interval may be computed for each trip rate. The equation for this computation is as follows (*42*):

$$X - \frac{1.96\sigma}{\sqrt{N}} \le \mu \le X + \frac{1.96\sigma}{\sqrt{N}}$$

Where:

X	=	Average trips per household
σ	=	Standard deviation
N	=	Number of households surveyed
μ	=	True average trips per household
1.96	=	Statistical value representing a 95 percent confidence level

Table 9. Average Person Trips per Household.

Household Income 2004 Dollars			**Household Size**					**Weighted Averages**
			1	**2**	**3**	**4**	**5+**	
0	To	$9,999	2.552	3.710	9.119	12.205	18.511	8.124
$10,000	To	$19,999	2.910	5.303	9.668	13.882	18.633	10.533
$20,000	To	$34,999	4.503	5.255	10.821	13.991	21.586	12.605
$35,000	To	$49,999	3.365	5.441	12.811	17.262	22.222	13.460
$50,000		Plus	4.259	6.362	12.743	16.058	24.179	14.145
Weighted Averages			**3.174**	**5.333**	**11.025**	**14.705**	**21.286**	**11.743**

Table 10. Trip Rate Standard Deviations.

Household Income 2004 Dollars			**Household Size**					**Weighted Averages**
			1	**2**	**3**	**4**	**5+**	
0	To	$9,999	2.935	3.291	5.662	7.402	11.533	9.231
$10,000	To	$19,999	2.179	4.272	6.775	10.491	9.167	9.653
$20,000	To	$34,999	4.190	4.057	7.389	8.032	12.594	10.720
$35,000	To	$49,999	2.410	5.523	7.488	8.648	10.604	10.610
$50,000		Plus	3.636	4.173	7.134	8.174	13.500	10.707
			3.200	**4.371**	**6.974**	**8.735**	**11.765**	**10.311**

Using the equation with data from Tables 6, 9, and 10, lower and upper values of the average trips per household can be calculated that represent the 95 percent confidence interval for each trip rate. Tables 11 and 12 present these values.

Table 11. Trip Rate 95 Percent Confidence Lower Values.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Weighted Averages
0	To	$9,999	1.883	3.098	8.114	10.754	16.456	7.337
$10,000	To	$19,999	2.349	4.501	8.046	11.875	17.081	9.663
$20,000	To	$34,999	3.342	4.563	9.181	12.483	19.500	11.674
$35,000	To	$49,999	2.627	4.414	11.081	15.688	20.317	12.489
$50,000		Plus	3.197	5.784	11.439	14.741	21.858	13.314
			2.791	5.000	10.383	13.993	20.377	11.347

Table 12. Trip Rate 95 Percent Confidence Upper Values.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Weighted Averages
0	To	$9,999	3.221	4.322	10.124	13.656	20.566	8.911
$10,000	To	$19,999	3.471	6.105	11.290	15.889	20.185	11.403
$20,000	To	$34,999	5.664	5.947	12.461	15.499	23.672	13.536
$35,000	To	$49,999	4.103	6.468	14.541	18.836	24.127	14.431
$50,000		Plus	5.321	6.940	14.047	17.375	26.500	14.976
			3.557	**5.666**	**11.667**	**15.417**	**22.195**	**12.139**

The potential impact of households without phones may be estimated in terms of assumed maximum conditions. These households may be assumed to have trip characteristics that fall between two conditions. The first condition is these households make no trips. Their trip rates would then be zero. Under that condition, the estimated number of internal person trips would be computed by multiplying the trip rates in Table 9 by the number of households (i.e., those with phones) in Table 7. The second condition is that households make the maximum number of trips as observed in the survey for households having the same size and income characteristics. For example, one person households in the first income group (i.e., 0 to $9,999) were observed to make between 0 and 10 trips. The assumption under this condition would be that the 1,633 one person households in the first income group without phones (see Table 8) would each make 10 trips per day. The total number of person trips may be computed for each of these conditions and compared with the total estimated using the lower and upper 95 percent confidence interval trip rates. If the total trips under each condition fall within the total estimates for the lower and upper 95 percent confidence intervals, it can be concluded that households without phones may be assumed to have similar travel characteristics as households with phones. The travel characteristics of households without phone are not expected to impact the overall accuracy of the estimate of internal person trips.

The estimated number of person trips using the lower and upper 95 percent confidence trip rates (Tables 11 and 12) are shown in Tables 13 and 14. Table 15 shows the estimated number of person trips under the first condition (i.e., all households without phones make no trips).

Table 13. Person Trip Estimates Based on 95 Percent Confidence Lower Values.

Household Income 2004 Dollars			Household Size					Totals
			1	2	3	4	5+	
0	To	$9,999	24,450.8	26,097.6	48,091.7	63,126.0	142,130.5	303,896.6
$10,000	To	$19,999	18,547.7	55,776.4	74,827.8	111,518.1	253,994.5	514,664.5
$20,000	To	$34,999	15,831.1	59,465.0	90,010.5	151,119.2	371,358.0	687,783.8
$35,000	To	$49,999	9,804.0	38,013.4	71,793.8	103,713.4	232,142.0	455,466.6
$50,000		Plus	11,467.6	89,790.8	112,353.9	164,686.5	346,952.0	725,250.8
			80,101.2	**269,143.2**	**397,077.7**	**594,163.2**	**1,346,577.0**	**2,687,062.3**

Table 14. Person Trip Estimates Based on 95 Percent Confidence Upper Values.

Household Income 2004 Dollars			Household Size					Totals
			1	2	3	4	5+	
0	To	$9,999	41,824.7	36,408.5	60,004.9	80,160.7	177,628.5	396,027.3
$10,000	To	$19,999	27,407.0	75,653.2	104,997.0	149,213.6	300,151.0	657,421.8
$20,000	To	$34,999	26,830.4	77,501.3	122,167.6	187,630.9	450,809.6	864,939.8
$35,000	To	$49,999	15,312.4	55,702.4	94,211.1	124,524.8	275,675.1	565,425.8
$50,000		Plus	19,086.4	107,736.6	137,969.6	194,113.5	420,634.5	879,540.6
			130,463.9	**353,002.0**	**519,350.2**	**735,643.5**	**1,624,898.7**	**3,363,355.3**

Table 15. Person Trip Estimates Based on Condition 1.

Household Income 2004 Dollars			Household Size[2]					Totals
			1	2	3	4	5+	
0	To	$9,999	28,970.3	27,888.1	47,026.7	59,841.1	136,296.5	300,022.7
$10,000	To	$19,999	20,463.1	62,432.2	81,752.6	118,566.2	246,328.3	529,542.4
$20,000	To	$34,999	20,452.6	64,736.3	101,804.0	159,385.5	382,676.6	729,055.0
$35,000	To	$49,999	12,093.8	45,693.5	79,658.8	111,529.8	245,175.3	494,151.2
$50,000		Plus	15,174.8	97,828.5	123,823.7	178,195.6	380,166.4	795,189.0
			97,154.6	**298,578.6**	**434,065.8**	**627,518.2**	**1,390,643.1**	**2,847,960.3**

[2]Households with no phones make zero trips.

Since the total estimated person trips of 2,847,960 under condition one lies between the low and high estimates for the 95 percent confidence, it may be concluded that under this condition where all households with no phones make zero trips, the inclusion of those households in the survey would not result in a significant difference in the accuracy of the estimate of total person trips.

Data from the Valley household survey were processed to determine the distribution of households within each income and size strata by number of person trips. This provided the range of trips that were made by households in each strata and the identification of the maximum number of trips made by the households. Table 16 shows the maximum observed person trips made. Under condition two, it is assumed that households with no phones make the maximum number of trips shown in Table 16. The total person trips are then estimated by multiplying the number of households in Table 7 by the trip rates in Table 9, multiplying the number of households in Table 8 by the trip rates in Table 16, and adding the two estimates. Table 17 shows the result.

Table 16. Maximum Number of Observed Person Trips by a Household.

Household Income 2004 Dollars			Household Size					Maximum Number
			1	2	3	4	5+	
0	To	$9,999	10	21	35	34	51	51
$10,000	To	$19,999	9	18	28	51	39	51
$20,000	To	$34,999	17	29	36	33	56	56
$35,000	To	$49,999	12	33	30	37	51	51
$50,000		Plus	17	26	32	36	59	59
			17	**33**	**36**	**51**	**59**	**59**

Table 17. Person Trip Estimates Based on Condition 2.

Household Income 2004 Dollars			Household Size[3]					Totals
			1	2	3	4	5+	
0	To	$9,999	45,300.3	46,935.1	73,976.7	92,719.1	201,270.5	460,201.7
$10,000	To	$19,999	28,239.1	73,574.2	105,384.6	161,916.2	310,678.3	679,792.4
$20,000	To	$34,999	23,767.6	85,413.3	116,060.0	182,947.5	456,372.6	864,561.0
$35,000	To	$49,999	13,749.8	52,755.5	87,488.8	117,079.8	265,218.3	536,292.2
$50,000		Plus	15,582.8	101,650.5	127,183.7	180,895.6	389,016.4	814,329.0
			126,639.6	**360,328.6**	**510,093.8**	**735,558.2**	**1,622,556.1**	**3,355,176.3**

[3]Households with no phones make the maximum number of trips observed in the survey for households with the same size and income characteristics.

The total estimate of person trips for condition two is 3,355,176 and is less than the upper 95 percent confidence estimate of 3,363,355.

Findings

The estimated number of person trips in the Valley in 2000 based on the household survey conducted in 2004 is 3,025,209. This estimate is based on a random sample of 2,607 households. Since the estimate is based on a sample, a confidence interval may be computed within which the true value is expected to lie. For the Valley, the true number of person trips is estimated to be between 2,687,062 and 3,363,355. The confidence level for this interval is 95 percent. Since the sample of households only includes households with phones, it is biased in the fact that households without phones are excluded. Historically, it has been assumed that households without phones behave the same as households with phones in terms of travel characteristics.

This task examined the question of whether households without phones could impact the accuracy of the estimated number of person trips if their travel was significantly different from that of households with phones. This question was examined by first estimating the number and distribution of households without phones and then making assumptions concerning the number of trips they might produce. These assumptions were made to examine the maximum range of trip generation considered possible for these households. Two conditions were examined; one where these households made no trips at all and one where these households made the same number of trips as the maximum observed for households with the same size and income characteristics. Under both conditions, total person trips were estimated and compared to the 95 percent confidence interval trip estimates. If the estimates fell within the 95 percent confidence interval estimates, it was concluded that households without phones would not be expected to change the accuracy of the estimated number of person trips even if they were included in the household survey. As can be seen from Figure 1, estimates of person trips with no phone households included under maximum impact assumptions still fell within the 95 percent confidence interval. It is recommended that current sampling procedures not be changed and no special efforts be made to include households without phones in the survey sample.

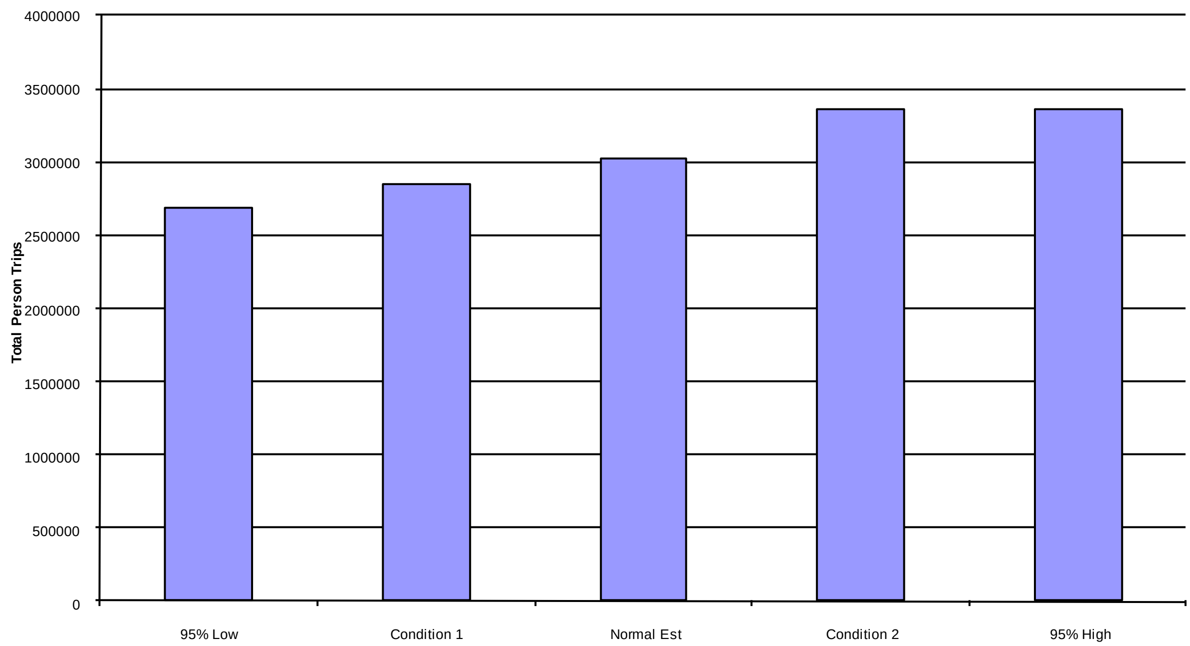


Figure 1. Estimates of Total Person Trips.

NON-RESPONSE IN HOUSEHOLD SURVEYS

Concerns have been raised historically about household surveys and the issue of non-response. Specifically, non-response households include those households that were contacted but choose not to participate in the household survey and households that agreed to participate but failed to complete the survey. Data from surveys has indicated that these two groups comprise a significant number of households. The question that this task will attempt to answer is whether these households could potentially impact the overall accuracy of the survey in terms of travel estimates if they were to participate in the survey. In other words, are the travel characteristics from these groups likely to differ enough from households that participate to impact the accuracy of the survey estimates of trips? Using data from the 2004 household survey in Cameron and Hidalgo Counties (the Valley), the potential range of impacts that households that choose to not participate may have on the survey results is analyzed.

Introduction

Texas practice is to request participation of a random sample of households by calling the households on a telephone. The sampling frame for household surveys consists of the population of households that have a telephone. In Texas as in other areas around the nation, it has been noted that a significant number of households cannot be contacted by phone even with repeated call backs and a large number of households that simply choose not to participate in the survey. The question asked often is whether these households have different travel characteristics than the households that do participate in the survey. The assumption has been made in the past that households within the sampling strata (i.e., household size and income groups) are assumed to behave the same as households in the same strata that either choose to not participate or cannot be contacted to even ask. The purpose of this task is to examine the potential impact of non-response households on the survey results under certain assumptions. For purposes of this analysis, non-response households are defined as those households that refuse to participate and those households that agree to participate but failed to complete the survey. Households that could not be contacted are considered part of the population of households that were not contacted and did not have an opportunity to participate in the survey.

Methodology

Using data from the household survey done in 2004 in the Valley, the potential impact of the non-response households are examined. The 95 percent confidence limits for the total person trips stratified by household size and income are determined based on the average person trips per household and the observed variances in the trip rates. These estimates are based strictly on the responses of households that agreed to participate in the survey. Using data from the 2001 household survey in Laredo, Texas, estimates of the percentage of non-response households were developed for the Rio Grande Valley (Valley). These households were assumed to be distributed in the same manner as the regional distribution of households by size and income for the Valley. Assumptions are made to develop worst case scenarios and estimates of the total person trips prepared for each scenario. These are then compared to the estimates developed for the 95 percent confidence levels. This comparison provides a basis to evaluate the maximum impact non-response households may have on the estimates of person trips in terms of relative accuracy.

Description of Data

In 2004 and 2005, a comprehensive household travel survey was conducted in the Valley. Three individual Metropolitan Planning Organizations are located in the two county area included in the survey. The household survey was designed to measure the amount of household travel and the characteristics of travel for a typical Monday through Friday weekday during the school year. The sampling plan required households to be randomly selected based on a two way stratification of households by size and income. Table 18 presents the number of households that were to be surveyed in the Valley. The number of households in the two way stratification was to achieve an overall accuracy of ±10 percent at a confidence level of 90 percent. Table 19 presents the actual number of households that were surveyed. The sampling plan specified the number of households to be surveyed and only used four categories of household size. The number of household size categories is increased to five in the data analysis and development of trip rates for travel demand modeling. The survey collected information on the number, purpose, activity, and location of trips made by every person in the household during a 24-hour period. These data were expanded to produce estimates of internal travel in the Valley.

Table 18. Household Survey Sampling Plan.

Household Income 2004 Dollars			Household Size				Total
			1	2	3	4+	
0	To	$9,999	62	101	135	240	538
$10,000	To	$19,999	50	98	60	260	468
$20,000	To	$34,999	39	104	67	270	480
$35,000	To	$49,999	30	82	60	259	431
$50,000		Plus	30	110	78	265	483
Total			**211**	**495**	**400**	**1,294**	**2,400**

Table 19. Distribution of Surveyed Households.

Household Income 2004 Dollars			Household Size					Total
			1	2	3	4	5+	
0	To	$9,999	74	111	122	100	121	528
$10,000	To	$19,999	58	109	67	105	134	473
$20,000	To	$34,999	50	132	78	109	140	509
$35,000	To	$49,999	41	111	72	116	119	459
$50,000		Plus	45	200	115	148	130	638
Total			**268**	**663**	**454**	**578**	**644**	**2,607**

It was reported in the Rio Grande Household Survey that 3,123 households were recruited from the list of 10,000 random households (*41*). Of those 3,123 households, 2,607 completed the survey. The number of refusals was not reported in the survey report. In the

Laredo household survey, it was reported that 6,174 eligible households were contacted and 3,185 refused to participate, while 203 initially agreed but did not complete the survey and a total of 2,786 household were recruited that completed the survey. Assuming the Rio Grande Valley had a similar refusal rate, it can be estimated that 51.6 percent of the contacted households refused to participate. This implies that the 3,123 households recruited in the Valley represent 48.4 percent of the total contacts. This indicates that the estimated number of contacts in the Rio Grande Valley household survey was 6,453 households that yields an estimated 3,330 households refused to participate. For purposes of this analysis, it is assumed that these households are distributed in the same proportion as the regional distribution of households in the Rio Grande Valley as shown in Table 20. The households that initially agreed to participate but did not complete the survey (516) are added to the 3,330 households that refused to participate to yield a total of 3,846 non-response households. Table 21 shows the estimated distribution of these households.

Table 20. 2004 Rio Grande Valley Household Distribution.

Household Income 2004 Dollars			Household Size					Total
			1	2	3	4	5+	
0	To	$9,999	5.53%	3.17%	2.30%	2.37%	3.74%	17.11%
$10,000	To	$19,999	2.98%	4.40%	2.81%	3.05%	4.76%	18.00%
$20,000	To	$34,999	2.41%	4.95%	3.71%	4.26%	6.49%	21.82%
$35,000	To	$49,999	1.42%	3.63%	2.55%	2.97%	4.68%	15.25%
$50,000		Plus	1.82%	7.39%	4.86%	5.40%	8.35%	27.82%
Total			**14.16%**	**23.54%**	**16.23%**	**18.05%**	**28.02%**	**100.00%**

Table 21. Estimated Distribution of Non-Response Households.

Household Income 2004 Dollars			Household Size					Total
			1	2	3	4	5+	
0	To	$9,999	213	122	88	91	144	658
$10,000	To	$19,999	115	169	108	117	183	692
$20,000	To	$34,999	93	190	143	164	249	839
$35,000	To	$49,999	55	140	98	114	180	587
$50,000		Plus	70	284	187	208	321	1,070
Total			**546**	**905**	**624**	**694**	**1,077**	**3,846**

Data Analysis

Table 22 presents the average person trips per household as observed in the survey based on the 2004 household distribution. Table 23 presents the standard deviation of the average trips per household. Using the number of households surveyed and the standard deviation, a confidence interval may be computed for each trip rate. The equation for this computation is as follows (*42*):

$$X - \frac{1.96\sigma}{\sqrt{N}} \leq \mu \leq X + \frac{1.96\sigma}{\sqrt{N}}$$

Where:

X	=	Average trips per household
σ	=	Standard deviation
N	=	Number of households surveyed
μ	=	True average trips per household
1.96	=	Statistical value representing a 95 percent confidence level

Table 22. Average Person Trips Per Household.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Weighted Averages
0	To	$9,999	2.65	3.91	9.10	12.07	18.11	8.44
$10,000	To	$19,999	3.03	5.51	9.61	13.60	18.26	10.48
$20,000	To	$34,999	4.64	5.49	10.62	13.72	21.10	12.52
$35,000	To	$49,999	3.36	5.72	12.80	16.87	21.84	13.80
$50,000		Plus	4.24	6.42	12.54	15.75	23.68	14.34
Weighted Averages			**3.35**	**5.61**	**11.15**	**14.61**	**21.11**	**12.16**

Table 23. Trip Rate Standard Deviations.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Weighted Averages
0	To	$9,999	2.873	3.395	5.606	7.176	11.161	8.957
$10,000	To	$19,999	2.229	4.235	6.618	10.276	8.955	9.390
$20,000	To	$34,999	3.949	4.064	7.161	7.883	12.324	10.409
$35,000	To	$49,999	2.283	5.643	7.594	8.360	10.381	10.356
$50,000		Plus	3.540	4.106	7.090	7.976	13.088	10.420
Weighted Averages			**3.100**	**4.376**	**6.897**	**8.512**	**11.461**	**10.030**

Using the equation with data from Tables 19, 22, and 23, lower and upper values of the average trips per household can be calculated that represent the 95 percent confidence interval for each trip rate. Tables 24 and 25 shows these values.

Table 24. Trip Rate 95 Percent Confidence Lower Values.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Weighted Averages
0	To	$9,999	2.00	3.28	8.11	10.66	16.12	7.67
$10,000	To	$19,999	2.46	4.71	8.03	11.64	16.75	9.64
$20,000	To	$34,999	3.54	4.79	9.03	12.24	19.06	11.61
$35,000	To	$49,999	2.66	4.67	11.04	15.35	19.97	12.85
$50,000		Plus	3.21	5.85	11.25	14.46	21.43	13.53
Weighted Averages			**2.97**	**5.27**	**10.52**	**13.91**	**20.23**	**11.77**

Table 25. Trip Rate 95 Percent Confidence Upper Values.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Weighted Averages
0	To	$9,999	3.31	4.54	10.10	13.47	20.10	9.20
$10,000	To	$19,999	3.61	6.30	11.20	15.57	19.78	11.33
$20,000	To	$34,999	5.73	6.18	12.21	15.20	23.14	13.42
$35,000	To	$49,999	4.06	6.77	14.55	18.40	23.70	14.75
$50,000		Plus	5.28	6.99	13.84	17.03	25.93	15.14
Weighted Averages			**3.72**	**5.94**	**11.78**	**15.30**	**22.00**	**12.54**

The potential impact of non-response households may be estimated in terms of assumed maximum conditions. These households may be assumed to have trip characteristics that fall between certain conditions. The first condition is these households make no trips. Their trip rates would then be zero. The second condition is that these households make the maximum observed trips for households in each size and income category. Table 26 shows these maximum trip rates. The third condition is these households make the same trips as the low 95 percent confidence values (i.e., Table 24). The fourth condition is these households make the same trips as the upper 95 percent confidence values (i.e., Table 25).

Table 26. Maximum Number of Observed Person Trips by a Household.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Maximum Observed Value
0	To	$9,999	10	21	35	34	51	51
$10,000	To	$19,999	9	18	28	51	39	51
$20,000	To	$34,999	17	29	36	33	56	56
$35,000	To	$49,999	12	33	30	37	51	51
$50,000		Plus	17	26	32	36	59	59
Maximum Observed Value			**17**	**33**	**36**	**51**	**59**	**59**

Non-response households occur during the recruitment phase of the household survey. They may be expected to occur randomly during recruitment. To determine the impact these households could make on the survey results, the recruitment process was simulated using a random number generator. In essence, a data file was developed that had trip rates for the non-response households as distributed in Table 21. That data file was added to the file that contained the households that participated in the survey and included the observed person trips for each household. Each household (i.e., record) was assigned a sequential number. The random number generator was set to randomly pick numbers that related to the records in the household data file. As households were selected, the number within each size and income category was monitored such that when the number of households in each category agreed with the actual number of households surveyed, no more households would be selected in that size and income category. The end result was a sample of households that included both households that participated in the survey and households that were non-response and had the same number of households in each category of size and income as obtained in the actual survey. The non-response households were assigned trips according to the four conditions. New average trip rates were computed for each of the four conditions. Using the average trip rates, total person trips were estimated for each of the four conditions and compared to the person trips estimated from the survey and the estimates based on the upper and lower 95 percent confidence values.

Tables 27 and 28 show the number of households selected in the random process from the households that participated in the survey as well as the households that were considered non-response. As can be seen, more households were selected in the non-response category that from the households that did respond. This is expected since there were more households in the non-response category than in the group that did participate. This has a direct bearing on the results. However, the results do reflect the maximum impacts that the non-response households may have had on the survey if they had participated. That is the objective of this analysis.

Tables 29 through 32 show the average trip rates that resulted for each of the four conditions being evaluated. Tables 33 through 36 show estimates of person trips from applying these trip rates to the estimated households in each category of size and income. Tables 37 and 38 show the estimated number of person trips using the lower and upper 95 percent confidence trip rates (Tables 24 and 25).

Table 27. Selected Households That Participated in Survey.

Household Income 2004 Dollars			Household Size					Totals
			1	2	3	4	5+	
0	To	$9,999	21	50	62	53	57	243
$10,000	To	$19,999	21	45	25	50	58	199
$20,000	To	$34,999	14	56	26	51	42	189
$35,000	To	$49,999	17	46	29	63	47	202
$50,000		Plus	18	84	34	64	34	234
Totals			**91**	**281**	**176**	**281**	**238**	**1,067**

Table 28. Selected Non-Response Households.

Household Income 2004 Dollars			Household Size					Totals
			1	2	3	4	5+	
0	To	$9,999	53	61	60	47	64	285
$10,000	To	$19,999	37	64	42	55	76	274
$20,000	To	$34,999	36	76	52	58	98	320
$35,000	To	$49,999	24	65	43	53	72	257
$50,000		Plus	27	116	81	84	96	404
Totals			**177**	**382**	**278**	**297**	**406**	**1,540**

Table 29. Person Trip Rates Based on Condition 1.

Household Income 2004 Dollars			Household Size[1]				
			1	2	3	4	5+
0	To	$9,999	0.92	2.39	4.24	5.82	8.28
$10,000	To	$19,999	1.26	2.33	3.42	6.65	8.01
$20,000	To	$34,999	1.88	3.20	3.08	5.89	5.56
$35,000	To	$49,999	1.90	2.58	4.64	7.90	8.08
$50,000		Plus	1.82	3.17	3.53	6.62	6.35

[1]Non-response households make zero trips.

Table 30. Person Trip Rates Based on Condition 2.

Household Income 2004 Dollars			Household Size[2] 1	2	3	4	5+
0	To	$9,999	8.08	13.93	21.45	21.80	35.26
$10,000	To	$19,999	7.00	12.90	20.97	33.36	30.13
$20,000	To	$34,999	14.12	19.89	27.08	23.45	44.76
$35,000	To	$49,999	8.93	21.90	22.56	24.80	38.93
$50,000		Plus	12.02	18.25	26.07	27.05	49.92

[2]Non-response households make maximum observed trips (see Table 26).

Table 31. Person Trip Rates Based on Condition 3.

Household Income 2004 Dollars			Household Size[3] 1	2	3	4	5+
0	To	$9,999	2.35	4.19	8.23	10.83	16.81
$10,000	To	$19,999	2.83	5.10	8.45	12.75	17.51
$20,000	To	$34,999	4.43	5.96	9.10	12.40	18.91
$35,000	To	$49,999	3.46	5.31	11.23	14.91	20.16
$50,000		Plus	3.75	6.56	11.45	14.83	22.17

[3]Non-Response households make trips at the lower 95 percent confidence level.

Table 32. Person Trip Rates Based on Condition 4.

Household Income 2004 Dollars			Household Size[4] 1	2	3	4	5+
0	To	$9,999	3.29	4.88	9.21	12.15	18.91
$10,000	To	$19,999	3.56	6.03	10.44	14.80	19.23
$20,000	To	$34,999	6.01	6.76	11.22	13.98	21.76
$35,000	To	$49,999	4.28	6.54	13.33	16.30	22.42
$50,000		Plus	4.99	7.22	13.28	16.29	25.49

[4] Non-response households make trips at the upper 95 percent confidence level.

Table 33. Person Trip Estimates Based on Condition 1.

Household Income 2004 Dollars			Household Size[5] 1	2	3	4	5+	Totals
0	To	$9,999	14,983.4	22,308.9	28,737.9	40,664.3	91,306.3	198,000.8
$10,000	To	$19,999	11,061.6	30,224.8	28,318.1	59,778.8	112,370.2	241,753.5
$20,000	To	$34,999	13,357.4	46,657.0	33,656.2	73,978.4	106,461.6	274,110.6
$35,000	To	$49,999	7,963.7	27,579.1	34,876.0	69,146.1	111,432.6	250,997.5
$50,000		Plus	9,776.9	68,955.9	50,577.8	105,428.9	156,225.8	390,965.3
Totals			**57,143.0**	**195,725.7**	**176,166.0**	**348,996.5**	**577,796.5**	**1,355,827.7**

[5] Non-response households make zero trips.

Table 34. Person Trip Estimates Based on Condition 2.

Household Income 2004 Dollars			Household Size[6] 1	2	3	4	5+	Totals
0	To	$9,999	131,752.6	130,171.1	145,459.2	152,316.6	388,732.7	948,432.2
$10,000	To	$19,999	61,502.0	167,325.8	173,736.5	299,991.1	422,802.3	1,125,357.7
$20,000	To	$34,999	100,322.6	290,333.0	296,168.2	294,532.0	856,514.4	1,837,870.2
$35,000	To	$49,999	37,377.3	234,384.5	169,576.0	217,166.3	537,197.5	1,195,701.6
$50,000		Plus	64,510.1	397,503.8	373,531.0	430,726.7	1,228,807.5	2,495,079.1
Totals			**395,464.6**	**1,219,718.2**	**1,158,470.9**	**1,394,732.7**	**3,434,054.4**	**7,602,440.8**

[6] Non-response households make maximum observed trips (see Table 9).

Table 35. Person Trip Estimates Based on Condition 3.

Household Income 2004 Dollars			Household Size[7] 1	2	3	4	5+	Totals
0	To	$9,999	38,330.7	39,159.7	55,780.5	75,669.2	185,314.0	394,254.1
$10,000	To	$19,999	24,846.8	66,105.3	70,024.8	114,603.0	245,693.2	521,273.1
$20,000	To	$34,999	31,468.0	86,907.3	99,503.0	155,781.7	361,747.4	735,407.4
$35,000	To	$49,999	14,487.0	56,838.3	84,442.2	130,552.0	278,140.1	564,459.6
$50,000		Plus	20,111.8	142,879.1	164,112.9	236,092.5	545,805.7	1,109,002.0
Totals			**129,244.3**	**391,889.7**	**473,863.4**	**712,698.4**	**1,616,700.4**	**3,324,396.2**

[7] Non-Response households make trips at the lower 95 percent confidence level.

Table 36. Person Trip Estimates Based on Condition 4.

Household Income 2004 Dollars			Household Size[8] 1	2	3	4	5+	Totals
0	To	$9,999	53,640.2	45,624.2	62,419.1	84,899.0	208,523.7	455,109.2
$10,000	To	$19,999	31,295.7	78,208.2	86,487.1	133,108.6	269,817.7	598,917.3
$20,000	To	$34,999	42,672.6	98,582.5	122,691.5	175,563.7	416,394.1	855,904.4
$35,000	To	$49,999	17,916.2	70,001.8	100,199.9	142,749.1	309,282.2	640,149.2
$50,000		Plus	26,776.3	157,280.4	190,261.5	259,305.3	627,611.3	1,261,234.8
Totals			**172,301.0**	**449,700.1**	**562,059.1**	**795,625.7**	**1,831,629.0**	**3,811,314.9**

[8] Non-Response households make trips at the upper 95 percent confidence level.

Table 37. Lower 95 Percent Confidence Level Person Trip Estimates from Survey.

Household Income 2004 Dollars			Household Size 1	2	3	4	5+	Totals
0	To	$9,999	32,565.6	30,649.4	54,981.8	74,484.9	177,775.7	370,457.4
$10,000	To	$19,999	21,616.6	61,149.3	66,497.9	104,634.9	235,023.0	488,922.7
$20,000	To	$34,999	25,168.7	69,973.8	98,822.5	153,697.9	364,685.0	712,347.9
$35,000	To	$49,999	11,138.1	49,969.8	83,012.8	134,427.7	275,584.9	554,133.3
$50,000		Plus	17,212.4	127,409.0	161,120.6	230,217.3	527,517.7	1,063,477.0
Totals			**107,701.4**	**339,151.3**	**464,435.6**	**697,462.7**	**1,580,587.3**	**3,189,338.3**

Table 38. Upper 95 Percent Confidence Level Person Trip Estimates from Survey.

Household Income 2004 Dollars			Household Size					Totals
			1	2	3	4	5+	
0	To	$9,999	53,910.8	42,455.0	68,473.1	94,139.3	221,630.2	480,608.4
$10,000	To	$19,999	31,696.9	81,776.2	92,756.3	139,983.5	277,581.9	623,794.8
$20,000	To	$34,999	40,723.1	90,209.9	133,588.1	190,873.2	442,808.1	898,202.4
$35,000	To	$49,999	16,990.1	72,439.7	109,387.8	161,069.8	327,056.5	686,943.9
$50,000		Plus	28,312.7	152,205.4	198,254.3	271,135.0	638,292.3	1,288,199.7
Totals			**171,633.6**	**439,086.2**	**602,459.6**	**857,200.8**	**1,907,369.0**	**3,977,749.2**

The trip estimates shown in Tables 37 and 38 represent the lower and upper boundaries for the travel survey. The true number of daily person trips in the Rio Grande Valley may be expected to lie between those two values with a level of confidence of 95 percent. If the estimates under any of the four conditions being analyzed fall outside that range, it may be concluded that under the assumptions made in this analysis, non-response households could significantly impact the survey estimates if those households had participated in the survey. The estimate of person trips for conditions 1 and 2 fall outside the range of values. These estimates represent the most extreme conditions with non-response households either making zero trips or making the maximum number of trips observed for any household within the same size and income category. The estimate for conditions 3 and 4 (non-response households were assumed to make trips at the lower and upper 95 percent confidence levels) fall within the range of trips shown in Tables 37 and 38. This is intuitively what would be expected. It may be concluded that if non-response households have travel characteristics that fall within the 95 percent confidence level for households that participate in the survey, the inclusion of these households in the travel survey would not affect the accuracy of the survey results in terms of the overall estimate of travel.

The results of the analysis indicate that the inclusion of non-response households in the survey do impact the survey results. It should be noted that the analysis was performed with the estimated number of non-response households to be 60 percent of the eligible households. It should also be noted that if the non-response households had travel characteristics that fell within the 95 percent confidence range of the participating households, their inclusion would not impact the accuracy of the survey. For the non-response households to impact the survey estimates, their travel characteristics have to be greater or less that the 95 percent confidences range of the observed travel from participating households. The probability of that occurring is less than or equal to 10 percent. Since there is a possibility these non-response households do impact the survey by not participating, it was determined to examine the range of non-response households to identify the percentage of these households that could occur without impacting the survey results. This would provide an estimated level of non-response households that may be acceptable for household surveys.

Following the same analysis procedure as before, distributions of households were developed for 5 percent, 10 percent, 20 percent, 30 percent, 40 percent, and 50 percent of eligible households being non-response. These were included in the random selection process and trip rates developed for low estimates (i.e., non-response households make zero trips) and for high estimates (i.e., non-response households make the same number of trips as observed for the highest household in the same size and income category). Figure 2 shows a plot of the resulting estimates of person trips with the survey 95 percent confidence interval estimates. As may be seen, the non-response households produce trips that fall outside the 95 percent confidence interval for all percentages except the 5 percent. The lines cross somewhere between 5 and 10 percent. This implies that under the above assumptions, only 5 to 10 percent of eligible households would be acceptable as non-response in a survey.

Since the above results are based on the most extreme conditions, it was decided to relax those conditions and redo the analysis to determine the outcome. The survey data were reprocessed to calculate for each household size and income category, the average trip rate for those households that had trips below or above the 95 percent confidence interval rates. Tables 39 and 40 show the low and high trip rates that resulted. Estimated person trips were developed for 5 through 50 percent non-response households. Figure 3 shows the results. As can be seen, the point at which the estimated trips fall within the 95 percent confidence interval is approximately 20 percent. This implies that under the assumptions made for non-response households (relative to their making the average trips shown in Tables 39 and 40), the survey may have up to 20 percent non-response households with no negative impact on the accuracy of the survey.

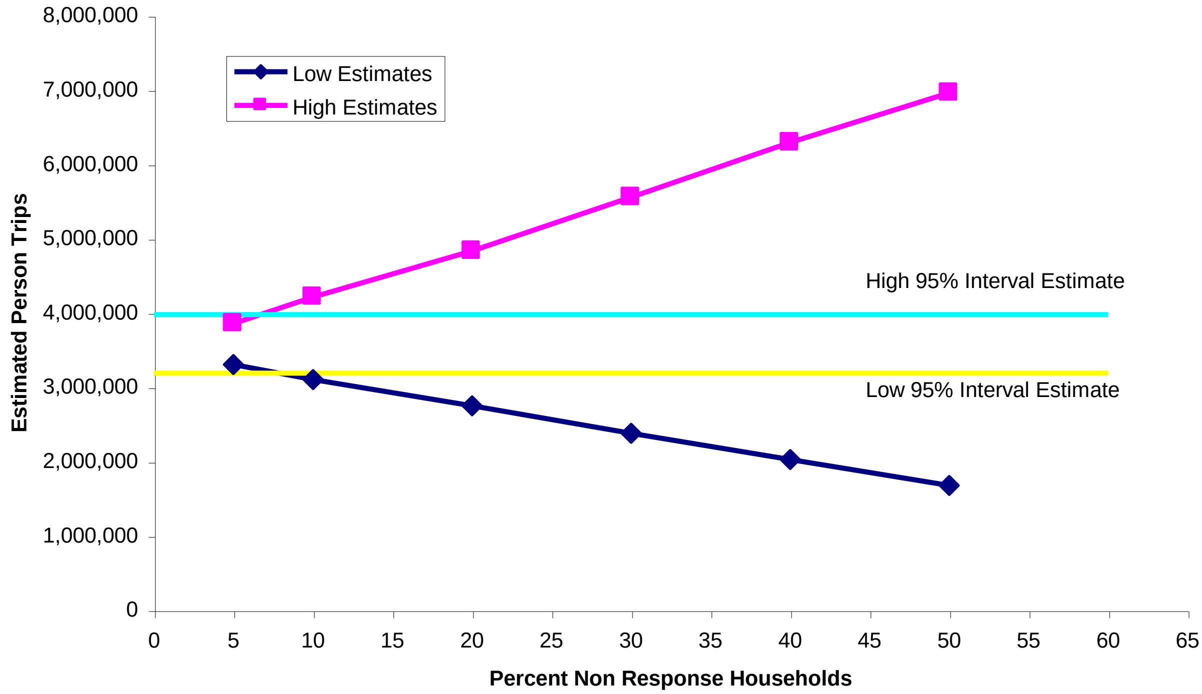


Figure 2. Person Trip Estimates for Non-Response Households Making Maximum and Minimum Trips per Household.

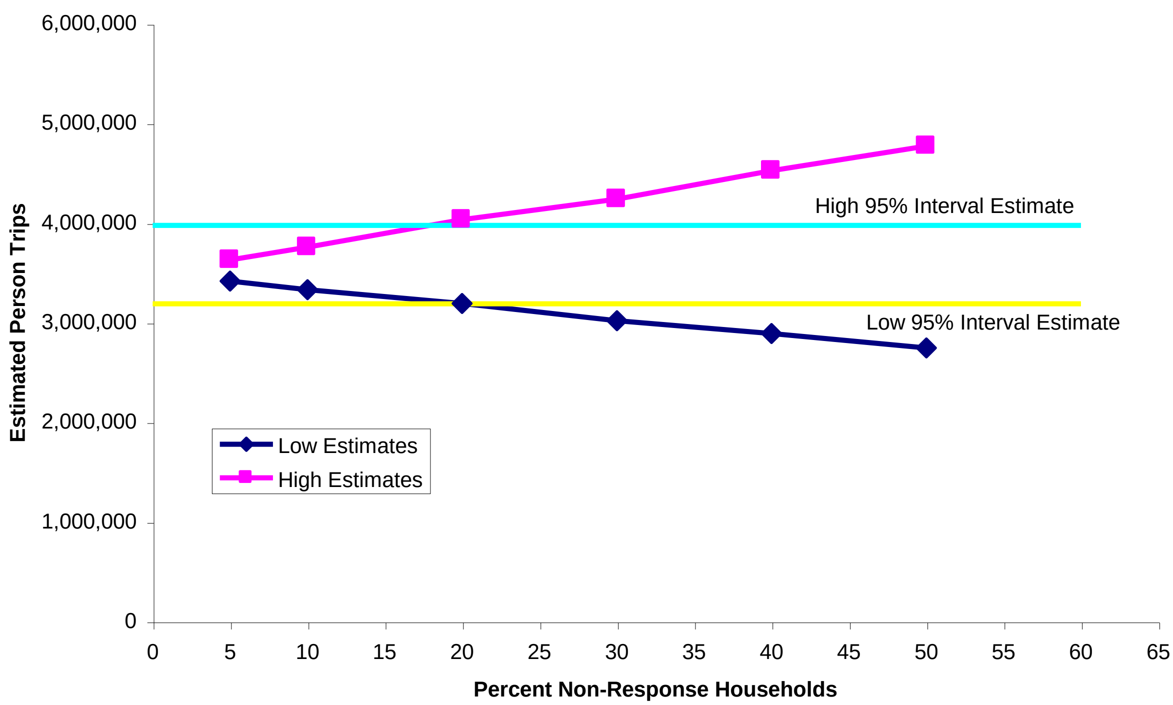


Figure 3. Person Trip Estimates for Non-Response Households Making Average Trips per Household Above and Below 95 Percent Confidence Interval Values.

Table 39. Average Person Trip Rates for Households with Less Trips than Low 95 Percent Confidence Interval Values.

Household Income 2004 Dollars			Household Size				
			1	2	3	4	5+
0	To	$9,999	1.16	1.26	5.47	6.50	10.45
$10,000	To	$19,999	1.19	2.40	5.28	6.70	10.97
$20,000	To	$34,999	1.83	2.72	6.29	7.51	12.67
$35,000	To	$49,999	1.75	2.53	6.97	9.59	13.74
$50,000		Plus	1.94	3.32	6.98	9.73	13.74

Table 40. Average Person Trip Rates for Households with More Trips than High 95 Percent Confidence Interval Values.

Household Income 2004 Dollars			Household Size				
			1	2	3	4	5+
0	To	$9,999	6.17	8.22	15.22	19.59	32.54
$10,000	To	$19,999	5.77	11.00	16.68	26.64	26.74
$20,000	To	$34,999	9.24	11.81	19.35	20.97	36.06
$35,000	To	$49,999	7.07	11.28	19.96	24.73	31.68
$50,000		Plus	9.15	10.93	19.06	24.30	35.74

Summary of Findings

The estimated number of person trips in the Valley based on the household survey conducted in 2004 is 3,583,544. This estimate is based on a random sample of 2,607 households. Since the estimate is based on a sample, a confidence interval may be computed within which the true value is expected to lie. For the Valley, the true number of person trips is estimated to be between 3,189,338 and 3,977,749. The confidence level for this interval is 95 percent. These estimates are based on the data for households that agreed to participate in the survey and completed the survey. An estimated 60 percent of the eligible households contacted either refused to participate or agreed to participate and failed to complete the survey. The question examined in this task was whether these non-response households could have impacted the accuracy of the survey results had they participated in the survey. Initially, this was addressed by establishing four conditions. The first assumed that the non-response households made zero trips. The second assumed the non-response households made the maximum number of trips observed in the survey for households within the same size and income stratification.

The third assumed non-response households made trips at the rate for the low 95 percent confidence interval. The fourth assumed non-response households made trips at the rate for the high 95 percent confidence interval. To evaluate the impact of each of these four conditions, a program was developed to randomly select households that participated in the survey and non-response households. Non-response households were assumed to be distributed in the same manner as the regional distribution of households for the Rio Grande Valley. Average trip rates were developed for each condition and used to estimate total person trips. These estimates were compared to the range of trips based on the 95 percent confidence interval as computed from the survey. This interval is considered the boundary within which the true number of trips being made in the valley lies with a confidence of 95 percent. The results indicate that under conditions 1 and 2, the estimated trips fall outside the 95 percent confidence interval. The analysis was repeated for varying percentages of non-response households to determine the likely point at which non-response households would not be expected to impact the survey results. Under the assumed trip rates for conditions 1 and 2, it was found that the percent of non-response households would have to be between 5 and 10 percent before these households would not impact the survey results.

To further examine the impact of non-response households, the survey data were processed to compute the average trip rates for households within each size and income strata that made trips outside the 95 percent confidence interval for households within each size and income strata. Using these trip rates for non-response households, estimates of person trips for varying percentages of non-response households were computed and plotted. It was found that using these trip rates for non-response households, the maximum percent of non-response households acceptable would be 20 percent. That is the percent of non-response households that could occur before any impact on the survey results.

The findings of these analyses are that non-response households can impact the survey results if these households have different travel characteristics than households that participate in the survey. It is recommended that within one of the upcoming household surveys, the survey specifications include specific tasks to recruit non-response households in sufficient numbers to allow the determination of their travel characteristics and address the question of whether their travel characteristics are in fact different from households that agreed to participate in the survey.

PROXY REPORTING IN HOUSEHOLD SURVEYS

Questions have been raised periodically about the use of proxy reporting in household surveys and how that may impact survey results. Proxy reporting is when one member of the household reports the travel and activity behavior for one or more other members of the households. Using data from the 2004 household survey in Cameron and Hidalgo Counties (the Valley), the 2006 household survey in Austin, and the 2006 household survey in Amarillo, an analysis of trip rates for individuals is performed specifically comparing the trip rates for individuals that were interviewed, individuals that returned the travel activity diary, and individuals that had their travel and activities reported by someone else (i.e., were represented by a proxy).

Background

Texas practice is to require survey vendors to attempt to interview every person in a household when retrieving their travel and activity data. Household members that are minors are allowed to be represented by an adult (i.e., proxy) when retrieving their travel and activity information. It has long been recognized that it is difficult for the vendor to interview every adult member of a household. When this situation arises, the vendor is allowed to use a proxy in the household or alternatively have the household return the completed travel activity diary for the person they were unable to interview. The method of data retrieval is required to be documented by the vendor as a part of each household members data file. This information provides the ability to examine the reported travel for individuals that were interviewed, represented by proxy, and those that returned a completed travel activity diary. The purpose of this task is to examine the potential impact of proxy reporting on the trip rates developed from household surveys.

Methodology

Table 41 shows the information developed using data from household surveys done in the Rio Grande Valley (i.e., Cameron and Hidalgo Counties), in the Austin area (i.e., Travis, Williamson, Hays, Bastrop, and Caldwell Counties), and in the Amarillo area (i.e., Randall and Potter Counties). These data were then processed to develop average person trip rates for individuals placed into three categories. These categories were persons that were interviewed and provided their travel and activity data personally, persons that were represented by a proxy that provided their travel and activity data, and persons that returned completed travel and activity diaries from which their travel and activity data were obtained. Persons were stratified by different measures to determine if differences in trip rates were consistent or if some bias may have been responsible for any difference in the average trip rates. Statistical tests were performed to determine if the observed differences were significant or if the differences could be attributed to chance.

Table 41. Household Survey Person Travel Data.

Variable #	Variable Description
1	Household sample number
2	Number of persons in household
3	Code indicating household income
4	Number of employed persons in household
5	Number of vehicles available to household members
6	Code indicating type of residence
7	Code indicating life cycle for household
8	Person number for individual in household
9	Age of person
10	Code indicating gender of person
11	Code indicating ethnicity of person
12	Code indicating if person was a licensed driver
13	Code indicating life cycle for individual
14	Code indicating if person used their travel activity diary
15	Code indicating how travel activity data was retrieved from individual
16	Number of person trips made by individual
17	Number of auto driver trips made by individual
18	Number of home based tours made by individual
19	Number of work based tours made by individual
20	Number of home based work person trips made by individual
21	Number of home based work auto driver trips made by individual
22	Number of home based non-work person trips made by individual
23	Number of home based non-work auto driver trips made by individual
24	Number of non-home based person trips made by individual
25	Number of non-home based auto driver trips made by individual

Description of Data

Between 2004 and 2006, comprehensive household travel surveys were conducted in the Valley (Cameron and Hidalgo Counties), in the Austin area (Travis, Williamson, Hays, Bastrop, and Caldwell Counties), and in Amarillo (Randall and Potter Counties). Five Metropolitan Planning Organizations are located in those areas. These household surveys were designed to measure the amount of household travel and the characteristics of travel for a typical Monday through Friday weekday during the school year. The sampling plans required households to be randomly selected based on a two way stratification of households by size and income. Table 42 presents the number of households and persons that were surveyed in these areas. The number of households in the survey sampling plans was to achieve overall accuracy of ±10 percent at a confidence level of 90 percent. For all of these surveys, the vendor performing the sample selection and data collection was to attempt to interview every person in the household except minors who would be represented by the adult(s) in the household. This interview occurred in the retrieval of the individual‘s travel and activities over a 24-hour period. Travel activity diaries were sent to each household for each person in the household to record their travel and activities. After the data were retrieved by phone, the household was requested to return the completed diaries using self-addressed envelopes that had been sent to the household. The survey collected information on the number, purpose, activity, and location of trips made by every person in the household during a 24-hour period.

Table 42. Number of Households and Persons Surveyed.

Area	Surveyed Households	Surveyed Persons
Rio Grande Valley	2,607	8,949
Austin	1,499	4,177
Amarillo	1,521	4,655
Totals	**5,627**	**17,781**

Data Analysis

Using the data files created for every person surveyed in the three areas, average trips per person (i.e., person trip rate) were computed with the number of observations and the variance for persons grouped into three categories, individuals that were interviewed, individuals that were represented by a proxy, and individuals that returned a completed diary. The average trip rates for each group of individuals were then tested to determine if the observed difference was significant or if the difference could be attributed to chance. The test statistic for this comparison is as follows (*42*):

$$Z = \frac{X_1 - X_2}{\sqrt{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)}}$$

Where:

Z	=	Test Statistic
X_1	=	Average Person Trip Rate for Group 1
X_2	=	Average Person Trip Rate for Group 2
σ_1^2	=	Variance of Group 1 Person Trip Rates
σ_2^2	=	Variance of Group 2 Person Trip Rates
N_1	=	Number of Observations in Group 1
N_2	=	Number of Observations in Group 2

If the value of the test statistic falls between -1.96 and + 1.96, the difference between the two average trip rates is not considered significant and could be attributed to chance. If the value of the test statistic falls outside that range, the difference between the two average trip rates may be considered significant.

Table 43 presents the average person trip rates, number of observations, and variances for each method of data retrieval for all persons, males only, and females only for the three areas. The persons represented by proxy are significant, i.e., 59 percent in the Valley, 56 percent in Austin, and 60 percent in Amarillo. The initial comparison of trip rates were done for each area individually, comparing the average trip rates between respondents, proxy represented, and diary. The trip rates for respondents were found to be significantly different from those for individuals represented by proxy for all cases with the trip rates for respondents ranging from 25 percent to 45 percent higher than those for persons represented by proxy. Similarly, the trip rates for individuals that returned diaries were found to be significantly different that those for persons represented by proxy in every case. The trip rates for persons that returned the diaries were 58 percent to 96 percent higher than those for persons represented by proxy. Comparing trip rates for respondents versus those for persons that returned the diary yielded similar results. All were significantly different with the diary based trip rates being 18 percent to 27 percent higher than the trip rates for respondents. Figure 4 presents the trip frequency distributions for the three areas by respondent, proxy, and diary. These provide some explanation as to the differences in the overall average trip rates. As shown, a significant percentage of persons represented by proxy were reported as making just two trips. The differences in the distributions imply a bias in the results by method of reporting. To determine if there were potential reasons for these differences, the data were stratified based on several different measures and compared.

Table 43. Person Trip Rate Comparisons.

Area	Persons	Measure	Data Retrieval Method		
			Respondent	Proxy	Diary
Valley	All Persons	Observations	2,234	5,301	1,414
		Average Trip Rate	3.935	2.760	5.144
		Variance	9.2636	4.2049	14.7416
	Males Only	Observations	863	2,743	662
		Average Trip Rate	4.006	2.777	4.896
		Variance	9.2192	4.2471	13.7123
	Females Only	Observations	1,371	2,557	752
		Average Trip Rate	3.891	2.741	5.362
		Variance	9.2931	4.1620	15.5654
Austin	All Persons	Observations	1,305	2,330	542
		Average Trip Rate	3.812	2.774	4.935
		Variance	7.2860	3.5499	12.7814
	Males Only	Observations	514	1,246	264
		Average Trip Rate	3.677	2.848	4.780
		Variance	5.7746	3.5109	13.5333
	Females Only	Observations	791	1,084	276
		Average Trip Rate	3.900	2.689	5.098
		Variance	8.2571	3.5847	12.1249
Amarillo	All Persons	Observations	1,310	2,781	564
		Average Trip Rate	4.121	3.068	5.202
		Variance	11.2328	5.5746	14.7726
	Males Only	Observations	496	1,491	274
		Average Trip Rate	3.875	3.083	4.883
		Variance	8.2066	5.4629	12.4405
	Females Only	Observations	814	1,290	290
		Average Trip Rate	4.271	3.050	5.503
		Variance	13.0295	5.7074	16.8391

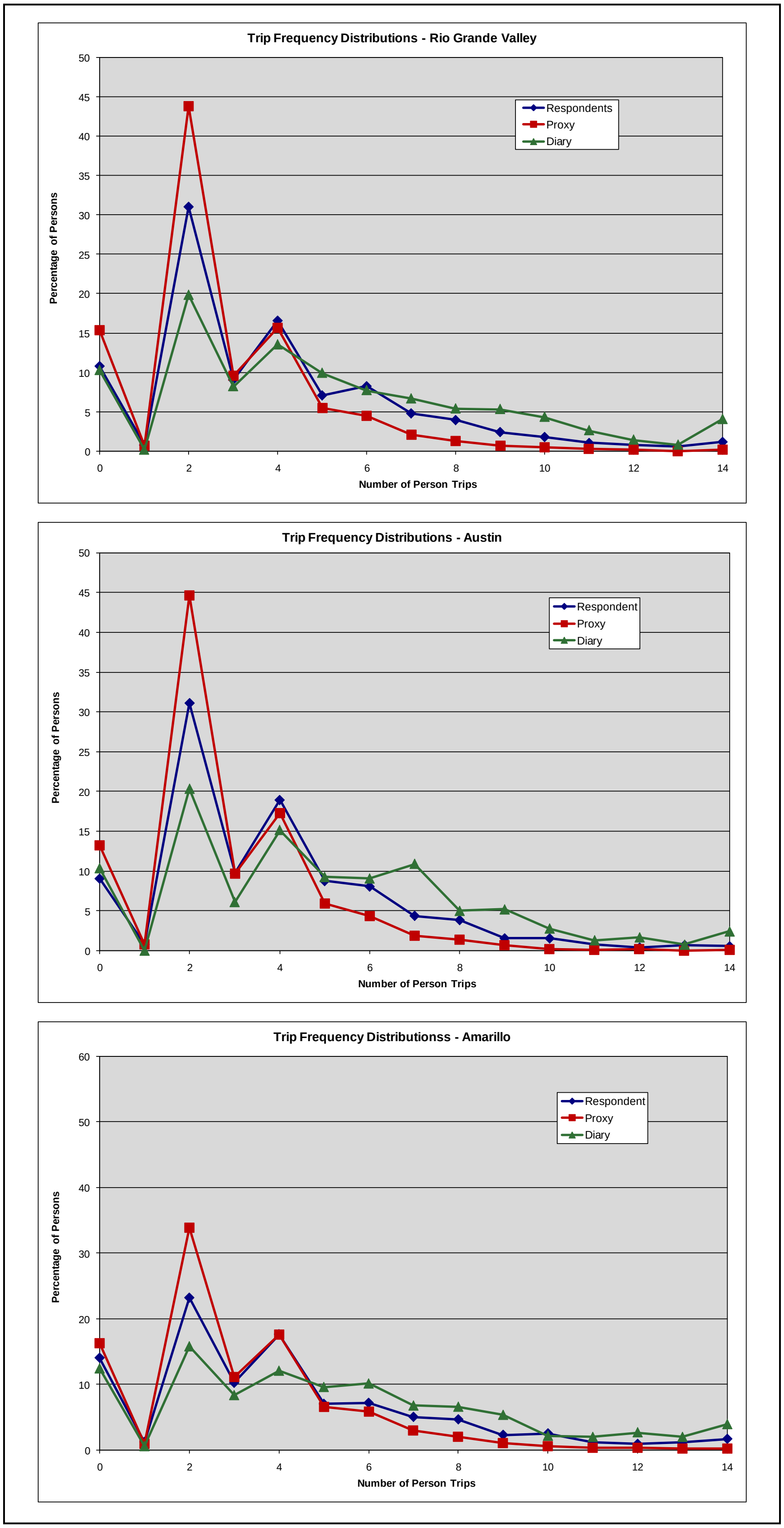


Figure 4. Trip Frequency Distributions by Area.

The first stratification examined was age. Individuals were grouped into 15 age cohorts, trip rates computed for each age cohorts and the results compared. Tables 44, 45, and 46 present the data for all persons, males only, and females only, respectively.

Table 44. Trip Data by Age Cohort for All Persons.

Age Cohort	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
0 to 14	Observed	2	2105	378	0	872	125	0	1068	111
	Average	2.000	2.891	4.209	0.000	2.75	3.904	0.000	3.298	4.324
	Variance	0.0000	3.6848	6.7069	0.0000	3.1292	6.4101	0.0000	5.1765	7.6393
15 to 19	Observed	56	530	108	15	205	36	19	301	43
	Average	4.071	2.874	4.194	3.667	2.8	4.5	4.316	3.399	5.465
	Variance	5.6675	2.7874	8.8871	3.0952	2.2294	5.7429	9.2281	4.2072	7.1118
20 to 24	Observed	119	318	78	35	93	16	49	129	13
	Average	3.941	2.371	6.359	3.029	2.806	3.188	3.571	2.535	3.462
	Variance	7.6152	3.1994	13.2721	5.3815	3.5708	5.7625	9.75	4.0164	9.2692
25 to 29	Observed	179	259	78	63	92	24	93	110	23
	Average	4.011	2.595	5.603	3.794	2.5	4.5	4.376	2.773	5.261
	Variance	7.719	3.5676	21.0997	4.6825	3.3077	13.5652	9.3894	5.0763	27.5652
30 to 34	Observed	226	247	106	103	121	32	94	118	24
	Average	4.46	2.964	6.453	3.845	2.975	5.875	4.085	3.331	7.292
	Variance	10.7651	6.7588	20.5358	5.7992	5.1577	13.7903	9.1755	6.6676	27.9547
35 to 39	Observed	218	240	102	154	123	42	118	123	30
	Average	4.743	2.975	6.657	4.539	3	6.024	6.424	3.504	6.833
	Variance	10.9291	6.0245	19.3761	9.9233	3.1967	9.536	20.9813	7.2029	16.7644
40 to 44	Observed	223	251	91	129	142	32	140	161	40
	Average	4.578	3.291	7.637	4.465	3.268	5.969	4.629	3.565	5.65
	Variance	11.9026	5.3991	24.1004	12.2507	4.7222	19.9022	15.6596	7.0973	17.7718
45 to 49	Observed	182	247	92	144	139	45	129	164	41
	Average	4.407	2.81	6.033	4.604	2.777	6.156	4.767	3.171	6.341
	Variance	11.2702	5.0978	14.8231	7.3737	4.4209	14.4071	11.4611	8.1179	19.6805
50 to 54	Observed	206	236	92	140	120	47	120	122	47
	Average	3.864	2.669	5.652	3.836	2.875	4.766	4.158	2.557	6.213
	Variance	8.0009	4.9031	18.3832	8.8145	3.6733	12.5745	10.5882	4.0339	18.9103
55 to 59	Observed	163	201	78	90	103	40	104	111	32
	Average	3.755	2.527	4.321	3.822	2.786	5.25	3.519	2.541	5.062
	Variance	9.3715	3.7005	14.1167	6.0804	3.5618	16.5513	8.2132	4.5052	12.9637
60 to 64	Observed	153	145	72	104	77	34	90	90	38
	Average	3.784	2.255	4.431	3.25	2.649	5.5	3.5	2.522	5.263
	Variance	10.5387	4.3025	11.9669	5.6262	4.1781	11.0455	7.1966	6.2074	18.037
65 to 69	Observed	141	163	46	109	77	17	99	76	36
	Average	3.277	2.301	4	3.596	2.766	5.294	3.848	2.645	4.25
	Variance	6.8587	4.4585	11.3333	5.2429	3.9973	12.8456	9.7625	6.0188	13.7929
70 to 74	Observed	143	135	40	93	69	19	100	71	28
	Average	2.895	2.57	4.35	2.871	2.522	5.105	3.23	2.296	5.607
	Variance	5.5453	5.6648	12.1308	3.8962	3.312	50.5439	7.3708	6.0398	10.0251
75 to 79	Observed	120	89	37	65	43	14	82	65	40
	Average	3.15	2.213	3.324	2.877	2.349	5.929	3.146	2.154	4.5
	Variance	6.6832	3.7607	8.0586	4.4221	5.0421	3.9176	5.2623	4.601	10.359
80 Plus	Observed	103	135	16	61	54	19	73	72	18
	Average	2.583	1.815	1.625	2.885	1.796	3.474	2.575	1.542	2.389
	Variance	4.775	4.9729	3.85	3.6699	3.6747	13.9298	3.4144	3.463	7.781

Table 45. Trip Data by Age Cohort for Males Only.

Age Cohort	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
0 to 14	Observed	2	1065	180	0	452	72	0	558	61
	Average	2	2.918	3.939	0	2.803	3.792	0	3.326	4.328
	Variance	0	3.7311	6.9851	0	3.1962	7.125	0	4.9922	8.824
15 to 19	Observed	29	267	51	7	111	15	6	155	23
	Average	4.103	2.82	4.059	4.571	2.811	3.467	3.833	3.342	4.957
	Variance	6.6675	2.8849	7.7765	3.9524	2.0821	1.981	6.9667	4.0447	4.7708
20 to 24	Observed	45	162	41	9	54	4	19	58	7
	Average	3.556	2.34	6.073	3.333	2.685	4	5	2.293	4
	Variance	4.6616	3.2567	13.4195	5.75	3.0122	2.6667	13.4444	3.3336	11.6667
25 to 29	Observed	60	156	39	20	46	12	24	60	9
	Average	3.317	2.635	4.487	3.95	2.478	4.833	4	2.633	5.556
	Variance	4.4234	3.5237	16.3617	5.6289	2.4773	17.0606	4.3478	3.4565	21.5278
30 to 34	Observed	79	134	46	30	69	16	30	71	12
	Average	4.342	2.836	6.326	3.4	3.217	6.125	3.667	3.099	5.417
	Variance	8.3304	7.4916	25.958	2.2483	4.4962	13.3167	4.7126	5.0044	17.5379
35 to 39	Observed	77	145	55	56	70	22	47	72	13
	Average	4.494	2.669	5.291	3.893	3.143	5.318	5.234	3.264	5.846
	Variance	7.569	5.1119	13.8397	5.5883	3.6315	8.2273	13.9658	5.6336	16.141
40 to 44	Observed	85	134	38	47	88	11	49	98	24
	Average	4.835	3.336	7.895	3.936	3.239	4.455	3.939	3.765	4.917
	Variance	12.3535	5.9841	29.1238	9.0176	4.5746	15.6727	13.9753	7.1505	22.4275
45 to 49	Observed	71	123	41	59	82	23	45	94	16
	Average	4.577	2.756	5.707	4.78	2.829	5.565	3.689	3.298	6.125
	Variance	11.9903	5.3663	12.2622	7.623	3.6989	14.7115	7.0374	9.0716	12.7833
50 to 54	Observed	75	119	37	53	77	25	57	67	20
	Average	4.427	2.748	5.432	3.906	2.831	4.24	3.825	2.791	5.4
	Variance	10.4641	5.4783	15.6967	5.8179	3.6159	6.1067	7.1115	4.1981	16.6737
55 to 59	Observed	63	103	35	36	55	18	46	65	17
	Average	4.016	2.748	4.371	3.611	2.673	5.167	4.217	2.354	4.765
	Variance	10.403	3.1709	11.2403	4.7016	3.5946	24.1471	10.5739	4.6697	12.5662
60 to 64	Observed	61	71	33	48	32	18	39	39	15
	Average	4.607	2.211	5.394	3.167	3	6.278	3.256	2.641	4.067
	Variance	16.3426	3.3976	12.9962	4.0567	4.7097	13.7418	5.3536	8.7625	12.9238
65 to 69	Observed	60	94	22	46	34	6	40	35	19
	Average	3.617	2.468	3.727	3.717	3.147	5.5	3.4	2.914	4.789
	Variance	7.8675	4.9613	11.3506	6.6961	5.5838	11.5	4.9128	7.1983	11.3977
70 to 74	Observed	54	73	20	48	35	9	39	42	12
	Average	3.056	2.603	4.65	2.812	2.6	6.333	3.897	2.071	6
	Variance	5.7516	4.3539	8.3447	4.4535	4.3059	92.5	6.5155	7.1411	14.3636
75 to 79	Observed	57	41	16	29	18	7	30	43	17
	Average	3.175	2.439	3.875	2.724	2.444	5.286	3.1	2.302	4.941
	Variance	8.0401	5.0024	7.45	3.6355	3.9085	5.5714	4.7828	3.9779	9.5588
80 Plus	Observed	45	56	8	26	23	6	25	34	9
	Average	2.689	2.214	2	3.385	2.087	5.333	2.92	1.971	3.111
	Variance	4.7192	5.7351	4.5714	4.7262	4.6285	25.4667	3.5767	4.1506	10.3611

Table 46. Trip Data by Age Cohort for Females Only.

Age Cohort	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
0 to 14	Observed	0	1040	198	0	420	53	0	510	50
	Average	0	2.862	4.455	0	2.693	4.057	0	3.267	4.32
	Variance	0	3.6394	6.3609	0	3.0582	5.516	0	5.3865	6.3445
15 to 19	Observed	27	262	57	8	94	21	13	146	20
	Average	4.037	2.931	4.316	2.875	2.787	5.238	4.538	3.459	6.05
	Variance	4.8063	2.7002	10.0056	1.2679	2.4274	7.2905	10.7692	4.4017	9.5237
20 to 24	Observed	74	156	37	26	39	12	30	71	6
	Average	4.176	2.404	6.676	2.923	2.974	2.917	2.667	2.732	2.833
	Variance	9.3523	3.1584	13.2808	5.4338	4.3941	6.8106	5.6092	4.5416	7.3667
25 to 29	Observed	119	103	39	43	46	12	69	50	14
	Average	4.361	2.534	6.718	3.721	2.522	4.167	4.507	2.94	5.071
	Variance	9.0632	3.663	23.8394	4.3488	4.2106	11.0606	11.1654	7.078	33.3022
30 to 34	Observed	147	113	60	73	52	16	64	47	12
	Average	4.524	3.115	6.55	4.027	2.654	5.625	4.281	3.681	9.167
	Variance	12.1279	5.9063	16.7263	7.1937	5.9563	15.05	11.253	9.1351	33.2424
35 to 39	Observed	141	95	47	98	53	20	71	51	17
	Average	4.879	3.442	8.255	4.908	2.811	6.8	7.211	3.843	7.588
	Variance	12.7782	7.1216	21.4551	12.1049	2.6176	10.2737	24.3119	9.3749	16.8824
40 to 44	Observed	138	117	53	82	54	21	91	63	16
	Average	4.42	3.239	7.453	4.768	3.315	6.762	5	3.254	6.75
	Variance	11.6469	4.7698	20.9064	13.9827	5.05	21.0905	16.3333	6.9667	9.6667
45 to 49	Observed	111	124	51	85	57	22	84	70	25
	Average	4.297	2.863	6.294	4.482	2.702	6.773	5.345	3	6.48
	Variance	10.8835	4.8672	17.0118	7.2527	5.5345	13.9935	12.9758	6.8986	24.76
50 to 54	Observed	131	117	55	87	43	22	63	55	27
	Average	3.542	2.59	5.8	3.793	2.953	5.364	4.46	2.273	6.815
	Variance	6.3732	4.3475	20.4593	10.7241	3.8549	19.8615	13.704	3.7576	20.3875
55 to 59	Observed	100	98	43	54	48	22	58	46	15
	Average	3.59	2.296	4.279	3.963	2.917	5.318	2.966	2.804	5.4
	Variance	8.7494	4.1899	16.7774	7.0552	3.5674	11.1797	5.7883	4.2498	14.1143
60 to 64	Observed	92	74	39	56	45	16	51	51	23
	Average	3.239	2.297	3.615	3.321	2.4	4.625	3.686	2.431	6.043
	Variance	6.0741	5.2255	9.9271	7.0584	3.7455	7.1833	8.6596	4.3702	20.498
65 to 69	Observed	81	69	24	63	43	11	59	41	17
	Average	3.025	2.072	4.25	3.508	2.465	5.182	4.153	2.415	3.647
	Variance	6.0494	3.7447	11.6739	4.254	2.6357	14.7636	12.9591	5.0488	16.6176
70 to 74	Observed	89	62	20	45	34	10	61	29	16
	Average	2.798	2.532	4.05	2.933	2.441	4	2.803	2.621	5.312
	Variance	5.4586	7.3022	16.3658	3.3818	2.3752	16	7.5607	4.4581	7.2958
75 to 79	Observed	63	48	21	36	25	7	52	22	23
	Average	3.127	2.021	2.905	3	2.28	6.571	3.173	1.864	4.174
	Variance	5.5643	2.7017	8.4905	5.1429	6.0433	1.9524	5.6361	5.9329	11.1502
80 Plus	Observed	58	79	8	35	31	11	48	38	9
	Average	2.5	1.532	1.25	2.514	1.581	2.545	2.396	1.158	1.667
	Variance	4.886	4.3035	3.3571	2.6689	2.9849	9.2727	3.3081	2.623	5

Figures 5 through 10 present the trip rates plotted by age cohort for the individual areas and for the method of data retrieval. Statistical tests were done to compare trip rates to identify if the differences in the rates were significant or if the differences could be attributed to chance. For all persons, males, and females, the following comparisons were done:

1. Trip rates between adjacent age cohorts by retrieval method for each area;
2. Trip rates by age cohort between retrieval methods for each area; and
3. Trip rates by age cohort and retrieval method between each area.

Since the survey specifications allowed travel and activities for minors to be reported by an adult in the household, nearly all of the data for the age group 0 to 14 was reported by proxy or diary. Only two persons were interviewed in that age group. As a result, the only trip rates compared for that age group were for proxy and diary. The following summarize the findings for the three comparisons for all persons (results for males and females were similar):

1. For each area, 41 comparisons between adjacent age cohorts by method of data retrieval were made for all persons, males, and females. Of these 41, 13 were for respondent, 14 were for proxy, and 14 were for diary. For the respondent retrieval method, none of the comparisons were found significantly different in the Valley, three were found significantly different in Austin, and two were found significantly different in Amarillo. For the proxy retrieval method, two were found significantly different in the Valley, none were found significantly different in Austin, and two were found significantly different in Amarillo. For the diary retrieval method, four were found significantly different in the Valley, one was found significantly different in Austin, and three were found significantly different in Amarillo. The data indicate strong similarity between trip rates for adjacent age cohorts and imply many of the age cohorts could be combined with no degradation in the results. The plots shown in Figure 5 indicate trip rates do change over the full range of age cohorts.

2. When comparing the trip rates by retrieval method for each area, nearly all of the comparisons were found to be significantly different. This is further illustrated by the plots shown in Figures 5 through 7. A total of 43 comparisons were made for each area. For the Valley, eight (19 percent) were found to not be significantly different. For Austin, 16 (37 percent) were found to not be significantly different. For Amarillo, 10 (23 percent) were found to not be significantly different. The data indicate the method of data retrieval has a strong influence on the resulting trip rates.

3. The comparison of trip rates between the three areas was done by age cohort for each method of data retrieval. For the respondent method, a total of 42 comparisons were made. No trip rate was found significantly different between the Valley and Austin. One trip rate was found significantly different between the Valley and Amarillo. One trip rate was found significantly different between Austin and Amarillo. For the proxy method, a total of 45 comparisons were made. One trip rate was found significantly different between the Valley and Austin. Two trip rates were found significantly different between the Valley and Amarillo. Two trip rates were found significantly different between Austin and Amarillo. For the diary method, a total of 45 comparisons were made. Two trip rates were found significantly different between the Valley and Austin. Three trip rates were found significantly different between the Valley and Amarillo. None of the trip rates were found significantly different between Austin and Amarillo. The data indicate strong similarity between the trip rates for all three areas for each method of data retrieval. This is illustrated in Figures 8 through 10. This indicates the method of data retrieval produced similar results for all three areas despite the geographical and cultural differences between the areas.

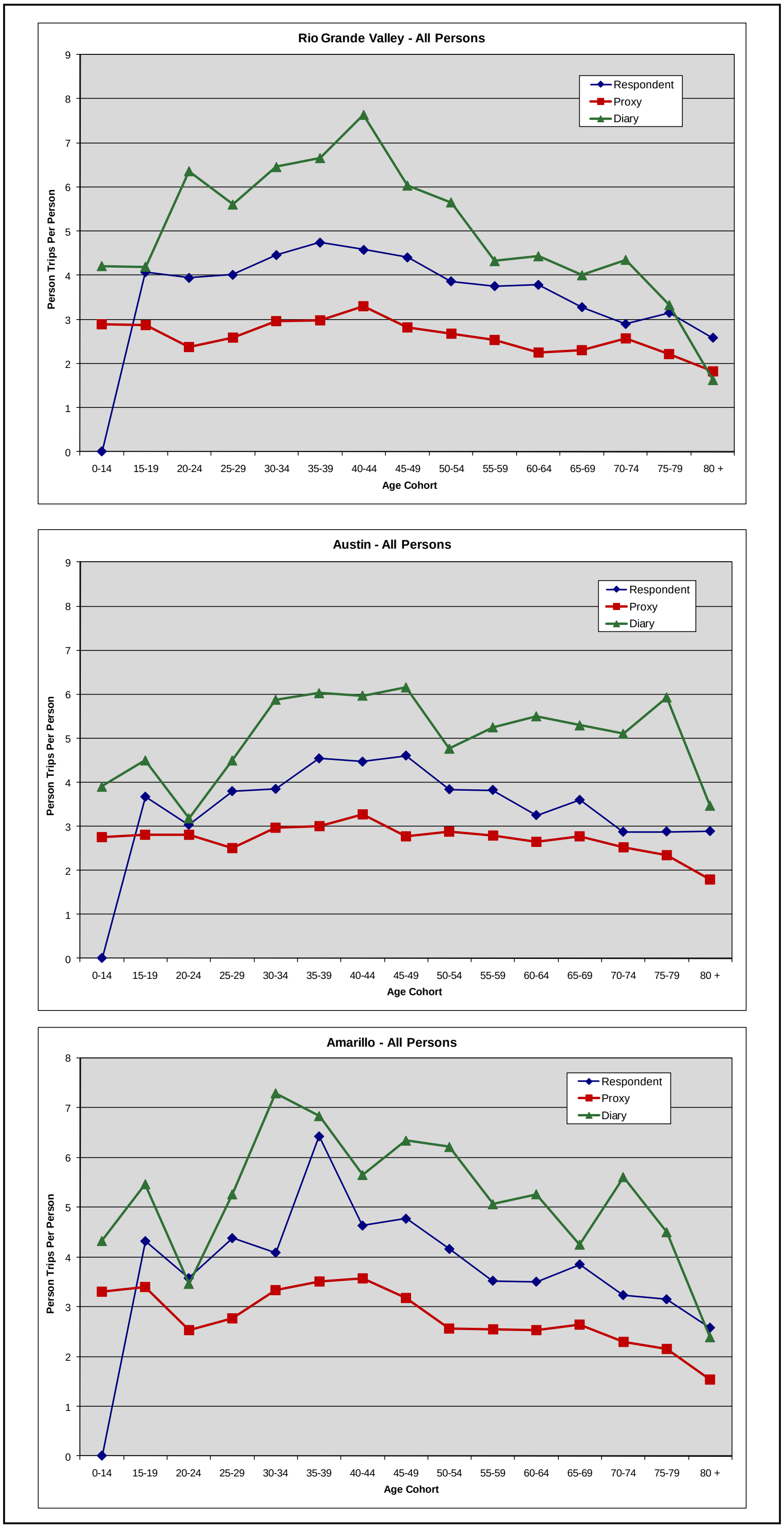


Figure 5. Trip Rates for All Persons by Age Cohort.

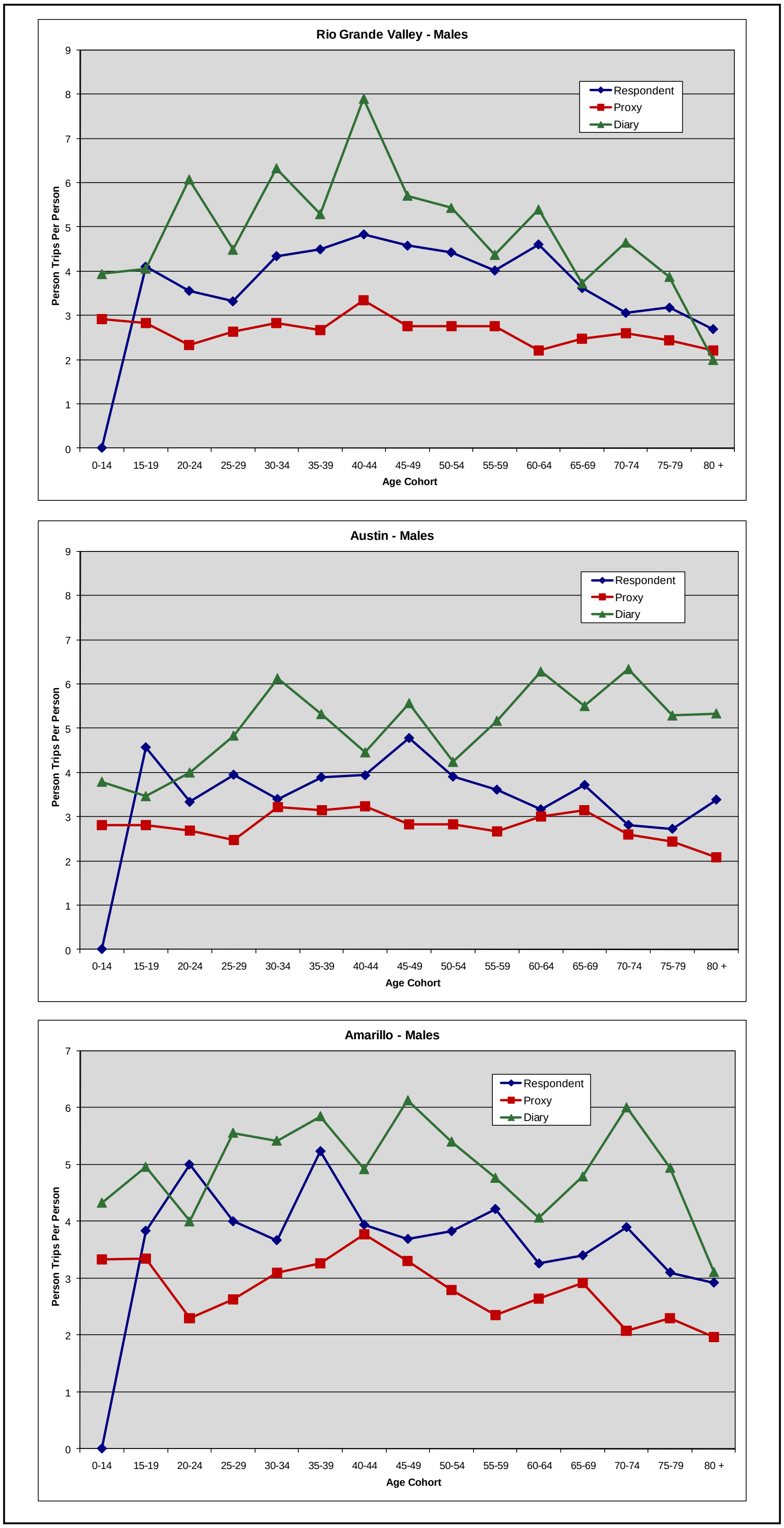


Figure 6. Trip Rates for Males by Age Cohort.

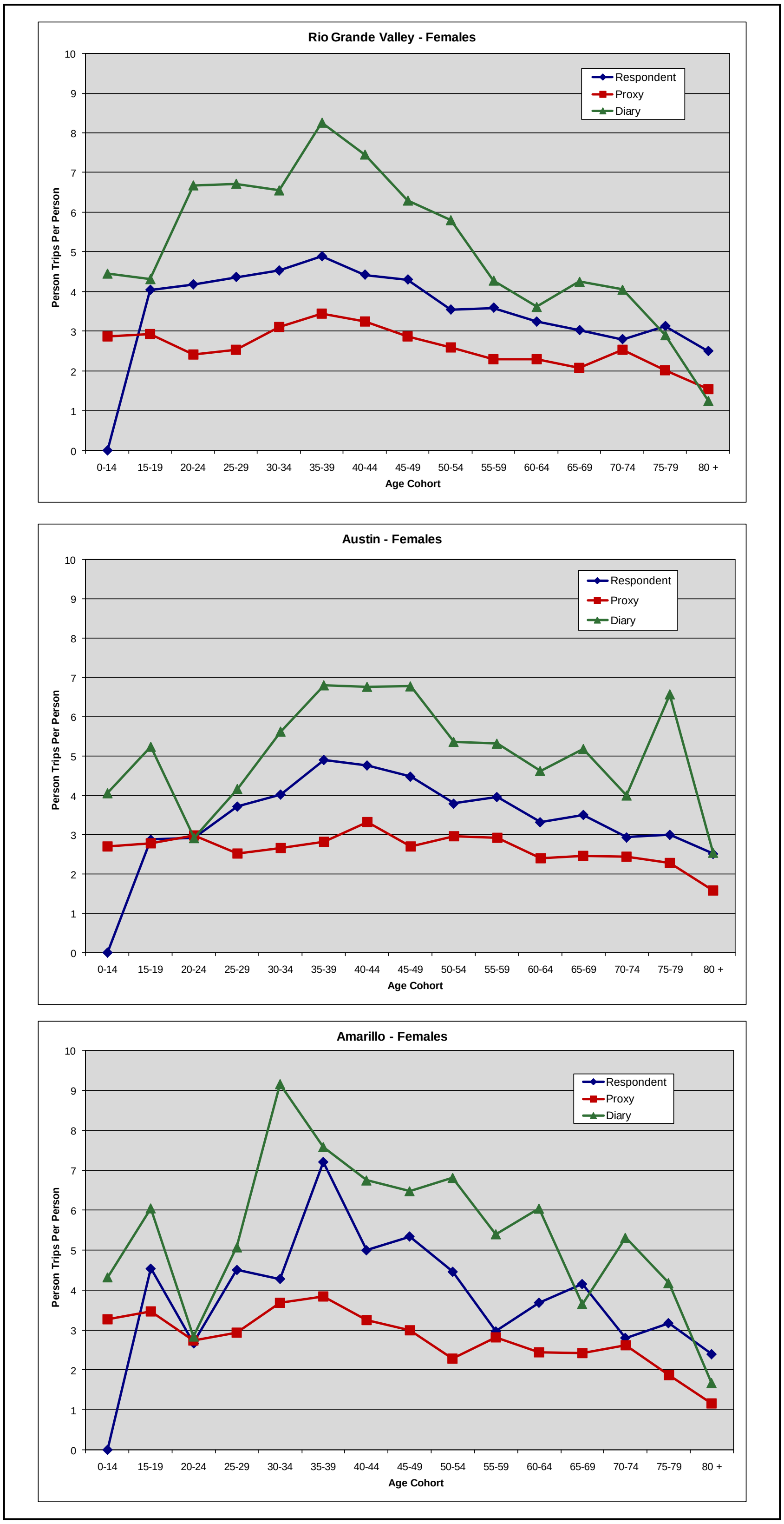


Figure 7. Trip Rates for Females by Age Cohort.

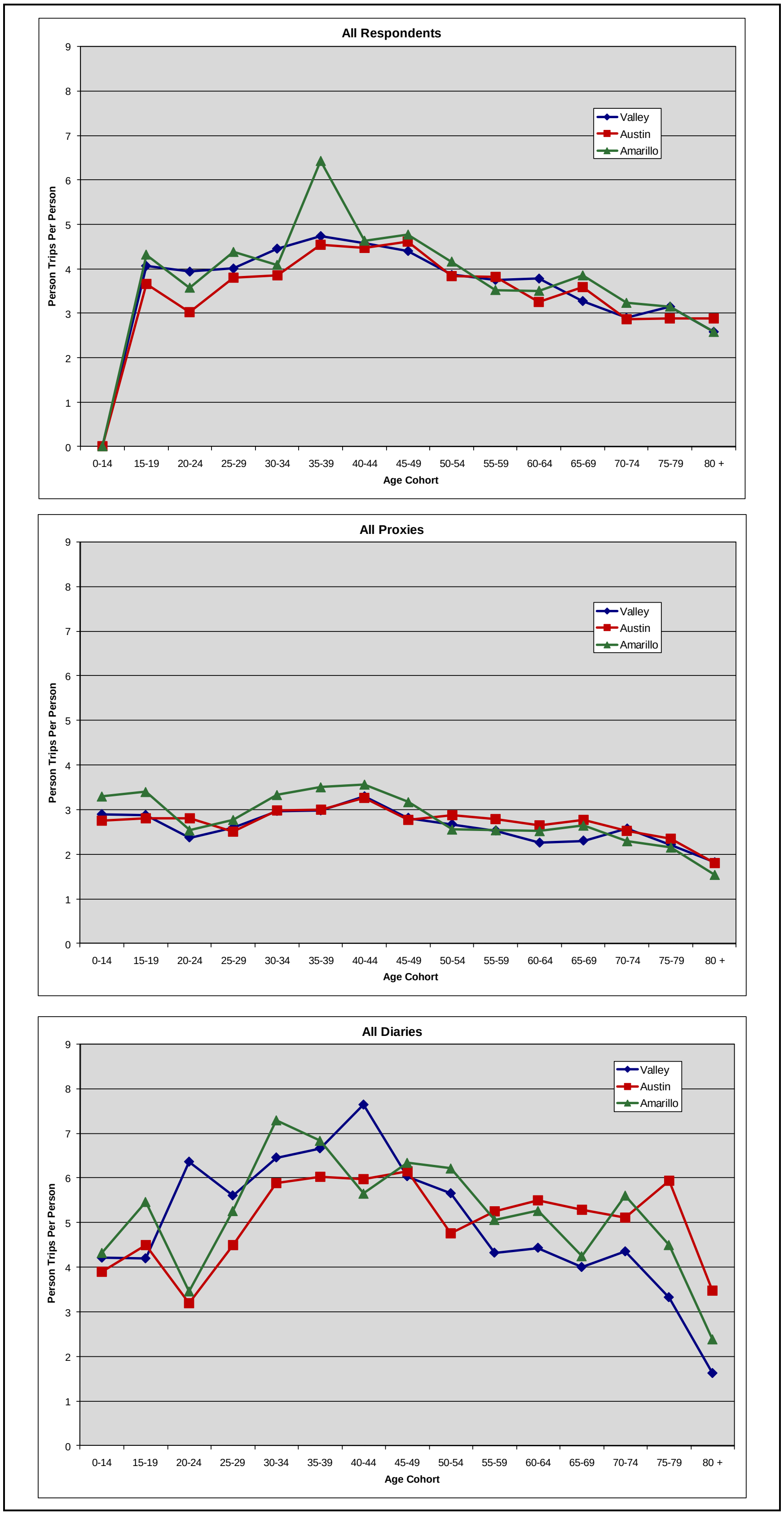


Figure 8. Trip Rates for All Persons by Retrieval Method Comparisons.

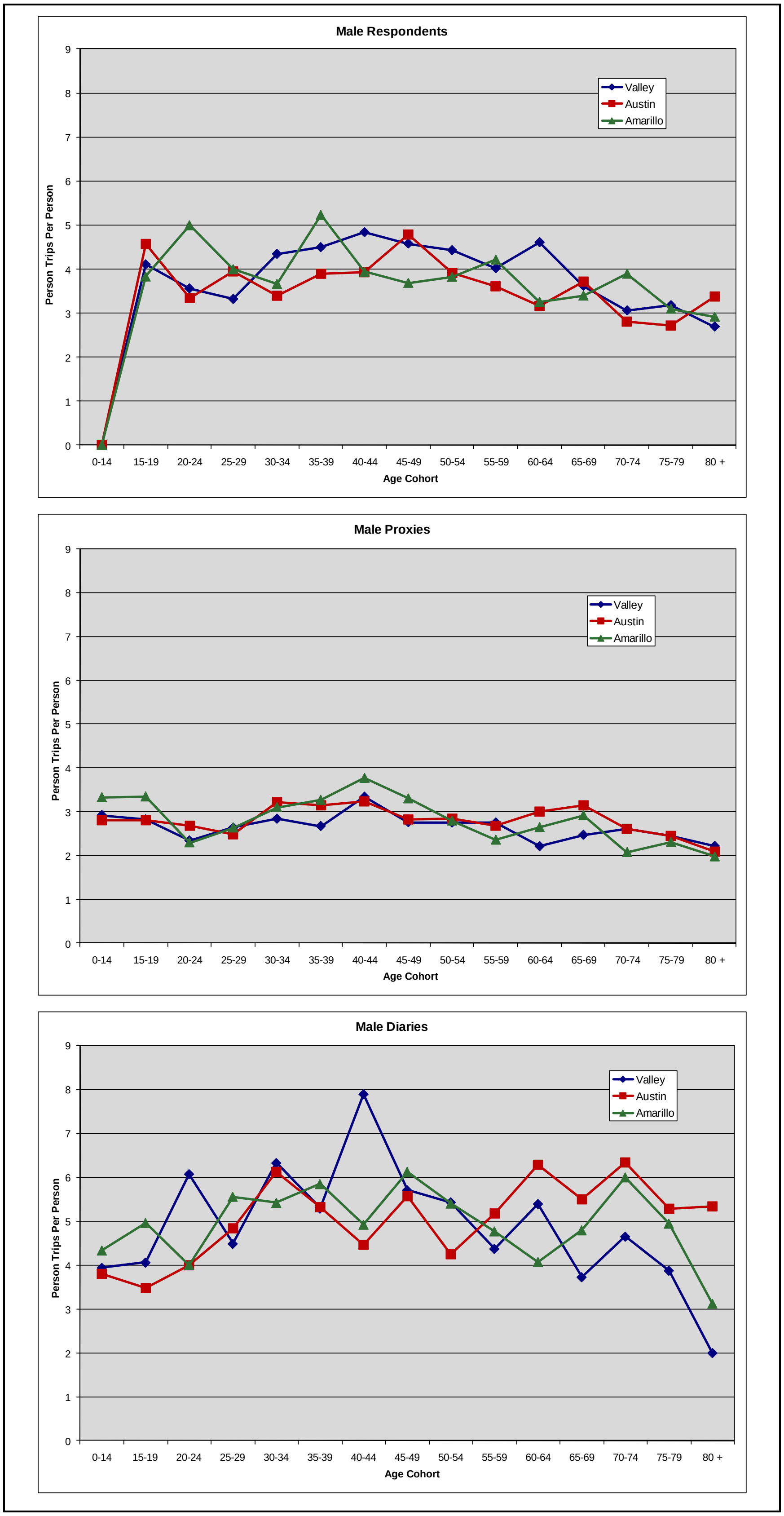


Figure 9. Trip Rates for Males by Retrieval Method Comparisons.

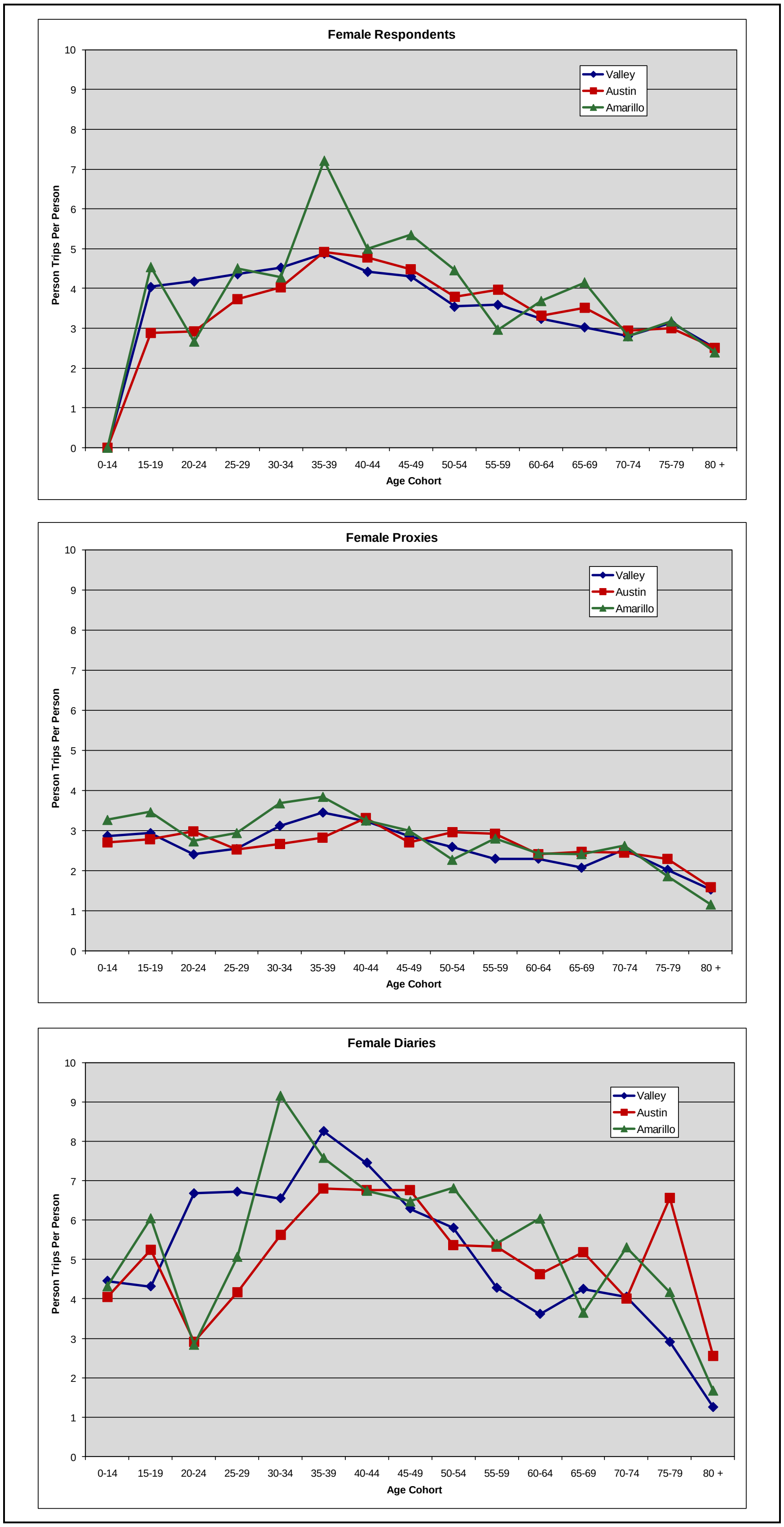


Figure 10. Trip Rates for Females by Retrieval Method Comparisons.

As stated previously, for the three comparisons done, the same findings were found for males and females. An additional comparison was made between the male and female trip rates. That comparison found statistical differences in 15 of the 132 rates compared between the males and females by age cohort and retrieval method for the three areas. Figures 11 through 13 plots these rates.

The second stratification examined was developed based on what is termed a person's life cycle. This represents a measure of where individuals are in their life. Individuals were grouped into four categories: employed, retired, student, and other. Trip rates were compiled from the surveys for each area and compared for all persons. Trip rates for males and females were developed and examined but a comparison was not considered necessary due to the results found in the previous analysis (i.e., rates were very similar for males and females). Table 47 presents the trip data for each area stratified by person life cycle.

The first comparison made was between each person life cycle category for each type of retrieval within each area. This comparison evaluates whether the trip rates for each person life cycle are different, i.e., does stratifying by person life cycle make any difference in the rates. Table 48 shows the results. Essentially, this table presents the absolute percent difference between trip rates and whether this difference was found to be statistically significant. For example, in the Valley for data retrieved by respondent, the average trip rate for employed persons was 37 percent different than the rate for retired persons. This was statistically significant. The average trip rate for students was 12 percent different than that for retired persons. This was also statistically significant. The average trip rate for students was 16 percent different from that for persons in the other category and that difference was also statistically significant. Figure 14 shows the trip rates plotted by person life cycle by method of data retrieval for each area. Trip rates based on proxy reporting were consistently lower than the other methods of retrieval. Trip rates by diary were higher in all but one case. The data in Table 48 indicate mixed results. For the Valley, trip rates stratified by person life cycle are mostly different depending on the method of data retrieval. For Austin, they are mostly not different again depending on method of data retrieval. For Amarillo, most of the trip rates for respondents were different while some of the rates for proxy were not different and most of the rates for diary were not different. The results varied depending on the area and the method of data retrieval.

The second comparison was between trip rates by method of data retrieval for each person life cycle between the areas. Table 49 presents this comparison that shows the absolute difference in trip rates as well as whether this difference was found to be statistically significant. Figure 15 presents plots of the person trip rates for each area based on the method of data retrieval. Person trip rates stratified by person life cycle were very similar between the Valley and Austin for all three methods of data retrieval. This was not the case for comparisons between the Valley and Amarillo or between Austin and Amarillo. About a third of the trip rates compared was statistically different indicating the trip rates by person life cycle were different in Amarillo from those in the Valley and Austin. When reviewing the results for individual person life cycles, the trip rates for retired persons were the most consistent. Of the nine comparisons, only one was found to be statistically different, i.e., the retired trip rate for diary retrieval between the Valley and Austin. For employed persons, of the nine comparisons, two were found statistically different. For students, of the nine comparisons, one was found statistically different and for the other category, six of the nine comparisons were found statistically different. The results in Table 49 indicate the aggregate trip rates by person life cycle vary between the three areas with the majority of differences due to the rates in Amarillo.

The third comparison was between each method of data retrieval for each area and person life cycle. This comparison was intended to determine if the method of data retrieval had any impact on the trip rates for persons stratified by person life cycle within each area. Table 50 presents the results of these comparisons. For employed persons, the rates were significantly different in every case for all three areas. For retired persons, the rates were significantly different except between respondents and diary for one area. For students, the rates were significantly different except between respondents and diary in one area. For persons in the other category, the rates were significantly different in all but two cases between respondents and diary. From these data, it appears the method of data retrieval has an impact on the number of trips and resulting trip rates.

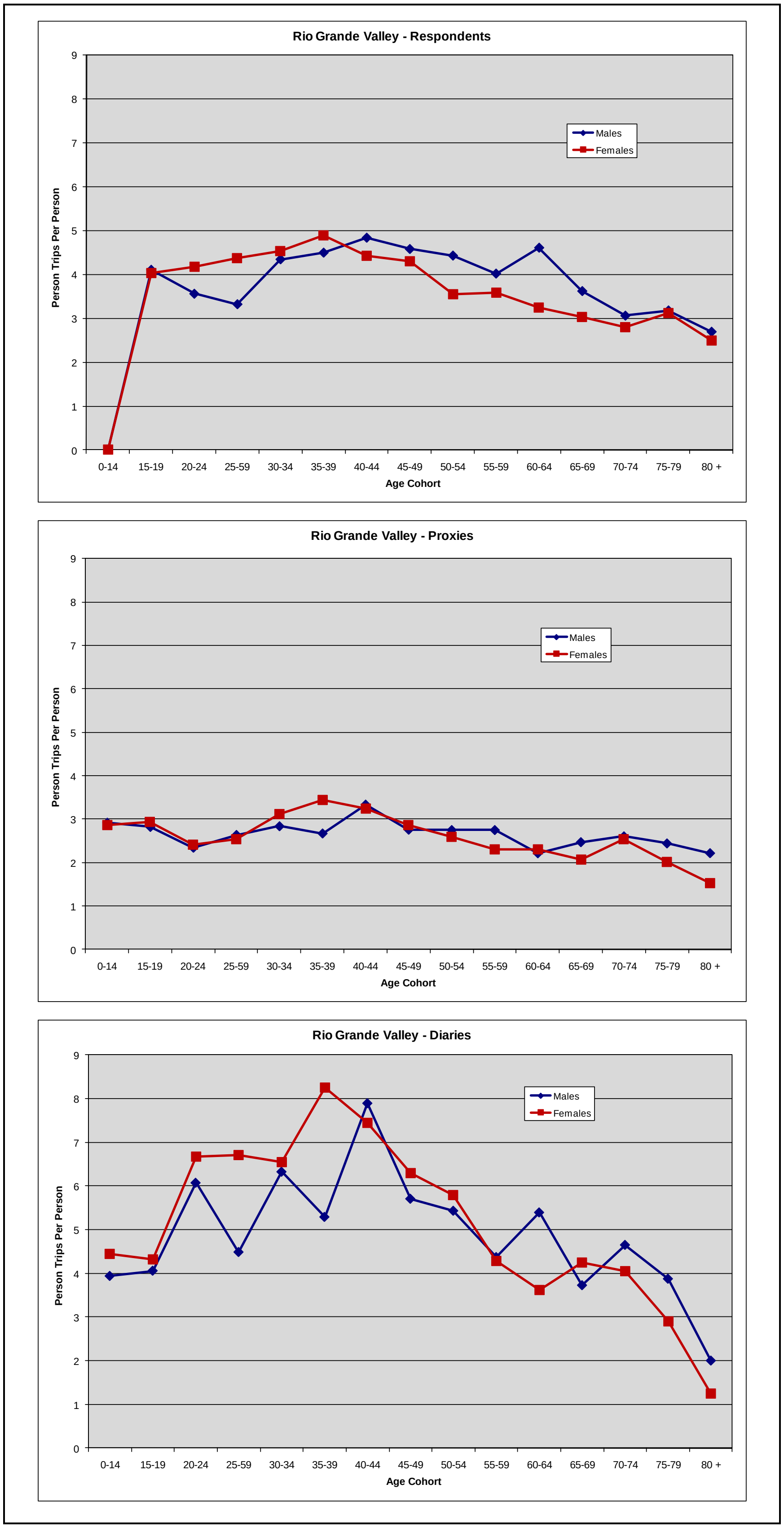


Figure 11. Rio Grande Valley Comparison of Trips Rates by Age Cohorts.

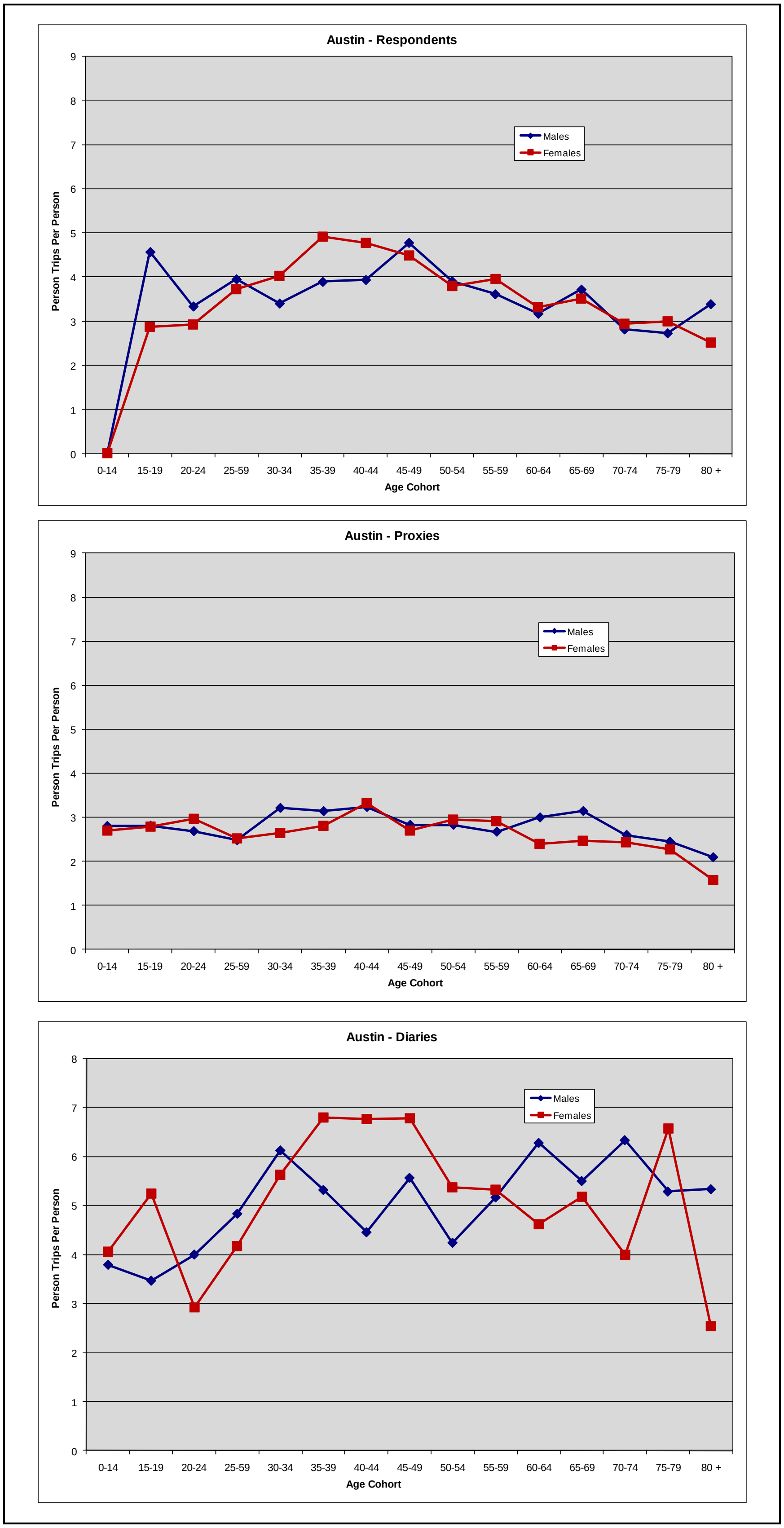


Figure 12. Austin Comparison of Trip Rates by Age Cohorts.

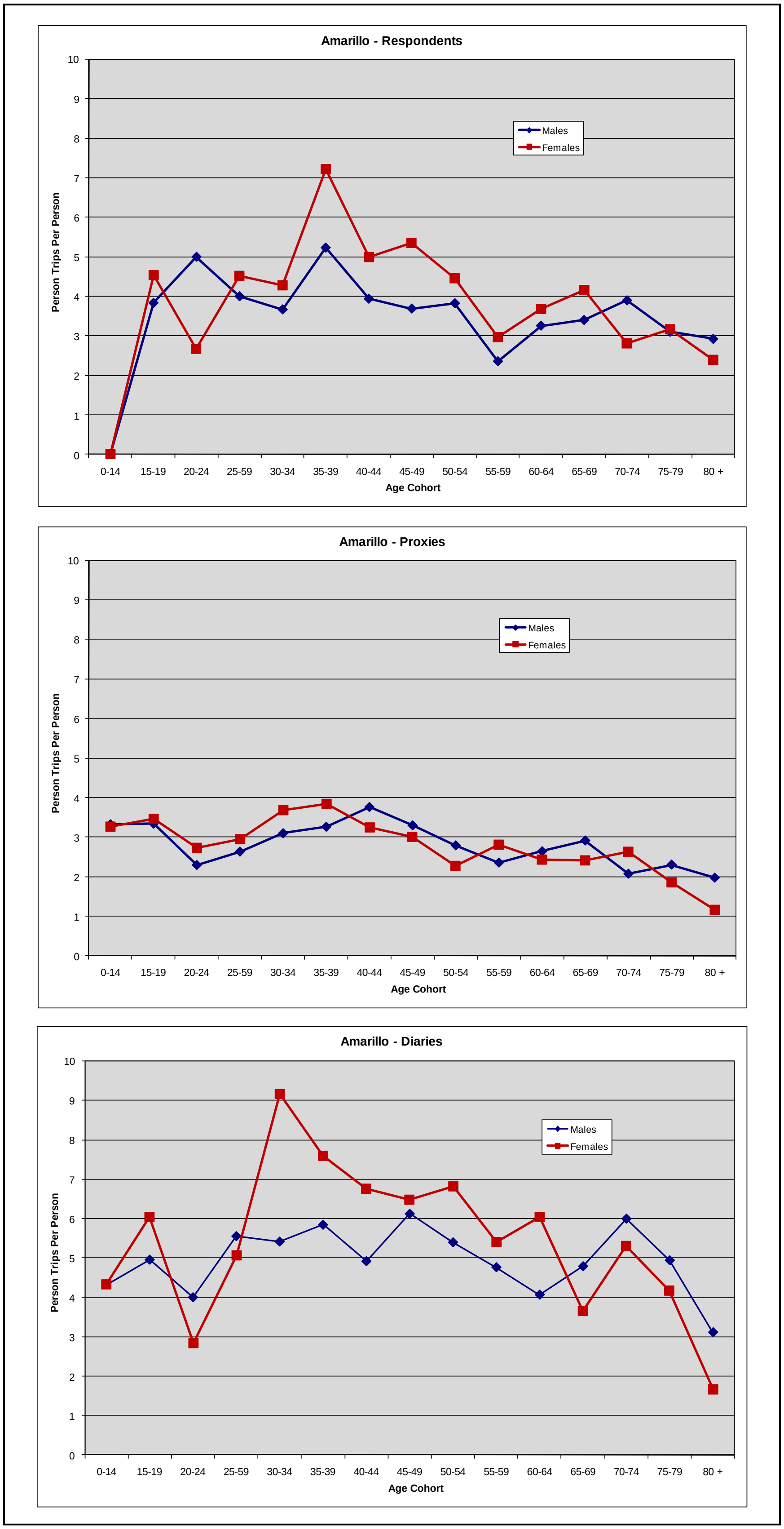


Figure 13. Amarillo Comparison of Trip Rates by Age Cohort.

Table 47. Person Trip Data by Person Life Cycle.

Area	Person Life Cycle	Measure	Data Retrieval Method		
			Respondent	Proxy	Diary
Valley	Employed	Observations	1082	1562	630
		Average Trip Rate[1]	4.404	3.01	5.963
		Variance	9.4103	4.0947	16.0225
	Retired	Observations	524	454	139
		Average Trip Rate	3.208	2.205	3.554
		Variance	6.8534	4.7902	10.046
	Student	Observations	558	1127	239
		Average Trip Rate	3.654	2.33	5.699
		Variance	10.539	7.1201	23.8248
	Other	Observations	70	2158	406
		Average Trip Rate	4.371	2.919	4.089
		Variance	7.0484	2.4135	5.9131
Austin	Employed	Observations	692	825	249
		Average Trip Rate	4.171	3.046	5.574
		Variance	7.3139	3.2891	15.3261
	Retired	Observations	346	237	70
		Average Trip Rate	3.124	2.489	4.571
		Variance	4.8106	4.4459	10.8571
	Student	Observations	243	420	90
		Average Trip Rate	3.737	2.252	4.967
		Variance	9.8064	5.5209	14.3697
	Other	Observations	24	848	133
		Average Trip Rate	4.167	2.847	3.91
		Variance	6.8406	2.3566	6.3251
Amarillo	Employed	Observations	666	975	252
		Average Trip Rate	4.407	3.309	5.917
		Variance	9.6582	5.5319	16.8098
	Retired	Observations	363	272	113
		Average Trip Rate	3.234	2.224	4.221
		Variance	6.7213	5.7539	11.9774
	Student	Observations	260	505	80
		Average Trip Rate	4.331	2.356	5.062
		Variance	18.1141	8.4005	19.553
	Other	Observations	21	1029	119
		Average Trip Rate	7.81	3.411	4.714
		Variance	25.9619	3.5886	8.0024

[1]Person trips per person.

Table 48. Trip Rate Comparisons within Each Area by Person Life Cycle.

Area	Retrieval Method	Person Life Cycle	Left of Diagonal	Person Life Cycle: Employed	Retired	Student	Other
				Right of Diagonal – Statistical Difference			
Valley	Respondent	Employed	Absolute Difference In Trip Rates		Yes	Yes	No
		Retired		37%		Yes	Yes
		Student		21%	12%		Yes
		Other		1%	27%	16%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	No
		Retired		37%		No	Yes
		Student		29%	5%		Yes
		Other		3%	24%	20%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	No	Yes
		Retired		68%		Yes	No
		Student		5%	38%		Yes
		Other		46%	13%	39%	
Austin	Respondent	Employed	Absolute Difference In Trip Rates		Yes	No	No
		Retired		34%		Yes	No
		Student		12%	16%		No
		Other		<1%	25%	10%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		22%		No	Yes
		Student		35%	11%		Yes
		Other		7%	12%	21%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	No	Yes
		Retired		22%		No	No
		Student		12%	8%		Yes
		Other		43%	17%	27%	
Amarillo	Respondent	Employed	Absolute Difference In Trip Rates		Yes	No	Yes
		Retired		36%		Yes	Yes
		Student		2%	25%		Yes
		Other		44%	59%	45%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	No
		Retired		49%		No	Yes
		Student		40%	6%		Yes
		Other		3%	35%	31%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	No	Yes
		Retired		40%		No	No
		Student		17%	17%		No
		Other		26%	10%	7%	

Table 49. Trip Rate Comparisons by Person Life Cycle between Areas.

Area	Retrieval Method	Person Life Cycle	Person Trip Rate Comparison	
			Absolute Percent Difference	Statistically Significant
Valley versus Austin	Respondent	Employed	6%	No
		Retired	3%	No
		Student	2%	No
		Other	5%	No
	Proxy	Employed	1%	No
		Retired	11%	No
		Student	3%	No
		Other	3%	No
	Diary	Employed	7%	No
		Retired	22%	Yes
		Student	15%	No
		Other	5%	No
Valley versus Amarillo	Respondent	Employed	< 1%	No
		Retired	1%	No
		Student	16%	Yes
		Other	44%	Yes
	Proxy	Employed	9%	Yes
		Retired	1%	No
		Student	1%	No
		Other	14%	Yes
	Diary	Employed	1%	No
		Retired	16%	No
		Student	13%	No
		Other	13%	Yes
Austin versus Amarillo	Respondent	Employed	5%	No
		Retired	3%	No
		Student	14%	No
		Other	47%	Yes
	Proxy	Employed	8%	Yes
		Retired	12%	No
		Student	4%	No
		Other	17%	Yes
	Diary	Employed	6%	No
		Retired	8%	No
		Student	2%	No
		Other	17%	Yes

The third stratification examined was for persons by household life cycle. Household life cycle was defined as 12 categories with each category based on the presence of children under the age of 18 in the households, the number of persons employed in the household, and if there was one or more retired persons in the household. Table 51 presents the criteria for the household life cycles used in this evaluation. It is hypothesized that persons within similar households (based on their household life cycle) will have similar travel characteristics in terms of person trip rates.

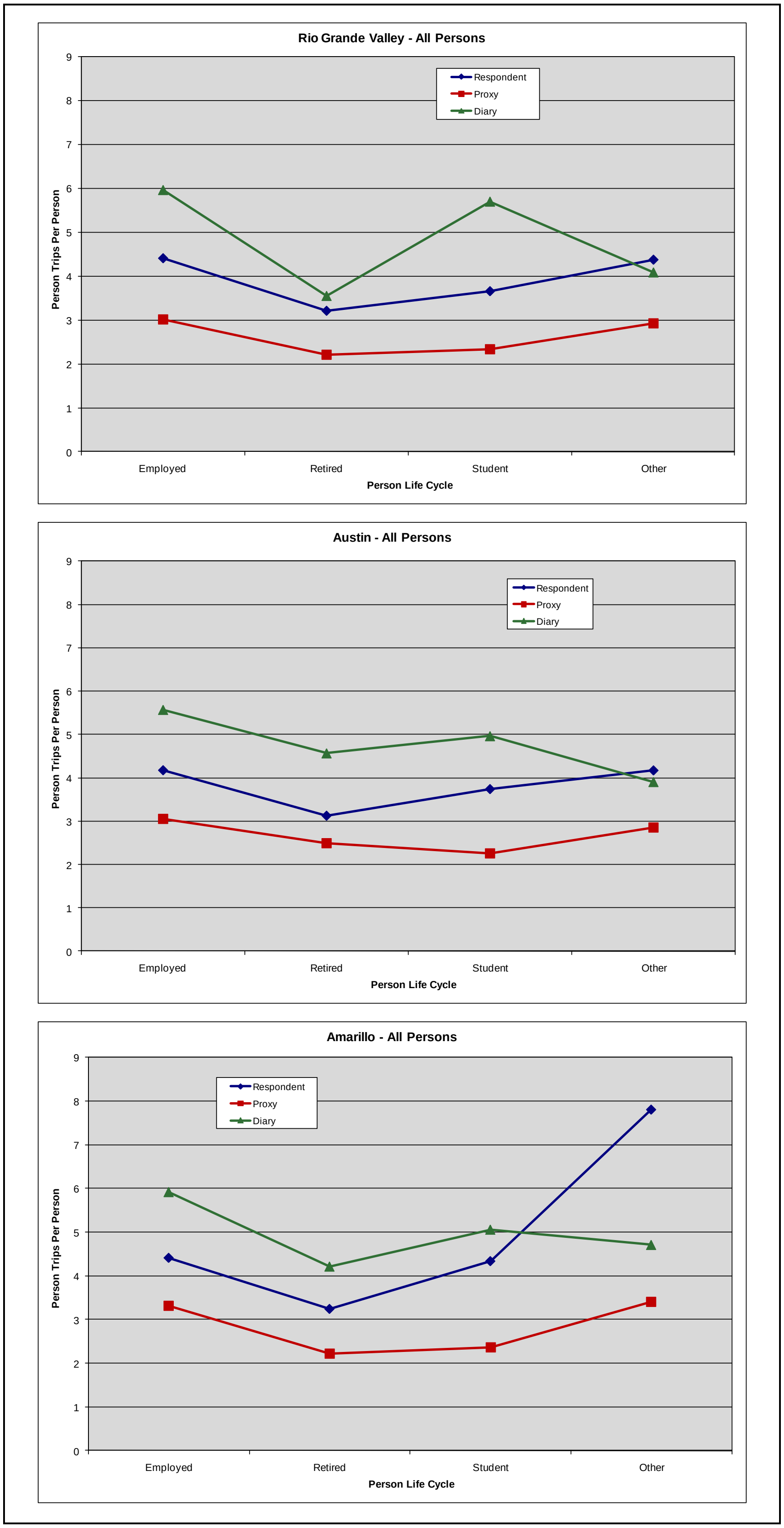


Figure 14. All Person Trip Rates by Person Life Cycle.

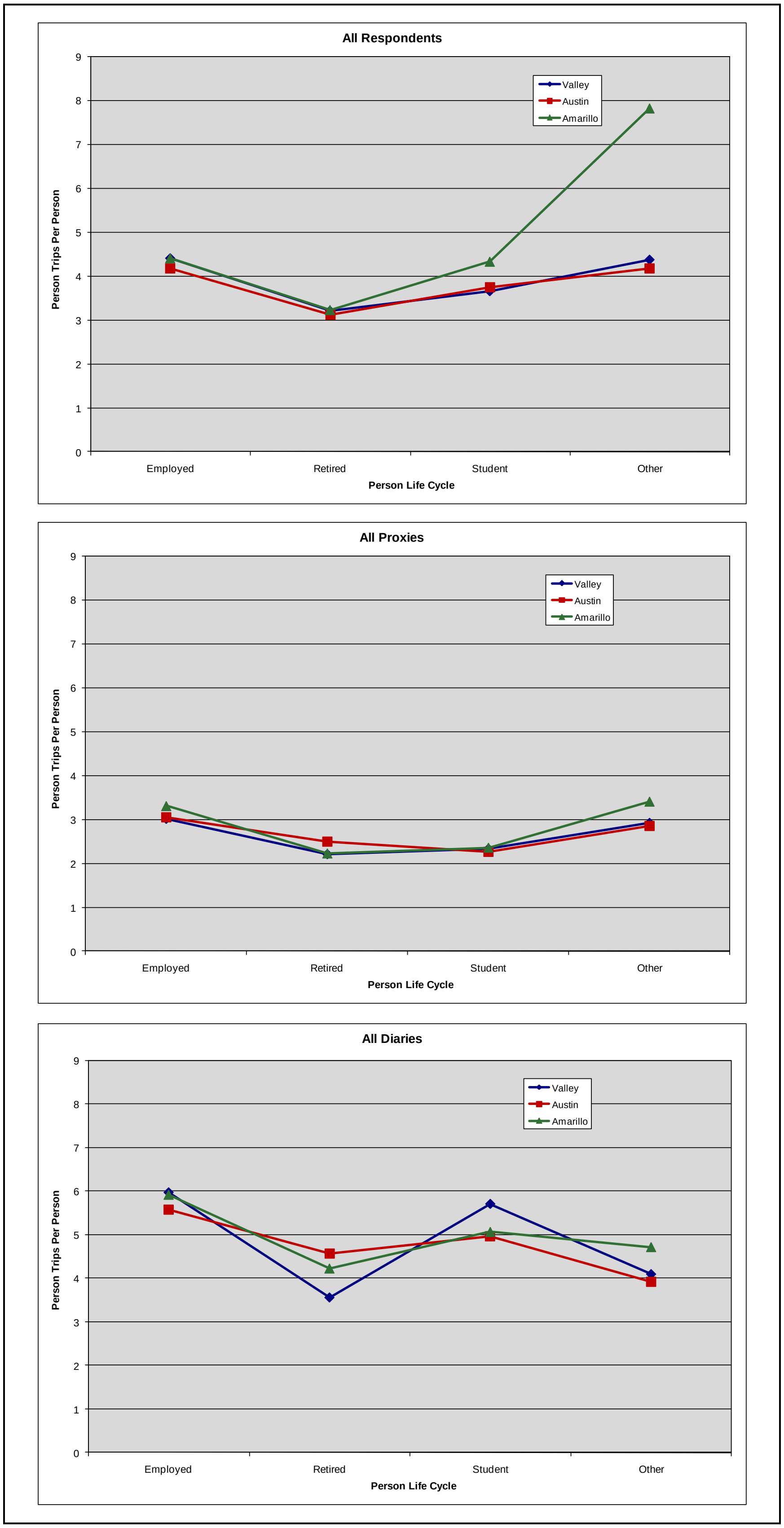


Figure 15. All Person Trip Rate by Person Life Cycle Comparisons between Areas.

Table 50. Comparison of Trip Rates by Method of Data Retrieval.

Area	Person Life Cycle	Measure	Trip Rates Being Compared		
			Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary
Valley	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	46%	26%	50%
	Retired	Statistically Different	Yes	No	Yes
		Absolute Difference	45%	10%	38%
	Student	Statistically Different	Yes	Yes	Yes
		Absolute Difference	57%	36%	59%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	50%	7%	29%
Austin	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	37%	25%	45%
	Retired	Statistically Different	Yes	Yes	Yes
		Absolute Difference	26%	32%	46%
	Student	Statistically Different	Yes	Yes	Yes
		Absolute Difference	66%	25%	55%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	46%	7%	27%
Amarillo	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	33%	26%	44%
	Retired	Statistically Different	Yes	Yes	Yes
		Absolute Difference	45%	23%	47%
	Student	Statistically Different	Yes	No	Yes
		Absolute Difference	84%	14%	53%
	Other	Statistically Different	Yes	Yes	Yes
		Absolute Difference	129%	66%	28%

Table 51. Criteria for Household Life Cycle Classifications.

Code	Household Life Cycle Criteria
1	No children < 18 yrs of age, No employed persons, 1 or more retired persons
2	No children < 18 yrs of age, No employed persons
3	No children < 18 yrs of age, 1 employed person
4	No children < 18 yrs of age, 2 or more employed persons
5	1 child < 18 yrs of age, No employed persons, 1 or more retired persons
6	1 child < 18 yrs of age, No employed persons
7	1 child < 18 yrs of age, 1 employed person
8	1 child < 18 yrs of age, 2 or more employed persons
9	2 or more children < 18 yrs of age, No employed persons, 1 or more retired persons
10	2 or more children < 18 yrs of age, No employed persons
11	2 or more children < 18 yrs of age, 1 employed person
12	2 or more children < 18 yrs of age, 2 or more employed persons

Table 52 presents the trip data by household life cycle for all persons for the three areas and the data retrieval method. It should be noted that in a number of cells very few or no observations were found for one or more of the areas. For this reason, some of the data are considered too sparse to provide a valid comparison. No comparison was made when the number of observations was less than five in one cell or the other. The standard rule of thumb is to have at least 30 observations to have acceptable results from a statistical perspective. For purposes of this research, a minimum of five observations was used to allow more comparisons.

Table 52. Trip Data by Household Life Cycle for All Persons.

HH Life Cycle	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	Observed	453	337	74	289	192	57	276	211	95
	Average	3.04	2.401	3.851	3.09	2.688	4.877	3.065	2.223	4.516
	Variance	5.3966	4.5682	7.9913	4.3252	4.4568	9.8596	5.1375	5.0311	10.5077
2	Observed	53	38	7	43	11	5	16	5	5
	Average	2.094	1.421	6.286	3.047	2.818	7	2.125	0.4	5.4
	Variance	4.2025	1.926	21.5714	3.9025	2.7636	21.5	6.25	0.8	10.3
3	Observed	287	323	174	264	201	61	197	201	82
	Average	3.498	2.17	5.017	3.595	2.483	4.803	3.457	2.234	4.89
	Variance	8.111	3.5144	17.2656	6.934	2.8109	10.394	6.7902	5.16	16.4446
4	Observed	300	543	215	204	290	113	194	332	76
	Average	3.877	2.575	4.781	3.529	2.755	5.009	3.593	2.672	5.039
	Variance	8.0683	3.6545	13.3772	4.5853	3.1544	14.116	6.854	5.2182	14.9451
5	Observed	10	22	11	5	8	3	11	26	0
	Average	3.6	2.273	5	3.6	2.25	5.333	4.091	3.038	0
	Variance	5.8222	4.2078	13.6	4.3	1.9286	5.3333	5.4909	7.8785	0
6	Observed	25	52	10	1	1	6	9	20	0
	Average	3.24	2.058	3.6	2	2	4	3.889	2.3	0
	Variance	5.2733	2.7221	8.9333	0	0	10	13.3611	2.9579	0
7	Observed	111	260	102	69	141	19	69	146	22
	Average	4.342	2.608	5.745	3.536	2.638	6.526	3.652	2.74	5.864
	Variance	9.3908	4.2084	22.0532	4.9288	3.3468	18.2632	9.4655	5.2697	13.6472
8	Observed	180	531	174	108	262	50	120	285	68
	Average	4.378	2.733	5.655	4.139	2.66	4.36	4.45	3.042	5.441
	Variance	8.5604	3.4378	12.6319	7.5974	2.8842	8.1127	9.4429	4.1672	15.8622
9	Observed	6	30	5	3	11	0	11	40	4
	Average	6	2.1	5.6	3.667	1.818	0	3.273	2.25	6.75
	Variance	40	8.7138	11.3	0.3333	0.9636	0	14.6182	2.6538	22.9167
10	Observed	61	211	25	12	44	12	9	30	0
	Average	4.246	2.592	4.52	4.333	2.114	5.5	4.333	2.833	0
	Variance	11.2219	3.3093	14.6767	18.4242	5.4054	11.7273	33.5	5.523	0
11	Observed	375	1441	270	129	472	118	175	646	74
	Average	4.448	3.032	5.693	4.729	2.847	5.042	5.754	3.438	4.797
	Variance	12.2266	4.8087	17.5743	10.8867	4.0404	16.6392	19.1519	6.169	12.931
12	Observed	373	1513	347	178	697	98	223	839	138
	Average	4.788	2.909	4.911	5.045	2.973	4.694	5.35	3.499	5.891
	Variance	10.8556	4.0454	11.9429	11.1166	3.5179	11.3899	15.8321	5.4365	16.9151

The first comparisons made were the trip rates for each area and household life cycle by type of data retrieval. For the Valley, 36 pairs of trip rates were compared, for Austin 28 pairs were compared, and for Amarillo 28 pairs were compared. The number compared varied depending on the number of observations in the cells. Of the 36 comparisons for the Valley, 27 (75 percent) were found to be statistically different. For Austin, 20 (71 percent) of the 28 comparisons were found to be statistically different and for Amarillo, 21 (75 percent) of the 28 comparisons were found to be statistically different. Figure 16 presents plots of the trip rates by type of data retrieval versus the household life cycle code for each area. These data indicate the type of data retrieval impacts the number of trips recorded in the survey.

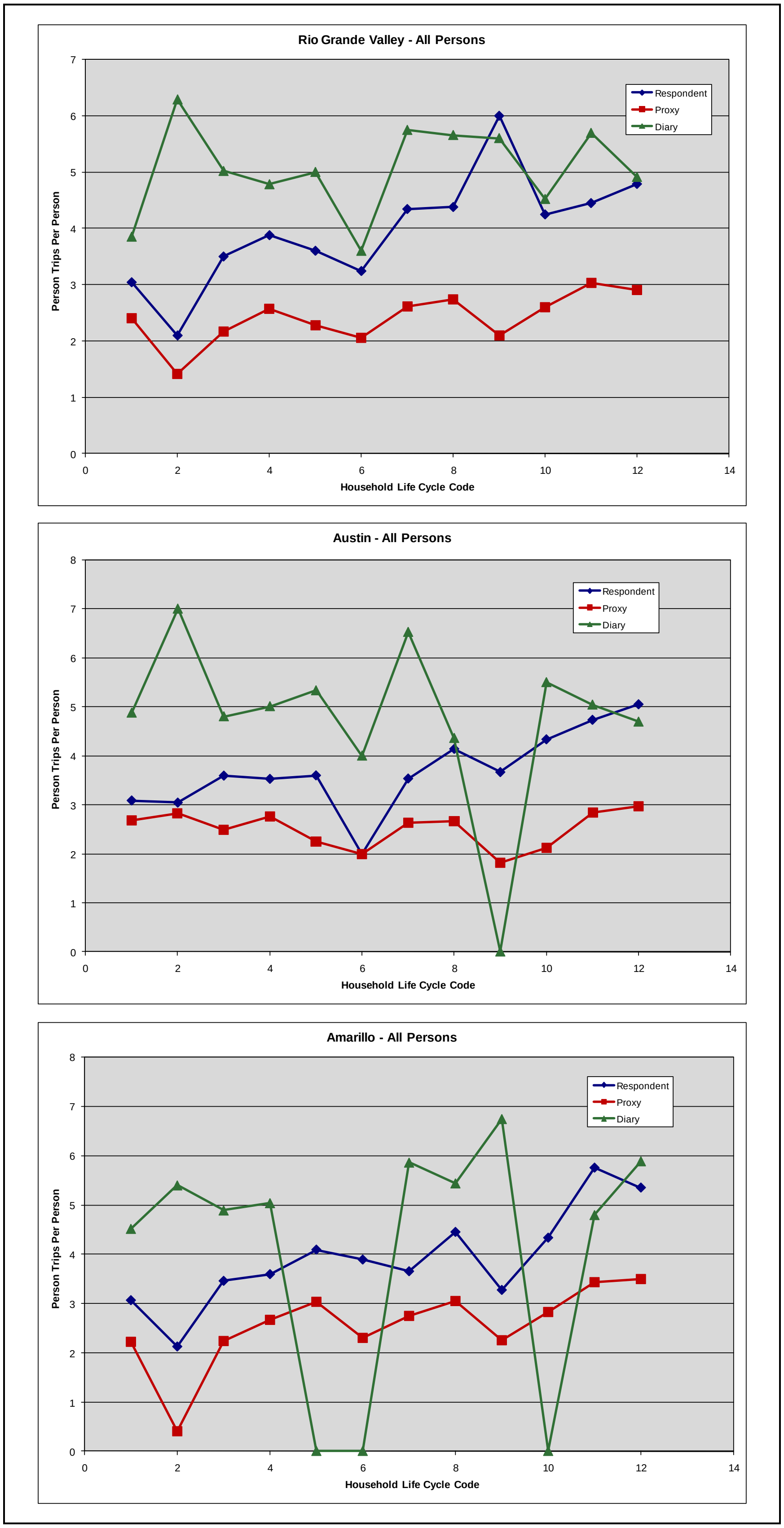


Figure 16. All Person Trip Rates by Household Life Cycle.

The second comparisons made were the trip rates by type of data retrieval method and household life cycle between the areas. This comparison evaluates the difference in the trip rates between the areas for similar data retrieval methods and household life cycle. Figure 17 presents plots of the trip rates for each data retrieval method comparing the rates between the areas. For the respondent method of retrieval, 32 pairs of trip rates were compared and 4 (13 percent) were found statistically different. For the proxy method, 34 pairs of trip rates were compared and 11 (32 percent) found statistically different. For the diary method, 26 pairs were compared and 3 (12 percent) were found statistically different. These data indicate strong similarities between the areas in terms of trip rates by life cycle for the same method of data retrieval.

In reviewing the data in Figure 17, the changes in trip rates between different household life cycles indicates for data retrieved from respondents the presence of children appears to indicate higher person trips per person. This trend is not as noticeable with the data retrieved from proxy or diary. It appears that both the presence of children and employed persons in the household tends to influence the number of trips per person. This is not conclusive but suggested from the data retrieved from respondents.

The final comparison was between trip rates stratified by household size and household income. For purposes of this research, households were stratified by five household size categories (i.e., 1, 2, 3, 4, and 5+) and five income ranges (i.e., 0 - $14,999; $15,000 - $34,999; $35,000 - $49,999; $50,000 - $74,999; and $75,000 plus). Average person trips per person were computed for each of the three methods of data retrieval. Table 53 presents these data with the number of observations and variances for each stratification cell. Several items should be noted. First, one person households could not have any proxy representation and the trip rates for those households are always zero. Second, a number of cells had very few observations and as a result, no comparisons were made for cells with fewer than five observations. Figures 18 through 20 present plots of the average trips per person for each household size group by household income group for each method of data retrieval within each area.

The first comparison made was to compare the trip rates by method of data retrieval within each cell of the two way stratification for each area. Of the possible 75 comparisons for each area, 64 were valid for the Valley, 60 were valid for Austin, and 60 were valid for Amarillo. For the Valley, 51 (80 percent) were found statistically different. For Austin, 36 (60 percent) were found statistically different and for Amarillo, 36 (60 percent) were found statistically different. These results indicate the method of data retrieval influenced the number of trips recorded in the survey. Table 54 presents the frequency distribution of absolute differences in the trip rates compared. The majority of differences were greater than 25 percent for all three areas.

Table 53. Trip Data by Household Income and Size Groups for All Persons.

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	1	Observed	101	0	12	69	0	8	39	0	8
		Average	2.782	0	5.833	2.71	0	3.875	2.154	0	6.5
		Variance	5.5921	0	12.1515	3.5324	0	18.9821	3.4494	0	9.1429
	2	Observed	148	138	28	45	45	2	55	55	12
		Average	2.345	1.978	5.321	3.156	2.6	7.5	2.309	2.091	6.083
		Variance	3.8056	2.9411	15.4114	4.2707	4.3818	4.5	3.8471	3.5657	19.1742
	3	Observed	133	257	84	14	28	12	45	90	3
		Average	3.316	2.261	5.131	3.286	3.143	4.583	3.467	2.311	5
		Variance	5.7329	2.756	20.1393	9.7582	4.2011	10.447	14.7091	6.2841	19
	4	Observed	131	370	83	7	21	0	44	132	4
		Average	3.412	2.303	5.145	5.143	2.524	0	3.955	2.212	1.75
		Variance	6.7057	3.1385	14.5154	15.8095	2.2619	0	12.8816	5.2982	5.5833
	5 +	Observed	173	839	77	17	80	6	29	143	16
		Average	3.41	2.353	5.935	4.118	2.188	5.333	4.828	2.79	4.375
		Variance	8.8131	2.916	14.6405	12.4853	2.4834	15.8667	16.4335	3.7867	18.65
2	1	Observed	52	0	17	87	0	12	48	0	17
		Average	4.058	0	7.412	3.437	0	6.583	3.396	0	5.294
		Variance	5.9378	0	23.8824	4.4349	0	14.9924	4.1166	0	9.7206
	2	Observed	167	159	64	141	142	37	117	117	34
		Average	3.431	2.686	4.703	3.291	2.775	5.216	3.154	2.744	4.471
		Variance	10.4275	4.4701	13.0375	7.3791	3.5942	14.3408	6.3899	7.0889	11.2264
	3	Observed	79	155	93	64	128	15	73	146	24
		Average	3.329	2.4	4.796	3.094	2.297	7.133	3.658	2.336	3.917
		Variance	3.9159	2.813	15.1209	4.3085	2.2104	12.981	8.3116	4.5831	15.2971
	4	Observed	158	442	72	47	141	8	54	162	24
		Average	3.759	2.588	5.347	3.872	2.433	8.25	4.037	2.815	4
		Variance	9.9036	4.0341	22.1735	9.2442	2.8044	13.3571	10.0741	3.0462	13.7391
	5 +	Observed	196	870	131	46	225	23	78	369	18
		Average	4.796	2.832	4.771	4.043	2.507	2.652	5.974	3.577	4.556
		Variance	13.9274	4.9476	14.3625	8.4425	4.1171	3.2372	22.1032	7.6034	3.7908
3	1	Observed	31	0	10	49	0	9	12	0	6
		Average	3.419	0	5.8	3.694	0	6.667	3.833	0	4.833
		Variance	4.1849	0	12.6222	2.8835	0	4.25	4.3333	0	13.3667
	2	Observed	92	74	56	89	89	38	53	53	32
		Average	3.054	2.297	4.982	3.146	2.674	5.053	3.094	2.83	5.156
		Variance	5.4586	3.2255	19.1088	4.5352	3.7222	11.889	3.9717	3.836	14.0716
	3	Observed	51	90	75	48	96	12	49	98	18
		Average	4.725	3.156	5.16	3.438	2.344	5.667	4.143	2.949	4.556
		Variance	8.7631	5.9081	15.947	5.4854	1.9543	10.9697	10.875	6.2139	13.5556
	4	Observed	99	293	72	50	150	20	47	141	24
		Average	4.97	3.365	5.639	3.94	2.88	3.15	3.426	2.957	5.708
		Variance	9.0705	4.7189	12.0368	8.0984	3.0325	4.3447	7.8585	3.8696	9.8678
	5 +	Observed	98	454	112	34	157	8	30	126	15
		Average	5.133	3.205	4.366	4.588	2.758	6.75	5.067	3.294	6.467
		Variance	9.1059	4.3707	12.5585	9.9465	3.7487	13.0714	17.5816	5.9051	5.4095

Table 53. Trip Data by Household Income and Size Groups for All Persons (continued).

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
4	1	Observed	26	0	7	21	0	5	25	0	4
		Average	4.346	0	8.857	3.571	0	4.4	4.24	0	5.75
		Variance	5.1954	0	30.1429	5.6571	0	3.3	5.94	0	14.25
	2	Observed	66	57	43	89	87	22	62	62	34
		Average	4.182	3.14	4.674	3.472	2.908	5.545	3.79	2.306	5.382
		Variance	6.6741	5.1228	10.9391	4.5248	3.5496	22.0693	6.234	2.8718	15.0918
	3	Observed	43	68	60	36	72	30	57	114	24
		Average	4.791	2.956	5.567	3.556	2.819	4.733	3.877	3.351	4.708
		Variance	10.6932	3.4458	11.6734	4.4825	3.8683	8.2713	6.2882	7.0439	20.2156
	4	Observed	49	139	72	35	106	23	71	213	28
		Average	4.082	2.921	4.778	3.914	2.802	5.087	4.718	3.141	5.786
		Variance	5.7015	3.0299	11.5274	4.4336	1.8747	10.6285	11.6338	4.782	25.582
	5 +	Observed	46	210	74	33	157	30	39	170	47
		Average	5.826	3.59	6.149	5.515	3.185	4.9	5.897	3.124	4.809
		Variance	11.8357	5.4009	16.0461	14.3826	3.4977	8.0931	23.4629	4.6888	13.0278
5	1	Observed	12	0	0	16	0	3	29	0	7
		Average	3.833	0	0	4.312	0	4.667	4.517	0	6
		Variance	6.8788	0	0	5.0292	0	4.3333	8.6158	0	7.3333
	2	Observed	98	87	49	90	88	30	78	78	54
		Average	4.01	3.034	4.918	4.044	3.205	4.933	3.641	2.833	4.722
		Variance	8.0721	4.7546	13.1182	6.1553	3.36	10.754	6.1292	3.855	13.9025
	3	Observed	45	89	40	75	150	42	67	134	33
		Average	4.689	3.079	5.675	4.467	2.853	4.095	4.09	3.067	5.97
		Variance	9.9919	4.9142	13.6096	8.5495	3.6965	6.7712	7.8706	4.6797	17.0303
	4	Observed	74	218	40	65	195	84	70	210	44
		Average	5.676	3.147	4.825	5.631	3.308	4.536	6.129	3.948	6
		Variance	14.2221	4.7525	8.6609	13.3928	4.6368	10.7577	19.9977	6.2604	17.9535
	5 +	Observed	66	292	43	38	173	63	39	168	34
		Average	5.273	3.024	4.186	5.816	2.884	5.302	6.769	3.702	6.706
		Variance	15.8014	4.9582	7.6788	12.2624	4.5563	25.5366	12.2348	5.6833	19.1836

Table 54. Frequency Distribution of Trip Rate Differences by Area.

Absolute Percent Difference	Number of Trip Rate Pairs		
	Valley	Austin	Amarillo
< 10%	3	5	6
10% to 25%	9	11	13
26% to 50%	36	27	26
50% or Greater	16	17	15
Totals	**64**	**60**	**60**

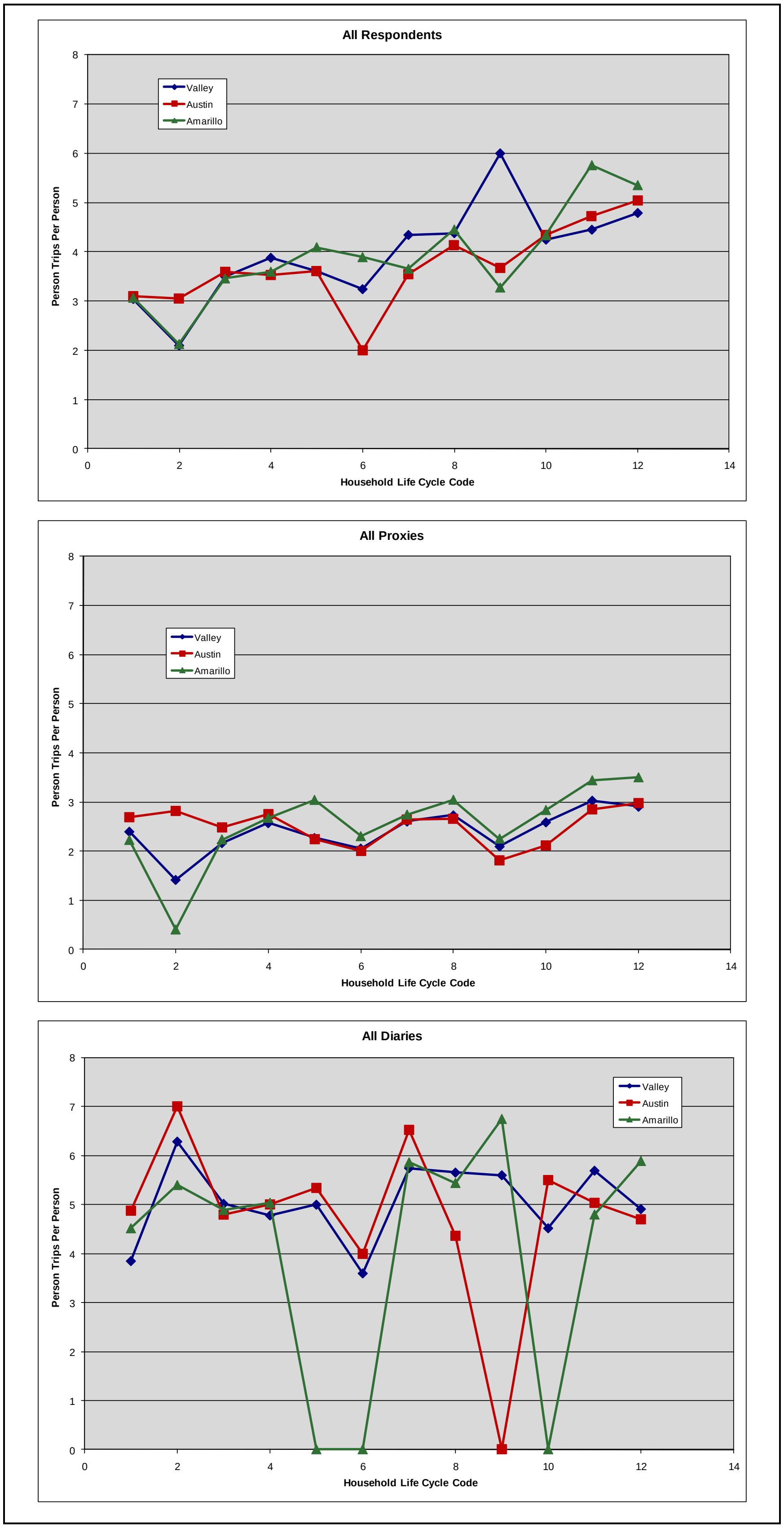


Figure 17. All Person Trip Rates by Household Life Cycle Comparisons between Areas.

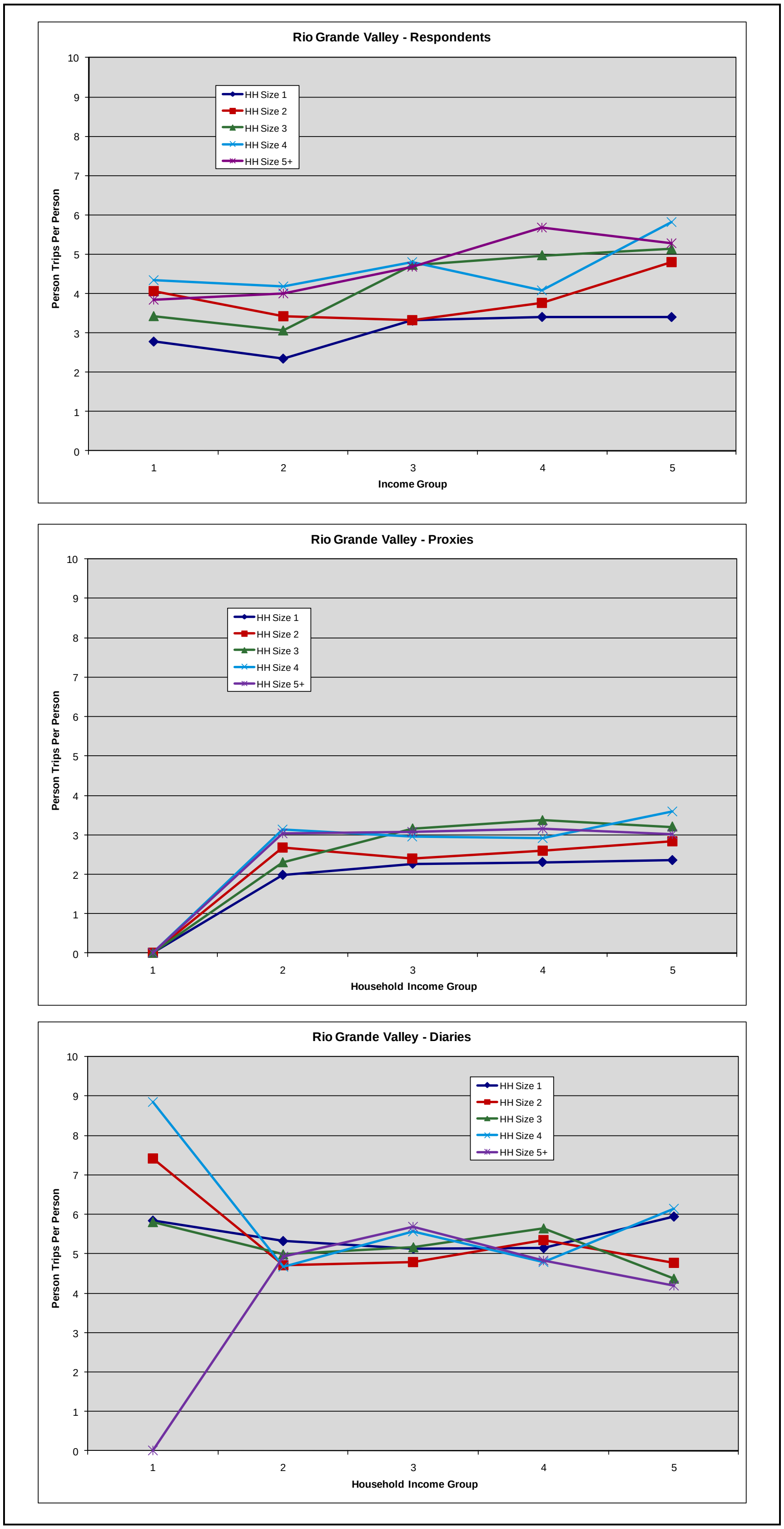


Figure 18. Rio Grande Valley Person Trip Rates by Household Size and Income.

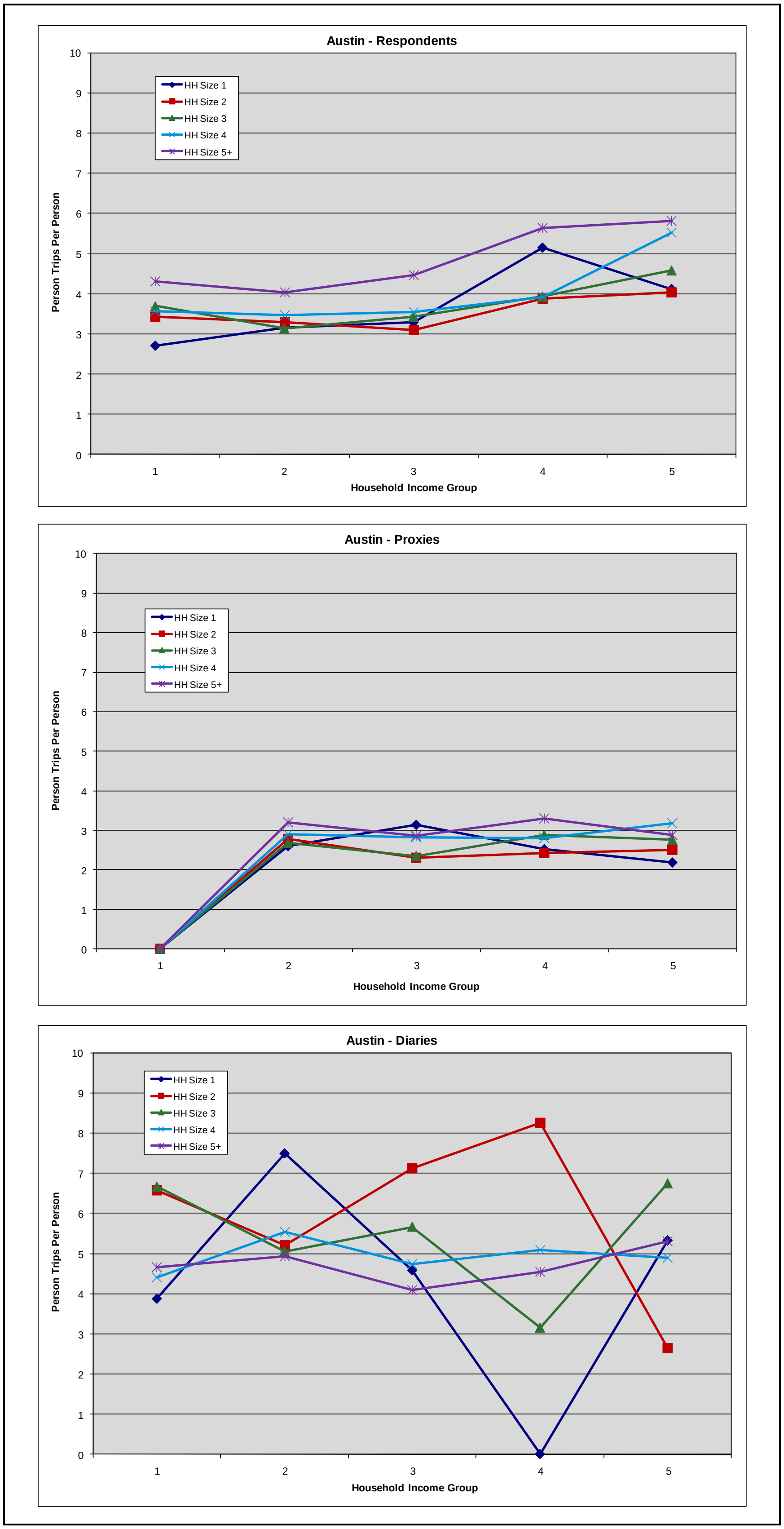


Figure 19. Austin Person Trip Rates by Household Size and Income.

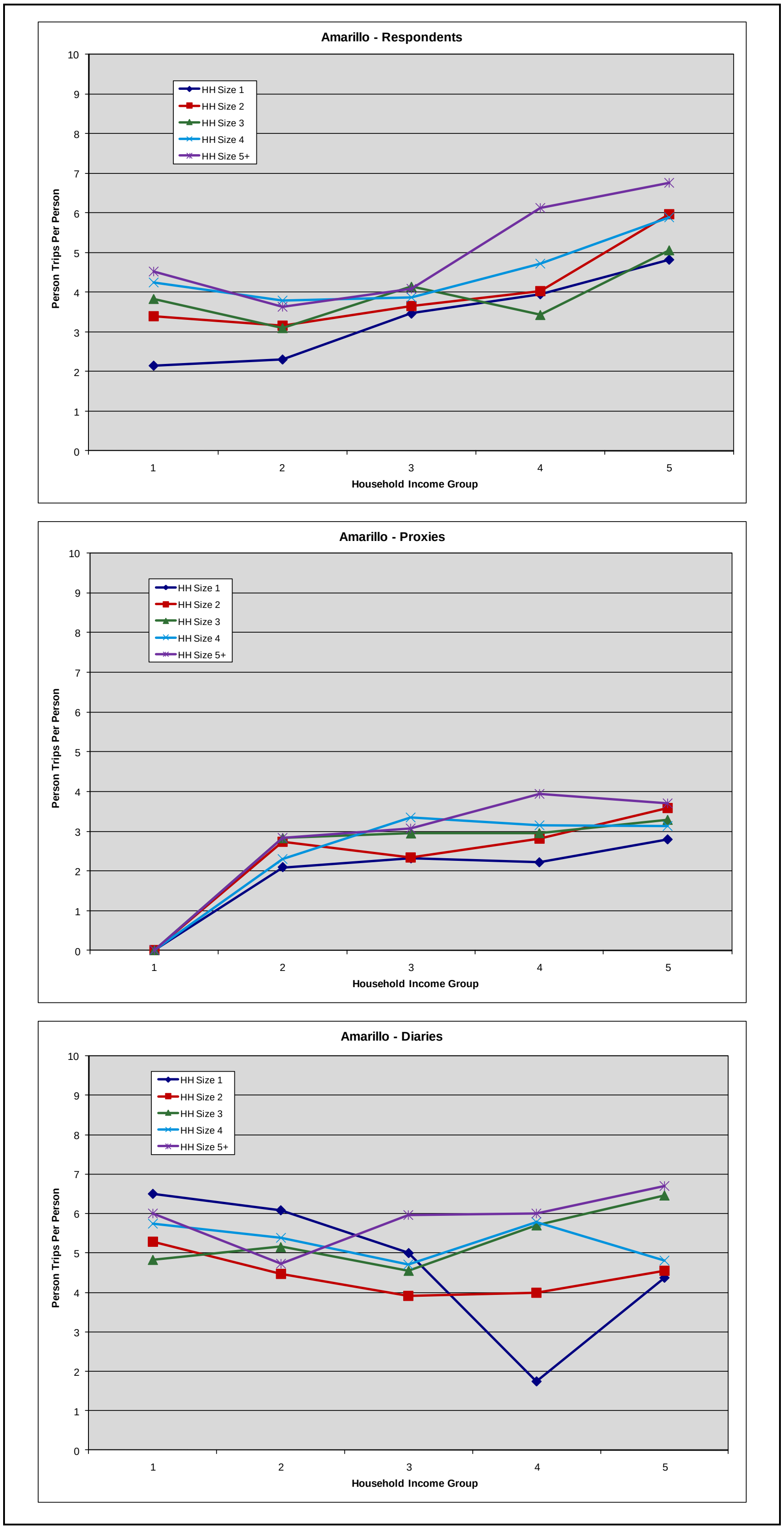


Figure 20. Amarillo Person Trip Rates by Household Size and Income.

Trip rates by type of data retrieval were compared between the three areas. This comparison was done to determine if there were any similarities in the trip rates between the areas for each type of data retrieval. Again, trip rates with fewer than five observations were not compared. For the respondent data retrieval, a total of 75 pairs of trip rates were compared. Only nine (12 percent) were found to be significantly different between the three areas. For the proxy data retrieval, a total of 60 pairs of trip rates were compared. The number found statistically different was 18 (30 percent). For the diary method of retrieval, a total of 63 pairs of trip rates were compared. Of those compared, the number found statistically different was 14 (22 percent). It should be noted that while the majority of trip rates were found not statistically different (i.e., the difference could be attributed to chance), the difference in many of the trip rates was substantial. Table 55 present the frequency distribution of the absolute percent difference between the trip rates compared for each type of data retrieval. Even though the differences may be attributed to random variation, the magnitude of the differences is substantial in many cases.

Table 55. Frequency Distribution of Trip Rate Differences by Data Retrieval Type.

Absolute Percent Difference	Number of Trip Rate Pairs		
	Respondent	Proxy	Diary
< 10%	36	29	18
10% to 25%	27	25	23
26% to 50%	12	6	16
50% or Greater	0	0	6
Totals	**75**	**60**	**63**

The previous discussions have examined trip rates by method of data collection stratified by a number of variables. The data indicate a potential bias in the results due to the method of data retrieval. In order to examine the impact of this bias, it is necessary to look at the results by trip purpose. Rates are developed by trip purpose for application in travel demand models. If consideration is given to adjusting rates to account for the possible bias due to data retrieval method, it is necessary to examine the differences in these trip rates by method of data collection for trip purposes home based work (HBW), home based non-work (HBNW) and non-home based (NHB). If adjustments are felt necessary, this examination will allow the adjustments to be made more accurately for the travel demand models.

Table 56 presents the trip data for each area by trip purpose for all persons. The HBW trip rates are similar with the rates for respondents slightly higher for all three areas. While the HBW rates for persons represented by proxy are lower for all three areas, these data are misleading. Proxy reporting was permitted for all minors and since these persons do not make HBW trips, the lower average for persons represented by proxy is misleading since it includes all minors that made no HBW trips. The trip rates for HBNW and NHB were lower for persons represented by proxy for all three areas. Figure 21 presents plots of the trip rates between areas for each trip purpose. As can be seen the trip rates are very similar between the three areas and follow the same pattern between the three types of data retrieval. The highest HBNW and NHB trip rates are for persons that returned completed diaries. The largest variation in the magnitude of the trip rates are shown for NHB trips. Since these results can be misleading due to the inclusion of minors being represented by proxies, the next evaluation by age cohort should reveal differences more accurately.

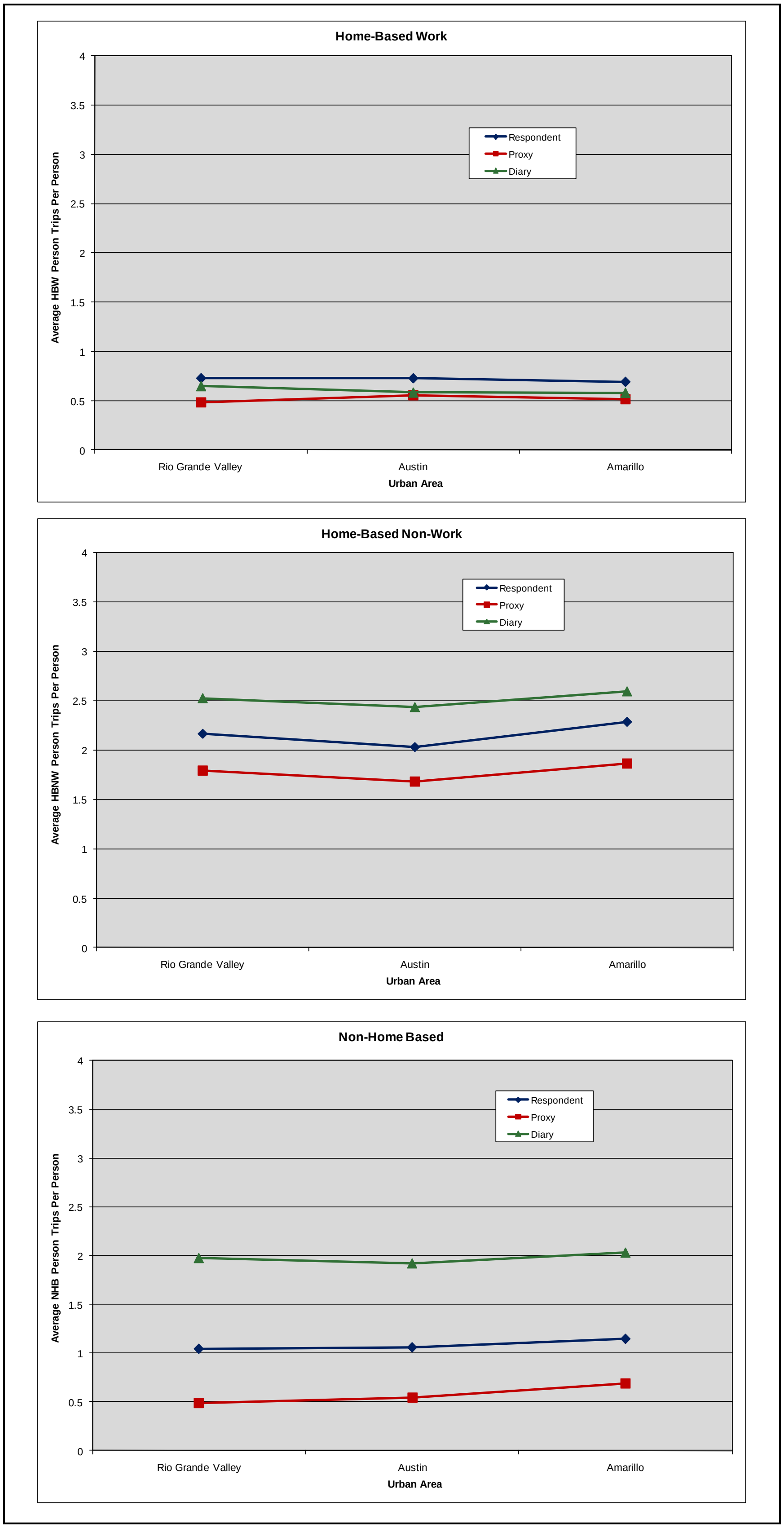


Figure 21. Trip Rates by Purpose by Area.

Table 56. Trip Data by Trip Purpose and Method of Data Retrieval.

Trip Purpose	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
HBW	Obs	2,234	5,301	1,414	1,305	2,330	542	1,310	2,781	564
	Average	0.727	0.484	0.646	0.726	0.553	0.583	0.691	0.517	0.580
	Variance	1.0710	0.8268	1.1035	0.9964	0.8562	1.0495	1.0831	0.8476	0.9723
HBNW	Obs	2,234	5,301	1,414	1,305	2,330	542	1,310	2,781	564
	Average	2.164	1.788	2.523	2.027	1.681	2.432	2.287	1.863	2.592
	Variance	4.5150	2.6450	5.0437	3.5139	2.2534	4.2014	5.9099	3.0554	4.8387
NHB	Obs	2,234	5,301	1,414	1,305	2,330	542	1,310	2,781	564
	Average	1.044	0.487	1.975	1.059	0.540	1.921	1.144	0.687	2.030
	Variance	3.2542	0.9759	6.3815	2.8056	1.0480	6.3320	3.1253	1.4546	6.1714

Tables 57 through 59 present the average person trip rates by trip purpose stratified by age cohort for the three areas. When stratified by age cohort, the data present a different picture, especially for HBW trips. As mentioned before, nearly everyone aged 14 and younger was represented by a proxy. There were a number of individuals that completed diaries in that age group but it is suspected that these diaries were actually completed by adults for the minors. Just reviewing the average HBW trip rates for the age groups above 14, the majority (32 out of a possible 42, i.e.,76 percent) of the proxy HBW trip rates were higher than the respondents and most were higher than those reported by diary (24 out of a possible 42, i.e., 57 percent). It is suspected that when a person is represented by a proxy, the proxy knows the person went to work and returned home but in many cases probably did not know about other trips made by the person. This would be expected to result in a higher HBW trip rate for persons represented by proxy than for persons that were interviewed or completed the diary. This does appear to be the case. Conversely, the opposite would be expected for HBNW and NHB trips. For those trips, it is expected the persons represented by a proxy would have lower trip rates that those for respondents or persons that completed a diary. The data support this. Not including the age group 14 and under, the proxy trip rates were the lowest in 41 out of 42 cases (98 percent) for HBNW trips and in every case for NHB trips. For HBNW trips, the rates for persons that completed the diary were the highest in the majority of cases (25 out of 42 cases, i.e., 60 percent). For NHB trips, the diary rates were the highest in 41 out of 42 cases (98 percent).

The trip rates by method of retrieval were next compared statistically for each area being analyzed. This was not done for the age group 14 and under since nearly all of those individuals were represented by proxy. For each area and trip purpose a total of 42 pairs of trip rates were compared to determine if the different was statistically significant or could be attributed to chance. Table 60 presents the results of this comparison. Out of 42 pairs of trip rates compared for each area and trip purpose, the method of data retrieval obviously impacts the results for all trip purposes. It is of note, however, that the HBNW and NHB trip rates were significantly higher in terms of the number of pairs found to be statistically different. This again supports the theory that persons represented by proxy are most likely to have a high number of under reported trips for HBNW and NHB trip purposes. Figures 22 through 24 present plots of the trip rates by purpose and age cohort for each method of retrieval for each area.

The trip rates were next compared between the areas of study by trip purpose for each method of data retrieval. The purpose was to determine if trip rates by purpose are similar between areas when stratified by age cohort. For each method of data retrieval, a total of 42 pairs of trip rates were compared statistically. Table 61 presents the results of this comparison.

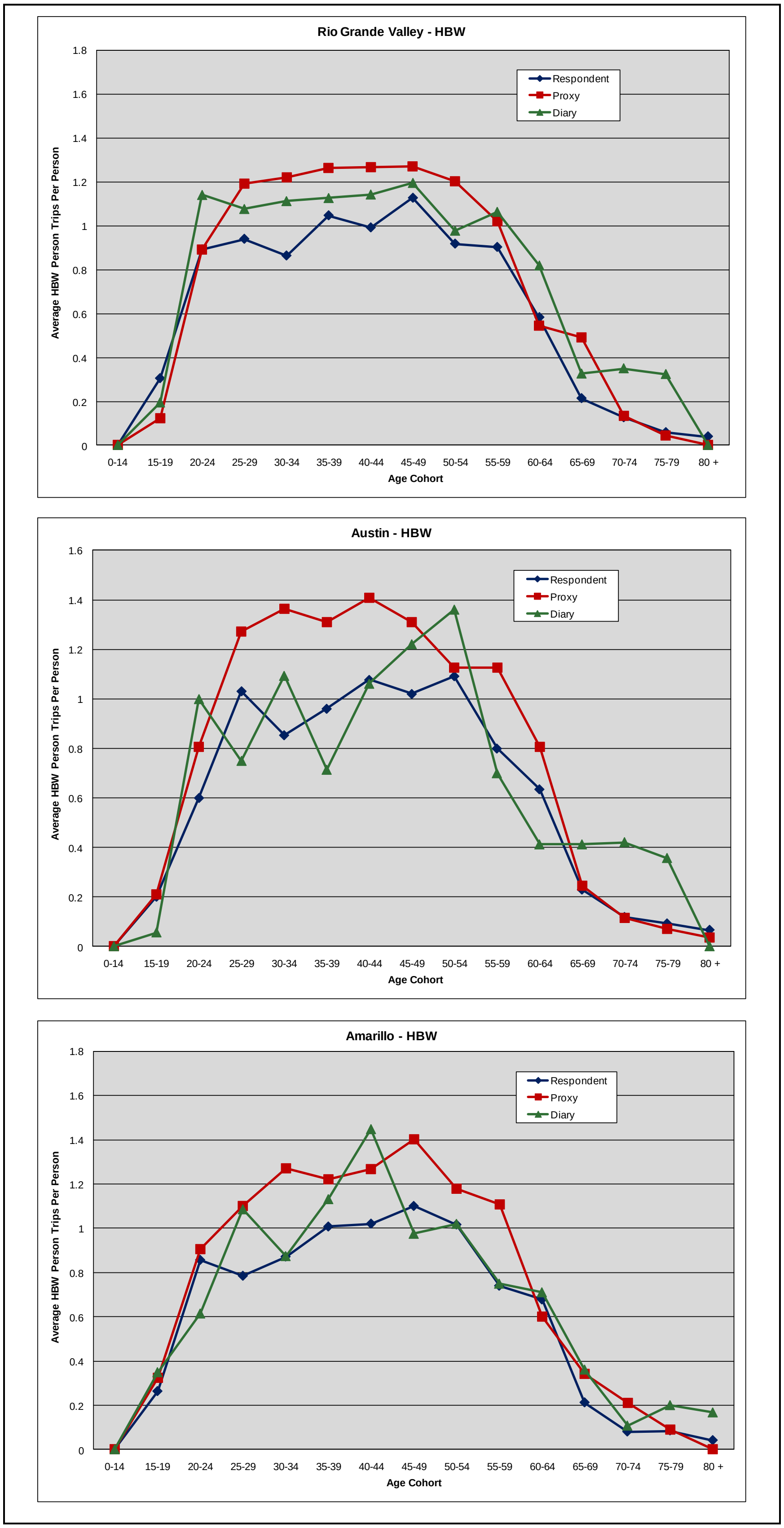


Figure 22. HBW Trips Rates by Age Cohort and Urban Area.

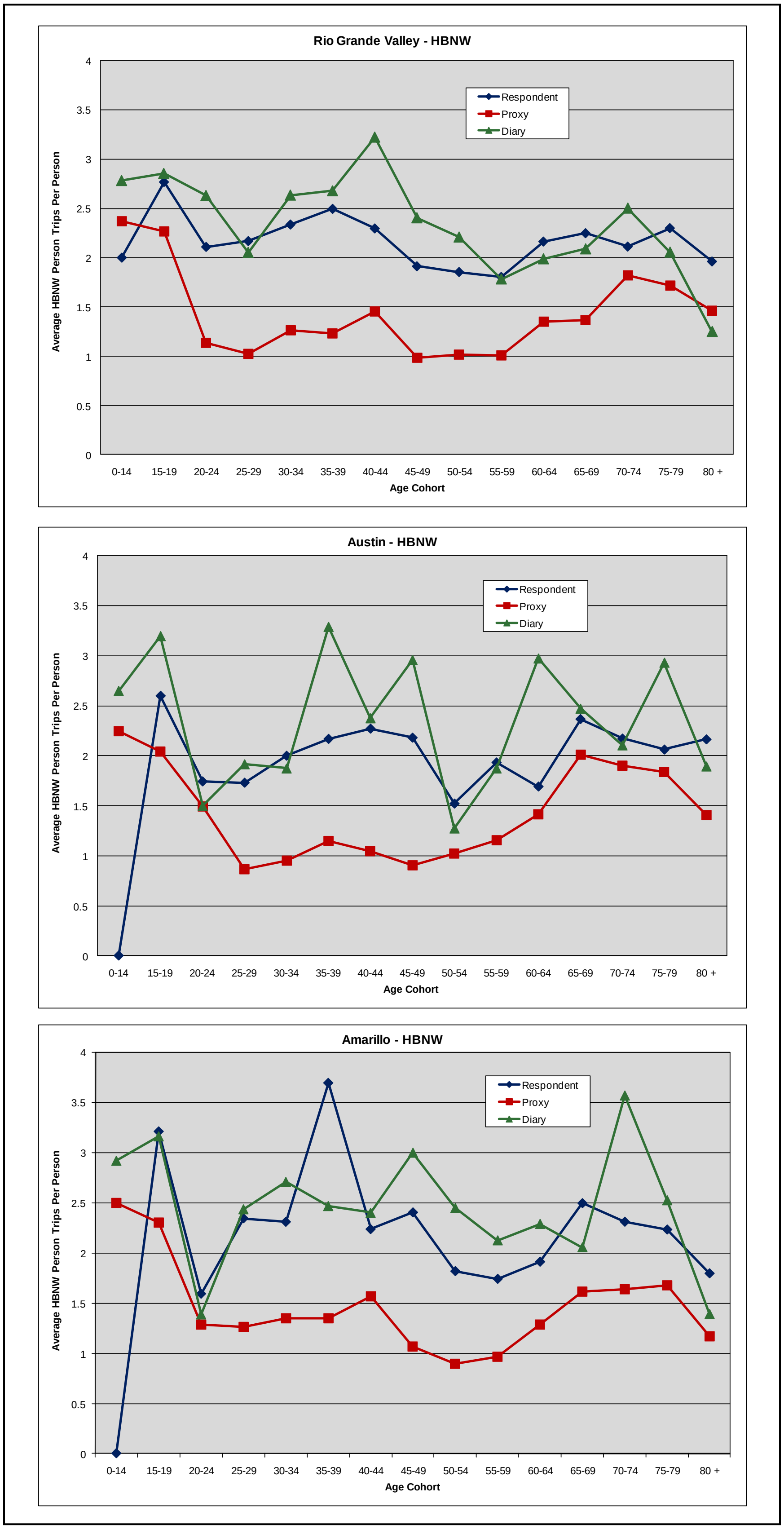


Figure 23. HBNW Trip Rates by Age Cohort and Urban Area.

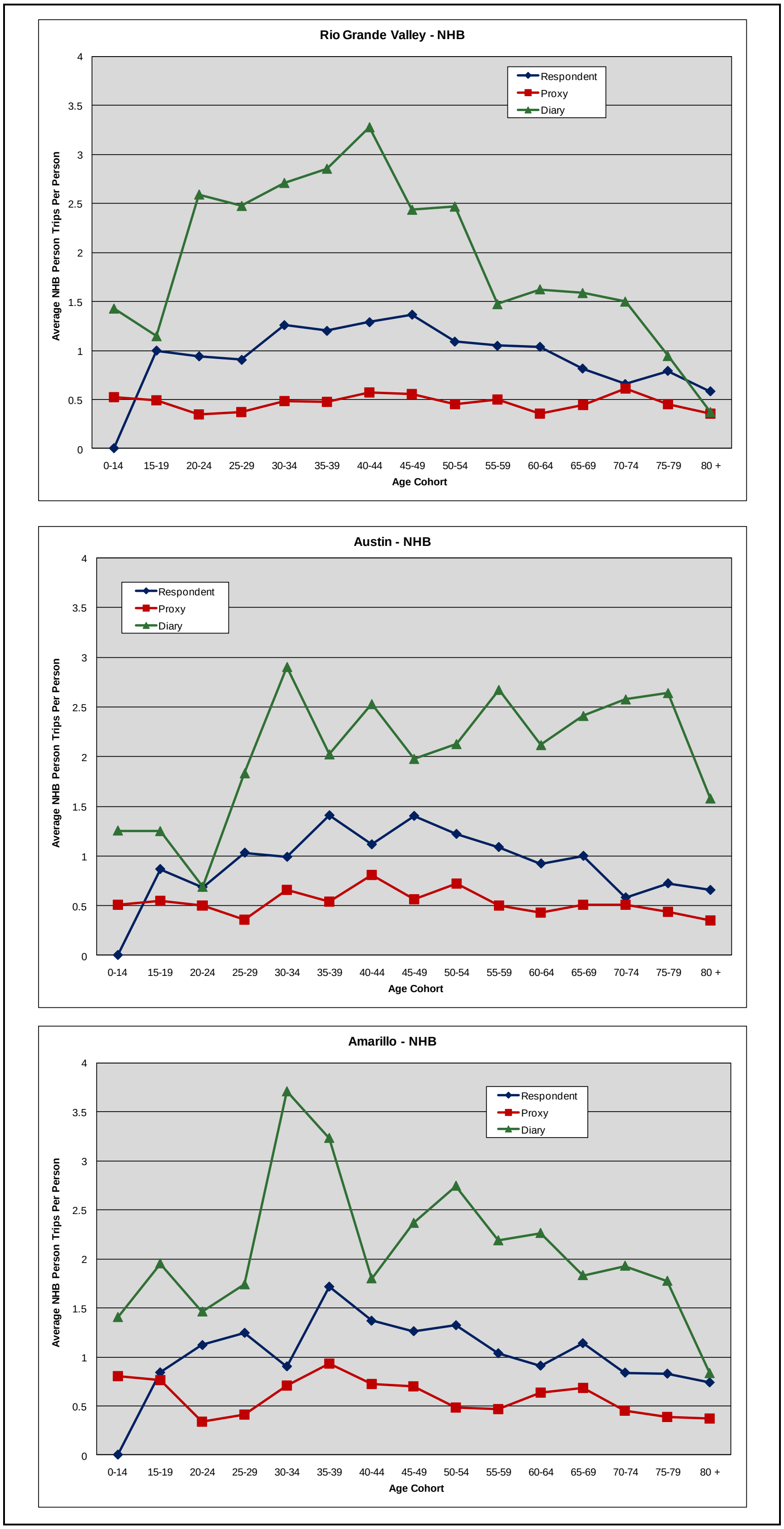


Figure 24. NHB Trip Rates by Age Cohort and Urban Area.

The results are surprising with very few of the trip rates found to be statistically different between the three urban areas. The indication is that trips per person when stratified by age cohort are very similar between urban areas for each trip purpose as long as the method of data retrieval is held constant. Figures 25 through 27 present plots of these trip rates and while there appear to be some differences, the majority of trip rates were very similar for each trip purpose within each method of data retrieval.

Table 57. HBW Trip Data by Age Cohort for All Persons.

Age Cohort	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
0 to 14	Observed	2	2105	378	0	872	125	0	1068	111
	Average	0	0.001	0	0	0	0	0	0	0
	Variance	0	0.0019	0	0	0	0	0	0	0
15 to 19	Observed	56	530	108	15	205	36	19	301	43
	Average	0.304	0.123	0.194	0.2	0.21	0.056	0.263	0.326	0.349
	Variance	0.4698	0.2288	0.3824	0.3143	0.3528	0.1111	0.3158	0.5336	0.5183
20 to 24	Observed	119	318	78	35	93	16	49	129	13
	Average	0.891	0.89	1.141	0.6	0.806	1	0.857	0.907	0.615
	Variance	1.149	1.1519	1.3695	0.7765	0.9839	2.1333	1.25	1.1788	0.7564
25 to 29	Observed	179	259	78	63	92	24	93	110	23
	Average	0.939	1.193	1.077	1.032	1.272	0.75	0.785	1.1	1.087
	Variance	1.3164	1.0556	1.3447	0.999	0.9253	0.8043	1.0837	1.2468	1.2648
30 to 34	Observed	226	247	106	103	121	32	94	118	24
	Average	0.863	1.219	1.113	0.854	1.364	1.094	0.872	1.271	0.875
	Variance	1.1322	1.1715	1.1109	0.8707	1.2333	1.12	1.0803	1.0711	0.8967
35 to 39	Observed	218	240	102	154	123	42	118	123	30
	Average	1.046	1.263	1.127	0.961	1.309	0.714	1.008	1.22	1.133
	Variance	1.2698	1.0647	1.4588	1.1619	1.0185	0.6969	1.3418	0.9924	1.154
40 to 44	Observed	223	251	91	129	142	32	140	161	40
	Average	0.991	1.267	1.143	1.078	1.408	1.062	1.021	1.267	1.45
	Variance	1.2251	1.2365	1.6349	1.0564	1.0802	1.5444	1.2441	0.9845	2.2538
45 to 49	Observed	182	247	92	144	139	45	129	164	41
	Average	1.126	1.271	1.196	1.021	1.309	1.222	1.101	1.402	0.976
	Variance	1.0834	1.2635	1.4558	1.0555	0.9978	1.8586	1.4507	1.3708	1.1244
50 to 54	Observed	206	236	92	140	120	47	120	122	47
	Average	0.917	1.203	0.978	1.093	1.125	1.362	1.017	1.18	1.021
	Variance	1.0907	1.4648	1.1863	1.2647	0.9674	1.975	1.3275	1.3391	1.0648
55 to 59	Observed	163	201	78	90	103	40	104	111	32
	Average	0.902	1.02	1.064	0.8	1.126	0.7	0.74	1.108	0.75
	Variance	1.2743	1.0796	1.4374	1.0831	1.3271	0.9333	1.1455	0.97	1.2903
60 to 64	Observed	153	145	72	104	77	34	90	90	38
	Average	0.582	0.545	0.819	0.635	0.805	0.412	0.678	0.6	0.711
	Variance	0.8897	0.9025	1.4458	1.0691	0.9484	0.795	1.1197	0.8719	0.8058
65 to 69	Observed	141	163	46	109	77	17	99	76	36
	Average	0.213	0.491	0.326	0.229	0.247	0.412	0.212	0.342	0.361
	Variance	0.4258	0.9305	0.4913	0.4562	0.3988	0.6324	0.4341	0.7614	0.9802
70 to 74	Observed	143	135	40	93	69	19	100	71	28
	Average	0.126	0.133	0.35	0.118	0.116	0.421	0.08	0.211	0.107
	Variance	0.2798	0.2507	1.0538	0.2141	0.3393	0.7018	0.0945	0.369	0.3214
75 to 79	Observed	120	89	37	65	43	14	82	65	40
	Average	0.058	0.045	0.324	0.092	0.07	0.357	0.085	0.092	0.2
	Variance	0.2067	0.0889	0.7252	0.1788	0.1141	1.1703	0.1531	0.3038	0.3692
80 Plus	Observed	103	135	16	61	54	19	73	72	18
	Average	0.039	0	0	0.066	0.037	0	0.041	0	0.167
	Variance	0.0769	0	0	0.129	0.0741	0	0.0677	0	0.2647

Table 58. HBNW Trip Data by Age Cohort for All Persons.

Age Cohort	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
0 to 14	Observed	2	2105	378	0	872	125	0	1068	111
	Average	2	2.368	2.78	0	2.243	2.648	0	2.496	2.919
	Variance	0	1.9827	2.6334	0	1.6653	2.4396	0	2.6345	1.8752
15 to 19	Observed	56	530	108	15	205	36	19	301	43
	Average	2.768	2.262	2.852	2.6	2.044	3.194	3.211	2.306	3.163
	Variance	3.3088	1.2865	4.1648	1.4	1.3265	3.0754	6.1754	2.0996	3.7586
20 to 24	Observed	119	318	78	35	93	16	49	129	13
	Average	2.109	1.135	2.628	1.743	1.495	1.5	1.592	1.287	1.385
	Variance	4.6575	1.9028	4.3145	3.5496	2.144	2.4	3.0799	2.628	2.4231
25 to 29	Observed	179	259	78	63	92	24	93	110	23
	Average	2.168	1.027	2.051	1.73	0.87	1.917	2.344	1.264	2.435
	Variance	4.1291	2.1892	5.0103	2.8776	2.0707	3.558	4.7281	2.8014	7.8933
30 to 34	Observed	226	247	106	103	121	32	94	118	24
	Average	2.336	1.259	2.632	2	0.95	1.875	2.309	1.347	2.708
	Variance	5.282	3.5098	7.1681	3.9608	2.5309	3.6613	6.4522	3.4082	10.5634
35 to 39	Observed	218	240	102	154	123	42	118	123	30
	Average	2.495	1.233	2.676	2.169	1.146	3.286	3.695	1.35	2.467
	Variance	6.7857	3.5269	9.0923	4.9778	1.9784	6.0627	13.3762	3.3604	4.8782
40 to 44	Observed	223	251	91	129	142	32	140	161	40
	Average	2.296	1.45	3.22	2.271	1.049	2.375	2.236	1.571	2.4
	Variance	5.867	3.5765	10.4623	6.1524	2.3593	6.5645	7.1599	3.6714	6.1949
45 to 49	Observed	182	247	92	144	139	45	129	164	41
	Average	1.912	0.98	2.402	2.181	0.906	2.956	2.403	1.067	3
	Variance	4.4121	2.4752	5.1881	4.2049	2.5926	6.5434	7.8206	2.7501	7.9
50 to 54	Observed	206	236	92	140	120	47	120	122	47
	Average	1.854	1.017	2.207	1.521	1.025	1.277	1.817	0.893	2.447
	Variance	3.9592	3.1316	6.0338	2.8413	1.9742	2.6392	4.5039	2.2448	5.4699
55 to 59	Observed	163	201	78	90	103	40	104	111	32
	Average	1.804	1.005	1.782	1.933	1.155	1.875	1.74	0.964	2.125
	Variance	4.381	1.925	5.1337	3.3213	1.8776	3.5481	3.8251	2.5987	5.5968
60 to 64	Observed	153	145	72	104	77	34	90	90	38
	Average	2.163	1.352	1.986	1.692	1.416	2.971	1.911	1.289	2.289
	Variance	3.8613	3.0768	3.197	2.1374	2.5882	5.2415	4.7111	2.5223	6.4815
65 to 69	Observed	141	163	46	109	77	17	99	76	36
	Average	2.248	1.362	2.087	2.367	2.013	2.471	2.495	1.618	2.056
	Variance	3.9022	2.3311	3.6367	2.5122	2.9867	3.8897	4.0484	3.1725	4.3397
70 to 74	Observed	143	135	40	93	69	19	100	71	28
	Average	2.112	1.822	2.5	2.172	1.899	2.105	2.31	1.634	3.571
	Variance	2.9029	3.2517	4.359	2.0136	1.916	5.5439	4.0544	3.1497	3.8836
75 to 79	Observed	120	89	37	65	43	14	82	65	40
	Average	2.3	1.719	2.054	2.062	1.837	2.929	2.232	1.677	2.525
	Variance	3.1529	2.477	3.6081	2.1212	2.3776	1.9176	3.2173	2.5346	3.2301
80 Plus	Observed	103	135	16	61	54	19	73	72	18
	Average	1.961	1.459	1.25	2.164	1.407	1.895	1.795	1.167	1.389
	Variance	2.9004	3.0711	2.0667	1.906	2.2082	4.2105	1.4433	1.8873	2.2516

Table 59. NHB Trip Data by Age Cohort for All Persons.

Age Cohort	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
0 to 14	Observed	2	2105	378	0	872	125	0	1068	111
	Average	0	0.522	1.429	0	0.507	1.256	0	0.801	1.405
	Variance	0	0.8827	2.8609	0	0.9001	2.1597	0	1.5313	4.516
15 to 19	Observed	56	530	108	15	205	36	19	301	43
	Average	1	0.489	1.148	0.867	0.546	1.25	0.842	0.767	1.953
	Variance	1.8182	0.9271	2.7442	0.981	0.9157	1.6786	1.2515	1.5791	2.8073
20 to 24	Observed	119	318	78	35	93	16	49	129	13
	Average	0.941	0.346	2.59	0.686	0.505	0.688	1.122	0.341	1.462
	Variance	2.5813	0.6308	8.7905	1.516	1.1657	1.4292	4.6514	0.4296	4.2692
25 to 29	Observed	179	259	78	63	92	24	93	110	23
	Average	0.905	0.375	2.474	1.032	0.359	1.833	1.247	0.409	1.739
	Variance	2.6258	0.8088	11.5253	2.128	0.9359	5.1884	4.4708	1.1797	10.2016
30 to 34	Observed	226	247	106	103	121	32	94	118	24
	Average	1.261	0.486	2.708	0.99	0.661	2.906	0.904	0.712	3.708
	Variance	3.8382	1.4866	9.7898	2.0489	1.3592	8.6038	2.0445	1.3864	14.3025
35 to 39	Observed	218	240	102	154	123	42	118	123	30
	Average	1.202	0.479	2.853	1.409	0.545	2.024	1.72	0.935	3.233
	Variance	3.7563	1.3217	9.5524	3.825	0.9877	2.7067	4.0493	1.9138	8.4609
40 to 44	Observed	223	251	91	129	142	32	140	161	40
	Average	1.291	0.574	3.275	1.116	0.81	2.531	1.371	0.727	1.8
	Variance	3.6399	1.2135	10.8681	3.4942	2.07	6.3861	4.2927	1.4873	5.6
45 to 49	Observed	182	247	92	144	139	45	129	164	41
	Average	1.368	0.559	2.435	1.403	0.561	1.978	1.264	0.701	2.366
	Variance	5.3941	1.3451	6.3583	2.7877	1.2191	3.7949	3.0237	2.3703	6.4878
50 to 54	Observed	206	236	92	140	120	47	120	122	47
	Average	1.092	0.449	2.467	1.221	0.725	2.128	1.325	0.484	2.745
	Variance	3.5183	1.1846	7.2627	4.6772	1.3607	6.0268	4.0195	0.6815	7.716
55 to 59	Observed	163	201	78	90	103	40	104	111	32
	Average	1.049	0.502	1.474	1.089	0.505	2.675	1.038	0.468	2.188
	Variance	3.3926	1.1212	4.798	3.0032	0.8014	11.8147	2.3674	0.7785	4.6734
60 to 64	Observed	153	145	72	104	77	34	90	90	38
	Average	1.039	0.359	1.625	0.923	0.429	2.118	0.911	0.633	2.263
	Variance	5.5248	0.6205	4.125	2.7513	0.9586	6.8342	2.1493	2.0775	6.3613
65 to 69	Observed	141	163	46	109	77	17	99	76	36
	Average	0.816	0.448	1.587	1	0.506	2.412	1.141	0.684	1.833
	Variance	1.78	1.113	5.2256	2.1296	0.8059	9.7574	3.6737	1.3923	6.3714
70 to 74	Observed	143	135	40	93	69	19	100	71	28
	Average	0.657	0.615	1.5	0.581	0.507	2.579	0.84	0.451	1.929
	Variance	1.3818	1.1341	5.0769	1.507	0.783	43.2573	2.0145	1.394	5.5503
75 to 79	Observed	120	89	37	65	43	14	82	65	40
	Average	0.792	0.449	0.946	0.723	0.442	2.643	0.829	0.385	1.775
	Variance	1.5613	0.7275	2.0526	1.4221	1.2525	4.4011	1.6495	0.8654	4.5378
80 Plus	Observed	103	135	16	61	54	19	73	72	18
	Average	0.583	0.356	0.375	0.656	0.352	1.579	0.74	0.375	0.833
	Variance	0.7358	0.6637	0.65	1.2295	0.4965	4.0351	1.1674	0.6602	1.3235

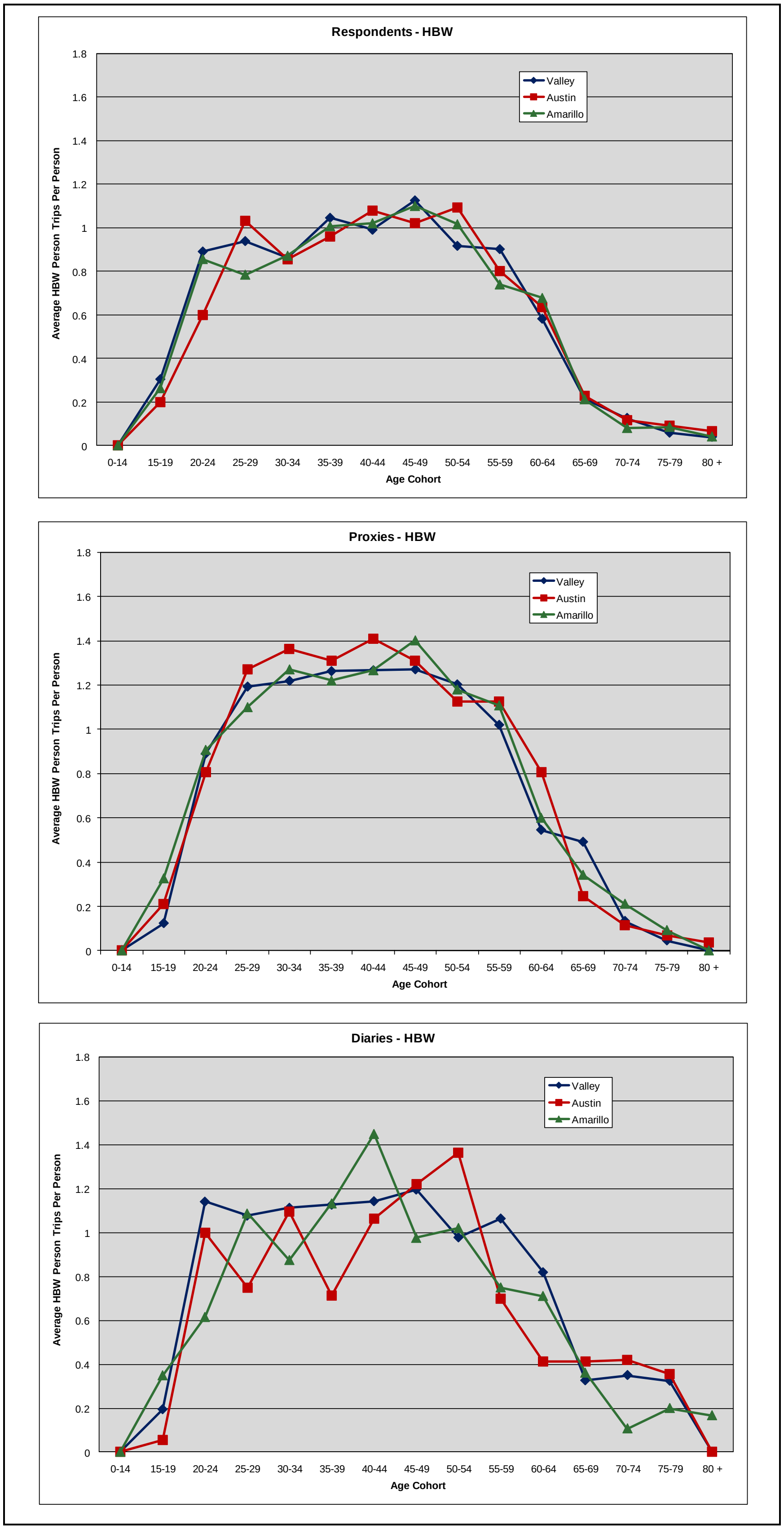


Figure 25. HBW Trip Rates by Age Cohort and Retrieval Method.

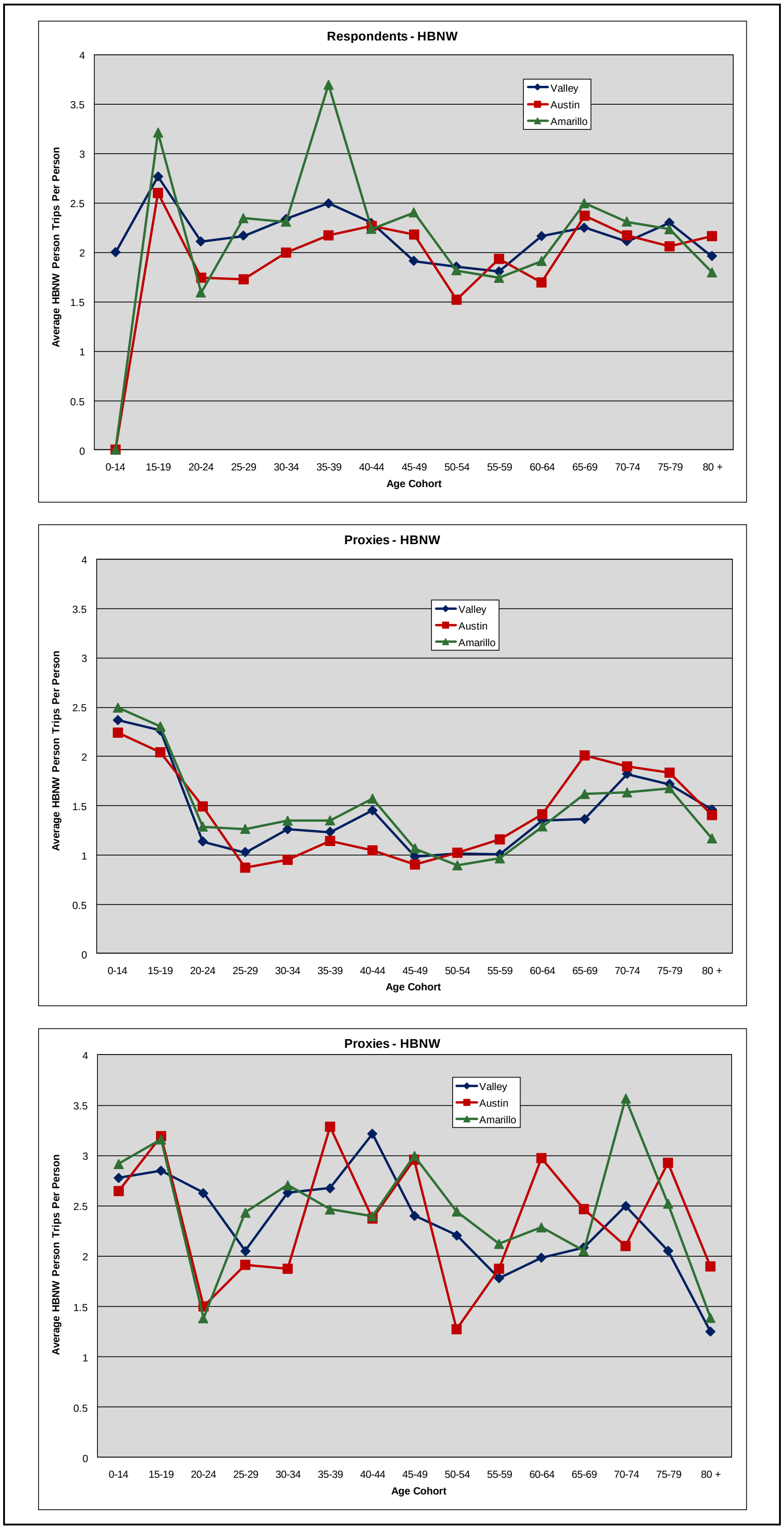


Figure 26. HBNW Trip Rates by Age Cohort and Retrieval Method.

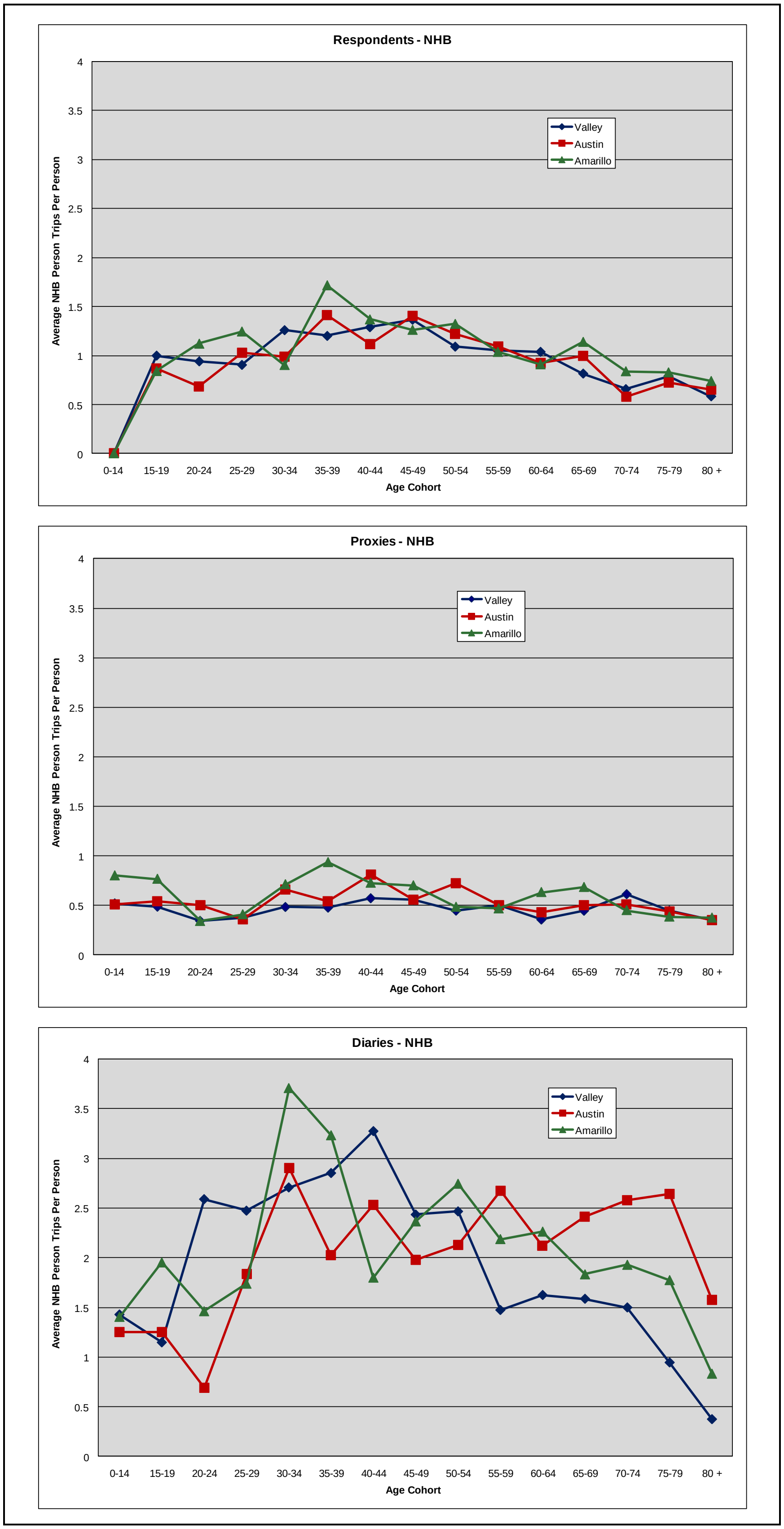


Figure 27. NHB Trip Rates by Age Cohort and Retrieval Method.

Table 60. Comparison of Trips Rates by Method of Data Retrieval.

Area	Number of Statistically Different Pairs of Trip Rates – Max = 42					
	HBW Trips		HBNW Trips		NHB Trips	
	Number	Percent	Number	Percent	Number	Percent
Valley	7	17%	25	60%	35	83%
Austin	10	24%	20	48%	26	62%
Amarillo	6	14%	24	57%	30	71%

Table 61. Comparison of Trips Rates Between Areas by Method of Data Retrieval.

Method of Data Retrieval	Number of Statistically Different Pairs of Trip Rates – Max = 42					
	HBW Trips		HBNW Trips		NHB Trips	
	Number	Percent	Number	Percent	Number	Percent
Respondent	0	0%	4	10%	1	2%
Proxy	3	7%	6	14%	5	12%
Diary	2	5%	7	17%	10	24%

Trip rates by purpose were next stratified by person life cycle. Tables 62 through 64 present these data. As expected for HBW trips, the rates for employed persons are significantly higher than those for retired, student, or others. It is interesting to note that there were HBW trips made by retired persons as well as students and other. These rates were very small in all cases as would be expected. Trip rates were first compared for each method of data retrieval between each person life cycle. Table 65 shows the results for HBW trips. While the HBW rates for employed persons were statistically different between the other categories, these comparisons were not felt to be valid since the data for retired, student, and other were so small as to be attributed to random variation.

Table 66 shows the results for HBNW trips. The comparison of HBNW trip rates showed that persons that were employed had statistically different values than those for retired, students, and others in nearly all cases. Retired persons had statistically different HBNW trip rates than those for students and others 60 percent of the time, while students had statistically different rates from others in about 67 percent of the cases. Table 67 shows the results for NHB trips. Results were mixed for NHB trip rates. The NHB trip rates for employed persons were statistically different from those for retired, students, and others in 63 percent of the cases. NHB trips rates for retired persons were different from those for students and others in 33 percent of the cases. The NHB rate for students was different from others in 56 percent of the cases.

Comparisons were next made between the rates based on the method of data collection. This identifies differences that could be attributed to the method of data collection. Comparisons were done for each trip purpose and each person life cycle category. Tables 68 through 70 show the results. For each trip purpose, a total of 36 pairs of trip rates were compared statistically (i.e., respondent rates compared to proxy rates, respondent rates compared to diary rates, and proxy rates compared to diary rates). Only 11 valid comparisons could be made for HBW trips and eight (73 percent) were found statistically different. Nearly 78 percent were found statistically different for HBNW trips and 92 percent were found statistically different for NHB trips. It appears the method of data collection does impact the average trip rate for HBW, HBNW, and NHB trips. Interestingly, the HBW trip rates found not to be different were those for respondent and diary. The rates for proxies were different in all cases for all trip purposes. Figures 28 through 30 present plots of these rates for each area by person life cycle.

Table 62. HBW Person Trip Data by Person Life Cycle.

Area	Person Life Cycle	Measure	Data Retrieval Method		
			Respondent	Proxy	Diary
Valley	Employed	Observations	1082	1562	630
		Average Trip Rate[1]	1.499	1.637	1.425
		Variance	1.0513	0.9104	1.3132
	Retired	Observations	524	454	139
		Average Trip Rate	0.004	0	0.007
		Variance	0.0076	0	0.0072
	Student	Observations	558	1127	239
		Average Trip Rate	0	0.005	0.063
		Variance	0	0.0106	0.1767
	Other	Observations	70	2158	406
		Average Trip Rate	0	0.001	0
		Variance	0	0.0019	0
Austin	Employed	Observations	692	825	249
		Average Trip Rate	1.37	1.556	1.269
		Variance	0.9975	0.8491	1.4152
	Retired	Observations	346	237	70
		Average Trip Rate	0	0	0
		Variance	0	0	0
	Student	Observations	243	420	90
		Average Trip Rate	0	0.01	0
		Variance	0	0.019	0
	Other	Observations	24	848	133
		Average Trip Rate	0	0	0
		Variance	0	0	0
Amarillo	Employed	Observations	666	975	252
		Average Trip Rate	1.356	1.473	1.298
		Variance	1.2251	1.0072	1.2457
	Retired	Observations	363	272	113
		Average Trip Rate	0.006	0	0
		Variance	0.011	0	0
	Student	Observations	260	505	80
		Average Trip Rate	0	0	0
		Variance	0	0	0
	Other	Observations	21	1029	119
		Average Trip Rate	0	0.002	0
		Variance	0	0.0039	0

[1]Person trips per person.

Table 63. HBNW Person Trip Data by Person Life Cycle.

Area	Person Life Cycle	Measure	Data Retrieval Method		
			Respondent	Proxy	Diary
Valley	Employed	Observations	1082	1562	630
		Average Trip Rate[1]	1.616	0.86	2.013
		Variance	3.7186	1.8831	4.6008
	Retired	Observations	524	454	139
		Average Trip Rate	2.406	1.758	2.424
		Variance	3.5649	2.9213	3.8113
	Student	Observations	558	1127	239
		Average Trip Rate	2.894	1.879	3.448
		Variance	5.8901	4.4899	9.8533
	Other	Observations	70	2158	406
		Average Trip Rate	2.986	2.419	2.803
		Variance	3.1447	1.1531	2.371
Austin	Employed	Observations	692	825	249
		Average Trip Rate	1.552	0.874	1.924
		Variance	3.1536	1.6977	4.1353
	Retired	Observations	346	237	70
		Average Trip Rate	2.341	2.008	2.714
		Variance	2.1152	2.5423	3.7143
	Student	Observations	243	420	90
		Average Trip Rate	2.831	1.821	3.311
		Variance	5.083	3.3547	5.9695
	Other	Observations	24	848	133
		Average Trip Rate	3.042	2.305	2.639
		Variance	3.0851	1.112	2.3839
Amarillo	Employed	Observations	666	975	252
		Average Trip Rate	1.823	1.15	2.123
		Variance	4.9099	2.534	4.9529
	Retired	Observations	363	272	113
		Average Trip Rate	2.353	1.743	2.602
		Variance	3.367	3.1808	4.1704
	Student	Observations	260	505	80
		Average Trip Rate	3.185	1.905	3.188
		Variance	9.9349	5.0941	8.2809
	Other	Observations	21	1029	119
		Average Trip Rate	4.762	2.551	3.176
		Variance	9.7905	1.5648	1.994

[1]Person trips per person.

Table 64. NHB Person Trip Data by Person Life Cycle.

Area	Person Life Cycle	Measure	Data Retrieval Method		
			Respondent	Proxy	Diary
Valley	Employed	Observations	1082	1562	630
		Average Trip Rate[1]	1.288	0.513	2.525
		Variance	4.5551	1.2827	8.8284
	Retired	Observations	524	454	139
		Average Trip Rate	0.798	0.447	1.122
		Variance	1.634	0.8438	3.1371
	Student	Observations	558	1127	239
		Average Trip Rate	0.76	0.445	2.188
		Variance	2.014	0.908	6.4896
	Other	Observations	70	2158	406
		Average Trip Rate	1.386	0.5	1.286
		Variance	3.1389	0.8166	2.4466
Austin	Employed	Observations	692	825	249
		Average Trip Rate	1.249	0.616	2.382
		Variance	3.3158	1.2781	9.5676
	Retired	Observations	346	237	70
		Average Trip Rate	0.783	0.481	1.857
		Variance	1.9848	0.9626	4.6749
	Student	Observations	243	420	90
		Average Trip Rate	0.905	0.421	1.656
		Variance	2.3918	0.9222	3.7564
	Other	Observations	24	848	133
		Average Trip Rate	1.125	0.541	1.271
		Variance	2.0272	0.9003	2.1231
Amarillo	Employed	Observations	666	975	252
		Average Trip Rate	1.228	0.686	2.496
		Variance	3.2711	1.5688	7.6215
	Retired	Observations	363	272	113
		Average Trip Rate	0.876	0.482	1.619
		Variance	2.1034	1.0181	4.7735
	Student	Observations	260	505	80
		Average Trip Rate	1.146	0.451	1.875
		Variance	3.1291	0.9664	4.693
	Other	Observations	21	1029	119
		Average Trip Rate	3.048	0.858	1.538
		Variance	11.8476	1.6374	4.6744

[1]Person trips per person.

Table 65. HBW Trip Rate Comparisons in Each Area by Person Life Cycle.

Area	Retrieval Method	Person Life Cycle	Left of Diagonal	Person Life Cycle: Employed	Retired	Student	Other
				Right of Diagonal – Statistical Difference			
Valley	Respondent	Employed	Absolute Difference In Trip Rates		Yes	NA	NA
		Retired		>100%		NA	NA
		Student		NA[1]	NA		NA
		Other		NA	NA	NA	
	Proxy	Employed	Absolute Difference In Trip Rates		NA	Yes	Yes
		Retired		NA		NA	NA
		Student		>100%	NA		No
		Other		>100%	NA	>100%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	Yes	NA
		Retired		>100%		Yes	NA
		Student		>100%	>100%		NA
		Other		NA	NA	NA	
Austin	Respondent	Employed	Absolute Difference In Trip Rates		NA	NA	NA
		Retired		NA		NA	NA
		Student		NA	NA		NA
		Other		NA	NA	NA	
	Proxy	Employed	Absolute Difference In Trip Rates		NA	Yes	NA
		Retired		NA		NA	NA
		Student		>100%	NA		NA
		Other		NA	NA	NA	
	Diary	Employed	Absolute Difference In Trip Rates		NA	NA	NA
		Retired		NA		NA	NA
		Student		NA	NA		NA
		Other		NA	NA	NA	
Amarillo	Respondent	Employed	Absolute Difference In Trip Rates		Yes	NA	NA
		Retired		>100%		NA	NA
		Student		NA	NA		NA
		Other		NA	NA	NA	
	Proxy	Employed	Absolute Difference In Trip Rates		NA	NA	Yes
		Retired		NA		NA	NA
		Student		NA	NA		NA
		Other		>100%	NA	NA	
	Diary	Employed	Absolute Difference In Trip Rates		NA	NA	NA
		Retired		NA		NA	NA
		Student		NA	NA		NA
		Other		NA	NA	NA	

[1]NA – Not applicable due to one value having no observations and a value of zero.

Table 66. HBNW Trip Rate Comparisons in Each Area by Person Life Cycle.

Area	Retrieval Method	Person Life Cycle	Left of Diagonal	Person Life Cycle			
				Employed	Retired	Student	Other
				Right of Diagonal – Statistical Difference			
Valley	Respondent	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		33%		Yes	Yes
		Student		44%	17%		No
		Other		46%	19%	3%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		51%		No	Yes
		Student		54%	6%		Yes
		Other		64%	27%	22%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		17%		Yes	Yes
		Student		42%	30%		Yes
		Other		28%	14%	23%	
Austin	Respondent	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		34%		Yes	No
		Student		45%	17%		No
		Other		49%	23%	7%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		56%		No	Yes
		Student		52%	10%		Yes
		Other		62%	12%	21%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		29%		No	No
		Student		42%	18%		Yes
		Other		27%	3%	25%	
Amarillo	Respondent	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		23%		Yes	Yes
		Student		43%	26%		Yes
		Other		62%	51%	33%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		34%		No	Yes
		Student		40%	9%		Yes
		Other		55%	32%	25%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		18%		No	Yes
		Student		33%	18%		No
		Other		33%	18%	<1%	

Table 67. NHB Trip Rate Comparisons in Each Area by Person Life Cycle.

Area	Retrieval Method	Person Life Cycle	Left of Diagonal	Person Life Cycle: Employed	Retired	Student	Other
				Right of Diagonal – Statistical Difference			
Valley	Respondent	Employed	Absolute Difference In Trip Rates		Yes	Yes	No
		Retired		61%		No	Yes
		Student		69%	5%		Yes
		Other		7%	42%	45%	
	Proxy	Employed	Absolute Difference In Trip Rates		No	No	No
		Retired		15%		No	No
		Student		15%	<1%		No
		Other		3%	11%	11%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	No	Yes
		Retired		>100%		Yes	No
		Student		15%	49%		Yes
		Other		96%	13%	70%	
Austin	Respondent	Employed	Absolute Difference In Trip Rates		Yes	Yes	No
		Retired		60%		No	No
		Student		38%	13%		No
		Other		11%	30%	20%	
	Proxy	Employed	Absolute Difference In Trip Rates		No	Yes	No
		Retired		28%		No	No
		Student		46%	14%		Yes
		Other		14%	11%	22%	
	Diary	Employed	Absolute Difference In Trip Rates		No	Yes	Yes
		Retired		28%		No	Yes
		Student		44%	12%		No
		Other		87%	46%	30%	
Amarillo	Respondent	Employed	Absolute Difference In Trip Rates		Yes	No	Yes
		Retired		40%		Yes	Yes
		Student		7%	24%		Yes
		Other		60%	71%	62%	
	Proxy	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		42%		No	Yes
		Student		52%	7%		Yes
		Other		20%	44%	47%	
	Diary	Employed	Absolute Difference In Trip Rates		Yes	Yes	Yes
		Retired		54%		No	No
		Student		33%	14%		No
		Other		62%	5%	22%	

Trip rates were next compared by trip purpose and person life cycle between the three areas in this study. Tables 71 through 73 present the results for each trip purpose showing the absolute percent differences and whether the differences were found to be statistically significant. The results indicate strong similarities in the trip rates by purpose for the three urban areas. For example, only 36 percent (4 out of 11) of the HBW rates compared were found statistically different. For HBNW trips, 31 percent (11 out of 36) were found different and for

NHB trips, 25 percent (9 out of 36) were found different. These similarities are more striking when you examine Figures 31 through 33. These plots show strong similarities in the trip rates by purpose between the areas by person life cycle.

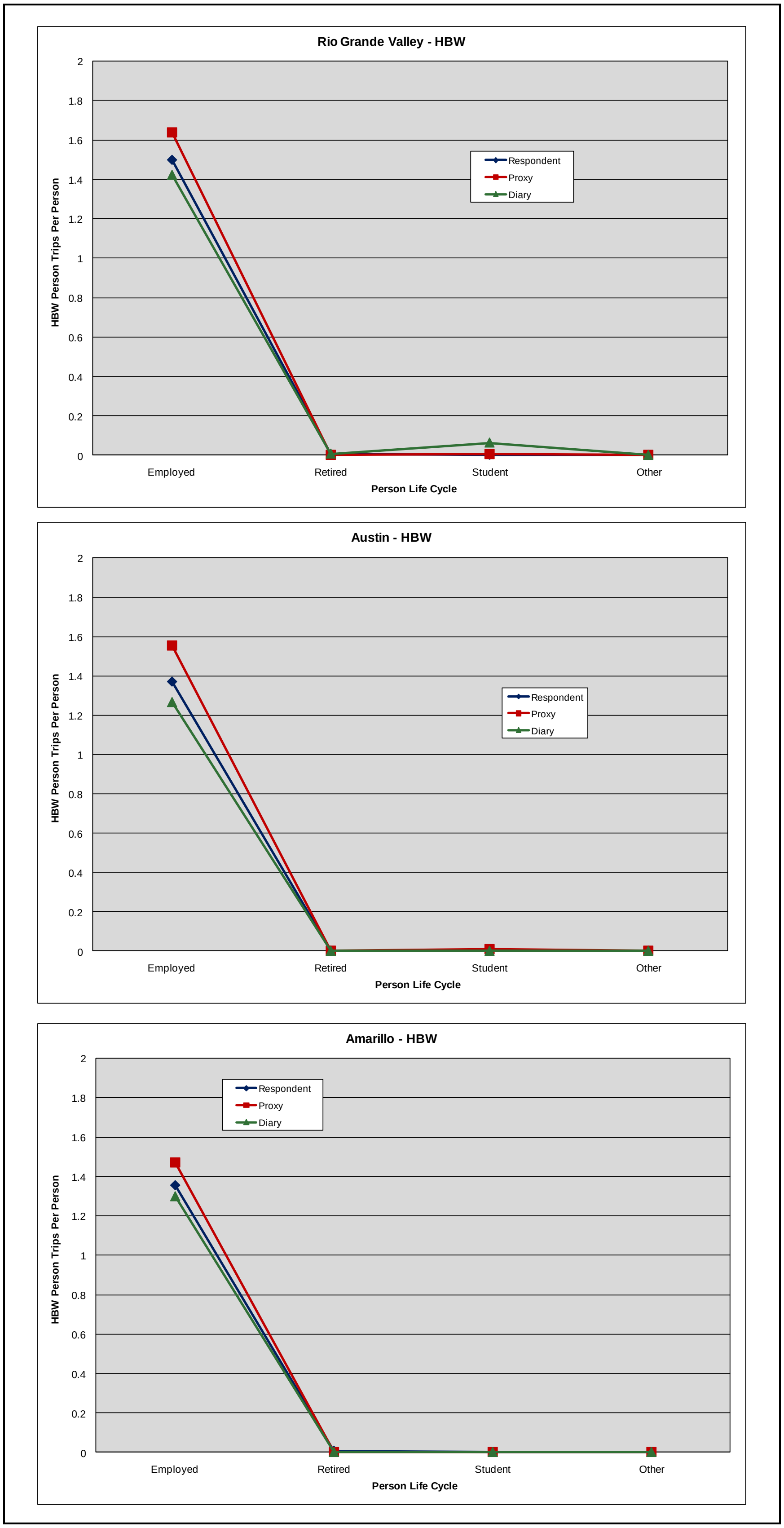


Figure 28. HBW Trip Rates by Person Life Cycle and Urban Area.

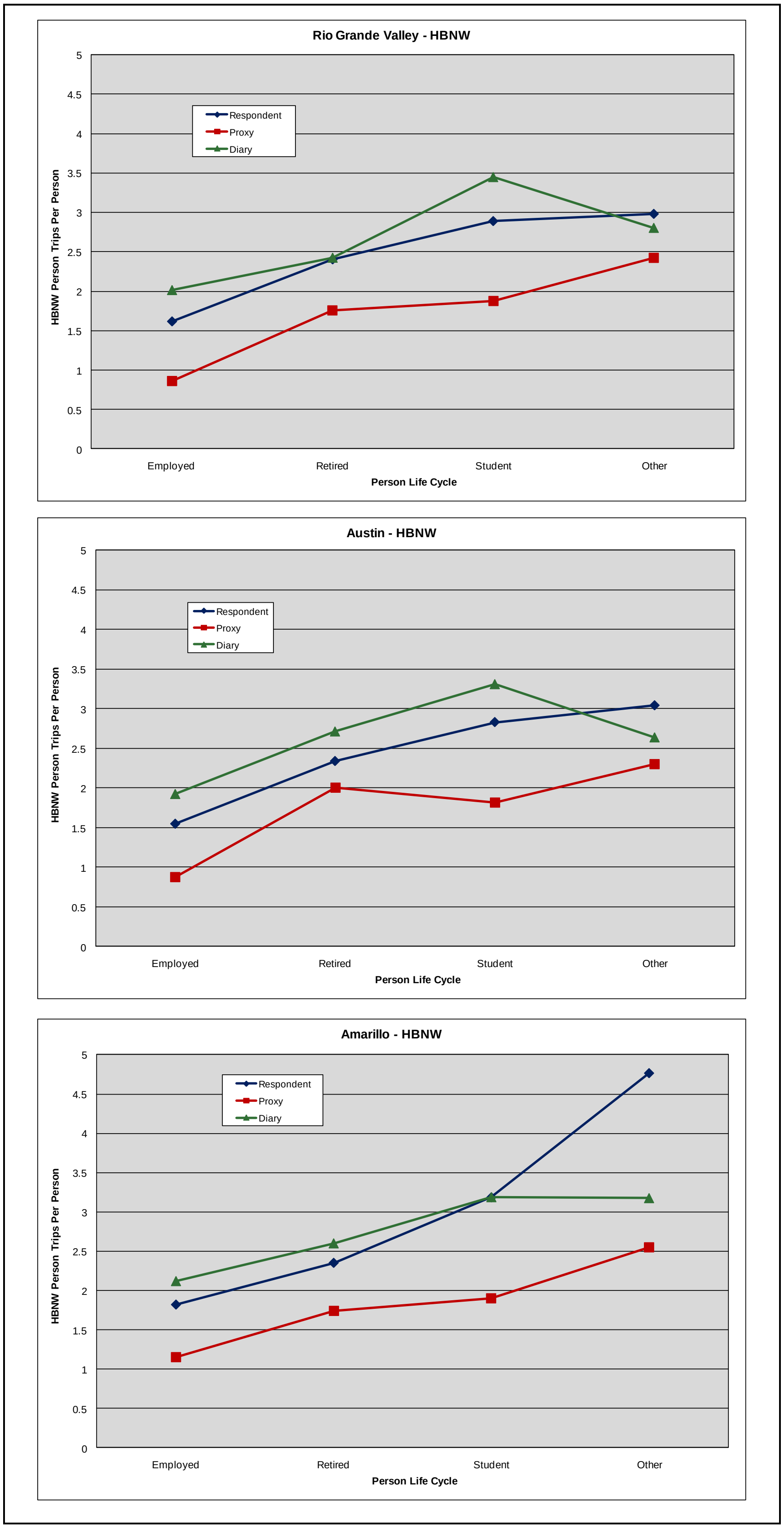


Figure 29. HBNW Trip Rates by Person Life Cycle and Urban Area.

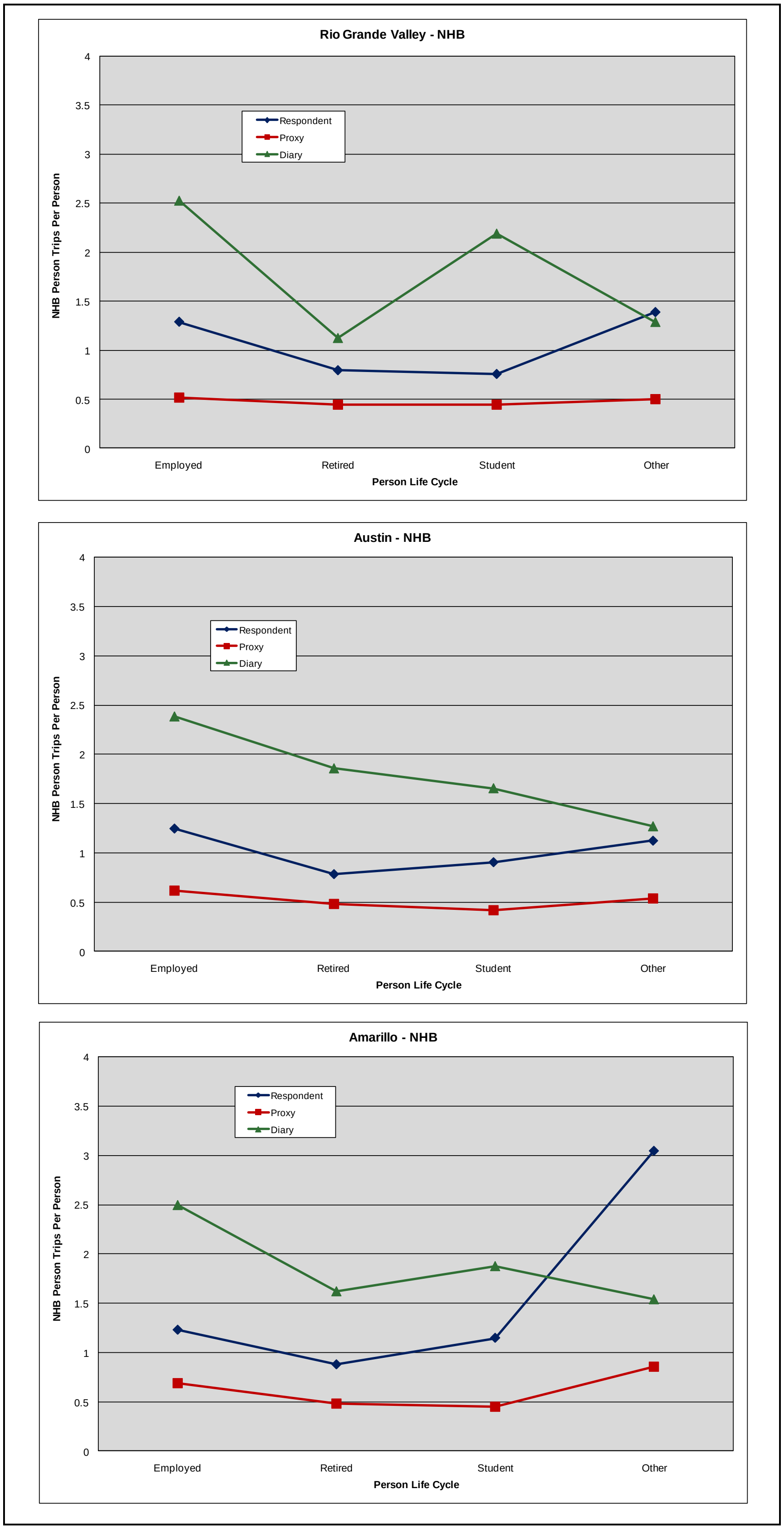


Figure 30. NHB Trip Rates by Person Life Cycle and Urban Area.

Table 68. Comparison of HBW Trip Rates by Method of Data Retrieval.

Area	Person Life Cycle	Measure	Trip Rates Being Compared[1]: Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary
Valley	Employed	Statistically Different	Yes	No	Yes
		Absolute Difference	8%	5%	15%
	Retired	Statistically Different		No	
		Absolute Difference		43%	
	Student	Statistically Different			Yes
		Absolute Difference			92%
	Other	Statistically Different			
		Absolute Difference			
Austin	Employed	Statistically Different	Yes	No	Yes
		Absolute Difference	12%	8%	23%
	Retired	Statistically Different			
		Absolute Difference			
	Student	Statistically Different			
		Absolute Difference			
	Other	Statistically Different			
		Absolute Difference			
Amarillo	Employed	Statistically Different	Yes	No	Yes
		Absolute Difference	8%	4%	13%
	Retired	Statistically Different			
		Absolute Difference			
	Student	Statistically Different			
		Absolute Difference			
	Other	Statistically Different			
		Absolute Difference			

[1]Blank cells indicate no valid comparison could be made

Table 69. Comparison of HBNW Trip Rates by Method of Data Retrieval.

Area	Person Life Cycle	Measure	Trip Rates Being Compared: Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary
Valley	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	88%	20%	57%
	Retired	Statistically Different	Yes	No	Yes
		Absolute Difference	37%	1%	27%
	Student	Statistically Different	Yes	Yes	Yes
		Absolute Difference	54%	16%	46%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	23%	7%	14%
Austin	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	78%	19%	55%
	Retired	Statistically Different	Yes	No	Yes
		Absolute Difference	17%	14%	26%
	Student	Statistically Different	Yes	No	Yes
		Absolute Difference	55%	14%	45%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	32%	15%	13%
Amarillo	Employed	Statistically Different	Yes	No	Yes
		Absolute Difference	59%	14%	46%
	Retired	Statistically Different	Yes	No	Yes
		Absolute Difference	35%	10%	33%
	Student	Statistically Different	Yes	No	Yes
		Absolute Difference	67%	<1%	40%
	Other	Statistically Different	Yes	Yes	Yes
		Absolute Difference	87%	50%	20%

Table 70. Comparison of NHB Trip Rates by Method of Data Retrieval.

Area	Person Life Cycle	Measure	Trip Rates Being Compared: Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary
Valley	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	151%	49%	80%
	Retired	Statistically Different	Yes	Yes	Yes
		Absolute Difference	79%	29%	60%
	Student	Statistically Different	Yes	Yes	Yes
		Absolute Difference	71%	65%	80%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	177%	8%	61%
Austin	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	103%	48%	74%
	Retired	Statistically Different	Yes	Yes	Yes
		Absolute Difference	63%	58%	74%
	Student	Statistically Different	Yes	Yes	Yes
		Absolute Difference	115%	45%	75%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	108%	11%	57%
Amarillo	Employed	Statistically Different	Yes	Yes	Yes
		Absolute Difference	79%	51%	73%
	Retired	Statistically Different	Yes	Yes	Yes
		Absolute Difference	82%	46%	70%
	Student	Statistically Different	Yes	Yes	Yes
		Absolute Difference	154%	39%	76%
	Other	Statistically Different	Yes	No	Yes
		Absolute Difference	255%	98%	44%

Table 71. HBW Trip Rate Comparisons by Person Life Cycle between Areas.

Area	Retrieval Method	Person Life Cycle	Person Trip Rate Comparison[1]	
			Absolute Percent Difference	Statistically Significant
Valley versus Austin	Respondent	Employed	9%	Yes
		Retired		
		Student		
		Other		
	Proxy	Employed	5 %	Yes
		Retired		
		Student	50%	No
		Other		
	Diary	Employed	12%	No
		Retired		
		Student		
		Other		
Valley versus Amarillo	Respondent	Employed	11%	Yes
		Retired	33%	No
		Student		
		Other		
	Proxy	Employed	11%	Yes
		Retired		
		Student		
		Other	50%	No
	Diary	Employed	10%	No
		Retired		
		Student		
		Other		
Austin versus Amarillo	Respondent	Employed	1%	No
		Retired		
		Student		
		Other		
	Proxy	Employed	6%	No
		Retired		
		Student		
		Other		
	Diary	Employed	2%	No
		Retired		
		Student		
		Other		

[1]Blank cells represent conditions where no valid comparison could be made.

Table 72. HBNW Trip Rate Comparisons by Person Life Cycle between Areas.

Area	Retrieval Method	Person Life Cycle	Person Trip Rate Comparison	
			Absolute Percent Difference	Statistically Significant
Valley versus Austin	Respondent	Employed	4%	No
		Retired	3%	No
		Student	2%	No
		Other	2%	No
	Proxy	Employed	2%	No
		Retired	12%	No
		Student	3%	No
		Other	5%	Yes
	Diary	Employed	5%	No
		Retired	10%	No
		Student	4%	No
		Other	6%	No
Valley versus Amarillo	Respondent	Employed	11%	Yes
		Retired	2%	No
		Student	9%	No
		Other	37%	Yes
	Proxy	Employed	25%	Yes
		Retired	1%	No
		Student	1%	No
		Other	5%	Yes
	Diary	Employed	5%	No
		Retired	7%	No
		Student	8%	No
		Other	12%	Yes
Austin versus Amarillo	Respondent	Employed	15%	Yes
		Retired	1%	No
		Student	11%	No
		Other	36%	Yes
	Proxy	Employed	24%	Yes
		Retired	15%	No
		Student	4%	No
		Other	10%	Yes
	Diary	Employed	9%	No
		Retired	4%	No
		Student	4%	No
		Other	17%	Yes

Table 73. NHB Trip Rate Comparisons by Person Life Cycle between Areas.

Area	Retrieval Method	Person Life Cycle	Person Trip Rate Comparison	
			Absolute Percent Difference	Statistically Significant
Valley versus Austin	Respondent	Employed	3%	No
		Retired	2%	No
		Student	16%	No
		Other	1%	No
	Proxy	Employed	17%	Yes
		Retired	7%	No
		Student	6%	No
		Other	8%	No
	Diary	Employed	6%	No
		Retired	40%	Yes
		Student	32%	Yes
		Other	1%	No
Valley versus Amarillo	Respondent	Employed	5%	No
		Retired	9%	No
		Student	34%	Yes
		Other	55%	Yes
	Proxy	Employed	25%	Yes
		Retired	7%	No
		Student	1%	No
		Other	42%	Yes
	Diary	Employed	1%	No
		Retired	31%	No
		Student	17%	No
		Other	16%	No
Austin versus Amarillo	Respondent	Employed	2%	No
		Retired	10%	No
		Student	21%	No
		Other	63%	Yes
	Proxy	Employed	10%	No
		Retired	< 1%	No
		Student	7%	No
		Other	37%	Yes
	Diary	Employed	5%	No
		Retired	15%	No
		Student	12%	No
		Other	17%	No

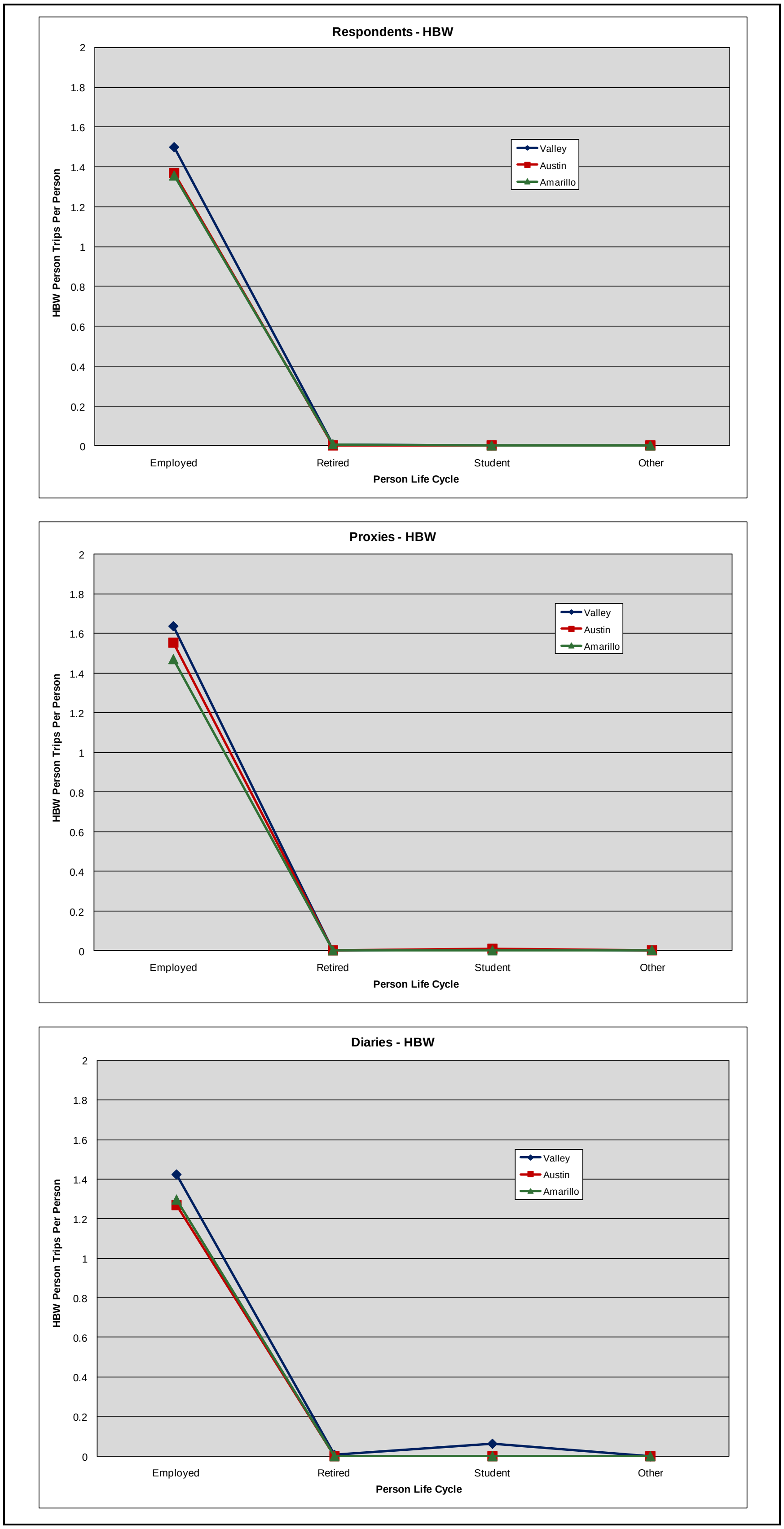


Figure 31. HBW Trip Rates by Person Life Cycle and Method of Retrieval.

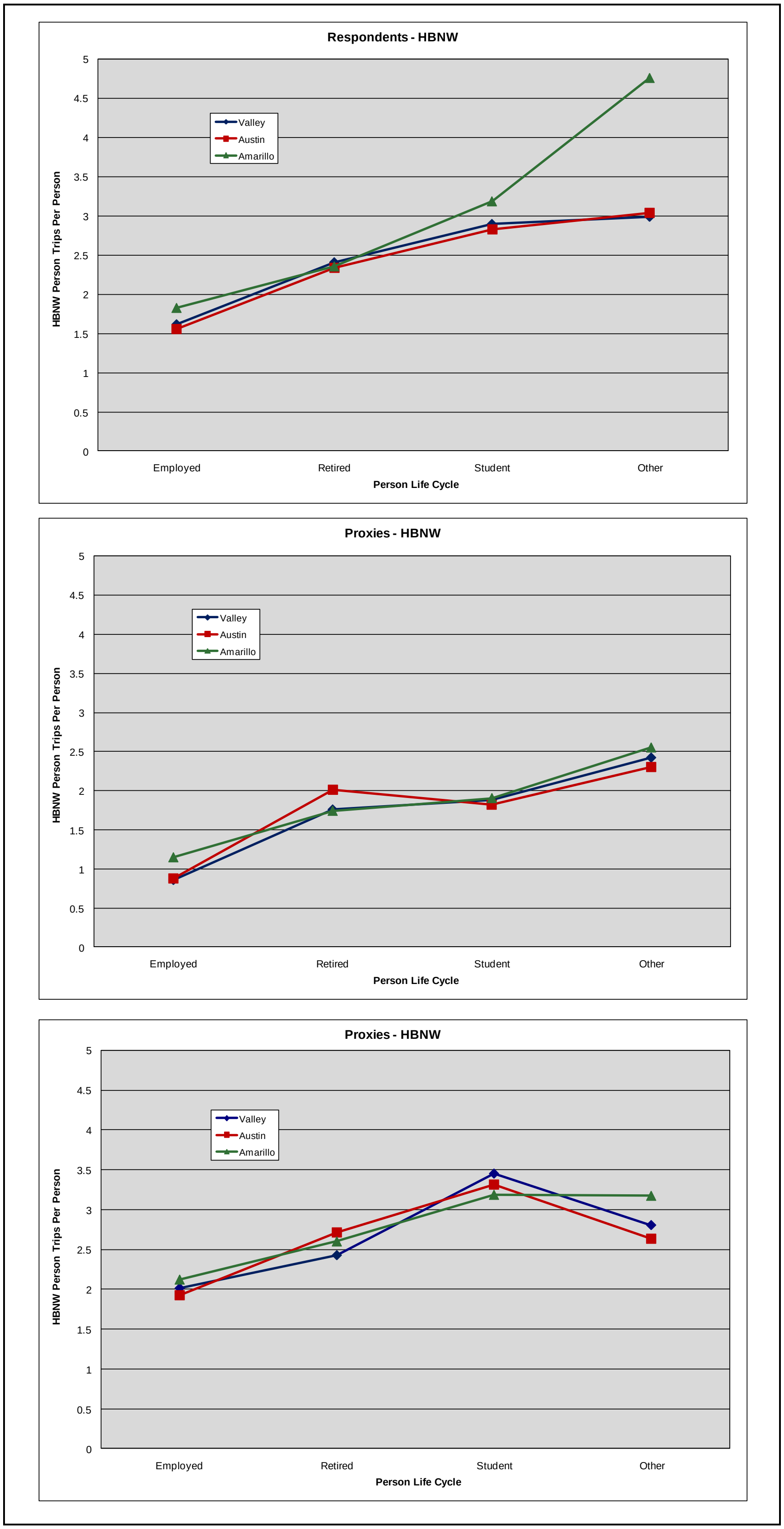


Figure 32. HBNW Trip Rates by Person Life Cycle and Method of Retrieval.

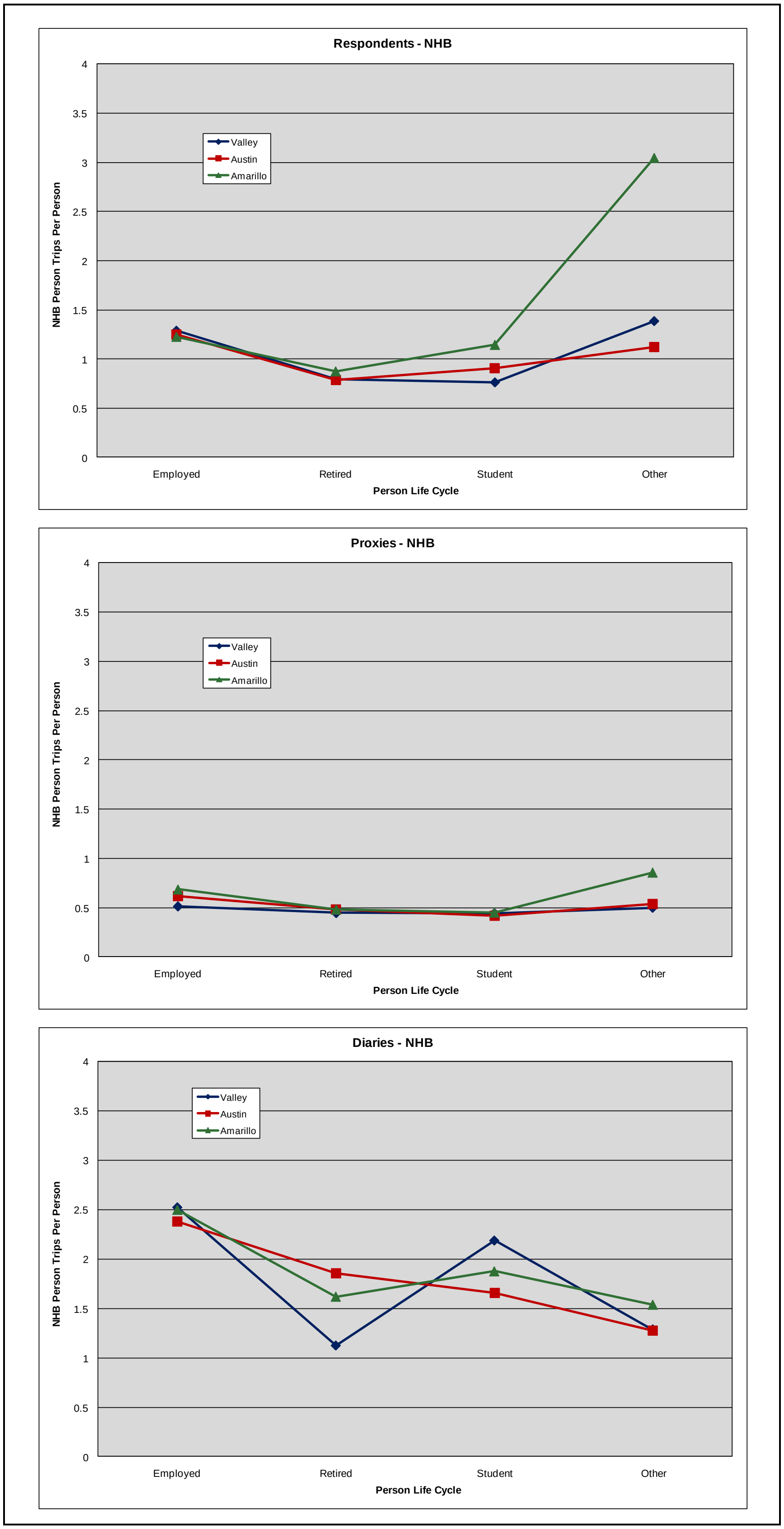


Figure 33. NHB Trip Rates by Person Life Cycle and Method of Retrieval.

Trip rates were then stratified by household life cycle for each trip purpose. Tables 74 through 76 show the resulting trip data. It will be noted that the delineation of trips by purpose creates a number of cells with few or no observed trips. Since four of the household life cycle categories included households with no persons employed, this is most noticeable with HBW trips. As done earlier in this analysis, cells with fewer than five observations are not included in the paired trip rate comparisons.

The first comparison was trip rates by method of data retrieval for each area. Table 77 presents the comparison results for HBW trips. For the Valley, a total of 18 pairs of trip rates could be compared for HBW trips. Of those, 9 (50 percent) were found to be statistically different. For Austin, a total of 18 pairs of trip rates could be compared for HBW trips. Of those, eleven (61 percent) were found to be statistically different. For Amarillo, a total of 18 pairs of trip rates could be compared for HBW trips. Of those, five (28 percent) were found to be statistically different. Figure 34 presents plots of the HBW trip rates for each method of data collection by household life cycle.

Table 78 presents the comparison results for HBNW trips. In comparing the HBNW trip rates, a total of 36 paired rates could be evaluated for the Valley, 27 for Austin, and 28 for Amarillo. In the Valley, 22 (61 percent) were found statistically different. In Austin, 14 (52 percent) were found statistically different and in Amarillo, 14 (50 percent) were found statistically different. Figure 35 presents plots of the HBNW rates by household life cycle for each area and method of data collection. HBNW trip rates for persons represented by proxy are generally the lowest rates while rates based on returned diaries tend to be the highest. Where rates are zero, typically there were very few or no observations.

Table 79 presents the comparison results for NHB trips. For NHB trips, a total of 36 comparisons can be made for the Valley, 27 for Austin, and 26 for Amarillo. For the Valley, 26 (72 percent) were found statistically different. That number for Austin was 17 (63 percent) and for Amarillo the number was 21 (81 percent). Figure 36 shows the NHB trip rates plotted by method of data retrieval against the household life cycles for each of the three areas. The most obvious observation that can be made is the magnitude of the differences in the NHB trip rates between the methods of data retrieval. The proxy rates are the lowest and the highest are the rates based on returned diaries for nearly all household life cycles.

Table 74. HBW Trip Data by Household Life Cycle for All Persons.

HH Life Cycle	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	Observed	453	337	74	289	192	57	276	211	95
	Average	0.004	0	0	0	0	0	0	0	0
	Variance	0.0088	0	0	0	0	0	0	0	0
2	Observed	53	38	7	43	11	5	16	5	5
	Average	0	0	0	0	0	0	0	0	0
	Variance	0	0	0	0	0	0	0	0	0
3	Observed	287	323	174	264	201	61	197	201	82
	Average	0.739	0.656	0.868	0.962	0.761	0.623	0.716	0.692	0.707
	Variance	1.1238	1.0275	1.4911	1.1545	1.0327	0.8388	1.0923	0.9744	0.975
4	Observed	300	543	215	204	290	113	194	332	76
	Average	1.283	1.269	1.163	1.176	1.372	1.292	1.144	1.238	1.263
	Variance	1.2539	1.2338	1.2304	1.0623	1.0511	1.7622	1.3055	1.0882	1.4498
5	Observed	10	22	11	5	8	3	11	26	0
	Average	0	0	0	0	0	0	0	0	0
	Variance	0	0	0	0	0	0	0	0	0
6	Observed	25	52	10	1	1	6	9	20	0
	Average	0	0	0	0	0	0	0	0	0
	Variance	0	0	0	0	0	0	0	0	0
7	Observed	111	260	102	69	141	19	69	146	22
	Average	0.847	0.327	0.451	0.565	0.525	0.632	0.435	0.521	0.636
	Variance	1.3127	0.5684	0.8243	1.1023	0.8655	2.2456	0.8376	1.0237	1.7662
8	Observed	180	531	174	108	262	50	120	285	68
	Average	1.344	0.802	0.787	1.25	0.752	0.78	1.383	0.856	0.897
	Variance	1.0315	1.0457	1.0932	0.993	1.0225	1.2771	1.1627	1.194	1.1683
9	Observed	6	30	5	3	11	0	11	40	4
	Average	0	0	0	0	0	0	0.182	0	0
	Variance	0	0	0	0	0	0	0.3636	0	0
10	Observed	61	211	25	12	44	12	9	30	0
	Average	0	0	0	0	0	0	0	0	0
	Variance	0	0	0	0	0	0	0	0	0
11	Observed	375	1441	270	129	472	118	175	646	74
	Average	0.563	0.261	0.278	0.496	0.28	0.271	0.56	0.248	0.365
	Variance	0.9152	0.4833	0.4839	0.8301	0.4864	0.4386	1.0754	0.4657	0.6733
12	Observed	373	1513	347	178	697	98	223	839	138
	Average	1.282	0.514	0.735	1.213	0.479	0.5	1.103	0.486	0.514
	Variance	1.1114	0.8902	1.3515	0.9598	0.7643	0.6856	1.201	0.7943	0.821

Table 75. HBNW Trip Data by Household Life Cycle for All Persons.

HH Life Cycle	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	Observed	453	337	74	289	192	57	276	211	95
	Average	2.274	1.89	2.73	2.367	2.12	2.912	2.232	1.735	2.695
	Variance	2.6904	2.6278	3.4328	2.0108	2.4515	3.01	2.6515	2.7578	3.5548
2	Observed	53	38	7	43	11	5	16	5	5
	Average	1.585	1.158	4.286	2.442	2.545	4	1.5	0.4	3.2
	Variance	2.0552	1.0014	9.9048	2.7763	2.4727	10	2.9333	0.8	5.2
3	Observed	287	323	174	264	201	61	197	201	82
	Average	1.822	1.192	1.908	1.527	1.318	2.148	1.695	1.07	2.244
	Variance	3.3984	2.2736	4.558	2.2883	1.8781	3.9945	2.9884	2.3051	5.3225
4	Observed	300	543	215	204	290	113	194	332	76
	Average	1.45	0.888	1.614	1.275	0.783	1.496	1.381	0.907	1.566
	Variance	3.0443	1.7973	3.0419	2.0425	1.3402	2.8236	2.5688	1.8674	3.7423
5	Observed	10	22	11	5	8	3	11	26	0
	Average	2.8	2	3.091	2.4	2	2.667	3.727	2.462	0
	Variance	3.7333	2.6667	4.2909	0.8	1.1429	1.3333	4.8182	4.2585	0
6	Observed	25	52	10	1	1	6	9	20	0
	Average	2.56	1.827	2.3	2	2	2.5	2.667	1.9	0
	Variance	2.5067	2.0283	2.4556	0	0	2.3	6	2.3053	0
7	Observed	111	260	102	69	141	19	69	146	22
	Average	2.45	1.9	2.951	2.217	1.61	3.895	2.42	1.774	2.864
	Variance	5.7589	3.2409	7.1362	3.7903	2.0682	5.9883	6.5119	3.2658	3.5519
8	Observed	180	531	174	108	262	50	120	285	68
	Average	1.833	1.488	2.661	1.648	1.473	1.9	1.883	1.698	2.515
	Variance	3.6145	2.5258	4.63	3.2769	2.0204	2.9082	5.1796	2.3875	6.0744
9	Observed	6	30	5	3	11	0	11	40	4
	Average	4.333	1.867	4.8	2.667	1.636	0	2	1.9	4
	Variance	8.6667	5.7747	5.2	1.3333	0.6545	0	6.4	1.4256	13.3333
10	Observed	61	211	25	12	44	12	9	30	0
	Average	3.361	2.218	3.12	2.833	1.773	3.083	3.333	2.233	0
	Variance	6.1344	2.0284	6.0267	4.697	2.8309	4.0833	16	2.7368	0
11	Observed	375	1441	270	129	472	118	175	646	74
	Average	2.728	2.22	3.411	2.953	2.047	3.025	3.594	2.337	3.041
	Variance	6.3001	2.937	7.2095	6.2009	2.5881	4.5207	10.8747	3.3712	5.9572
12	Observed	373	1513	347	178	697	98	223	839	138
	Average	2.182	1.841	2.34	2.388	1.861	2.51	2.758	2.145	2.986
	Variance	6.0581	2.1785	3.2713	5.798	2.0338	4.5205	9.0042	3.0337	4.102

Table 76. NHB Trip Data by Household Life Cycle for All Persons.

HH Life Cycle	Measure	Valley			Austin			Amarillo		
		Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	Observed	453	337	74	289	192	57	276	211	95
	Average	0.762	0.51	1.122	0.723	0.568	1.965	0.833	0.488	1.821
	Variance	1.359	0.9352	2.3275	1.5203	1.1158	4.9987	1.5576	1.032	5.0634
2	Observed	53	38	7	43	11	5	16	5	5
	Average	0.509	0.263	2	0.605	0.273	3	0.625	0	2.2
	Variance	1.5624	0.4694	3.6667	0.7209	0.2182	10.5	1.05	0	1.7
3	Observed	287	323	174	264	201	61	197	201	82
	Average	0.937	0.322	2.241	1.106	0.403	2.033	1.046	0.473	1.939
	Variance	3.9191	0.6351	8.1842	3.502	0.6418	5.4656	3.0438	1.4205	5.416
4	Observed	300	543	215	204	290	113	194	332	76
	Average	1.143	0.418	2.005	1.078	0.6	2.221	1.067	0.527	2.211
	Variance	4.8055	1.1035	7.5841	2.181	1.272	8.4417	2.7882	1.5733	6.3284
5	Observed	10	22	11	5	8	3	11	26	0
	Average	0.8	0.273	1.909	1.2	0.25	2.667	0.364	0.577	0
	Variance	0.8444	0.3983	5.8909	4.7	0.2143	1.3333	0.4545	0.8138	0
6	Observed	25	52	10	1	1	6	9	20	0
	Average	0.68	0.231	1.3	0	0	1.5	1.222	0.4	0
	Variance	2.7267	0.3771	2.6778	0	0	4.3	5.1944	0.5684	0
7	Observed	111	260	102	69	141	19	69	146	22
	Average	1.045	0.381	2.343	0.754	0.504	2	0.797	0.445	2.364
	Variance	2.7343	0.6846	9.99	1.3943	1.0089	6.1111	1.6053	1.0073	7.9567
8	Observed	180	531	174	108	262	50	120	285	68
	Average	1.2	0.443	2.207	1.241	0.435	1.68	1.183	0.488	2.029
	Variance	3.6134	0.8623	5.1361	3.9976	0.7908	3.4057	3.5291	0.8282	6.3275
9	Observed	6	30	5	3	11	0	11	40	4
	Average	1.667	0.233	0.8	1	0.182	0	1.091	0.35	2.75
	Variance	16.6667	1.2195	1.7	1	0.1636	0	2.6909	0.4385	4.25
10	Observed	61	211	25	12	44	12	9	30	0
	Average	0.885	0.374	1.4	1.5	0.341	2.417	1	0.6	0
	Variance	2.0033	0.5687	3.75	6.6364	0.6485	3.3561	4	1.1448	0
11	Observed	375	1441	270	129	472	118	175	646	74
	Average	1.157	0.551	2.004	1.279	0.521	1.746	1.6	0.853	1.392
	Variance	3.6463	1.074	5.6171	3.4215	1.0781	9.3023	4.4138	1.707	4.269
12	Observed	373	1513	347	178	697	98	223	839	138
	Average	1.324	0.555	1.836	1.444	0.633	1.684	1.489	0.868	2.391
	Variance	3.5531	1.0818	6.0163	3.8641	1.1839	3.8061	4.4942	1.6209	8.0501

Table 77. HBW Trip Rate Comparisons by Household Life Cycle for Method of Retrieval[1].

HH Life Cycle	Difference	Valley			Austin			Amarillo		
		Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary	Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary	Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary
1	Statistical									
	Percent[2]									
2	Statistical									
	Percent									
3	Statistical	No	No	No	Yes	Yes	No	No	No	No
	Percent	13%	15%	24%	26%	54%	22%	3%	1%	2%
4	Statistical	No	No	No	Yes	No	No	No	No	No
	Percent	1%	10%	9%	14%	9%	6%	8%	9%	2%
5	Statistical									
	Percent									
6	Statistical									
	Percent									
7	Statistical	Yes	Yes	No	No	No	No	No	No	No
	Percent	159%	87%	27%	8%	10%	17%	17%	32%	18%
8	Statistical	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
	Percent	68%	71%	2%	66%	60%	4%	62%	54%	5%
9	Statistical									
	Percent									
10	Statistical									
	Percent									
11	Statistical	Yes	Yes	No	Yes	Yes	No	Yes	No	No
	Percent	116%	103%	6%	77%	83%	3%	126%	53%	32%
12	Statistical	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
	Percent	149%	74%	30%	153%	143%	4%	127%	115%	5%

[1]Blank cells indicate conditions where no valid comparisons could be made
[2]All percentages are displayed as rounded absolute values.

Table 78. HBNW Trip Rate Comparisons by Household Life Cycle for Method of Retrieval[1].

HH Life Cycle	Difference	Valley Respondent vs Proxy	Valley Respondent vs Diary	Valley Proxy vs Diary	Austin Respondent vs Proxy	Austin Respondent vs Diary	Austin Proxy vs Diary	Amarillo Respondent vs Proxy	Amarillo Respondent vs Diary	Amarillo Proxy vs Diary
1	Statistical	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
	Percent[2]	20%	17%	31%	12%	19%	27%	29%	17%	36%
2	Statistical	No	Yes	Yes	No	No	No	No	No	Yes
	Percent	37%	63%	72%	4%	39%	36%	275%	53%	88%
3	Statistical	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes
	Percent	53%	5%	38%	16%	29%	39%	58%	24%	52%
4	Statistical	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
	Percent	63%	10%	45%	63%	15%	48%	52%	12%	42%
5	Statistical	No	No	No				No		
	Percent	40%	9%	35%				26%		
6	Statistical	No	No	No				No		
	Percent	40%	11%	21%				40%		
7	Statistical	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes
	Percent	29%	17%	36%	38%	43%	59%	36%	16%	38%
8	Statistical	Yes	Yes	Yes	No	No	No	No	No	Yes
	Percent	23%	31%	44%	12%	13%	22%	11%	25%	32%
9	Statistical	No	No	Yes				No		
	Percent	132%	10%	61%				5%		
10	Statistical	Yes	No	No	No	No	Yes	No		
	Percent	52%	8%	29%	60%	8%	42%	49%		
11	Statistical	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
	Percent	22%	20%	35%	44%	2%	32%	54%	18%	23%
12	Statistical	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
	Percent	18%	7%	21%	28%	5%	26%	29%	8%	28%

[1]Blank cells indicate conditions where no valid comparisons could be made
[2]All percentages are displayed as rounded absolute values.

Table 79. NHB Trip Rate Comparisons by Household Life Cycle for Method of Retrieval[1].

HH Life Cycle	Difference	Valley			Austin			Amarillo		
		Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary	Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary	Respondent vs Proxy	Respondent vs Diary	Proxy vs Diary
1	Statistical	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes
	Percent[2]	49%	32%	55%	27%	63%	71%	71%	54%	73%
2	Statistical	No	Yes	Yes	No	No	No		Yes	
	Percent	94%	75%	87%	122%	80%	91%		72%	
3	Statistical	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Percent	191%	58%	86%	174%	46%	80%	121%	46%	76%
4	Statistical	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Percent	173%	43%	79%	80%	51%	73%	102%	52%	76%
5	Statistical	No	No	Yes				No		
	Percent	193%	58%	86%				37%		
6	Statistical	No	No	Yes				No		
	Percent	194%	48%	82%				206%		
7	Statistical	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
	Percent	174%	55%	84%	50%	62%	75%	79%	66%	81%
8	Statistical	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
	Percent	171%	46%	80%	185%	26%	74%	142%	42%	76%
9	Statistical	No	No	No				No		
	Percent	615%	108%	71%				212%		
10	Statistical	Yes	No	Yes	No	No	Yes	No		
	Percent	136%	37%	73%	340%	38%	86%	67%		
11	Statistical	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
	Percent	110%	42%	72%	145%	27%	70%	86%	15%	39%
12	Statistical	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
	Percent	139%	28%	70%	128%	14%	62%	72%	38%	64%

[1]Blank cells indicate conditions where no valid comparisons could be made.
[2]All percentages are displayed as rounded absolute values.

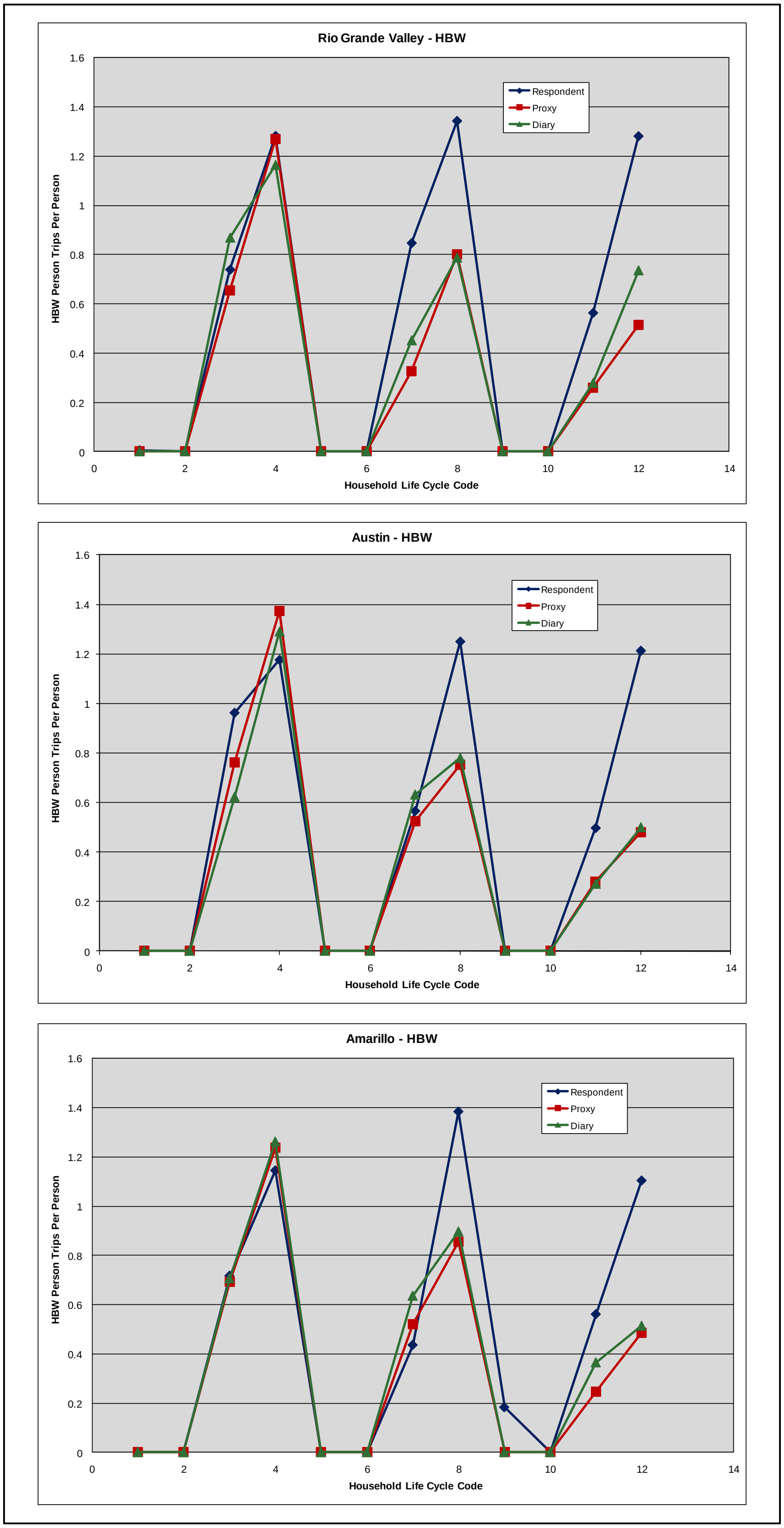


Figure 34. HBW Trip Rates by Household Life Cycle and Urban Area.

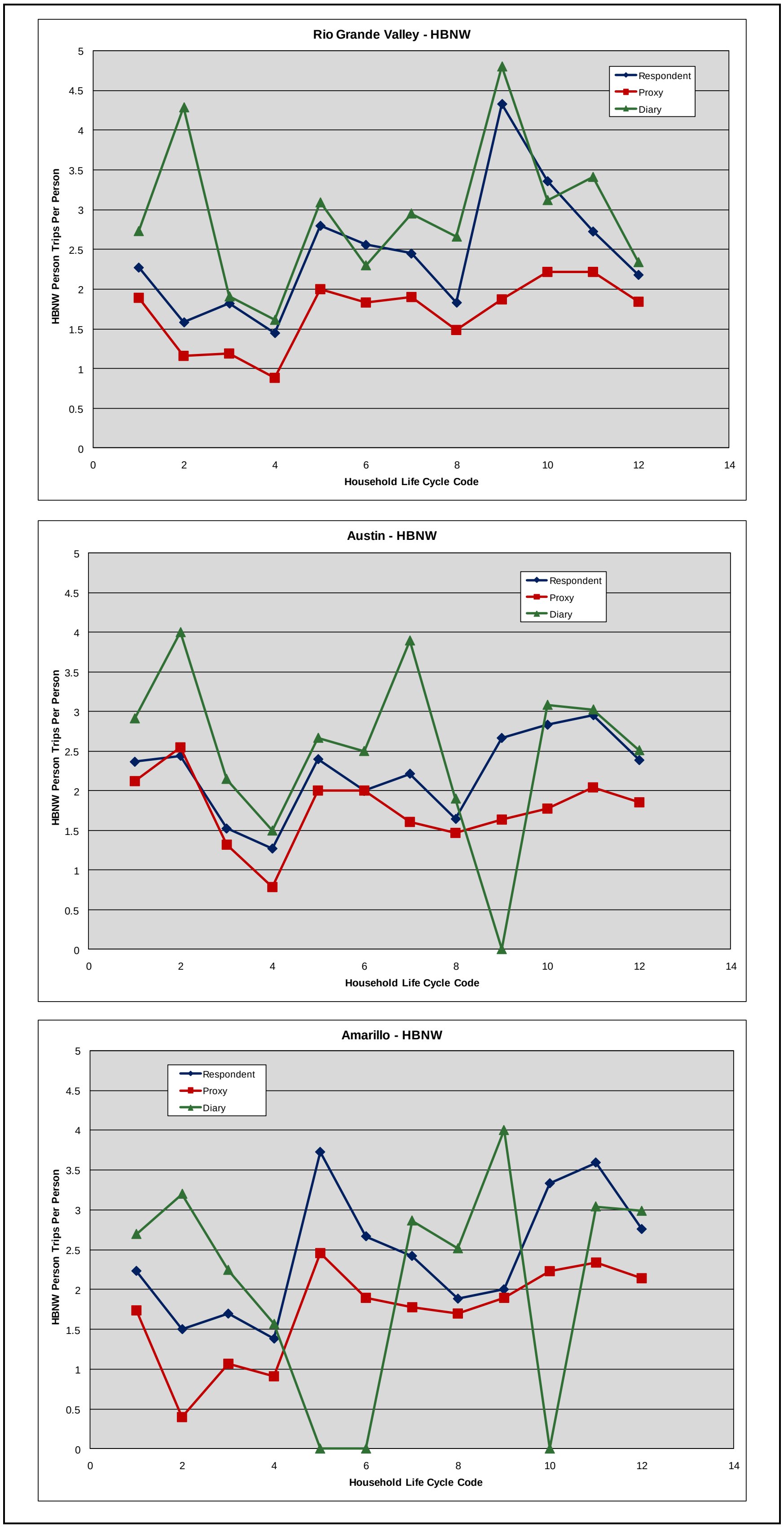


Figure 35. HBNW Trip Rates by Household Life Cycle and Urban Area.

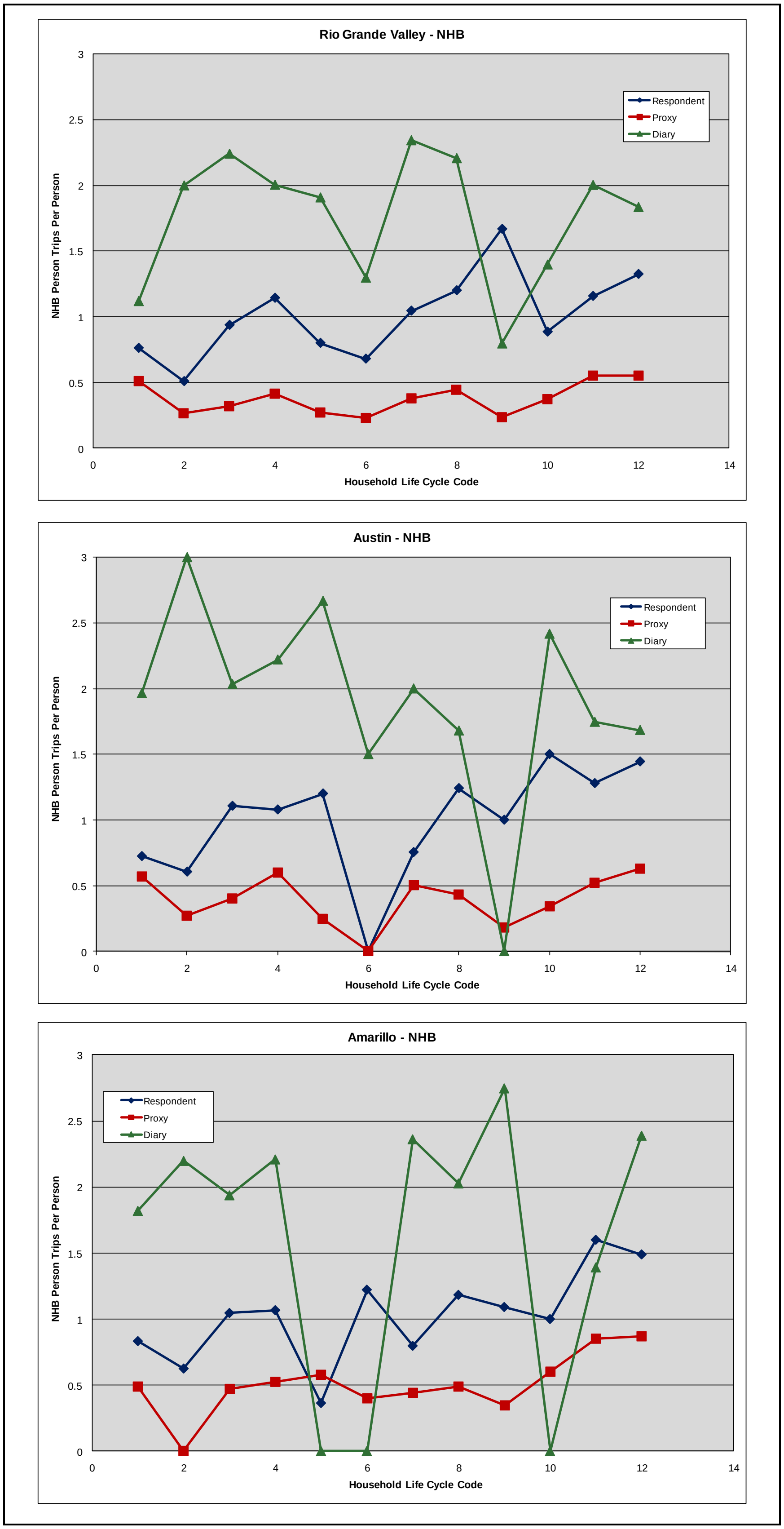


Figure 36. NHB Trip Rates by Household Life Cycle and Urban Area.

Trip rates were next compared between the three urban areas for each method of data retrieval. This comparison evaluates the trip rates to determine if the rates are similar between the areas for each method of data retrieval within each household life cycle. Tables 80 through 82 show the results for each trip purpose. For the respondent, proxy, and diary methods of data retrieval, a total of 18 paired trip rates could be compared for HBW trips. For HBW trips, only three (17 percent) paired rates were found to be statistically different for respondents, two (11 percent) for proxies and for diary. This indicates again strong similarities between the three areas in the average HBW trip rates for persons within households stratified by household life cycle. For HBNW and NHB trips, 32 paired trip rates for respondents could be compared, 34 rates for proxies, and 26 rates for diary. For HBNW trips, four (13 percent) of the respondent trip rates were found statistically different, seven (21 percent) of the proxy trip rates were found statistically different and two (8 percent) of the diary trip rates were found statistically different. For NHB trips, one (3 percent) of the respondent trip rates was found to be different, six (18 percent) of the proxy trip rates were found to be different and five (19 percent) of the diary trip rates were found to be different. Figures 37 through 39 present plots of the rates by method of data retrieval against the household life cycle categories. As indicated before, the trip rates for each type of data retrieval are very similar between the three areas being studied. This indicates that the influence of the method of data retrieval is consistent across urban areas.

For the final comparisons, trip rates were stratified by household size and income for each trip purpose. This is a two-way stratification with five categories of household size (1, 2, 3, 4, and 5+) and five categories of household income (0 - $14,999; $15,000 - $34,999; $35,000 - $49,999; $50,000 - $74,999; and $75,000 plus). Tables 83 through 85 present the trip data showing the number of observations, average person trips per person, and variance by method of data retrieval for each of the three urban areas. With the number of stratification cells involved, a number of them do not have any observations or the trip rates were zero. Cells with less than five observations or a trip rate of zero were not compared statistically.

The first comparison was between the methods of data retrieval for each urban area. Out of a possible 75 paired trip HBW rates that could be compared only 64 could be compared in the Valley, 57 could be compared in Austin, and 61 could be compared in Amarillo. These numbers vary between the areas due to the differences in the number of observations. For HBW trips in the Valley, a total of 22 (34 percent) of the paired trip rate comparisons were found statistically different. Interestingly only two of those were found in the comparisons between proxy and diary rates. The rest were split evenly between the other two comparisons (i.e., respondent versus proxy and respondent versus diary). For HBW trips in Austin, a total of 11 (19 percent) of the paired trip rate comparisons were found statistically different. Of those, only one occurred between proxy and diary rates. The rest were split evenly between the other two comparisons. For HBW trips in Amarillo, a total of 10 (16 percent) were found statistically different. None occurred between proxy and diary. The others were split fairly evenly between the other two comparisons. Plots of the two-way stratified trip rates for HBW trips in each area are presented in Figures 40 through 42. For all three areas, the majority of the trip rates compared was not significantly different implying that the method of data retrieval did not seem to impact the HBW trip rates.

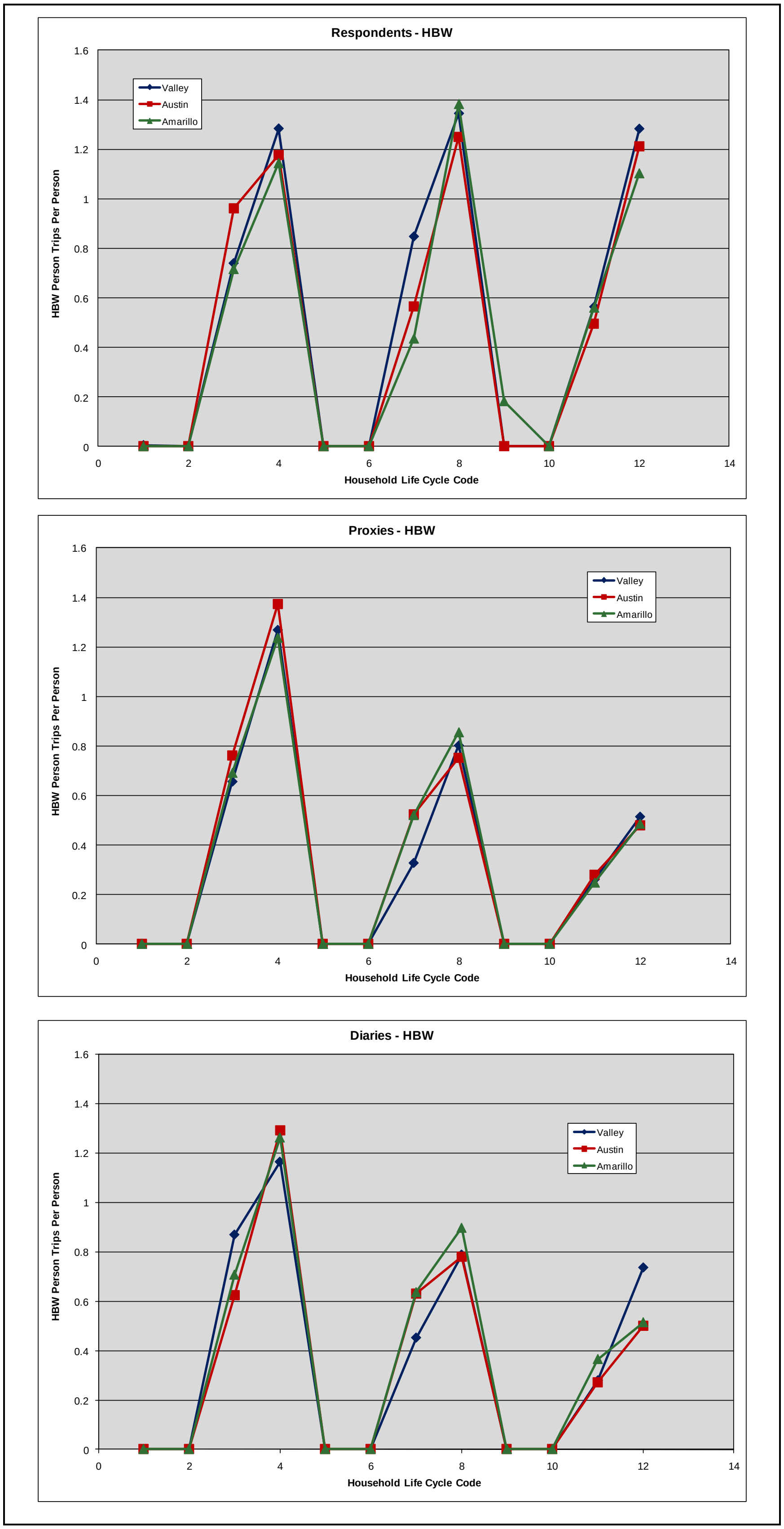


Figure 37. HBW Trip Rates by Household Life Cycle and Retrieval Method.

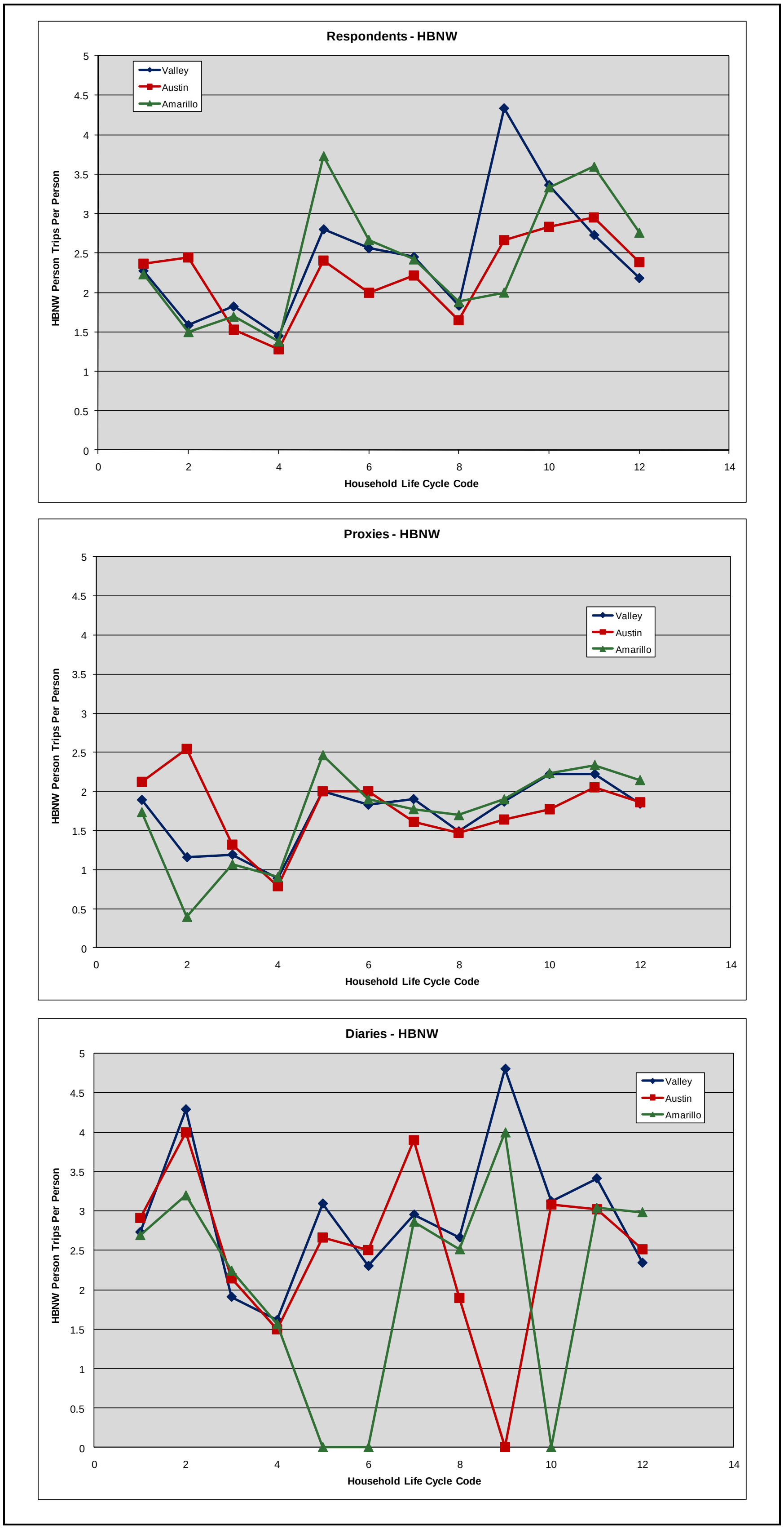


Figure 38. HBNW Trip Rates by Household Life Cycle and Retrieval Method.

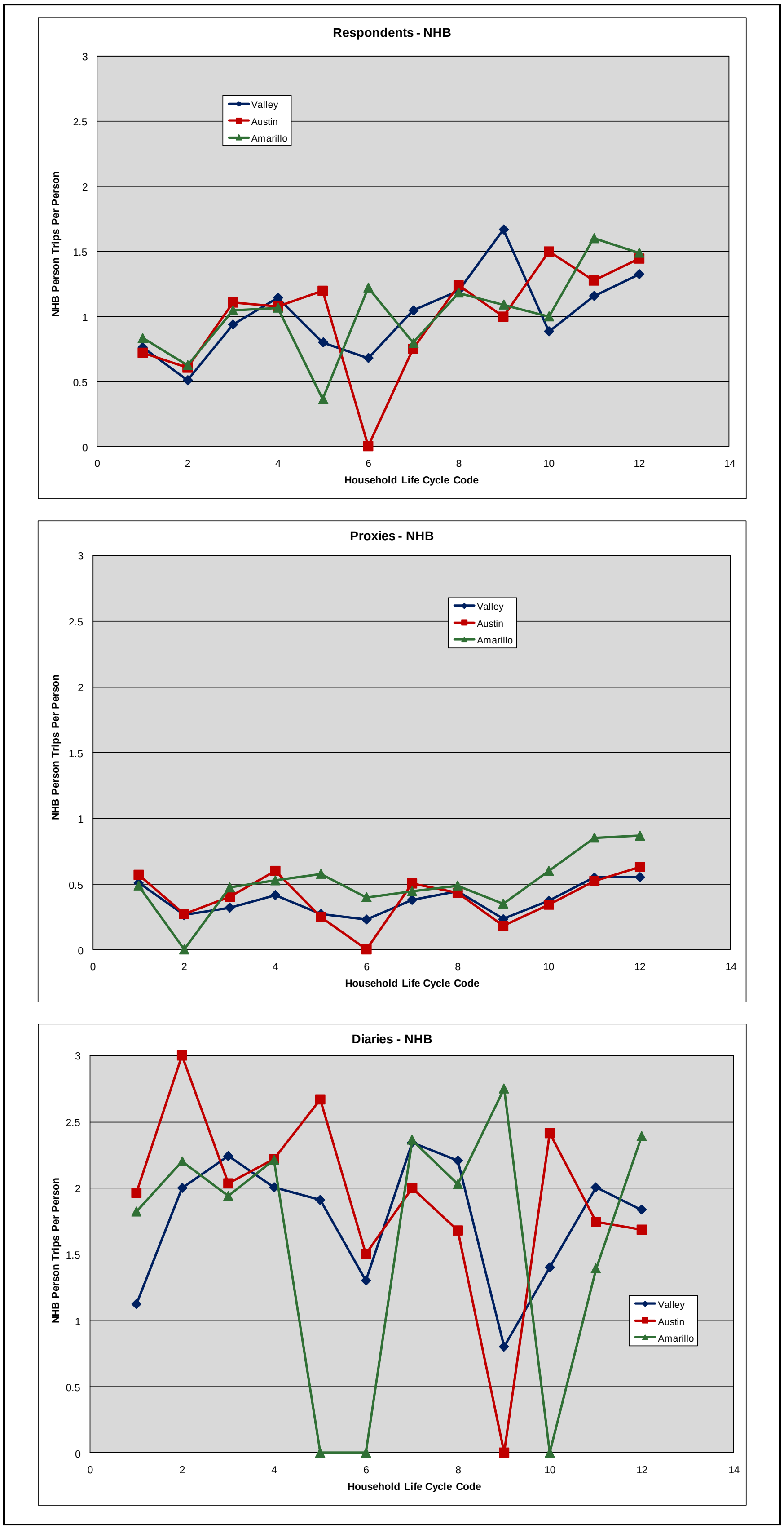


Figure 39. NHB Trip Rates by Household Life Cycle and Retrieval Method.

Table 80. HBW Trip Rate Comparisons by Household Life Cycle between Urban Areas.

HH Life Cycle	Difference	Respondent			Proxy			Diary		
		Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo	Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo	Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo
1	Statistical	No	No	No	No	No	No	No	No	No
	Percent[1]	26%	19%	35%	23%	10%	18%	578%	94%	71%
2	Statistical	No	No	No	Yes	No	No	No	No	No
	Percent	100%	100%	100%	100%	74%	100%	100%	100%	0%
3	Statistical	No	No	No	No	No	No	No	No	No
	Percent	17%	1%	18%	11%	11%	0%	32%	17%	12%
4	Statistical	No	No	No	No	No	No	No	No	No
	Percent	4%	5%	<1%	<1%	4%	4%	10%	15%	5%
5	Statistical	No	No	No	No	No	No	NA[2]	NA	NA
	Percent	0%	100%	100%	100%	136%	100%			
6	Statistical	NA	No	NA	NA	No	NA	No	NA	NA
	Percent		100%			35%		100%		
7	Statistical	No	Yes	No	No	No	No	No	No	No
	Percent	22%	97%	61%	19%	27%	10%	9%	15%	7%
8	Statistical	No	No	No	No	No	No	No	No	No
	Percent	9%	3%	11%	8%	4%	11%	6%	16%	10%
9	Statistical	NA	No	NA	No	No	No	NA	NA	NA
	Percent		100%		100%	100%	0%			
10	Statistical	No	Yes	No	No	Yes	No	No	NA	NA
	Percent	8%	100%	100%	30%	100%	100%	100%		
11	Statistical	No	No	No	No	No	No	No	No	No
	Percent	7%	7%	13%	2%	9%	11%	6%	24%	29%
12	Statistical	No	Yes	No	No	No	No	Yes	Yes	No
	Percent	7%	20%	12%	9%	9%	<1%	42%	49%	5%

[1]All percentages are displayed as rounded absolute values.
[2]NA represents condition where the number of observations was less than 5 and no comparison was made.

Table 81. HBNW Trip Rate Comparisons by Household Life Cycle between Urban Areas.

HH Life Cycle	Difference	Respondent			Proxy			Diary		
		Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo	Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo	Valley Vs Austin	Valley vs Amarillo	Austin vs Amarillo
1	Statistical	No	No	No	No	No	No	No	No	No
	Percent	2%	4%	5%	4%	3%	7%	3%	5%	8%
2	Statistical	Yes	No	No	Yes	No	Yes	No	No	No
	Percent	33%	9%	64%	50%	27%	158%	12%	31%	17%
3	Statistical	No	No	No	No	No	No	No	No	No
	Percent	14%	0%	12%	11%	12%	1%	10%	10%	<1%
4	Statistical	No	No	No	Yes	No	Yes	No	No	No
	Percent	9%	3%	11%	24%	1%	20%	<1%	11%	10%
5	Statistical	No	No	Yes	No	No	No	NA	NA	NA
	Percent	25%	25%	40%	2%	14%	12%			
6	Statistical	NA	No	NA	NA	No	NA	No	NA	NA
	Percent		3%			<1%		8%		
7	Statistical	No	No	No	No	No	No	No	No	No
	Percent	11%	14%	22%	15%	13%	2%	21%	2%	29%
8	Statistical	No	No	No	No	Yes	Yes	No	No	No
	Percent	8%	10%	17%	3%	17%	15%	22%	6%	13%
9	Statistical	NA	No	NA	Yes	Yes	No	NA	NA	NA
	Percent		59%		37%	40%	1%			
10	Statistical	No	No	No	No	No	No	No	NA	NA
	Percent	19%	11%	25%	9%	6%	14%	13%		
11	Statistical	No	Yes	Yes	No	Yes	Yes	No	No	No
	Percent	5%	23%	19%	5%	7%	11%	14%	10%	3%
12	Statistical	No	Yes	No	No	Yes	Yes	No	Yes	No
	Percent	6%	20%	15%	2%	10%	12%	5%	19%	15%

Table 82. NHB Trip Rate Comparisons by Household Life Cycle between Urban Areas.

HH Life Cycle	Difference	Respondent			Proxy			Diary		
		Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo	Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo	Valley vs Austin	Valley vs Amarillo	Austin vs Amarillo
1	Statistical	No	No	No	No	No	No	Yes	Yes	No
	Percent	2%	10%	9%	13%	25%	14%	40%	41%	2%
2	Statistical	No	No	No	No	Yes	Yes	No	No	No
	Percent	3%	9%	7%	1%	100%	100%	3%	23%	27%
3	Statistical	No	No	No	No	No	No	No	No	No
	Percent	12%	18%	7%	4%	24%	27%	12%	18%	5%
4	Statistical	No	No	No	No	No	No	No	No	No
	Percent	15%	1%	13%	17%	12%	5%	14%	17%	3%
5	Statistical	No	No	No	No	No	No	NA	NA	NA
	Percent	33%	47%	120%	64%	29%	57%			
6	Statistical	NA	No	NA	NA	No	NA	No	NA	NA
	Percent		43%			14%		40%		
7	Statistical	No	No	No	No	No	No	No	No	No
	Percent	38%	10%	20%	19%	8%	14%	20%	12%	27%
8	Statistical	No	No	No	No	Yes	No	Yes	No	No
	Percent	13%	<1%	15%	6%	27%	23%	39%	3%	26%
9	Statistical	NA	No	NA	No	No	No	NA	NA	NA
	Percent		41%		157%	7%	64%			
10	Statistical	No	No	No	No	No	No	No	NA	NA
	Percent	33%	18%	23%	5%	40%	43%	35%		
11	Statistical	No	No	No	No	Yes	Yes	No	Yes	No
	Percent	4%	23%	20%	5%	36%	39%	26%	50%	19%
12	Statistical	No	No	No	No	Yes	Yes	No	Yes	Yes
	Percent	6%	15%	10%	10%	35%	28%	3%	23%	25%

Table 83. HBW Trip Data by Household Income and Size Groups for All Persons.

Inc Grp	HH Size	Measure	Valley Respondent	Valley Proxy	Valley Diary	Austin Respondent	Austin Proxy	Austin Diary	Amarillo Respondent	Amarillo Proxy	Amarillo Diary
1	1	Observed	101	0	12	69	0	8	39	0	8
		Average	0.099	0	0.25	0.159	0	0	0.077	0	0.25
		Variance	0.1701	0	0.2045	0.283	0	0	0.1255	0	0.5
	2	Observed	148	138	28	45	45	2	55	55	12
		Average	0.236	0.203	0.429	0.178	0.222	0	0.255	0.164	0.167
		Variance	0.5219	0.4111	0.6243	0.3313	0.404	0	0.6377	0.2505	0.3333
	3	Observed	133	257	84	14	28	12	45	90	3
		Average	0.632	0.374	0.357	0.143	0.5	0.167	0.422	0.478	0
		Variance	1.0072	0.6021	0.6179	0.1319	0.7778	0.3333	0.9768	1.0838	0
	4	Observed	131	370	83	7	21	0	44	132	4
		Average	0.595	0.311	0.422	0.857	0.429	0	0.409	0.348	0.5
		Variance	0.812	0.5129	0.9054	1.4762	0.6571	0	0.8055	0.6868	1
	5+	Observed	173	839	77	17	80	6	29	143	16
		Average	0.405	0.297	0.195	0.176	0.2	0	0.345	0.224	0.375
		Variance	0.6493	0.5526	0.4484	0.2794	0.3392	0	0.5197	0.3862	0.65
2	1	Observed	52	0	17	87	0	12	48	0	17
		Average	0.442	0	1.176	0.644	0	0.583	0.396	0	0.353
		Variance	0.7613	0	1.6544	0.9762	0	0.8106	0.5421	0	0.4926
	2	Observed	167	159	64	141	142	37	117	117	34
		Average	0.371	0.428	0.781	0.461	0.585	0.73	0.274	0.496	0.294
		Variance	0.6565	0.7653	1.3165	0.7931	0.9396	2.0916	0.5452	0.8901	0.4563
	3	Observed	79	155	93	64	128	15	73	146	24
		Average	0.747	0.594	0.634	1.016	0.672	0.733	0.562	0.575	0.625
		Variance	1.0889	0.8922	1.2127	0.9998	0.8521	2.6381	0.9718	0.8391	1.5489
	4	Observed	158	442	72	47	141	8	54	162	24
		Average	1.063	0.543	0.597	0.851	0.539	0.375	0.574	0.451	0.417
		Variance	1.359	0.8791	0.9482	1.0426	0.8788	0.5536	0.7397	0.8329	0.6014
	5+	Observed	196	870	131	46	225	23	78	369	18
		Average	0.796	0.469	0.42	0.609	0.373	0.261	0.538	0.374	0.278
		Variance	1.1992	0.8592	0.7224	0.8657	0.6457	0.4743	0.7972	0.6478	0.3301
3	1	Observed	31	0	10	49	0	9	12	0	6
		Average	0.452	0	1.2	0.898	0	0.667	0.583	0	0.333
		Variance	0.6559	0	1.7333	1.0102	0	0.5	0.9924	0	0.2667
	2	Observed	92	74	56	89	89	38	53	53	32
		Average	0.478	0.568	0.571	0.697	0.775	0.684	0.566	0.755	0.531
		Variance	0.9995	1.0433	0.8675	1.2365	1.2217	0.9246	0.7504	1.1502	0.7732
	3	Observed	51	90	75	48	96	12	49	98	18
		Average	0.725	0.889	0.827	0.75	0.792	0.667	0.837	0.714	0.833
		Variance	0.8031	1.4482	1.0912	0.9574	0.9877	0.7879	1.2645	1.2784	1.2059
	4	Observed	99	293	72	50	150	20	47	141	24
		Average	1.232	0.618	0.708	1.04	0.607	0.4	1.17	0.532	0.75
		Variance	1.1802	1.0246	0.8856	1.2637	1.0724	0.5684	1.753	0.8222	1.587
	5+	Observed	98	454	112	34	157	8	30	126	15
		Average	0.867	0.482	0.562	1.029	0.522	0.125	0.9	0.405	0.267
		Variance	1.1678	0.833	0.897	1.1809	0.7255	0.125	1.0586	0.8669	0.4952

Table 83. HBW Trip Data by Household Income and Size Groups for All Persons (continued).

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
4	1	Observed	26	0	7	21	0	5	25	0	4
		Average	1.385	0	1	0.762	0	0.4	0.4	0	1
		Variance	3.0462	0	1	0.6905	0	0.8	0.5833	0	1.3333
	2	Observed	66	57	43	89	87	22	62	62	34
		Average	0.788	0.807	0.767	0.719	0.713	0.682	0.742	0.742	0.647
		Variance	1.0312	0.9799	1.4208	0.977	0.9513	0.7987	1.2766	0.8831	1.205
	3	Observed	43	68	60	36	72	30	57	114	24
		Average	1.326	0.765	0.933	1.111	0.778	1.267	1.07	1.018	0.875
		Variance	0.9867	1.3468	1.1819	1.0159	0.9077	2.0644	1.3164	1.4156	1.0707
	4	Observed	49	139	72	35	106	23	71	213	28
		Average	1.592	0.612	0.792	0.943	0.481	0.435	1.197	0.549	0.679
		Variance	0.9133	0.8915	1.6039	0.8202	0.7663	0.7115	1.3891	0.7676	1.1892
	5+	Observed	46	210	74	33	157	30	39	170	47
		Average	1.043	0.419	0.743	0.909	0.389	0.5	0.744	0.471	0.489
		Variance	1.4647	0.7901	1.4811	1.2102	0.6494	1.0172	1.143	0.8187	1.0379
5	1	Observed	12	0	0	16	0	3	29	0	7
		Average	0.917	0	0	0.938	0	0.667	0.828	0	0.714
		Variance	0.9924	0	0	1.3958	0	0.3333	1.1478	0	0.5714
	2	Observed	98	87	49	90	88	30	78	78	54
		Average	0.765	0.747	1.143	0.956	1.102	1.067	0.91	0.91	0.907
		Variance	1.0474	0.9818	1.4583	1.3238	1.4492	2.3402	1.4074	0.9139	1.4064
	3	Observed	45	89	40	75	150	42	67	134	33
		Average	1.133	1.079	1.075	0.933	0.74	0.833	1.015	0.918	0.879
		Variance	0.9818	1.3233	1.7122	1.1441	0.9991	1.0691	1.1664	1.0684	1.3598
	4	Observed	74	218	40	65	195	84	70	210	44
		Average	1.257	0.628	0.85	0.692	0.456	0.5	1.229	0.538	0.545
		Variance	1.0976	0.8705	1.259	0.7788	0.6824	0.6145	1.5992	0.7665	0.9979
	5+	Observed	66	292	43	38	173	63	39	168	34
		Average	1.152	0.61	0.721	0.947	0.376	0.317	0.923	0.315	0.5
		Variance	1.1152	0.9673	1.6346	0.9701	0.6545	0.6073	0.8097	0.5765	0.6212

Table 84. HBNW Trip Data by Household Income and Size Groups for All Persons.

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	1	Observed	101	0	12	69	0	8	39	0	8
		Average	1.931	0	2.333	1.928	0	2.75	1.538	0	3.5
		Variance	2.7051	0	6.9697	2.0094	0	7.9286	1.413	0	2
	2	Observed	148	138	28	45	45	2	55	55	12
		Average	1.689	1.428	2.857	2.4	1.911	7	1.527	1.473	3.417
		Variance	2.1748	1.794	5.8307	2.7	2.901	2	2.0316	2.0687	6.0833
	3	Observed	133	257	84	14	28	12	45	90	3
		Average	2.105	1.623	2.845	2.143	2	2.917	1.978	1.356	3.333
		Variance	3.3676	2.2359	6.1806	3.8242	2.3704	5.1742	7.0677	3.198	9.3333
	4	Observed	131	370	83	7	21	0	44	132	4
		Average	2.137	1.705	3.048	2.286	1.476	0	2.523	1.455	1
		Variance	4.2425	2.4523	5.6318	2.2381	1.1619	0	5.0925	2.5246	1.3333
	5+	Observed	173	839	77	17	80	6	29	143	16
		Average	2.399	1.763	3.805	2.647	1.675	2.5	3.517	1.944	3.125
		Variance	5.3923	2.1692	7.8168	4.8676	1.8677	3.1	9.1158	2.518	11.1833
2	1	Observed	52	0	17	87	0	12	48	0	17
		Average	2.212	0	2.529	1.782	0	2.417	2.083	0	3
		Variance	2.7975	0	5.1397	1.8471	0	1.7197	2.6738	0	3.875
	2	Observed	167	159	64	141	142	37	117	117	34
		Average	1.964	1.572	2.156	1.972	1.62	2.162	2.009	1.581	2.5
		Variance	3.8059	2.6387	4.1339	2.5849	2.0388	2.0841	2.543	3.0041	3.7727
	3	Observed	79	155	93	64	128	15	73	146	24
		Average	1.873	1.394	2.161	1.516	1.312	4.067	2.164	1.329	1.708
		Variance	1.9068	1.9026	5.615	3.2696	1.6339	5.2095	3.7782	2.5256	2.9112
	4	Observed	158	442	72	47	141	8	54	162	24
		Average	1.88	1.654	2.556	2.213	1.582	4.875	2.407	1.901	2
		Variance	4.6415	2.6078	5.3208	6.3016	2.3165	2.6964	6.2837	2.102	4.2609
	5+	Observed	196	870	131	46	225	23	78	369	18
		Average	2.776	1.911	2.847	2.652	1.778	1.87	3.923	2.317	2.944
		Variance	7.1186	3.0106	5.4688	6.143	2.629	2.3913	13.7862	4.0595	2.9967
3	1	Observed	31	0	10	49	0	9	12	0	6
		Average	2.194	0	1.7	1.98	0	2.333	1.583	0	2
		Variance	2.828	0	3.5667	2.3121	0	2.75	1.3561	0	2
	2	Observed	92	74	56	89	89	38	53	53	32
		Average	1.891	1.297	2.036	1.629	1.36	2.316	1.83	1.585	2.594
		Variance	3.2188	1.9926	4.1442	2.145	2.3011	4.4381	2.9129	2.4398	4.378
	3	Observed	51	90	75	48	96	12	49	98	18
		Average	2.314	1.589	2.227	1.792	1.26	3	2.204	1.622	1.722
		Variance	3.6196	2.8516	4.2047	2.3387	1.6683	5.2727	6.5408	2.4849	2.3301
	4	Observed	99	293	72	50	150	20	47	141	24
		Average	2.222	2	2.694	1.88	1.753	2.05	1.553	1.887	2.75
		Variance	5.8073	2.9384	5.9053	5.2098	1.9723	2.05	5.5569	2.987	2.4565
	5+	Observed	98	454	112	34	157	8	30	126	15
		Average	2.827	2.068	2.321	2.471	1.726	3.625	3.2	2.087	4
		Variance	6.3098	2.8761	4.4903	5.5294	2.8796	4.5536	10.5793	3.2163	1.1429

Table 84. HBNW Trip Data by Household Income and Size Groups for All Persons (continued).

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
4	1	Observed	26	0	7	21	0	5	25	0	4
		Average	1.731	0	2	1.571	0	2.4	2.44	0	2.25
		Variance	2.1246	0	1.6667	1.3571	0	1.3	3.7567	0	6.9167
	2	Observed	66	57	43	89	87	22	62	62	34
		Average	2.015	1.579	2.07	1.73	1.598	1.864	1.79	1.161	2.147
		Variance	3.0613	3.0695	3.7331	2.3583	2.5223	2.79	2.4635	2.2359	4.1292
	3	Observed	43	68	60	36	72	30	57	114	24
		Average	2.302	1.912	2.133	1.833	1.472	1.967	1.632	1.579	1.875
		Variance	8.2159	3.007	2.5243	4.7714	1.9429	2.792	3.7011	2.3521	6.5489
	4	Observed	49	139	72	35	106	23	71	213	28
		Average	1.755	1.878	2.569	2	1.717	3.13	2.07	1.826	3.143
		Variance	4.8554	2.3255	5.6853	3.0588	1.2906	4.4822	5.7807	2.3989	6.3492
	5+	Observed	46	210	74	33	157	30	39	170	47
		Average	2.891	2.305	2.743	3.152	1.981	2.667	3.846	1.876	2.702
		Variance	5.6546	2.8253	3.0702	7.3201	1.6727	3.1954	14.2389	2.5941	5.6485
5	1	Observed	12	0	0	16	0	3	29	0	7
		Average	1.833	0	0	1.625	0	2	1.931	0	1.571
		Variance	2.3333	0	0	2.5167	0	1	4.2808	0	1.619
	2	Observed	98	87	49	90	88	30	78	78	54
		Average	2.031	1.563	1.918	1.689	1.33	1.733	1.744	1.346	1.741
		Variance	3.6176	2.9465	4.6182	2.7561	1.7867	4.2713	3.4918	2.9046	3.7806
	3	Observed	45	89	40	75	150	42	67	134	33
		Average	1.867	1.281	2.1	1.867	1.453	1.738	2.119	1.619	3.515
		Variance	4.5273	1.977	3.0154	2.7387	2.1287	3.4663	5.0461	2.7338	8.4451
	4	Observed	74	218	40	65	195	84	70	210	44
		Average	2.297	1.784	2.425	3.062	2.149	2.333	2.843	2.362	3.023
		Variance	5.883	2.3819	5.4814	6.1837	3.1273	4.6104	8.6271	3.9641	5.046
	5+	Observed	66	292	43	38	173	63	39	168	34
		Average	2.333	1.808	2.07	2.816	1.855	2.762	3.41	2.482	3.029
		Variance	6.9026	3.3445	2.4474	4.857	2.3453	5.9908	8.3009	3.1494	3.9082

Table 85. NHB Trip Data by Household Income and Size Groups for All Persons.

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
1	1	Observed	101	0	12	69	0	8	39	0	8
		Average	0.752	0	3.25	0.623	0	1.125	0.538	0	2.75
		Variance	1.6681	0	6.0227	1.2971	0	4.4107	0.7287	0	7.0714
	2	Observed	148	138	28	45	45	2	55	55	12
		Average	0.419	0.348	2.036	0.578	0.467	0.5	0.527	0.455	2.5
		Variance	0.6669	0.5059	5.5172	0.9768	0.6182	0.5	0.8465	0.697	6.8182
	3	Observed	133	257	84	14	28	12	45	90	3
		Average	0.579	0.265	1.929	1	0.643	1.5	1.067	0.478	1.667
		Variance	1.382	0.336	7.7298	2.1538	1.127	2.4545	2.8364	1.1062	2.3333
	4	Observed	131	370	83	7	21	0	44	132	4
		Average	0.679	0.286	1.675	2	0.619	0	1.023	0.409	0.25
		Variance	1.5272	0.4705	5.149	9.3333	1.1476	0	3.7902	0.9611	0.25
	5+	Observed	173	839	77	17	80	6	29	143	16
		Average	0.607	0.293	1.935	1.294	0.312	2.833	0.966	0.622	0.875
		Variance	1.1469	0.4652	3.6405	4.4706	0.4707	6.1667	2.3916	1.1522	4.1167
2	1	Observed	52	0	17	87	0	12	48	0	17
		Average	1.404	0	3.706	1.011	0	3.583	0.917	0	1.941
		Variance	2.5984	0	17.3456	2.4766	0	13.3561	1.1418	0	2.3088
	2	Observed	167	159	64	141	142	37	117	117	34
		Average	1.096	0.686	1.766	0.858	0.57	2.324	0.872	0.667	1.676
		Variance	5.7498	1.7106	5.0394	3.3797	1.1262	10.2252	2.6645	2.0172	3.9831
	3	Observed	79	155	93	64	128	15	73	146	24
		Average	0.709	0.413	2	0.562	0.312	2.333	0.932	0.432	1.583
		Variance	1.3372	0.6985	6.7174	1.0119	0.5787	1.6667	2.7036	1.0332	6.7754
	4	Observed	158	442	72	47	141	8	54	162	24
		Average	0.816	0.391	2.194	0.809	0.312	3	1.056	0.463	1.583
		Variance	3.2209	0.8555	10.356	1.8538	0.4734	5.4286	2.2421	0.6477	5.0362
	5+	Observed	196	870	131	46	225	23	78	369	18
		Average	1.224	0.452	1.504	0.783	0.356	0.522	1.513	0.886	1.333
		Variance	3.9186	0.9338	4.6519	1.7739	0.7302	0.8972	4.5907	1.987	0.5882
3	1	Observed	31	0	10	49	0	9	12	0	6
		Average	0.774	0	2.9	0.816	0	3.667	1.667	0	2.5
		Variance	0.9806	0	11.2111	1.1947	0	5.75	2.2424	0	5.1
	2	Observed	92	74	56	89	89	38	53	53	32
		Average	0.685	0.432	2.375	0.82	0.539	2.053	0.698	0.491	2.031
		Variance	1.493	0.8241	11.6932	1.8764	0.8422	5.7809	0.984	0.9086	4.4183
	3	Observed	51	90	75	48	96	12	49	98	18
		Average	1.686	0.678	2.107	0.896	0.292	2	1.102	0.612	2
		Variance	4.4596	1.9737	5.8804	1.9676	0.3982	3.4545	3.6352	1.4563	6.8235
	4	Observed	99	293	72	50	150	20	47	141	24
		Average	1.515	0.747	2.236	1.02	0.52	0.7	0.702	0.539	2.208
		Variance	3.3135	1.3401	6.1266	2.7139	1.0969	1.1684	1.518	0.6788	5.2156
	5+	Observed	98	454	112	34	157	8	30	126	15
		Average	1.439	0.654	1.482	1.088	0.51	3	0.967	0.802	2.2
		Variance	3.5684	1.2378	4.0177	2.992	0.8541	2.2857	3.2747	1.4243	3.6

Table 85. NHB Trip Data by Household Income and Size Groups for All Persons (continued).

Inc Grp	HH Size	Measure	Valley			Austin			Amarillo		
			Respondent	Proxy	Diary	Respondent	Proxy	Diary	Respondent	Proxy	Diary
4	1	Observed	26	0	7	21	0	5	25	0	4
		Average	1.231	0	5.857	1.238	0	1.6	1.4	0	2.5
		Variance	2.1046	0	22.1429	2.5905	0	3.8	2.9167	0	4.3333
	2	Observed	66	57	43	89	87	22	62	62	34
		Average	1.379	0.754	1.837	1.022	0.598	3	1.258	0.403	2.588
		Variance	2.4851	1.3315	5.9491	2.0904	1.1502	14.6667	3.7684	0.7692	10.0677
	3	Observed	43	68	60	36	72	30	57	114	24
		Average	1.163	0.279	2.5	0.611	0.569	1.5	1.175	0.754	1.958
		Variance	5.3776	0.3536	7.6102	0.873	0.8965	3.0862	2.8615	2.7002	7.346
	4	Observed	49	139	72	35	106	23	71	213	28
		Average	0.735	0.432	1.417	0.971	0.604	1.522	1.451	0.765	1.964
		Variance	1.4906	0.8558	4.4155	1.205	0.7748	4.8972	4.5654	1.6805	11.369
	5+	Observed	46	210	74	33	157	30	39	170	47
		Average	1.891	0.867	2.662	1.455	0.815	1.733	1.308	0.776	1.617
		Variance	6.1435	1.5611	7.624	3.9432	1.4208	4.4092	3.6397	1.4172	3.6762
5	1	Observed	12	0	0	16	0	3	29	0	7
		Average	1.083	0	0	1.75	0	2	1.759	0	3.714
		Variance	4.0833	0	0	2.8667	0	1	3.5468	0	7.9048
	2	Observed	98	87	49	90	88	30	78	78	54
		Average	1.214	0.724	1.857	1.4	0.773	2.133	0.987	0.577	2.074
		Variance	4.1907	1.6439	4.7917	3.0742	1.6719	4.6023	2.0907	0.7927	5.7303
	3	Observed	45	89	40	75	150	42	67	134	33
		Average	1.689	0.719	2.5	1.667	0.66	1.524	0.955	0.53	1.576
		Variance	4.901	2.0907	8.0513	5.3063	1.5279	3.036	1.8313	0.8374	4.0019
	4	Observed	74	218	40	65	195	84	70	210	44
		Average	2.122	0.734	1.55	1.877	0.703	1.702	2.057	1.048	2.432
		Variance	6.1357	1.68	3.0744	4.8909	1.4368	3.7055	7.0692	2.0743	9.1813
	5+	Observed	66	292	43	38	173	63	39	168	34
		Average	1.788	0.606	1.395	2.053	0.653	2.222	2.436	0.905	3.176
		Variance	8.6312	1.0024	2.4828	6.6458	1.5999	15.4014	5.1471	1.6675	10.7558

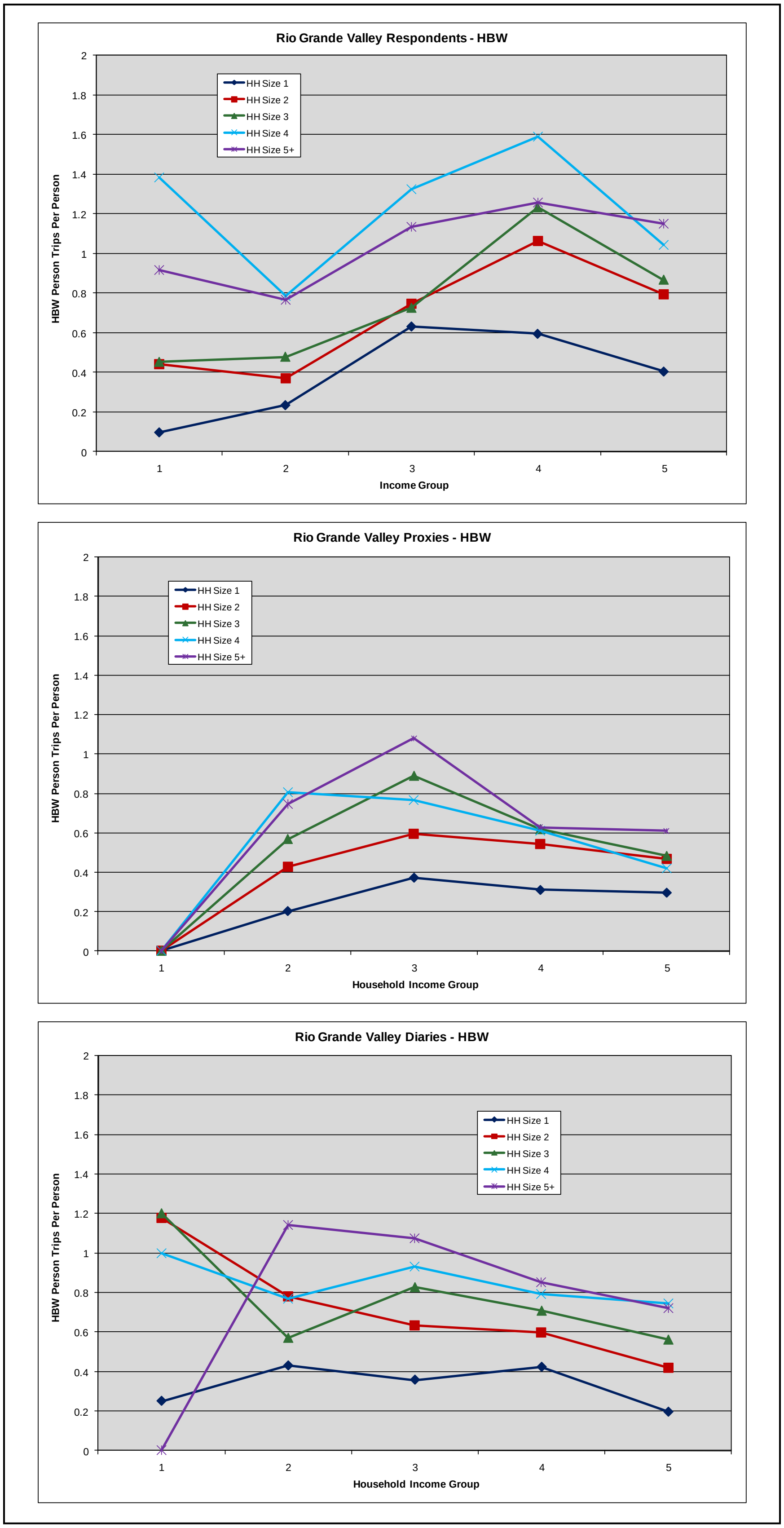


Figure 40. Rio Grande Valley HBW Trip Rates by Household Size and Income Group.

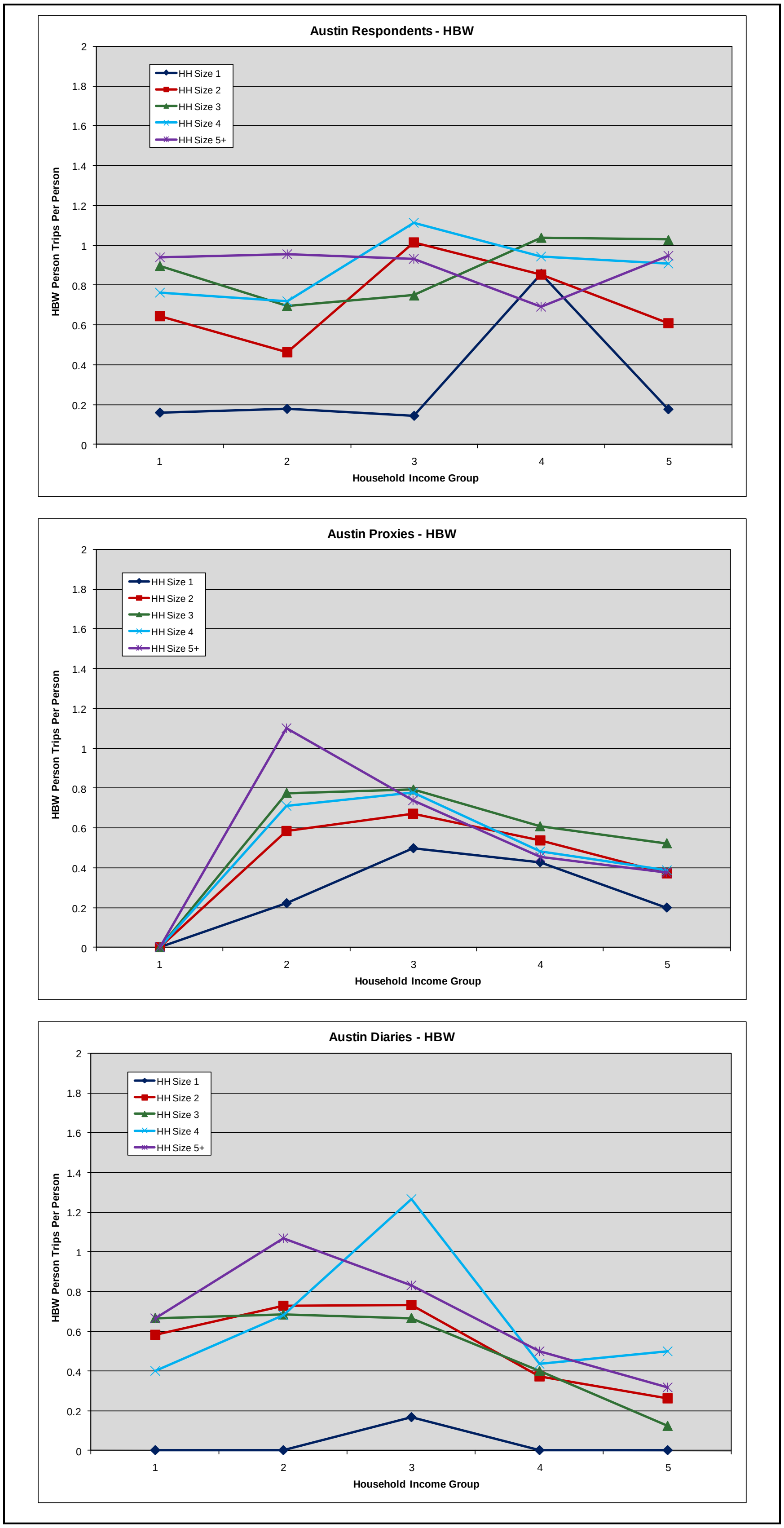


Figure 41. Austin Area HBW Trip Rates by Household Size and Income Group.

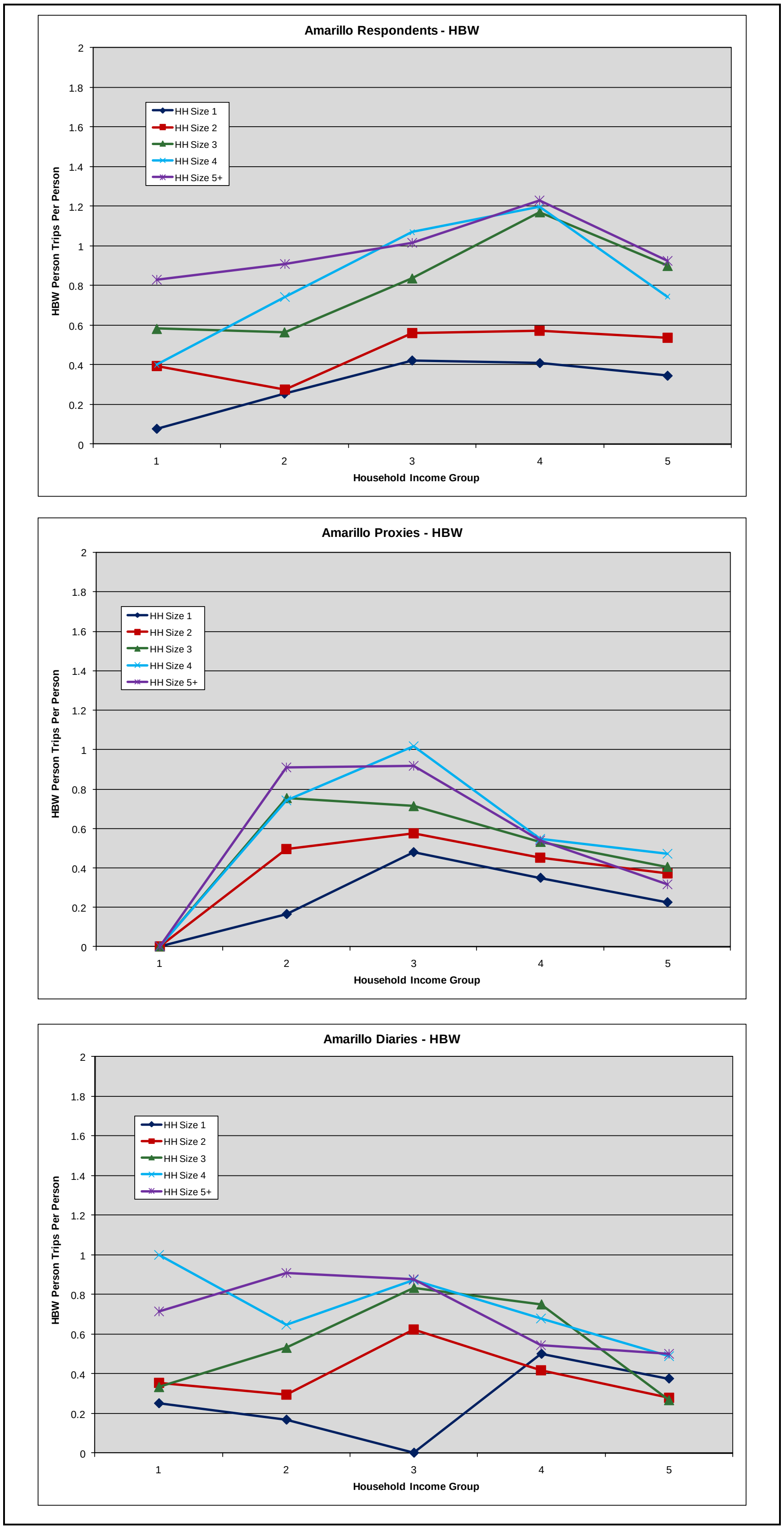


Figure 42. Amarillo Area HBW Trip Rates by Household Size and Income Group.

Out of a possible 75 paired trip HBNW rates that could be compared only 64 could be compared in the Valley, 60 could be compared in Austin, and 60 could be compared in Amarillo. For HBNW trips in the Valley, a total of 27 (42 percent) paired trip rate comparisons were found to be statistically different. The majority (nearly half) were between proxy and diary. In Austin, a total of 17 (28 percent) were found to be statistically different. Slightly more than half were between proxy and diary. In Amarillo, a total of 20 (33 percent) were found to be statistically different. Slightly less than half were between proxy and diary. Plots of the two-way stratified HBNW trip rates for each of the three areas are shown in Figures 43 through 45. Out of a possible 75 paired trip NHB rates that could be compared only 64 could be compared in the Valley, 60 could be compared in Austin, and 60 could be compared in Amarillo. For NHB trips in the Valley, a total of 51 (80 percent) of the paired trip rate comparisons were found to be statistically different. In Austin, a total of 32 (53 percent) were found to be statistically different and in Amarillo, a total of 36 (60 percent) were found to be statistically different. For NHB trips, the method of data retrieval appears to impact the resulting estimates of trips. Plots of the two-way stratified NHB trip rates for each of the three areas are presented in Figures 46 through 48. Table 86 presents the frequency distribution of the percent difference in the trip rates compared. It appears the method of data retrieval has the largest impact on the NHB trip rates. The impact on HBNW is slightly worse than HBW, but NHB trip rates varied significantly in the majority of comparisons between the methods of data retrieval.

Table 86. Frequency Distribution of Differences between Retrieval Methods by Area and Trip Purpose.

Absolute Percent Difference	Number of Trip Rate Pairs between Retrieval Methods								
	Valley			Austin			Amarillo		
	HBW	HBNW	NHB	HBW	HBNW	NHB	HBW	HBNW	NHB
< 10%	12	10	1	8	13	3	16	6	0
10% to < 25%	13	19	4	18	11	4	14	19	7
26% to < 50%	14	33	8	9	26	8	9	24	13
50% or Greater	25	2	51	22	10	45	21	11	40
Totals	64	64	64	57	60	60	60	60	60

Trip rates were next compared between the areas to identify any similarities in the rates by purpose and method of data retrieval. The number of paired trip rate comparisons made varied by method of data retrieval. For example, no observations were made for proxy for one person households since this condition could not exist. In some of the other cells, there were less than five observations and these were not used in the statistical comparisons. For the respondent method of data retrieval, a total of 75 paired trip rates could be compared. For the proxy method, a total of 60 paired trip rates could be compared and for the diary method, a total of 65 paired trip rates could be compared.

For HBW trips, nine (12 percent) of the 75 paired trip rates for the respondent method of data retrieval were found to be statistically different. For the proxy method, five (8 percent) of the 60 paired trip rates were found to be statistically different and for the diary method, four (6 percent) of the 63 paired trip rates were found to be statistically different.

For HBNW trips, five (7 percent) of the 75 paired trip rates for the respondent method of data retrieval were found to be statistically different. For the proxy method, eight (13 percent) of the 60 paired trip rates were found to be statistically different and for the diary method, 10 (15 percent) of the 65 paired trip rates were found to be statistically different.

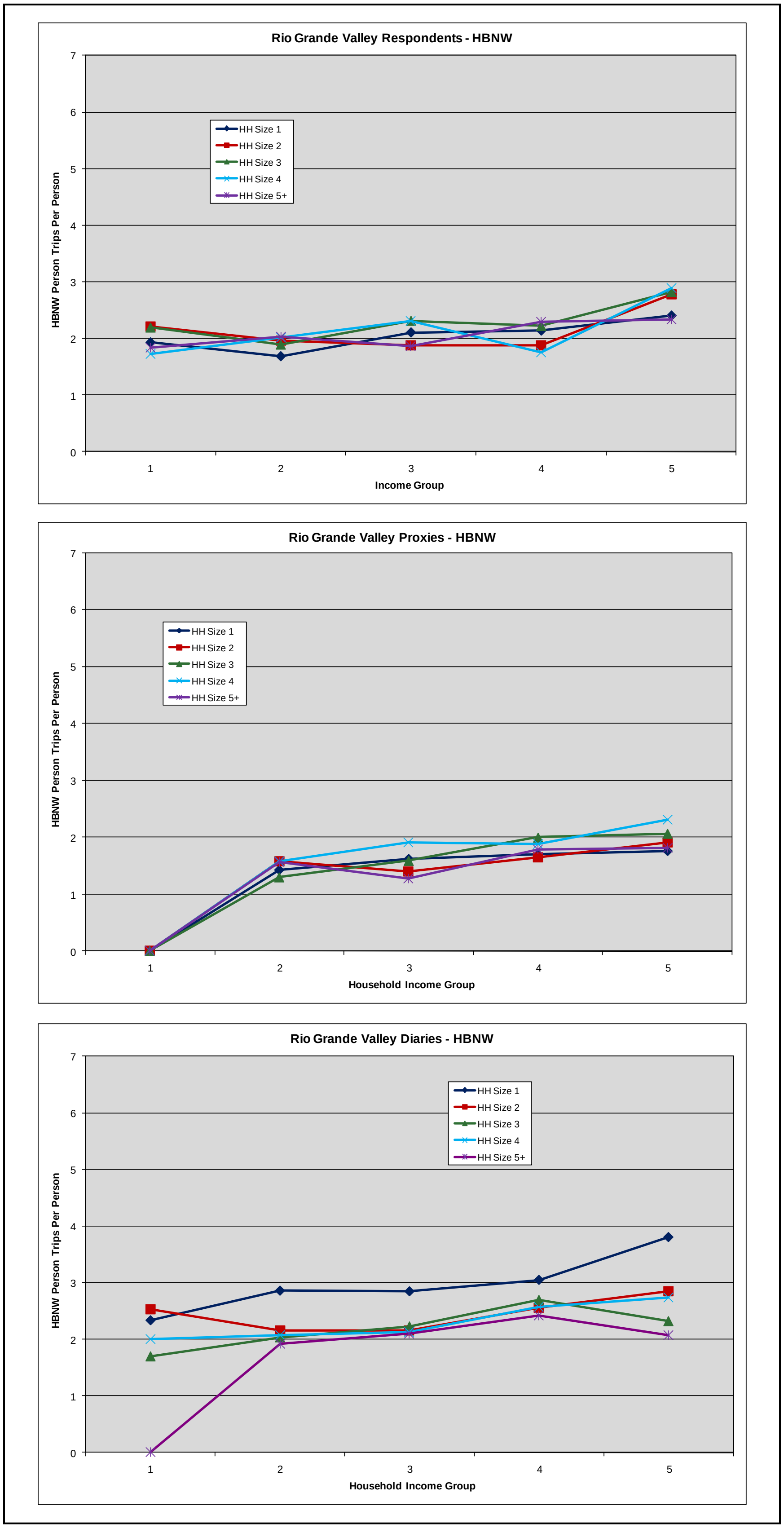


Figure 43. Rio Grande Valley HBNW Trip Rates by Household Size and Income Group.

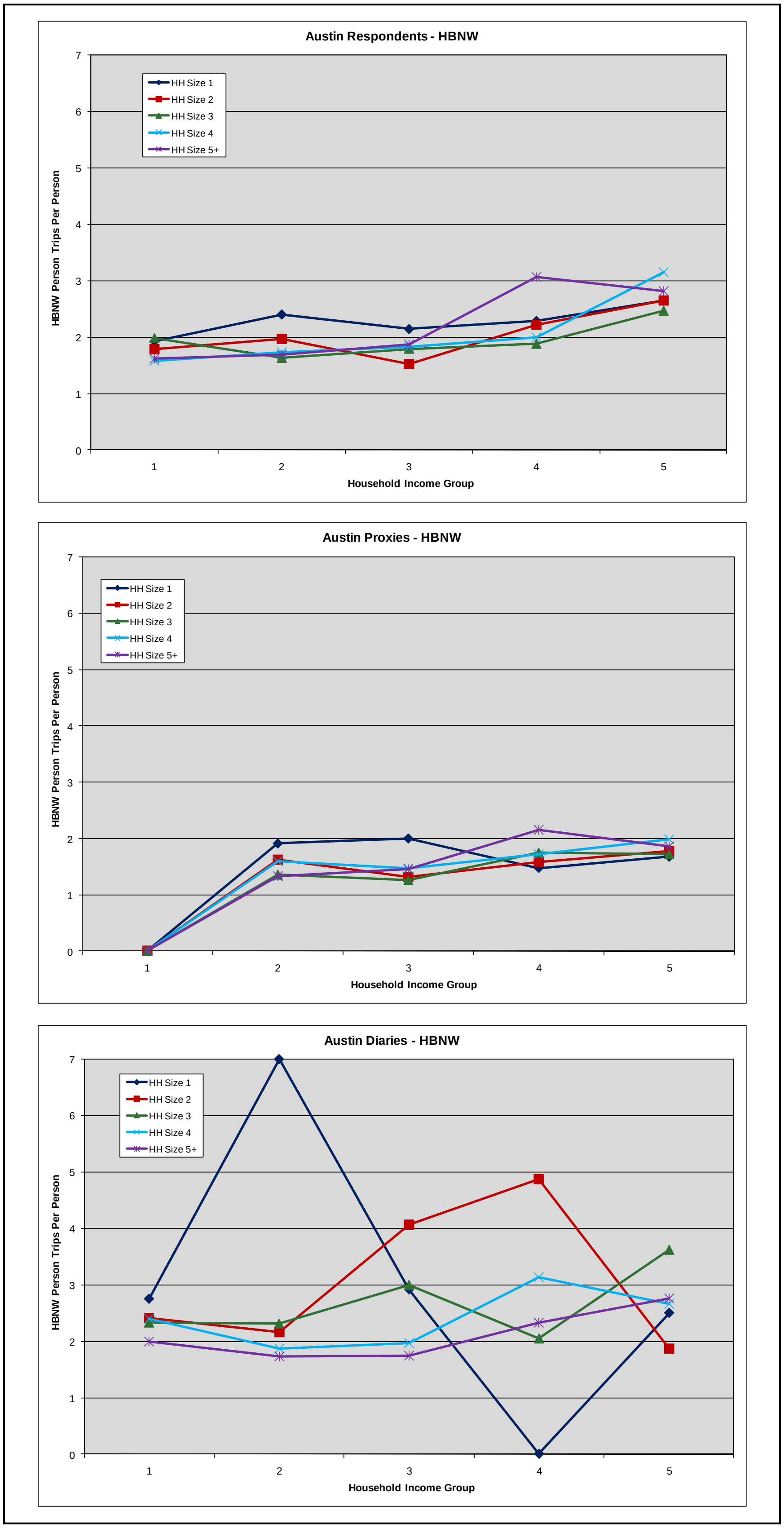


Figure 44. Austin Area HBNW Trip Rates by Household Size and Income Group.

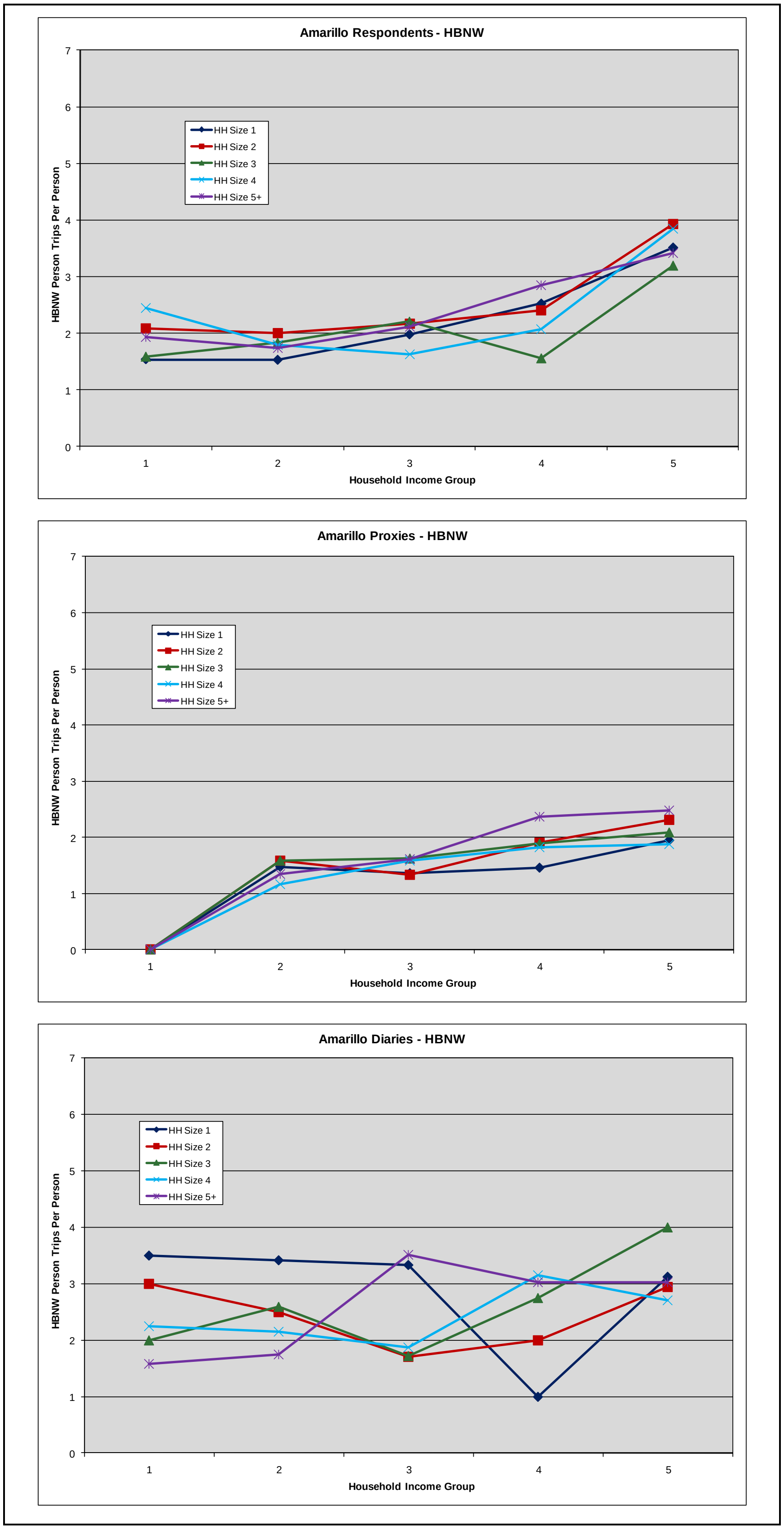


Figure 45. Amarillo Area HBNW Trip Rates by Household Size and Income Group.

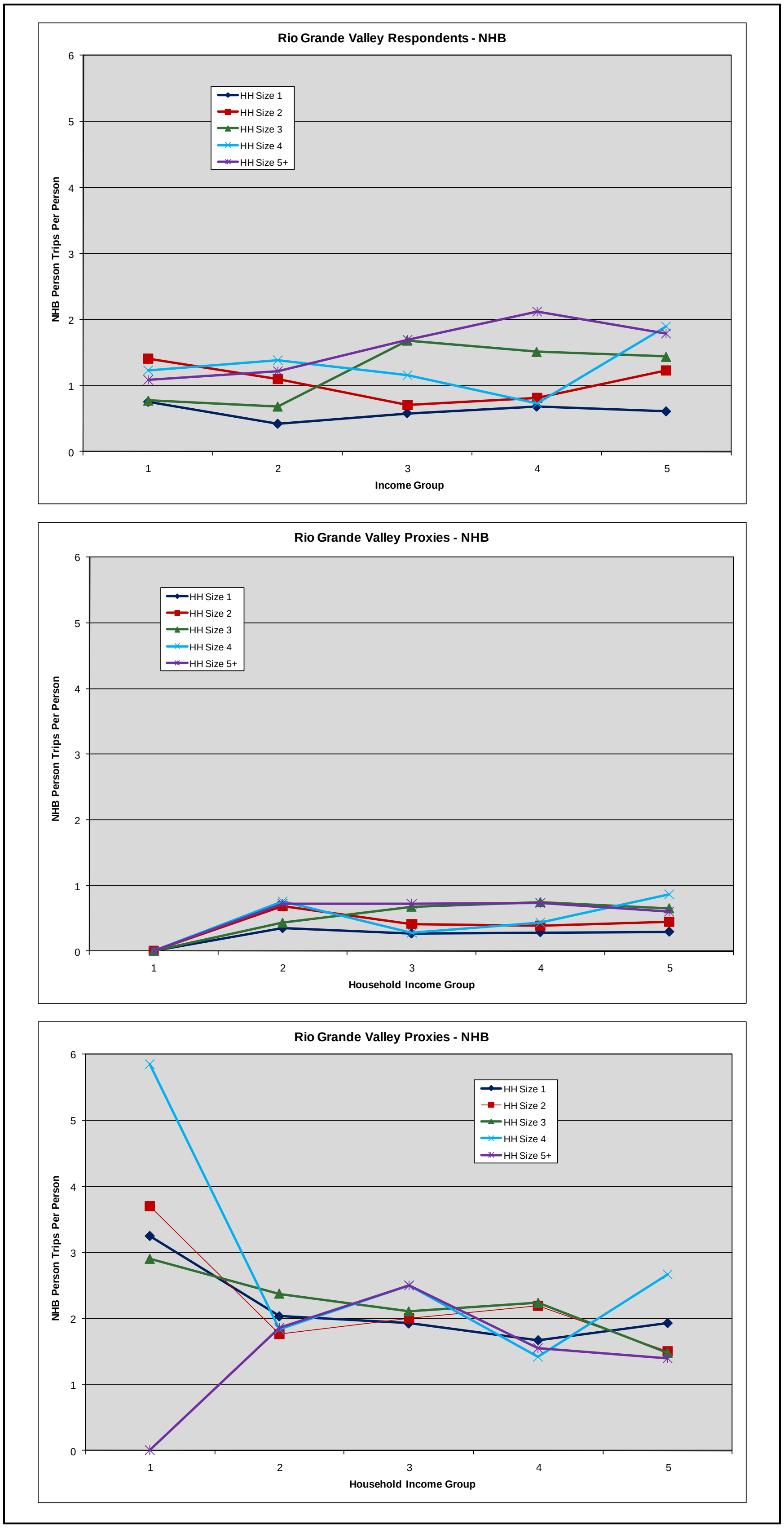


Figure 46. Rio Grande Valley NHB Trip Rates by Household Size and Income Group.

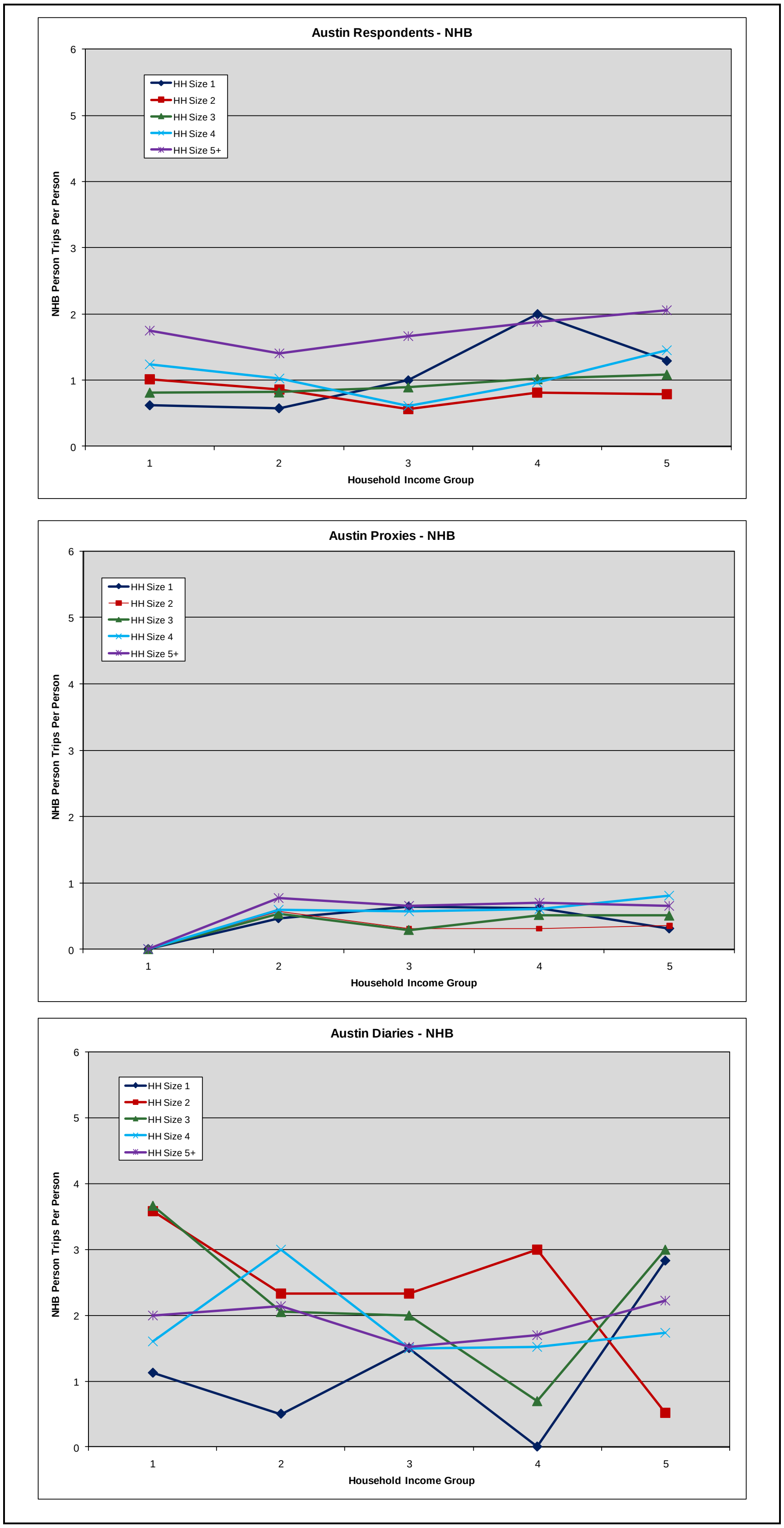


Figure 47. Austin Area NHB Trip Rates by Household Size and Income Group.

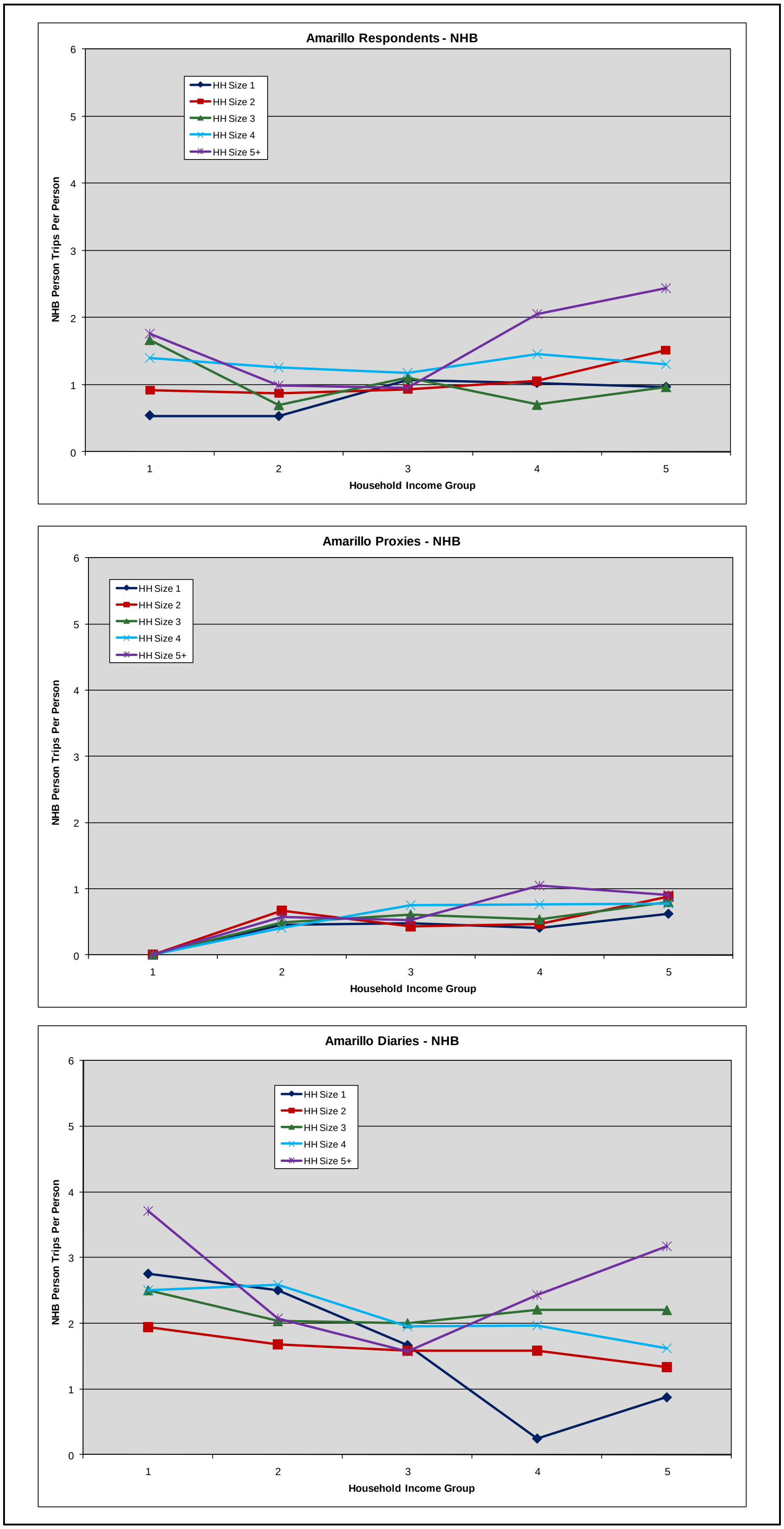


Figure 48. Amarillo Area NHB Trip Rates by Household Size and Income Group.

For NHB trips, seven (9 percent) of the 75 paired trip rates for the respondent method of data retrieval were found to be statistically different. For the proxy method, 15 (25 percent) of the 60 paired trip rates were found to be statistically different and for the diary method, ten (15 percent) of the 65 paired trip rates were found to be statistically different.

Based on the statistical comparisons, the trip rates for each method of data retrieval are similar between the three areas. Table 87 presents frequency distributions for the number of paired trip rates in terms of the absolute percent difference in values. This shows that even though the differences in trip rates were not statistically significant (i.e., the differences could be attributed to chance) the differences in values could be quite large.

Table 87. Frequency Distribution of Rate Differences between Areas by Data Retrieval Type and Trip Purpose.

Absolute Percent Difference	Number of Trip Rate Pairs between Areas								
	Respondent			Proxy			Diary		
	HBW	HBNW	NHB	HBW	HBNW	NHB	HBW	HBNW	NHB
< 10%	13	22	13	12	26	12	14	17	12
10% to < 25%	27	36	22	32	25	12	11	26	14
26% to < 50%	20	16	27	14	9	26	12	16	19
50% or Greater	15	1	13	2	0	10	28	6	20
Totals	75	75	75	60	60	60	65	65	65

Summary of Findings

The household survey data from three urban areas, the Rio Grande Valley (referred to as Valley), Austin, and Amarillo, were processed to create data files containing various household and person characteristics and the number of trips made by each person in each household (see Table 41). These files were used to compile the number of trips made by individuals grouped into three categories: respondent (the individual reported their travel and activities themselves), proxy (the individual's travel and activity was reported by another person in the household), and diary (the individual returned a completed travel and activity diary). The objective was to identify, measure, and evaluate any differences in the number of trips reported between the three methods of data retrieval: respondent, proxy, and diary. For this research, the primary variable of interest was person trips per person. None of the data analyzed were weighted. The three household travel and activity surveys were conducted using the same methodology and survey instruments. The sample sizes varied with 2,607 households surveyed in the Valley, 1,499 households surveyed in Austin, and 1,521 households surveyed in Amarillo. The total number of persons included in these surveys was 17,781.

Person trips per person for each group (respondent, proxy, and diary) were compiled, compared, and evaluated in the following arrangements:

- Aggregate total person trips per person for all persons, males only, and females only for each urban area
- Person trips per person stratified by age cohort (15 cohorts) for all persons, males only, and females only for each urban area
- Person trips per person stratified by person life cycle (4 categories) for all persons for each urban area
- Person trips per person stratified by household life cycle (12 categories) for all persons for each urban area
- Person trips per person stratified by household size and income (5 size groups by 5 income ranges) for all persons for each urban area
- Total home based work (HBW), home based non-work (HBNW), and non-home based (NHB) person trip per person for all persons for each urban area
- HBW, HBNW, and NHB person trips per person stratified by age cohort (15 cohorts) for all persons for each urban area
- HBW, HBNW, and NHB person trips per person stratified by person life cycle (4 categories) for all persons for each urban area
- HBW, HBNW, and NHB person trips per person stratified by household life cycle (12 categories) for all persons for each urban area
- HBW, HBNW, and NHB person trips per person stratified by household size and income (5 size groups by 5 income ranges) for all persons for each urban area

Person trip rates were compared between respondent and proxy, respondent and diary, and proxy and diary to determine if the difference was statistically significant at a confidence level of 95 percent or if the difference could be attributed to chance. Percent difference was also examined in terms of absolute percentage. The following summarize the principal findings from these analyses:

1. Aggregate average person trip rates for respondent were 25 to 45 percent higher than those for proxy. The rates for diary were 58 to 96 percent higher than those for proxy.
2. Average person trip rates for males and females when stratified by age cohort were not statistically different. For that reason, rates were not examined by male and female in the other stratifications.
3. Based on the trip frequency distributions for the three urban areas, 34 to 45 percent of the persons represented by proxy only reported two trips. For the respondent method, the percent of persons reporting only two trips ranged from 23 to 31 percent. This percentage for the diary method ranged from 16 to 20 percent.

4. When stratified by age cohort, the trip rates for the respondent method were higher than the rates for the proxy method in all of the comparable cases with the difference ranging from 8 percent to 83 percent. The trip rates for the diary method were higher than the rates for the proxy method in all but one case with the difference ranging from -10 percent to 152 percent. This was generally found to be true for all of the stratifications examined, i.e., trip rates for the respondent and diary methods were higher than those for the proxy method. There were some exceptions but very few.
5. When comparing trip rates by trip purpose, it was found that when stratified by age cohort, the HBW trip rates for the proxy method were generally higher than those for the respondent method and the diary method in nearly 70 percent of the cases. For HBNW and NHB trips, the rates for the respondent and diary methods were significantly higher than those for the proxy method. It appears there is a tendency to over report HBW trips and under report HBNW and NHB trips in the proxy method. This was also found to be the case in the majority of comparisons made for the other stratifications.
6. Trip rates were also compared between the three urban areas for each method of data retrieval. It was found that in a majority of these comparisons, the trip rates were essentially the same for the three areas for each method of data retrieval. This implies the raw survey data may be combined between urban areas and weighted to represent local conditions within each area to develop trip rates for modeling purposes.

Recommendations

It is clear from the analysis in this research that the use of proxies results in an under reporting of total travel. This under reporting is more prevalent in the reporting of HBNW and NHB travel and the data indicates there may be some over reporting of HBW travel. The potential impact of this on travel demand modeling and estimates of travel is significant. For example, in the Valley household survey only 698 households were surveyed with no proxies. Of that total, 268 were one person households where a proxy was not possible. This means that only 18 percent of the households surveyed in the Valley did not have anyone represented by a proxy. That percentage for Austin and Amarillo was 13 percent. These percentages may be misleading because individuals under the age of 15 are nearly always represented by proxy as minors. Households with one adult and one or more children then would have one or more individuals represented by proxy. For the three urban areas, the persons above the age of 14 that were represented by proxy were nearly 50 percent. The under reporting for adults represented by proxy is considered significant. As a result, the following recommendations are made:

1. Modify requirements for vendors performing household surveys to allow no more than 20 percent of individuals over the age of 15 to be represented by proxy. Vendors should be encouraged to have a household member complete and return a diary when they are unavailable for interview.
2. Modify current household survey analyses to include the development of adjustment rates by age cohort and trip purpose (HBW, HBNW, and NHB) for individuals represented by proxy. These adjustment rates should be developed in the analysis of the survey data and inserted into the person records for application in the weighting process used to developed estimates of trips and household trip rates.
3. Additional research should be under taken to examine the feasibility of combining un-weighted household surveys from different areas and using the combined data to develop household trip rates for urban areas that do not have a household survey. The rates should be developed by weighting the survey data to represent the local conditions for the urban area being modeled.

CHAPTER 4: EXTERNAL SURVEYS

LITERATURE REVIEW

The purpose for this task was to examine the state-of-the-practice in external surveys in other states for comparison to TxDOT external survey methods and practice. To acquire information for this task, researchers reviewed external survey reports and research articles and presentations on this topic. At this point, researchers have not found any ‗bid specifications' for external surveys, though two proposals for surveys were obtained and reviewed. Additionally, researchers found a guide for the conduct of external surveys developed by another state Department of Transportation (DOT) (Ohio) in 2004 (*43*). Source material for this task was identified through internet searches, consultants, and professional contacts, and list-servers. In addition to consultants, researchers also contacted survey sponsors (state DOT's, Metropolitan Planning Organizations (MPO's) and/or regional planning agencies) to obtain input relative to items such as quality control, data review/checks, and details on how vehicles were classified.

Researchers acquired information on 15 different external surveys from 14 states to address the scope of work for this task. Using these surveys, researchers reviewed 10 different elements of external surveys for comparison to TxDOT survey practice. The results of these reviews are provided in the following paragraphs.

Survey Methodology

The types of surveys methods utilized were reviewed for low volume and high volume sites as well as for non-commercial and commercial vehicle surveys. For low volume sites, the traditional intercept interview method using a survey station set-up with a traffic control plan (TCP) and law enforcement was used in seven external surveys reviewed. This method was used in the majority of low volume external sites. Several surveys (Philadelphia (*44*), Phoenix (*45*), Denver (*46*)) noted using the ‗platooning' method for bringing vehicles into the survey station in groups equal to the number of surveyors and not allowing another ‗platoon' into the site until the previous group was released and clear. This platooning method is the same as TxDOT current practice.

The majority of intercept surveys reviewed were conducted in the ‗outbound' direction for traffic leaving the study area. However, intercept surveys in several areas were conducted for both directions of traffic and in two areas (Berkeley-Charleston (*47*), SC and Kansas City, MO (phone conversation with Chris Tathum, ETC Institute, December 2006)) intercept surveys were conducted on traffic entering the study areas. For license capture surveys, surveys were conducted for both directions of traffic in the large majority of surveys reviewed using this method.

Four external surveys reviewed used an intercept postcard mail back method at low volume sites. Under this method, surveys were handed-out to motorists at intercept stations for them to mail back. One of these four surveys (Raleigh-Durham, N.C. (*48*, *49*)) used an intercept interview method during non-peak hours, and then switched to distributing postcard mail back surveys during peak periods.

Two surveys reviewed (Los Angeles, CA (*50*), Tampa, FL (*51*)), used a license mail-out method at all survey sites. The Los Angeles survey did not include any low-volume sites (as defined by TxDOT practice), though the Tampa survey did include low volume sites. One survey (Nashville, TN) (*52*) used a license match method (without survey mail out) at all external survey sites, both low and high volume.

Technology

Under the interview intercept method, most surveys were recorded using a paper survey instrument, though tablet personal computers (PC) were used in two surveys reviewed. (Note: these do not include any surveys in Texas). Several surveys mentioned color coding survey instruments to distinguish survey direction, non-commercial verses commercial forms, or time of day. As done in Texas, some surveys mentioned the use of handheld radios to coordinate the flagging of vehicles into intercept survey sites. For the postcard mail back survey in Chattanooga (*53*), respondents were given the option to complete the survey on-line – though this option yielded a very low response rate.

For methods involving license capture, a video camcorder was most frequently used to record plates. Most video license capture efforts used data reduction software to process and transcribe video recordings of plates into a license plate database, though some surveys manually transcribed the plates without the benefit of reduction software. One (Tampa, FL) (*51*) survey did not allow the use of video to capture license data (saying it was too intrusive), instead they used digital cameras and recorded plates manually by visual observation. The Nashville survey (*52*) used audio micro-cassette recorders and video camcorders to capture plate numbers. They noted problems using micro cassette recorders in the field, noting the recordings were often hard to understand due to background noise. An external survey in Little Rock, AR (*51*) used observers with binoculars to record license plate numbers.

Survey Design

When available, survey designs were reviewed for intercept and mail back survey forms for non-commercial and vehicles. Not all external surveys reviewed included copies of their survey instruments.

The key data elements collected in all intercept interview surveys included trip origin and destination, trip purpose, vehicle occupancy, vehicle type, and residency. Other data elements commonly included questions on interim stops made, time left last location, the frequency of the trip being made, fuel type, and study area or region entry/exit information. One survey also asked vehicle ownership to determine if the vehicle was for business or personal use.

Most, if not all, external survey forms reviewed had fewer questions than TxDOT intercept surveys. For example, the Denver (*46*), Philadelphia (*44*), and ODOT (*43*) intercept interview surveys included 11, 13, and 15 questions, respectively. The Denver and ODOT questionnaires were designed as a two-minute survey.

As expected, video mail out and intercept postcard survey forms reviewed contained fewer questions than the intercept interview surveys. Like the personal interview surveys, the mail back surveys all included the key questions on trip O&D, purpose, trip start and end times, vehicle occupancy, and trip frequency. Some mail back surveys also asked questions on vehicle type, intermediate stops made, and household demographics. The video mail back survey in Raleigh, NC, (*49*) included eight questions, while the one in Los Angeles (*50*) included 10 questions. Researchers did not find any instances where surveys were mailed out for commercial vehicles, though it was found to be common for postcard surveys to be distributed to commercial vehicles.

Like TxDOT surveys, the commercial survey forms reviewed generally contained the same (or near the same) questions as the non-commercial surveys but also included questions for gross vehicle weight and type of cargo being hauled. Also like TxDOT practice, the surveyors were required to determine the vehicle classification and the number of axles by visual observation. A few surveys asked if their load was full, partial, or empty and where their truck was garaged. Unlike TxDOT surveys, none of the commercial survey forms reviewed contained questions on the weight of the cargo being transported.

With the exception of one survey, all surveys used different survey forms for non-commercial and commercial vehicles. The survey for the Philadelphia, PA (*44*) region used the same survey form for non-commercial and commercial vehicles.

Survey Sample Size

The majority of surveys reviewed based their sample size on the traffic count for the facility being surveyed and a 95 percent statistical confidence level with either a ±5 or ±10 percent error rate. Some surveys, however, developed sample sizes on an ad hoc basis considering sample amounts from prior external surveys. Compared to TxDOT external surveys, most of the sample sizes from around the country are higher than that required by TxDOT specifications, especially for high volume facilities.

The sample size for the Phoenix survey (*45*) was based on a 95/5 confidence/precision level and the sample ranged from 330 surveys for low volume roads to 910 for interstates. An over-sampling factor of 15 percent was added to account for unusable surveys. In Denver (*46*), the sample size was developed using a 95/10 confidence/precision rate resulting in a target sample of about 460 vehicles per site. This figure included a 20 percent increase factor for unusable surveys. In Philadelphia, the survey sample size ranged from 3 percent for high volume highways to 20 percent for lower volume roadways. For the Tampa video mail out survey (*51*), the sample size was based on past experience and ranged from 250 surveys per site for low volume roadways to 900 surveys for interstates.

Unlike TxDOT practice, none of the surveys reviewed broke down the sample size by non-commercial and commercial vehicles.

Survey Conduct Times

All external intercept surveys reviewed were conducted on weekdays, either on Monday through Thursday or Tuesday through Thursday. Researchers did not find any intercept surveys conducted on Friday or on weekends. The majority of these surveys were conducted for a 12- or 13-hour duration, beginning from around 6 or 7 a.m. and ending at 6 or 7 p.m. Some surveys listed their survey time as from sunrise to sunset.

The majority of video capture surveys reviewed was conducted during same weekdays and times as noted for intercepts. One video capture survey (Tampa, FL) (*51*) was conducted from Noon to 6 p.m. on Tuesday through Thursday.

Vehicle Classifications in Surveys

In all intercept surveys reviewed, vehicles were generally classified as passenger vehicles, light trucks, and various categories for (non-light) trucks such as medium, heavy, or just simply commercial. In most surveys the vehicle classifications used or defined were not placed in categories of non-commercial or commercial, though truck categories other than light, were sometimes referred to as commercial. The descriptions for passenger vehicles typically included autos or cars, vans or minivans, light trucks, SUVs, and motorcycles.

The majority of survey forms classified trucks (excluding light trucks) into various subcategories by size. While all subcategories were similar among intercept surveys, none were the same. Commercial trucks in the Phoenix survey (*45*) were classified as single unit, double and multi-unit, while in Denver (*46*) trucks were classified as single unit, multi-unit, and combination. In the Philadelphia survey, light trucks were categorized as pick-up, panel, single unit and other, while heavy trucks were classified as tractor-trailer, double trailer, and other. All intercept surveys reviewed obtained gross vehicle weight and number of axles, so heavy or commercial trucks could also be categorized post survey by weight and axle as well.

All surveys reviewed collected roadway vehicle classification counts simultaneously with the survey. However, information on the classification schemes used was often not included with research material obtained for each survey. Two surveys reviewed used the FHWA scheme, which includes 13 classifications. In the Denver survey (*46*), the FHWA scheme was modified slightly to include dual rear tire pick-ups as pick-ups, not large trucks. One survey noted that for expansion purposes, vehicles were classified as autos, medium trucks, and heavy trucks. Also in Denver, in addition to 24-hour machine counts, manual classification counts were also performed during the 13-hour survey period in order that they could be compared and cross-checked with the tube counts.

Survey Geocoding

Detailed geocoding information was often not included in the external survey reports obtained for this project. It was obtained for about half of the surveys researched for Task 1. The majority of surveys reviewed used the Topologically Integrated Geographic Encoding and Referencing (TIGER) files or proprietary street/mapping software in combination with GIS for geocoding. Like TxDOT practice, many used overlay shape files to assign trip ends to traffic analysis zones (TAZ).

Survey forms reviewed asked for a street address and or a nearest cross street or intersection for trip ends. Like TxDOT surveys, some surveys also asked for a place name to help in locating a trip end and used phone books, business listings, and/or internet yellow pages to help in finding place names and incomplete addresses. Several surveys used a geocoding process that reported graduated levels of accuracy achieved in geocoding. In some surveys which were conducted by a consultant, the survey sponsor (Council of Governments (COG) or MPO) performed the survey geocoding in-house.

Compared to other surveys reviewed, TxDOT external surveys generally achieve a higher percent of trip ends that are geocoded to a specific identifiable point or location. TxDOT‘s external surveys require that a minimum of 90 percent of trip ends be geocoded to an address, nearest intersection, or place name. In recent years, the majority of TxDOT surveys have met or come close to meeting this 90 percent geocoding threshold. In the Philadelphia area survey (*44*), about 65 percent of the survey responses were geocoded to an address or intersection, 29 percent to a town/city locale, and 6 percent were unable to be geocoded. In the Denver external (*46*), between 20 to 30 percent of the trip ends were coded to specific address, 60 to 70 percent were coded to a locale such as a city or county, and 3 to 4 percent could not be geocoded.

Survey Quality Control and Training

All surveys reviewed indicated that a pilot survey was conducted and that methods and results of the pilot were evaluated for potential changes or modifications to the actual survey. Many surveys indicated that surveyors received classroom training prior to performing field work. Typical training items included background information on the purpose of the survey, review of survey goals and objectives, detailed review and discussion of the survey questionnaire, practice in administering the survey, emphasis on survey safety and procedures, roles and responsibilities of crew members, and information about the study area. As done in some TxDOT surveys, some areas developed field manuals for surveyors.

The majority of surveys reviewed noted the use or requirement for a team/crew leader or supervisor at each site to oversee data collection, traffic conditions, and monitor surveyor performance. Some surveys (e.g. Denver (*46*)) indicated that in the overall conduct of their external survey, the sequence of survey sites progressed from lower volume to high volume in order to better train and prepare surveyors for more difficult sites.

Other quality control elements identified included the use of color coded forms and numbering survey questionnaires. Color coded forms were used to distinguish between items such as vehicle type, survey direction, or a.m. verses p.m. survey time periods. Numbered questionnaires were used to prevent duplication of data entry and in some cases to identify the survey station and survey direction.

Quality control in many surveys reviewed occurred through extensive planning, preparation, and coordination that took place prior to commencement of the survey. Review of survey materials from the Denver (*46*), DVRPC (*44*, *54*, *55*), and ODOT (*43*) surveys revealed that these surveys were well planned, structured, and well coordinated between various agencies and jurisdictions.

Surveys conducted by the Ohio DOT (*43*), according to their in-house documentation, are well organized with ample quality control measures built into procedures. Briefings are required prior to the start of each survey (in the field) and the survey crew chief for each site completes a diary to keep track of survey conduct throughout the day. Key items recorded include work stoppages, surveys completed by hour, and any special conditions or problems. Per Ohio DOT survey guidelines (*43*), crew chiefs review each hour‘s interview forms for legibility, completeness, and reasonableness of codes.

Survey Data Entry and Checks

About half of the external survey reports reviewed contained information regarding how, or if, survey data were reviewed and checked by the sponsor before it was approved and accepted. However, the majority of surveys reviewed indicated that quality control measures and checks were put into place during survey data processing and entry.

Several surveys reviewed (BCDCOG (*47*) and Denver (*46*)) used a dual data entry process for quality control purposes. Dual data entry involved entering the same survey data into two separate databases by different persons. Once complete, the databases were merged and compared to find records that did not match. Non-matching records were corrected, and the process was repeated until all records in each of the two database matched.

In Phoenix (*45*), the consultant that conducted the survey edited the survey forms and sent them to the MPO for data entry. The MPO entered the data and used a database program to check for valid data ranges. In the DVRPC survey (*44*, *54*, *55*), data entry software was used that allowed for quality control checks. Here, a sub consultant was hired to do data entry and the prime consultant reviewed their work and forwarded it to the sponsor. The consultant used a dBase program to perform reasonableness checks on the data.

In Denver (*46*), paper surveys were brought from the field and reviewed for completeness, readability, and omissions. A dual entry process was for data entry whereby each form was entered by two separate persons, and data entry software was used to compare versions and correct differences. Data were compiled in ASCII and dBase formats and forwarded to the Denver Regional Council of Governments (DRGOG) for geocoding. Similar to TxDOT edit checks, the dBase program was used to check the reasonableness of each record in the database, for missing information, and invalid entries not matching pre-defined ranges.

Expansion of Survey Data

How survey data were expanded was addressed in about half of the survey reports reviewed. Some reports covered the topic in detail, while others provided only a brief explanation. In surveys where this information was available, survey data were expanded by using the classification counts that were taken when the survey was being conducted.

In the BCDCOG survey (*47*), survey data were expanded to the traffic counts that were taken on the day of the survey. Data were expanded by calculating the ratio of the number of vehicles that passed through the station each hour to the number of vehicles surveyed each hour. Statpac for Windows was used to develop the expanded database.

How survey data were expanded in the Denver (*46*) and Phoenix (*45*) surveys was not discussed in these respective reports other than to indicate survey data were expanded to 24-hour counts taken on the same day as the survey. In the Tampa survey (*51*), the number of surveys per hour was expanded to hourly counts and then 24-hour counts were used to expand the survey sample to a 24-hour period.

EXTERNAL SURVEYS – TEXAS PRACTICE

The purpose for this task was to examine the state-of-the-practice in external surveys for recently completely surveys in several Texas cities. Those cities are Tyler/Longview, Dallas/Fort Worth, Sherman/Denison, and Austin/San Antonio. To obtain information about these surveys, researchers reviewed external survey reports developed by the vendors conducting the respective surveys (*56, 57, 58*). Additionally, follow-up inquiries were made with the vendors to verify specific survey methodologies not discussed in their reports.

After examining the state-of-the-practice for external surveys in Texas, a comparison to those practices identified in the literature review was done. Preliminary recommendations for improving the practice in Texas are also made.

Overview

Surveys performed in the Texas cities that were reviewed consisted of three basic survey types. These are outbound surveys, two-way surveys, and high volume surveys. Additionally, vehicle classification counts were conducted at all external locations in each city. For outbound and two-way surveys, a traditional intercept interview method was used to collect data. For high volume roadways, a license matching program was utilized. The methodology section provides additional information on the survey types.

To provide an overview of the scope of the survey efforts in each of the areas reviewed, Table 88 below contains the number of survey locations by survey type and the number of classification count only locations for each of the study areas reviewed.

Table 88. Summary of Survey Types by City.

City	Outbound	Two-Way	High Volume	Count Only	Total*
Tyler	11	7	3	11	32
Longview	23	7	2	28	60
Dallas/Ft. Worth	28	4	8	39	79
Sherman/Denison	6	4	2	9	21
Austin	17	5	4	16	42
San Antonio	17	5	6	21	49

*Total may not match total from vendor reports. This is due to the survey totals being disaggregated by city rather than study area.

Survey Methodology

As previously mentioned, there were three basic survey types utilized in Texas during the period being investigated. The first method, the outbound survey, was an intercept interview procedure. For each external station surveyed using the intercept interview method, traffic control plans were set up and vehicles in the outbound direction (i.e., leaving the study area) were directed into an area where trained survey personnel interviewed the drivers. Those declining were allowed to continue on their trip. Drivers of commercial and non-commercial vehicles were interviewed using different survey instruments. Two-way surveys are essentially the same as outbound surveys (i.e., they are intercept interview) except the two-way surveys collect survey data for motorists traveling in both the inbound and outbound directions. Typically, two-way surveys are utilized when two study areas (e.g., Tyler and Longview) are adjacent to one another and therefore share a common border. External stations that were located along these adjacent borders were surveyed in both directions.

The final survey type was the high volume survey. For external stations that had high daily traffic volumes, the intercept interview method was not used. This was due to safety and congestion issues related to the procedures used in the intercept interview method. In lieu of the intercept interview method, all of the Texas cities reviewed had a license plate match performed on facilities deemed high volume. On high volume facilities, license plates were recorded by high speed cameras on all lanes in both directions on the same day. Travel time data were collected between each high volume location during peak and off peak times to establish base line travel times between the stations with no stops. The license data were downloaded into files and software programs used to match licenses between the stations that had travel times within the time frame for non-stop travel. These data were then used to estimate the number of through and local trips for each high volume station.

Technology

For intercept interview external surveys in the aforementioned selected Texas cities, all vendors utilized tablet personal computers for collecting the survey data. The survey instruments provided by TxDOT to the vendors were replicated on the tablet PCs. This provided a user-friendly interface for the surveyors administering the questionnaire. This is one of the big differences between external surveys in Texas versus other states. Most of the external surveys done in other areas outside Texas were still using paper surveys.

One vendor utilized GIS-based maps programmed on the tablet PCs to locate origin and destination information. The interviewer was trained to be able to quickly navigate the maps using zoom-in, zoom-out, and pan commands. This vendor stated that it was quicker to locate points with this method than it was to manually type in an entire address or intersection.

For data collection that involved license capture, video camcorders were used to record plates. The placement of camcorders on highway overpasses for overhead capture has generally been the vendor‘s first option for set-up, because the elevation and camera angles usually allow for a higher quality image. However, vendors also commonly use a side capture set-up with cameras placed within a median or on a shoulder. They say that good quality images can also be obtained in this manner as well. In accordance with TxDOT specifications, the camcorders are set up to record the rear license plates of passing vehicles. In an effort to collect data in a less obtrusive manner, one vendor has utilized specially designed traffic barrels in capturing license plates. The barrels have an access panel facing the approach direction that provides access to the camera and power supply. The downstream side has an opening that allows the camera to view the roadway. In the fall of 2007, this same vendor used this method for a license mail out survey on IH 35 for the Texas Turnpike Authority and received significant negative publicity.

In processing license data, both vendors used proprietary video license data plate reduction (VLPDR) software. The software allows for the video recordings from survey sites to be transcribed more efficiently by removing all of the video frames that do not contain a license plate image. Once a reduced video file has been developed, it allows for the vendors to review the license images and record the plate numbers into a data file in an expeditious manner. In developing the license plate data file, both vendors have commented on setting up teams of reviewers to go through video and transfer plates numbers into a data file. One vendor commented on having used up to 12 reviewers (which requires one PC per reviewer), in order to quickly process video data. The methodology for capturing license plate data and use of a mail out/mail back survey or license matching software is essentially the same as used in areas outside of Texas for the same type of survey.

One of the vendors has commented that it now has the capability of using optical character recognition (OCR) in video license capture. The 0-4869 research completed a couple of years ago found that OCR was still not a viable technology for temporary, single event applications such as travel surveys. While the levels of accuracy of OCR may have increased, it may be viable for use in license match surveys, but not for license mail out surveys where high percentage of recorded plates must be read in order to find addresses to mail surveys.

Vehicle Classification Counts Performed in Conjunction with Surveys

In all Texas external surveys, vehicle classification counts were required for all external station locations in an urban area. These counts serve as a basis for expanding the survey data collected, and as specified in the bid, the counts were grouped into 15-minute increments. In the Texas cities reviewed, the count data was submitted in two formats. One vendor submitted classification count data in Microsoft Excel files that classified the vehicles using the Texas 6 classification scheme. This particular scheme disaggregates the counts into 13 vehicle categories. Another vendor submitted classification count data in Microsoft Excel files and disaggregated the vehicles into two categories: commercial and non-commercial vehicles. The methodology used in Texas is essentially the same as used in areas outside Texas with the vehicle count data used to expand the survey data.

One vendor also experienced problems with tubes rupturing, thus losing count data for the day of the survey. The vendor countered this problem by using count data for the day before or day after the survey day. Although this generally could be considered acceptable, there were occurrences where the number of surveys being collected (specifically CV surveys) was more than the tube count for the site.

Survey Geocoding

For many years TxDOT‘s external bid specification required that 75 percent of addresses be coded to latitude and longitude and 90 percent be coded to the transportation analysis zone system. In light of improved technology, in recent years TxDOT has increased the geocoding accuracy requirements to require that 90 percent of addresses be coded to latitude/longitude.

There was a key difference in how surveys were geocoded in the Austin/San Antonio (A/SA) and Tyler/Longview (T/LV) surveys compared to how it was done in the Dallas-Ft-Worth (DFW) survey. In the DFW survey, the vendor used GIS-based maps programmed on the tablet PCs to electronically geocode origins and destinations during the survey interview.

The A/SA and T/LV externals were conducted by the same vendor, but not the vendor that conducted the DFW survey. The A/SA-T/LV vendor used tablet PCs and collected addresses, street intersections, or place names, and geocoded the majority of latitudes and longitudes (latitudes/longitudes) on location. The vendor utilized a ‗1-hour on, 1-hour off‘ process during the survey day where interviewers spent one hour on the road conducting interviews and one hour off the road in an air conditioned temporary workspace (a travel trailer) where they took time to review, edit as necessary, and geocode their past hours‘ surveys. Files were reviewed ‗ASAP‘ after collection in order that information would still be remembered and so that problems, if any, could be recognized early on and corrected. Importantly, this ‗hour off‘ method allowed surveyors to review their previous hours‘ surveys and correct street name spellings so such that a higher percentage of latitudes/longitudes could be found electronically.

Regarding the D/FW geocoding method used, in order to be able to successfully geocode ‗on the line‘ using interactive GIS mapping to TxDOT‘s required 90 percent accuracy level, interviewers must:

- have an above average skill and capability in using tablet PCs in order to quickly navigate local and regional maps using zoom-in, zoom-out, and pan commands;
- be able to quickly write-in address information, though for a certain unknown percentage the address field may be populated as part of the point locate;
- overcome the obstacle of glare in order for interviewees to locate and show the interviewer the last place they got in their vehicle;
- for large trucks and tractor trailers, be able to get the computer screen close enough and at the right angle for the driver to see the maps; and
- be able to pan and zoom maps, locate points, and write in address information sufficient to determine a latitude/longitude within TxDOT‘s 4-minute time line.

In the review of the external data, which used interactive GIS maps for geocoding during the interview, it was found that the majority of origins did not have a complete address and of those that had a complete address only a small percent were found to be accurate in terms of the latitude/longitude. The vendor indicated that these problems resulted from errors in processing the data (not in data collection) and revised files were subsequently re-submitted to improve accuracy and meet TxDOT bid specifications. The vendor using interactive GIS maps reported that it was quicker to locate points than to manually type in an entire address or intersection.

The vendor that used the hour-on/hour-off survey process indicated that interviewers in their hour off geocoded addresses to latitudes/longitudes (as time permitted) and what was not completed in the field was completed back at their office. Under this vendors method, once latitudes/longitudes were found the points were then electronically geocoded to TAZ and Statewide Analysis Model (SAM) zones (back in the office) using shape files provided by TxDOT. Address information that could not be electronically geocoded was printed and geocoded manually by survey staff using city and county maps, phone books, and personal knowledge of the study area.

Typical reasons for data not electronically matching address information with a latitude/longitude point were misspelled street names, street pairs that did not intersect, address numbers not within the address range, and the use of place names. They noted that the majority of the gecoding (to TAZ zones) was done electronically and that the match rate was about 95 percent. The practice of geocoding in Texas appears to be consistent with that used in areas outside Texas.

Survey Staffing, Quality Control, and Training

There were differences in the staffing, quality control, and training between the two vendors that conducted the external surveys being compared. The following subsections provide general observations and comparisons relative to these areas based on the bid proposals and survey report write-ups.

Staffing

One vendor primarily used in-house staff combined with a few temporary surveyors to install the traffic control plan and conduct the surveys. In addition to the project administrators and managers, the vendor had three or four senior to mid-level members of its in-house staff that served as site supervisors. Most of the interviewers and flaggers used by this vendor were in-house staff or on-call employees that had worked on previous surveys for the company. This vendor indicated that it hired a few temporary survey workers from the local area for one of the external surveys, but used no temporary workers in the other locales. From limited site visits, this vendor‘s project manager for the survey did not double as the site supervisor, except to provide for temporary breaks.

The other vendor also used in-house personnel for project management and site supervisor roles, but most, if not all, of this vendor‘s surveyors and flaggers were temporary workers who were hired from the local area. This vendor subcontracted out the installation and removal of the traffic control equipment, though they were able to make changes to the TCP that were requested by TxDOT in-house from one of their professional engineers. Based on the project proposals and field observations, it appears that this vendor does not have as many trained survey supervisors or interviewers as the other vendor. For the survey in question, it is not known if the vendor‘s project manager also doubled as a site supervisor on a recurring basis.

Quality Control

TxDOT is one of a few, if not the only, agencies around the country that uses a bid specification, as opposed to a proposal, to procure vendors or consultants to conduct travel surveys. TxDOT‘s use of bid specifications predisposes it to a higher degree of quality control due to the detailed requirements in all aspects of surveys—from preparation, design, and conduct to data processing and review. When proposals are used, much of the detail relating to survey preparation, design, conduct, and data delivery may be negotiated after a vendor has been selected and some detail may not be addressed. In light of this, it is probable that TxDOT travel surveys are conducted with a higher degree of quality control than the majority of other comparable surveys around the country.

TxDOT‘s use of pre-determined file formats and thorough data review processes are good quality control measures. The file formats identify all data variables to be collected and establish the framework for datasets by providing specific column ranges, character type (numeric or alphanumeric), and sizes of all fields. The use of edit check programs and spreadsheet macros in review of survey data are good quality control measures.

As previously noted, both vendors used tablet PCs to collect and record survey data in all surveys that are being evaluated. The use of tablet PCs offered some advantages over paper survey forms from a quality control standpoint. Both vendors incorporated edit checks into the tablet PC forms, which prevented many illogical and invalid responses being entered during the data collection process. The use of PCs also allowed the vendors to monitor the performance and efficiency of survey crews by checking survey data and their average survey times.

Both vendors said that a survey manager or supervisor monitored surveyors during data collection, noting that they looked at courtesy towards motorists and their technique and skill. They indicated that tablet PCs were periodically retrieved from each surveyor to check forms for recording accuracy, completeness, and spelling, and that this was done during the survey so adjustments could be made then. Once data entry was completed, the vendors said final databases were checked for completeness, and further checks are made for consistency and accuracy.

Both vendors mentioned the use of anonymous company personnel to drive through the survey site to check to see if the surveyors were accurately asking all survey questions and conducting the survey in a proper manner.

The methods the vendors used to geocode survey data had significant quality control implications. The use of interactive maps in tablets PCs to geocode respondent address information at the time of the interview raises quality control concerns. The vendor which used this method (for the DFW survey) indicated that interviewers had enough time to zoom and pan maps to locate the motorist‘s address as well as type in the complete address information in the required fields. However, there were significant geocoding problems encountered with the survey where interactive GIS maps were used. The other vendor indicated that it did not use this method because there was not enough time for the interviewers to use the maps and fill in the address information.

The use of interactive maps to geocode trip origin and destinations during the survey interview would be more viable if only latitude/longitude point locates were required, and not complete address information. Under this method, interviewers would touch the point on the map (computer screen) where the motorist trip end was and populate the origin or destination address field with a latitude/longitude point. This method (not recommended) raises serious quality control concerns because (1) interviewers could easily fabricate data (2) with no address information, there is no way to check the accuracy of trip ends.

The ‗1-hour on, 1-hour off' approach used by the Austin/San Antonio-Tyler/Longview vendor was good from a quality control standpoint because it allowed surveyors to go back and complete or edit the past hours surveys while they still may have been able recall the information. By completing address information and correcting misspellings, it is believed a higher percentage of trip ends were geocoded to longitude and latitude points.

For high volume license capture data, one vendor has developed a custom transcription interface that allows the transcriber to choose the clearest video image from among several camera angles to record the plate number and the clearest image is saved with the number. This vendor also performs a random accuracy check on 10 percent of manually transcribed data.

Training

There was a significant difference in the amount of training that was conducted by the two vendors who did the surveys being evaluated for this task. TxDOT's external bid specification requires that vendors conduct a 4-hour training class for surveyors. One vendor routinely conducts the training over a 4-day period, which included classroom training by the survey project manager and field training by the site supervisors. As part of the training, a procedures manual was developed and provided to all surveyors. The other vendor is believed to use one-half to a full day for training surveyors. Items covered by both vendors in their training of surveyors included:

- discussion of survey background and purpose;
- explanation survey methods, procedures, routines, and safety;
- rules for professional conduct, attire, courtesy;
- conduct of mock interviews (typically in an empty parking lot) to practice using tablet PCs, delivering questions and recording responses;
- instruction on how to classify vehicles based on the vehicle classification forms provided;
- sexual harassment training; and
- flagger training by an ATSSA instructor.

One vendor did a following training class after the pilot survey, the other did not. Both vendors used the pilot survey to allow survey supervisors to monitor surveyors and give them feedback on their verbal delivery and allow surveyors practice in data recording. One vendor stated that they used 12-14 surveyors with eight tablets per site.

Requirements for quality control and training in Texas appear to be equivalent and in most cases exceed those used in external station surveys in areas outside Texas.

Survey Data Entry and Checks

In Texas, the vendors selected to conduct the external surveys are responsible for entering and checking all survey data. The vendors are provided a prescribed format for preparing the data for each survey type. They are also provided with a Fortran program that checks the data for errors and omissions. The purpose of the edit checking program is to provide the vendor with a tool to correct any errors and omissions prior to the data being submitted to TxDOT for review.

While the edit checking programs do a good job of detecting erroneous answers and illogical responses, they still have the potential to miss certain errors in the data. Sometimes, these missed errors are not detected until a detailed analysis of the survey data is performed. This is problematic since at this point there is no way to go back and determine what the correct response should be. This creates the dilemma for the analyst of determining whether the data for that respondent should be deleted from the analysis or if professional judgment should be made as to what the respondent intended to convey to the surveyor.

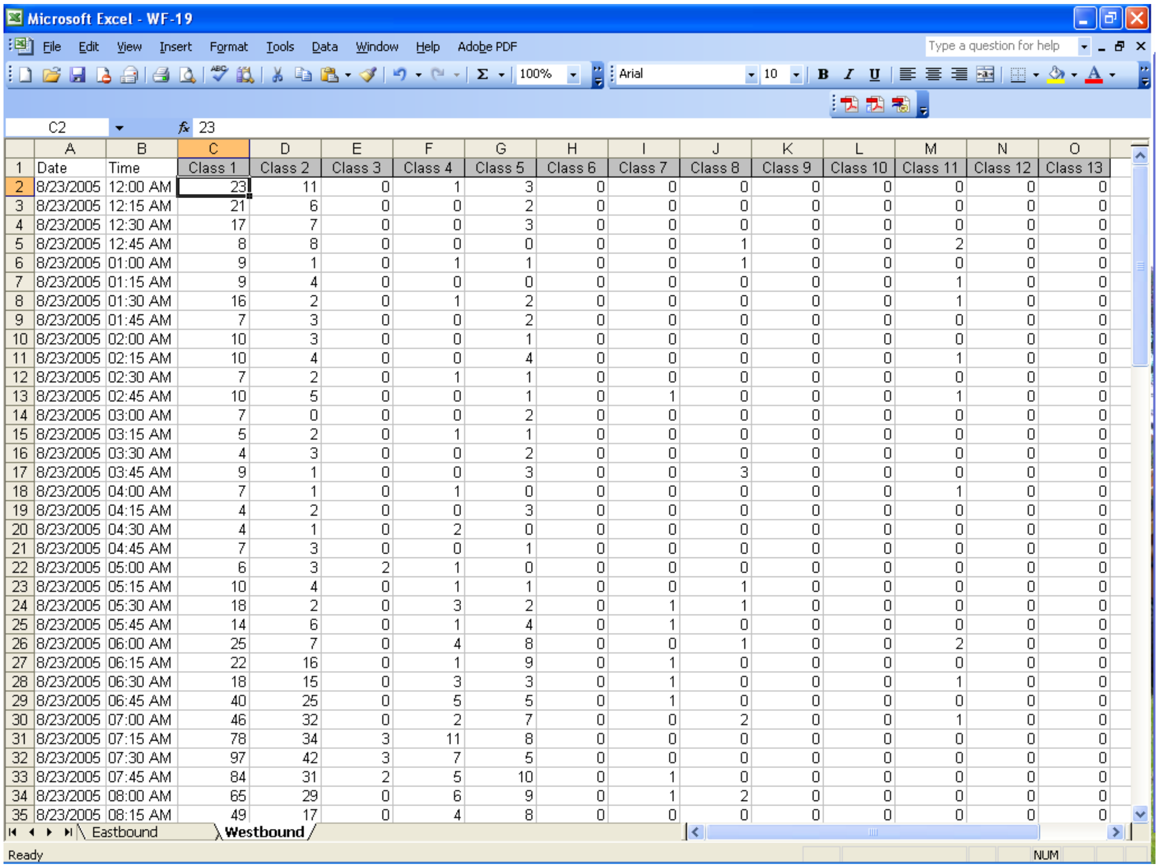
One vendor checked the geocoded data by merging data from all survey sites into one master file and then dividing the data into smaller review data sets that were based on similarities of origins and destinations. For each of these smaller data sets, a point layer was created for origins and a point layer was created for destinations. After reviewing the layers, they were merged back together. This merging approach used for geocoding involves risk of trip ends not being merged back correctly to the proper site. It is possible that these errors would not be detected using the edit check programs, so this may not be the best method of checking data.

In comparing data entry and checking procedures in Texas versus those used in external surveys in areas outside Texas, one of the biggest differences is the use of tablet PCs in Texas for the collection of the data. Data collected in this method are checked internally during the collection period and subsequent reviews and checking procedures in Texas are more extensive than in other areas. It is clear that in areas outside Texas as well as in Texas, a considerable amount of effort is expended in checking the data to ensure it is of the best and highest quality possible.

Potential Improvements

Based upon review and comparison of vendor practice as well as processing and analysis of subsequent survey data, researchers recommend that TxDOT consider the following changes to the current practice in the conduct of external travel surveys.

1. Require that all classification counts be in 15-minute increments and classified using the Federal Highway Administration (FHWA) Scheme F. For ease of analysis, it would be helpful that the data be in Excel and the count data start in the same cell (see highlighted cell in Figure 49 below) regardless of which vendor submits data. This way generic analysis programs can be written to compile any count data received. This can significantly reduce the amount of time needed to compile count data statistics and count summaries needed for the expansion of external survey data. (The vendor that submitted the data in the Texas 6 format had header information above the count data. This information could be placed below it or remove it all together.)



	Date	Time	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
2	8/23/2005	12:00 AM	23	11	0	1	3	0	0	0	0	0	0	0	0
3	8/23/2005	12:15 AM	21	6	0	0	2	0	0	0	0	0	0	0	0
4	8/23/2005	12:30 AM	17	7	0	0	3	0	0	0	0	0	0	0	0
5	8/23/2005	12:45 AM	8	8	0	0	0	0	0	1	0	0	2	0	0
6	8/23/2005	01:00 AM	9	1	0	1	1	0	0	1	0	0	0	0	0
7	8/23/2005	01:15 AM	9	4	0	0	0	0	0	0	0	0	1	0	0
8	8/23/2005	01:30 AM	16	2	0	1	2	0	0	0	0	0	1	0	0
9	8/23/2005	01:45 AM	7	3	0	0	2	0	0	0	0	0	0	0	0
10	8/23/2005	02:00 AM	10	3	0	0	1	0	0	0	0	0	0	0	0
11	8/23/2005	02:15 AM	10	4	0	0	4	0	0	0	0	0	1	0	0
12	8/23/2005	02:30 AM	7	2	0	1	1	0	0	0	0	0	0	0	0
13	8/23/2005	02:45 AM	10	5	0	0	1	0	1	0	0	0	1	0	0
14	8/23/2005	03:00 AM	7	0	0	0	2	0	0	0	0	0	0	0	0
15	8/23/2005	03:15 AM	5	2	0	1	1	0	0	0	0	0	0	0	0
16	8/23/2005	03:30 AM	4	3	0	0	2	0	0	0	0	0	0	0	0
17	8/23/2005	03:45 AM	9	1	0	0	3	0	0	3	0	0	0	0	0
18	8/23/2005	04:00 AM	7	1	0	1	0	0	0	0	0	0	1	0	0
19	8/23/2005	04:15 AM	4	2	0	0	3	0	0	0	0	0	0	0	0
20	8/23/2005	04:30 AM	4	1	0	2	0	0	0	0	0	0	0	0	0
21	8/23/2005	04:45 AM	7	3	0	0	1	0	0	0	0	0	0	0	0
22	8/23/2005	05:00 AM	6	3	2	1	0	0	0	0	0	0	0	0	0
23	8/23/2005	05:15 AM	10	4	0	1	1	0	0	1	0	0	0	0	0
24	8/23/2005	05:30 AM	18	2	0	3	2	0	1	1	0	0	0	0	0
25	8/23/2005	05:45 AM	14	6	0	1	4	0	1	0	0	0	0	0	0
26	8/23/2005	06:00 AM	25	7	0	4	8	0	0	1	0	0	2	0	0
27	8/23/2005	06:15 AM	22	16	0	1	9	0	1	0	0	0	0	0	0
28	8/23/2005	06:30 AM	18	15	0	3	3	0	1	0	0	0	1	0	0
29	8/23/2005	06:45 AM	40	25	0	5	5	0	1	0	0	0	0	0	0
30	8/23/2005	07:00 AM	46	32	0	2	7	0	0	2	0	0	1	0	0
31	8/23/2005	07:15 AM	78	34	3	11	8	0	0	0	0	0	0	0	0
32	8/23/2005	07:30 AM	97	42	3	7	5	0	0	0	0	0	0	0	0
33	8/23/2005	07:45 AM	84	31	2	5	10	0	1	0	0	0	0	0	0
34	8/23/2005	08:00 AM	65	29	0	6	9	0	1	2	0	0	0	0	0
35	8/23/2005	08:15 AM	49	17	0	4	8	0	0	0	0	0	0	0	0

Figure 49. Example of Vehicle Classification Count Data.

2. Require the use of tablet PCs as the primary means for conducting external intercept surveys with allowance for paper surveys to be used as a back-up method. Tablet PCs have the following advantages over paper forms:
   - data entry during course of interview, reducing labor, time, and costs;
   - checks for illogical or invalid responses can be built into the data collection process;
   - ability for a some geocoding at the time of the interview, or shortly thereafter; and,
   - allows for monitoring average survey times by interviewers.
3. Require that vendor collect or notate the number of non-commercial dual rear-wheel vehicles that come through the survey site so that the accuracy of commercial vehicles counts can be improved by these vehicles from the commercial vehicle mechanical count totals.
4. Require that the vendor maintain log of the number of surveyors being utilized to conduct surveys each hour throughout the course of the survey, along with the name of the survey supervisor on-site each hour and provide this data to TxDOT. This information, along with any information relating to survey delays, interruptions, or occurrences (e.g., rain, accidents, etc.) that impact survey data collection or safety, should be provided to TxDOT the day after the completion of an external survey.

5. Do not allow the project manager (PM) to also serve in the role as site supervisor on a full-time basis. The PM may temporarily relieve a site supervisor, however.
6. Do not allow the use of interactive GIS maps for geocoding at the time of interview (in the roadway), unless the vendor provides a demonstration showing that all of the five concerns listed in the Survey Geocoding section can be addressed to TxDOT's satisfaction.

EXTERNAL SURVEY VEHICLE CLASSIFICATION COUNTS

The objective of this task was to video record traffic during daylight hours at locations where automatic vehicle classification counters had been deployed. The video recordings were used to manually count and classify vehicles that passed over the AVC pneumatic tubes. An analysis and comparison of the AVC and video-derived data was subsequently performed to determine the accuracy of the AVC counts and classifications for commercial and non-commercial vehicles.

Background

One issue with external station surveys is discrepancies between the number of surveys of commercial and non-commercial vehicles and the classification counts of commercial and non-commercial vehicles by AVC counters. Past analyses of external survey data have indicated differences in the estimation of commercial vehicle related vehicle miles of travel (VMT) from the survey when compared to an independent estimate of VMT developed from Highway Performance Monitoring System (HPMS) data and vehicle classification count data. This was suspected to be the result of inconsistencies between the surveyed classifications and the AVC classification of vehicle types.

Bi-directional traffic streams at five locations in and around the Houston, Texas area were counted using AVC counters and recorded by video equipment. Data collection sites were selected based on the following criteria:

- presence of commercial and non-commercial traffic;
- 2-lane or 4-lane roadways;
- no turning lanes or movements within 60 feet of tubes;
- variety of traffic speeds;
- safe parking area for video recording vehicle; and
- ability to secure AVC equipment to a post, sign, or tree.

An AVC deployment and retrieval crew from the Texas Transportation Institute's Houston office was contracted to set up the AVC equipment. The brand of AVC device used in the study (TimeMark) was the same as that deployed by TxDOT crews for traffic counting purposes. Figure 50 shows installed tube counters at two of the data collection sites. The following urban and rural roadways in the greater Houston area were counted:

- North Post Oak Road (Arterial, 2 lanes each direction)
- Dacoma Street (Collector, 2 lanes each direction)
- Taylor Street (Arterial, 2 lanes each direction)
- FM 1093 (Rural/Suburban Highway, 1 lane each direction)
- SH 36 (Rural highway, 1 lane each direction)

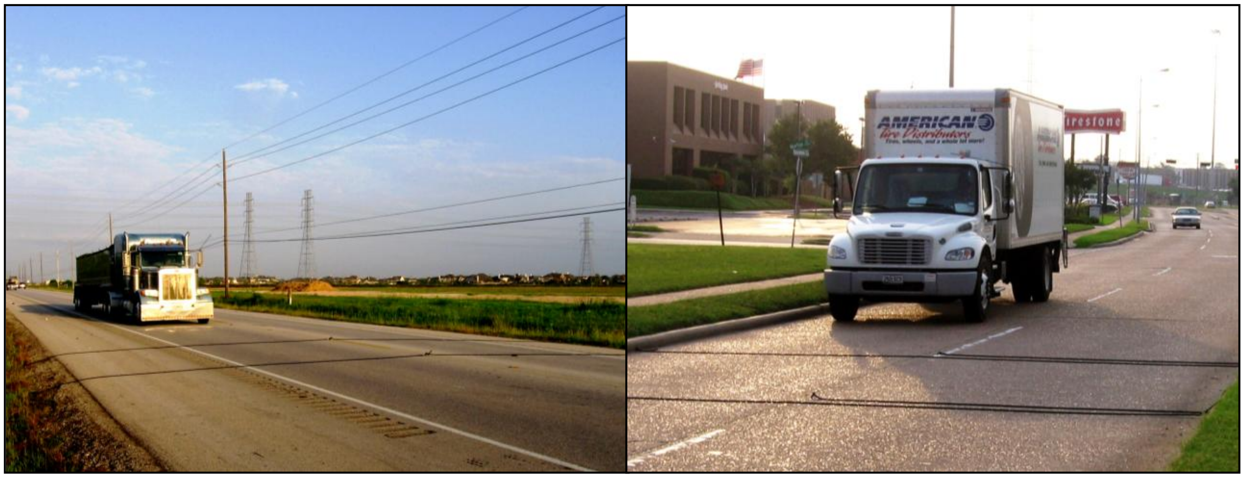


Figure 50. Installed AVC Tube Counters at Rural and Urban Survey Locations.

Traffic environments at the survey sites varied from low-speed urban to high-speed rural with a broad mix of commercial and non-commercial vehicles. Video recordings of tube counts at each location were made for one 12-hour period between 7 a.m. and 7 p.m. during the week of Monday, May 11, 2009. Cameras were placed on either side of the roadway at the three urban sites to ensure that the view of traffic in the far lanes would not be obstructed by vehicles traveling in the near lanes. This measure was not necessary at the rural sites where there was only one lane in each direction.

The video data were manually reduced according to the same 13-classisifacation FHWA F2 format used by the AVC counters. These 13 vehicle classes are described in Table 89 and illustrated in Table A-1 in Appendix A. No individuals using the road right of way were identified during the video reduction process.

Table 89. Description of FHWA F2 Vehicle Classifications.

Class	Description
1	Motorcycles
2	Cars & SUVs (also with 1 or 2-axle trailer)
3	Pickups & Vans (also with 1, 2 , or 3-axle trailer)
4	2 or 3-axle Bus or RV
5	2-axle rigid truck
6	3-axle rigid truck
7	4+ axle rigid truck
8	Tractor trailer with 3 or 4 axles
9	Tractor trailer with 5 axles
10	Tractor trailer with 6 axles
11	Tractor multi trailer with 4 or 5 axles
12	Tractor multi trailer with 6 axles
13	Tractor multi trailer with 7 or more axles

Analysis

AVC and video count data were compared at 15-minute, 1-hour, and 12-hour (daily) intervals. The following section provides analysis of the data based on 1-hour and 12-hour intervals. Tables 90 and 91 summarize the 12-hour AVC and video classification totals for each site and direction. Table 92 shows the AVC count totals as a percent of the video count totals. Tables 93 and 94 show the proportion of vehicles from each class that comprise the total vehicle count for that site and direction based on the AVC and video data. Table 95 presents a summary of the non-commercial and commercial vehicle classification count totals for all sites. Table 96 indicates the percent of vehicles in classes 2 and 3 that were visually identified as being used for commercial purposes in the video reduction process. This judgment was based on visual identification of a company logo on the vehicle or a trailer clearly containing commercial equipment (e.g., pickup pulling a trailer full of lawn maintenance equipment). Figures 50 to 59 show a side-by-side breakdown of the classification counts for each data collection method by 1-hour interval. Detailed results of the analysis of class 2 and 3 commercial vehicles for each site and direction are presented in Figures 60 to 69. Tables A-2 through A-11 in Appendix A present the AVC and video classification counts by 15-minute interval period.

Discrepancies between the AVC and video data for the eastbound direction at site 2 were more pronounced than at other sites and appear to indicate a technical problem with the AVC device used for that location and direction. For this reason, AVC results for site 2 in the eastbound direction were excluded from analysis in the findings section below. No additional study data were collected using that AVC device. Appendix A contains the 15-minute AVC and video data for site 2 in the eastbound direction. At site 5, the AVC pneumatic tubes for both directions of travel were dislodged the night prior to the video recording day. This resulted in the loss of one hour of data at that site (7–8 a.m.) while the tubes were reinstalled. With the exception of a brief rain event on the morning of May 11, 2009 (site 1), the weather was good for the entire data collection week.

Summary of Findings

The following observations were made through analysis and comparison of the vehicle classification count data obtained from the AVC and video recordings:

- The AVC counters consistently undercounted vehicles in classes 2, 3, 6, 7 and 9, and over counted vehicles in classes 4, 5, 8, 11, 12 and 13.
- While the magnitude of AVC counting errors varied, the most significant case of undercounting was for class 7; for over counting it was class 8.
- Despite a general underrepresentation of passenger vehicles (classes 1-3) and overrepresentation of commercial vehicles (classes 4-13) in the AVC data, the total number of vehicles counted by the AVC devices was relatively accurate.
- A significant proportion of class 3 vehicles appear to be used for commercial purposes.

Tables 90, 91, and 92 show that while the AVC devices generated relatively accurate total vehicle counts at each site over a 12-hour period, certain vehicle classes were consistently undercounted and others were over counted. This information is graphically presented by 1-hour interval for all sites and directions in Figures 51 to 59. Table 92 illustrates the undercounting and over counting trends by 12-hour interval with light and dark-shaded cells. Light-shaded cells, which indicate undercounting of vehicles by the AVC, are most prevalent in classes 2, 3, 6, 7 and 9. Class 7 was the most significantly undercounted (50 percent) by the AVC counters. Dark-shaded cells, which denote over counting by the AVC counters, cover all populated cells for classes 4, 5, 8, 11, 12 and 13. Extreme examples of AVC over counting occurred for class 8 vehicles and, to a lesser extent, class 4 and 5 vehicles. Class 1 and 10 vehicles were generally over counted or undercounted by small margins at the various survey locations, with their overall AVC and video counts being almost equal. It should be noted that many of the exceptionally high and low percentages shown in Table 92 are based on small sample sizes. The ―#DIV/0!" errors shown in some Table 92 cells indicate cases where there were AVC counts but no corresponding video counts for a vehicle class at a particular site and direction.

Another means of comparing the AVC and Video data is to analyze differences in the vehicle class proportions for each data collection method. Tables 93 and 94 present this information. A general underrepresentation of passenger vehicles (classes 1-3) and overrepresentation of commercial vehicles (classes 4-13) can be observed in the AVC data. Classes 6 and 9 are notable exceptions to this trend. The aggregated video data in Table 95 show that there were more than 12 times as many non-commercial vehicles as commercial vehicles recorded at the combined survey sites. Even though the number of AVC counts as a percentage of video counts was much greater for commercial vehicles (232 percent) than for non-commercial vehicles (88 percent), the larger volume of non-commercial vehicles resulted in similar overall count totals for both data collection methods (43,184 AVC vehicles versus 43,774 video vehicles).

In order to ascertain the extent to which passenger vehicles may be used for commercial purposes, class 2 and 3 vehicles with company logos or commercial equipment were separately enumerated during the video reduction process. These class 2 and 3 commercial vehicle tallies were then compared to the total number of vehicles counted for those classes (commercial and non-commercial). Table 96 presents a summary of the findings from this analysis for each site and all sites combined. Hourly results for this comparison by site and direction are presented in Figures 60 through 69. While the overall proportion of class 2 vehicles identified as commercial was small (1 percent), more than a quarter of all class 3 vehicles (26 percent) had a company logo, were hauling commercial equipment, or both.

Recommendations

The findings from this analysis indicate considerable discrepancies between the TimeMark AVC and video classification counts for commercial and non-commercial vehicles. However, percent differences in the AVC and video counts for individual vehicle classifications were relatively consistent across the sites monitored. Regular underreporting and over reporting of specific passenger and commercial vehicle classifications by the AVC counters suggests the need for calibration of the TimeMark classification software to mitigate this problem. Manual counts should be conducted for an hour where AVC equipment is deployed and used to develop appropriate adjustment factors for the AVC classification counts. Adherence to standardized AVC installation procedures is also recommended to reduce the potential for unusable data and help alleviate possible AVC under and over counting problems.

Based on the data from this study, a significant percentage of vehicles classified as category 3 are commercial vehicles that fall into the commercial service category. These are currently misclassified as non-commercial. Since there is no means by which an AVC counter can identify these vehicles, the proper classification of these vehicles may only be done manually. It is recommended that vendors be required to video tape vehicles in both directions at external surveys and manually classify the vehicles for the time period surveys are conducted using the procedures from this study. These data may be used to estimate the percentage of class 3 vehicles that are commercial. This percentage may then be applied to the 24-hour count of class 3 vehicles to combine with the class 4 through 13 vehicles to estimate the total commercial vehicles more accurately.

Table 90. 12-Hour AVC Counts.

Site \ Class	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTALS
1-NB	13	2,402	1,213	230	291	17	1	124	69	0	1	0	0	**4,361**
1-SB	16	3,306	1,292	217	334	10	1	162	62	1	9	2	1	**5,413**
2-WB	12	1,788	1,046	78	381	10	0	83	31	0	0	0	0	**3,429**
3-NB	39	4,210	1,962	221	756	18	1	263	96	0	12	1	1	**7,580**
3-SB	12	5,353	1,664	190	406	33	0	291	88	0	4	0	2	**8,043**
4-EB	18	2,472	1,492	34	432	82	2	92	164	6	0	0	0	**4,794**
4-WB	26	3,008	1,325	31	413	76	0	152	117	6	0	0	0	**5,154**
5-EB	14	1,082	500	35	142	12	2	170	48	1	3	0	0	**2,009**
5-WB	21	874	706	31	483	18	0	176	90	1	1	0	0	**2,401**
TOTALS	**171**	**24,495**	**11,200**	**1,067**	**3,638**	**276**	**7**	**1,513**	**765**	**15**	**30**	**3**	**4**	**43,184**

Table 91. 12-Hour Video Classification Counts.

Site \ Class	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTALS
1-NB	11	2,680	1,272	139	195	17	0	27	80	0	0	0	0	**4,421**
1-SB	19	3,544	1,563	131	218	11	0	30	85	1	0	0	0	**5,602**
2-WB	12	1,814	1,340	1	156	25	2	36	39	0	0	0	0	**3,425**
3-NB	17	5,213	1,995	34	138	48	3	25	134	0	0	0	0	**7,607**
3-SB	28	5,675	2,148	36	162	50	2	37	125	0	0	0	0	**8,263**
4-EB	17	2,988	1,448	8	77	89	1	6	162	8	0	0	0	**4,804**
4-WB	29	3,154	1,639	17	79	91	2	4	165	6	0	0	0	**5,186**
5-EB	13	1,077	760	6	21	19	3	6	151	0	0	0	0	**2,056**
5-WB	23	1,247	890	12	18	23	1	8	187	1	0	0	0	**2,410**
TOTALS	**169**	**27,392**	**13,055**	**384**	**1,064**	**373**	**14**	**179**	**1,128**	**16**	**0**	**0**	**0**	**43,774**

Table 92. Comparison of 12-Hour AVC and Video Classification Counts (AVC/Video as a Percent).

Site \ Class	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTALS
1-NB	118%	90%	95%	165%	149%	100%	#DIV/0!	459%	86%		#DIV/0!			**99%**
1-SB	84%	93%	83%	166%	153%	91%	#DIV/0!	540%	73%	100%	#DIV/0!	#DIV/0!	#DIV/0!	**97%**
2-WB	100%	99%	78%	7800%	244%	40%	0%	231%	79%					**100%**
3-NB	229%	81%	98%	650%	548%	38%	33%	1052%	72%		#DIV/0!	#DIV/0!	#DIV/0!	**100%**
3-SB	43%	94%	77%	528%	251%	66%	0%	786%	70%		#DIV/0!		#DIV/0!	**97%**
4-EB	106%	83%	103%	425%	561%	92%	200%	1533%	101%	75%				**100%**
4-WB	90%	95%	81%	182%	523%	84%	0%	3800%	71%	100%				**99%**
5-EB	108%	100%	66%	583%	676%	63%	67%	2833%	32%	#DIV/0!	#DIV/0!			**98%**
5-WB	91%	70%	79%	258%	2683%	78%	0%	2200%	48%	100%	#DIV/0!			**100%**
TOTALS	**101%**	**89%**	**86%**	**278%**	**342%**	**74%**	**50%**	**845%**	**68%**	**94%**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**99%**

AVC Count < Video Count.

AVC Count > Video Count.

Table 93. Vehicle Class Proportions for 12-Hour AVC Counts.

Site \ Class	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTALS
1-NB	0.3%	55.1%	27.8%	5.3%	6.7%	0.4%	0.0%	2.8%	1.6%	0.0%	0.0%	0.0%	0.0%	**100.0%**
1-SB	0.3%	61.1%	23.9%	4.0%	6.2%	0.2%	0.0%	3.0%	1.1%	0.0%	0.2%	0.0%	0.0%	**100.0%**
2-WB	0.3%	52.1%	30.5%	2.3%	11.1%	0.3%	0.0%	2.4%	0.9%	0.0%	0.0%	0.0%	0.0%	**100.0%**
3-NB	0.5%	55.5%	25.9%	2.9%	10.0%	0.2%	0.0%	3.5%	1.3%	0.0%	0.2%	0.0%	0.0%	**100.0%**
3-SB	0.1%	66.6%	20.7%	2.4%	5.0%	0.4%	0.0%	3.6%	1.1%	0.0%	0.0%	0.0%	0.0%	**100.0%**
4-EB	0.4%	51.6%	31.1%	0.7%	9.0%	1.7%	0.0%	1.9%	3.4%	0.1%	0.0%	0.0%	0.0%	**100.0%**
4-WB	0.5%	58.4%	25.7%	0.6%	8.0%	1.5%	0.0%	2.9%	2.3%	0.1%	0.0%	0.0%	0.0%	**100.0%**
5-EB	0.7%	53.9%	24.9%	1.7%	7.1%	0.6%	0.1%	8.5%	2.4%	0.0%	0.1%	0.0%	0.0%	**100.0%**
5-WB	0.9%	36.4%	29.4%	1.3%	20.1%	0.7%	0.0%	7.3%	3.7%	0.0%	0.0%	0.0%	0.0%	**100.0%**
OVERALL %	**0.4%**	**56.7%**	**25.9%**	**2.5%**	**8.4%**	**0.6%**	**0.0%**	**3.5%**	**1.8%**	**0.0%**	**0.1%**	**0.0%**	**0.0%**	**100.0%**

Table 94. Vehicle Class Proportions for 12-Hour Video Counts.

Site \ Class	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTALS
1-NB	0.2%	60.6%	28.8%	3.1%	4.4%	0.4%	0.0%	0.6%	1.8%	0.0%	0.0%	0.0%	0.0%	**100.0%**
1-SB	0.3%	63.3%	27.9%	2.3%	3.9%	0.2%	0.0%	0.5%	1.5%	0.0%	0.0%	0.0%	0.0%	**100.0%**
2-WB	0.4%	53.0%	39.1%	0.0%	4.6%	0.7%	0.1%	1.1%	1.1%	0.0%	0.0%	0.0%	0.0%	**100.0%**
3-NB	0.2%	68.5%	26.2%	0.4%	1.8%	0.6%	0.0%	0.3%	1.8%	0.0%	0.0%	0.0%	0.0%	**100.0%**
3-SB	0.3%	68.7%	26.0%	0.4%	2.0%	0.6%	0.0%	0.4%	1.5%	0.0%	0.0%	0.0%	0.0%	**100.0%**
4-EB	0.4%	62.2%	30.1%	0.2%	1.6%	1.9%	0.0%	0.1%	3.4%	0.2%	0.0%	0.0%	0.0%	**100.0%**
4-WB	0.6%	60.8%	31.6%	0.3%	1.5%	1.8%	0.0%	0.1%	3.2%	0.1%	0.0%	0.0%	0.0%	**100.0%**
5-EB	0.6%	52.4%	37.0%	0.3%	1.0%	0.9%	0.1%	0.3%	7.3%	0.0%	0.0%	0.0%	0.0%	**100.0%**
5-WB	1.0%	51.7%	36.9%	0.5%	0.7%	1.0%	0.0%	0.3%	7.8%	0.0%	0.0%	0.0%	0.0%	**100.0%**
OVERALL %	**0.4%**	**62.6%**	**29.8%**	**0.9%**	**2.4%**	**0.9%**	**0.0%**	**0.4%**	**2.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%**

Table 95. Comparison of 12-Hour Non-Commercial and Commercial Classification Counts.

Site \ Type	Non-Commercial Vehicle Counts (Classes 1-3)		Commercial Vehicle Counts (Classes 4-13)		**Total Vehicle Counts (Classes 1-13)**	
	AVC / Video	as %	AVC / Video	as %	**AVC / Video**	**as %**
1-NB	3628 / 3963	92%	733 / 458	160%	**4361 / 4421**	**99%**
1-SB	4614 / 5126	90%	799 / 476	168%	**5413 / 5602**	**97%**
2-WB	2846 / 3166	90%	583 / 259	225%	**3429 / 3425**	**100%**
3-NB	6211 / 7225	86%	1369 / 382	358%	**7580 / 7607**	**100%**
3-SB	7029 / 7851	90%	1014 / 412	246%	**8043 / 8263**	**97%**
4-EB	3982 / 4453	89%	812 / 351	231%	**4794 / 4804**	**100%**
4-WB	4359 / 4822	90%	795 / 364	218%	**5154 / 5186**	**99%**
5-EB	1596 / 1850	86%	413 / 206	200%	**2009 / 2056**	**98%**
5-WB	1601 / 2160	74%	800 / 250	320%	**2401 / 2410**	**100%**
TOTALS	**35866 / 40616**	**88%**	**7318 / 3158**	**232%**	**43184 / 43774**	**99%**

Table 96. Percent of Vehicles in Classes 2 and 3 Visually Identified as Commercial.

Site \ Class	Class 2	Class 3
1-NB	1%	28%
1-SB	1%	28%
2-EB	2%	32%
2-WB	3%	33%
3-NB	2%	27%
3-SB	2%	26%
4-EB	0%	26%
4-WB	0%	21%
5-EB	1%	14%
5-WB	0%	9%
All Sites	**1%**	**26%**

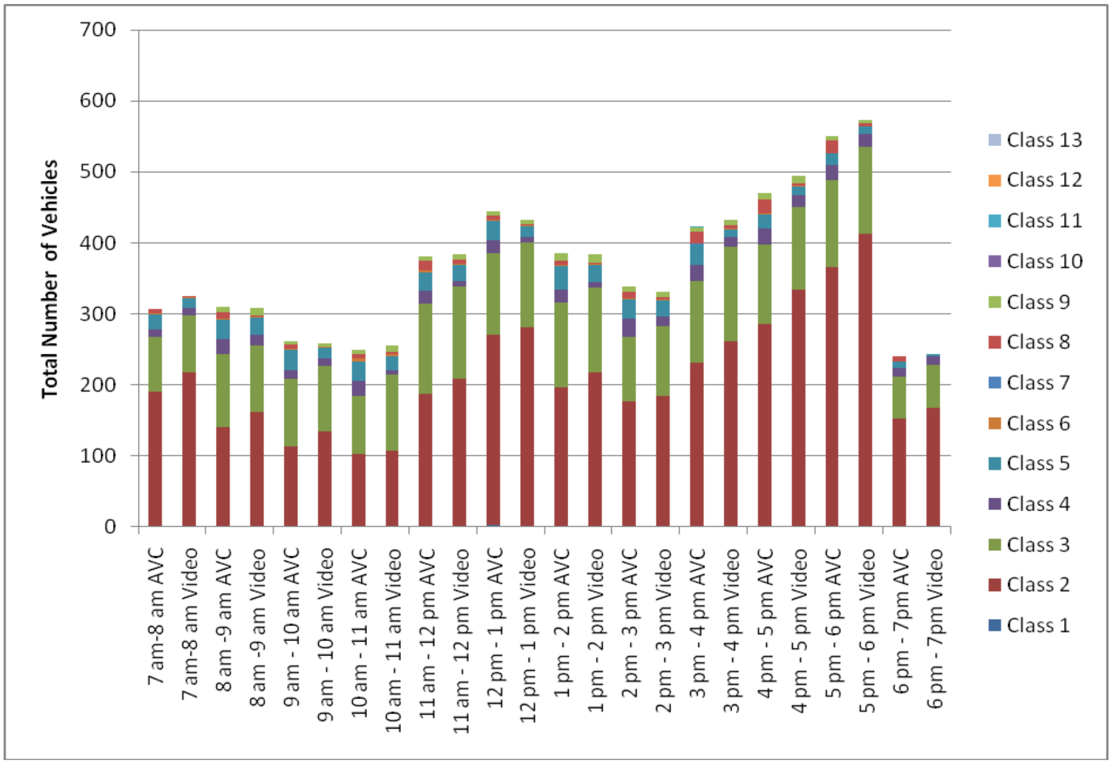


Figure 51. Site 1 Northbound – AVC vs Video Classification Counts by 1-Hour Interval.

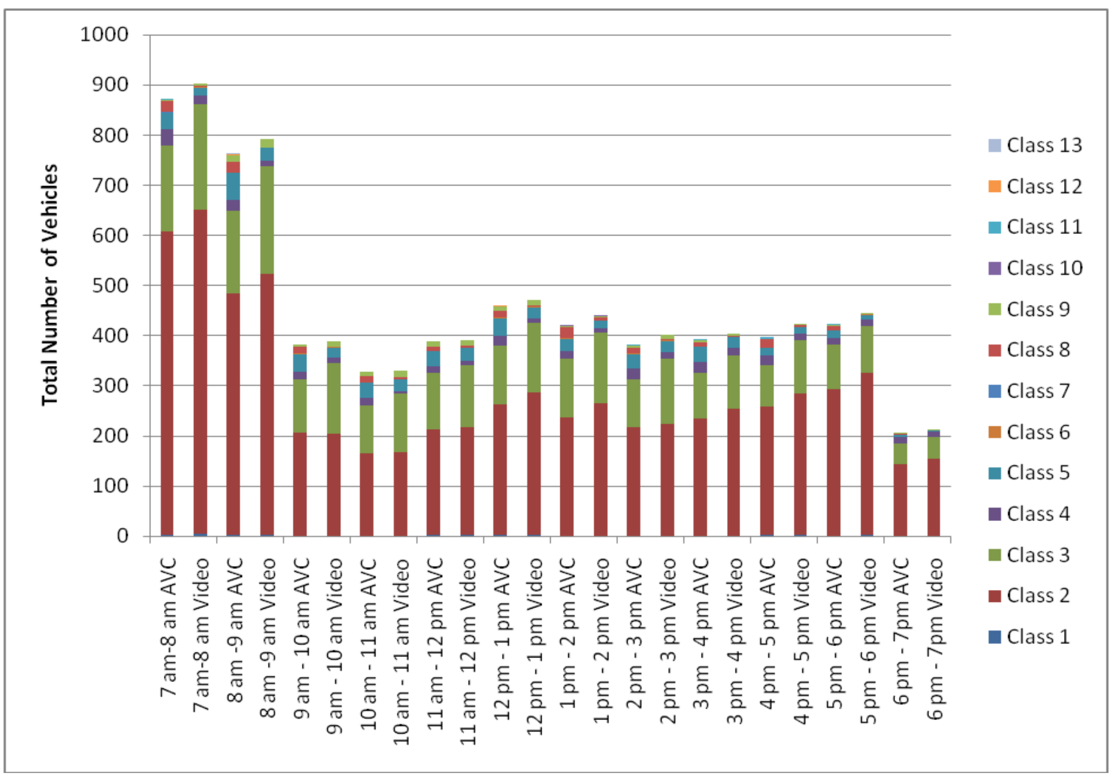


Figure 52. Site 1 Southbound – AVC vs Video Classification Counts by 1-Hour Interval.

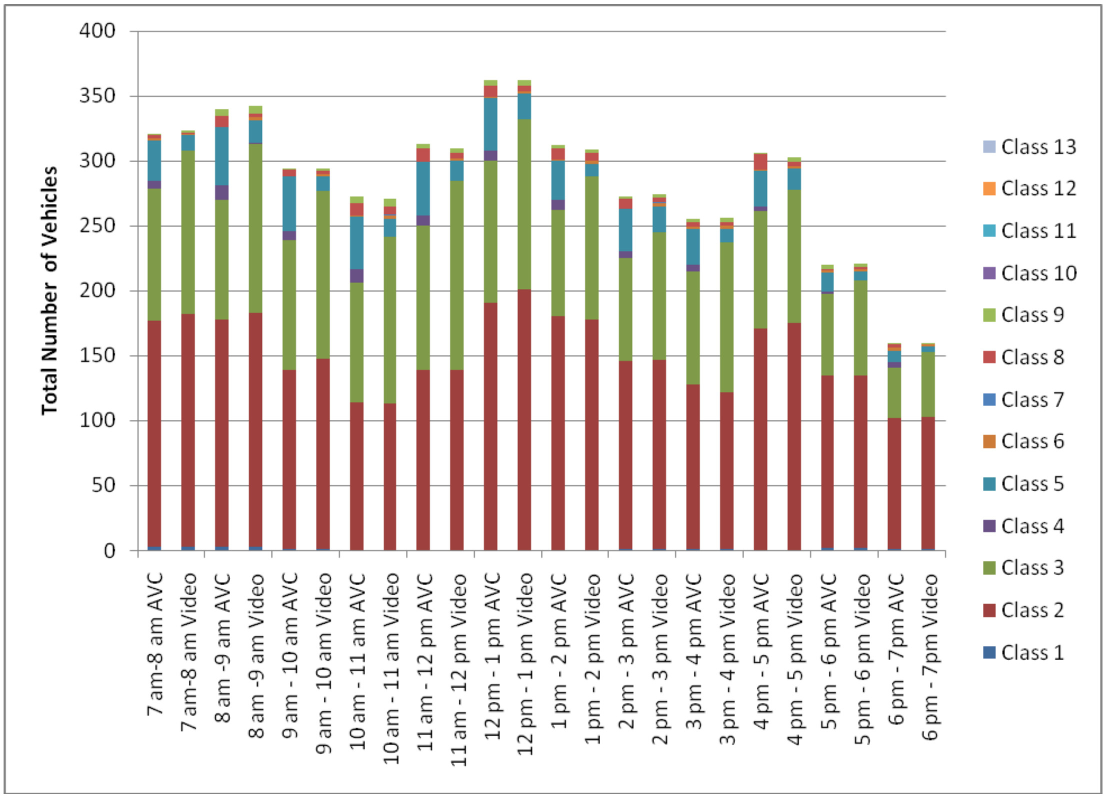


Figure 53. Site 2 Westbound – AVC vs Video Classification Counts by 1-Hour Interval.

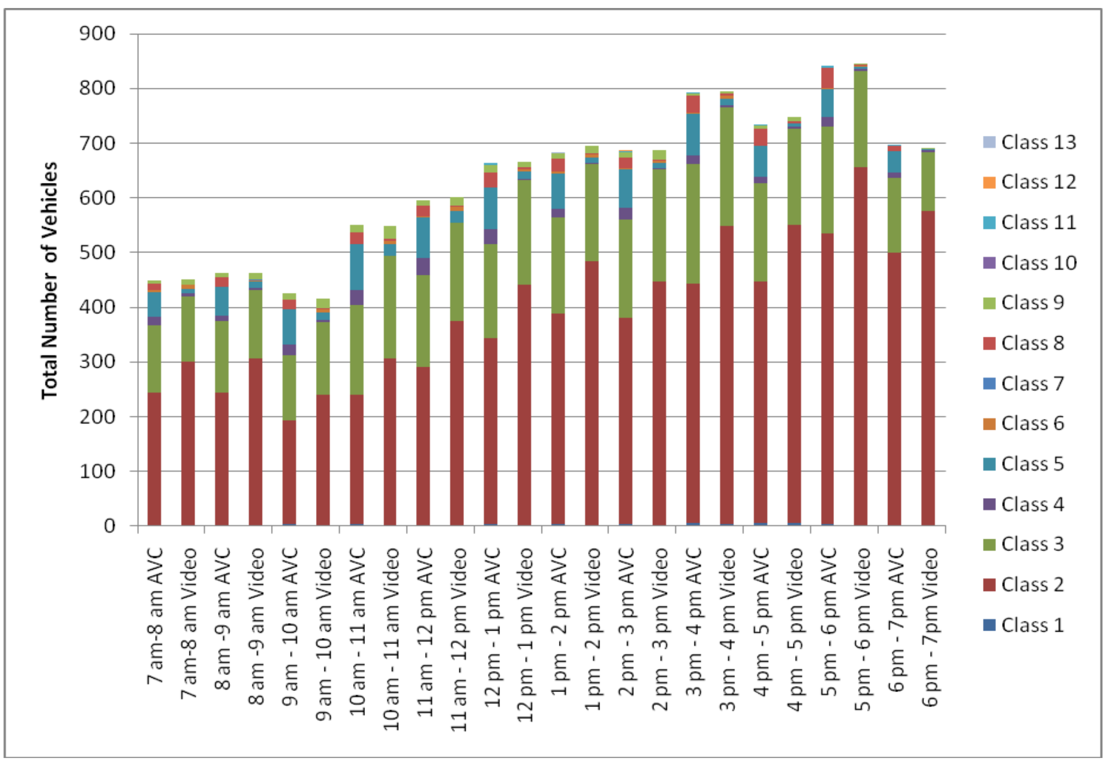


Figure 54. Site 3 Northbound – AVC vs Video Classification Counts by 1-Hour Interval.

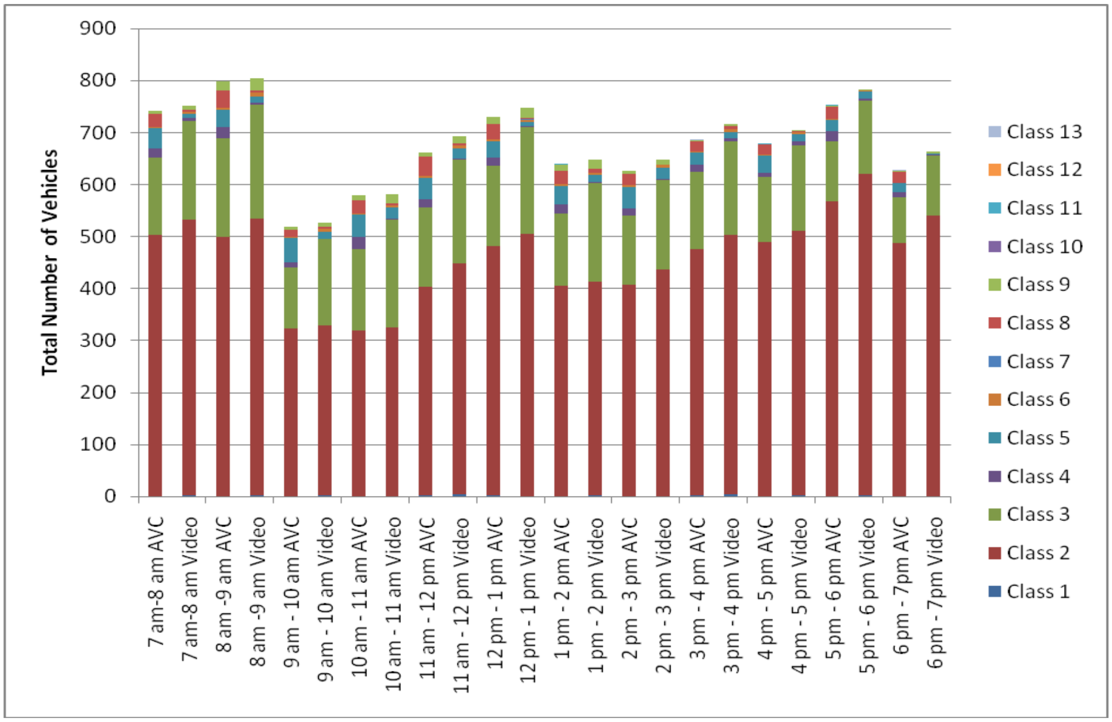


Figure 55. Site 3 Southbound – AVC vs Video Classification Counts by 1-Hour Interval.

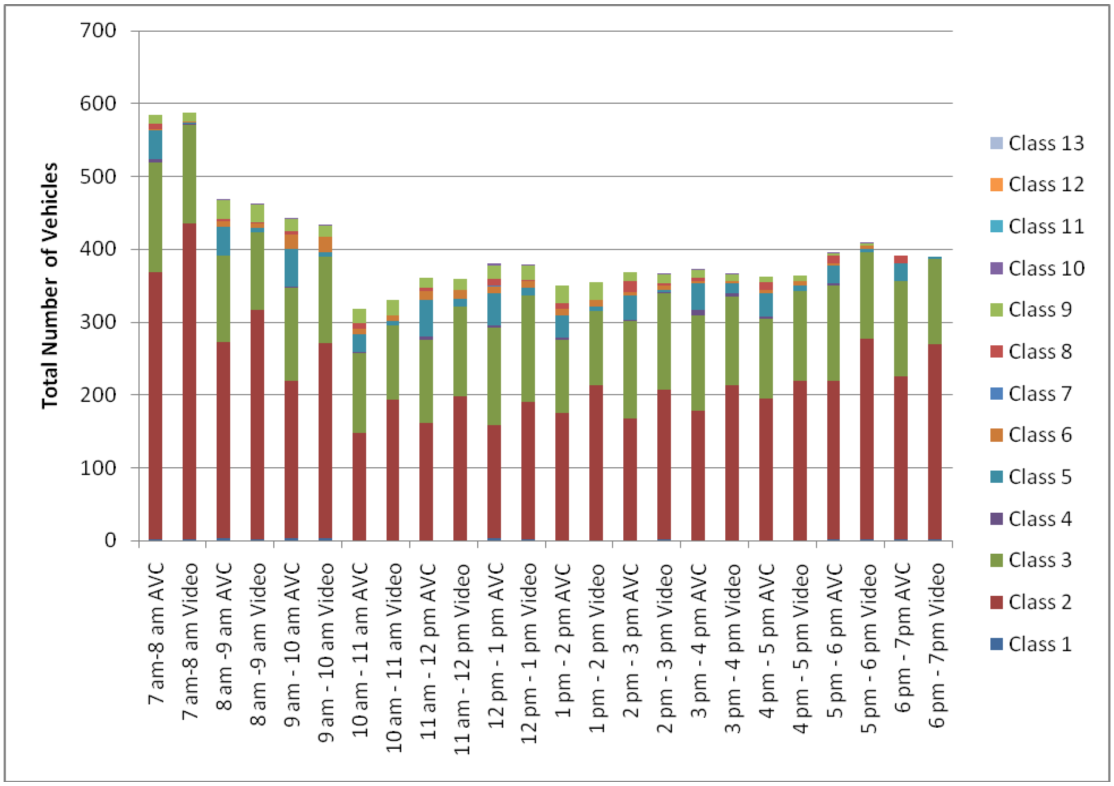


Figure 56. Site 4 Eastbound – AVC vs Video Classification Counts by 1-Hour Interval.

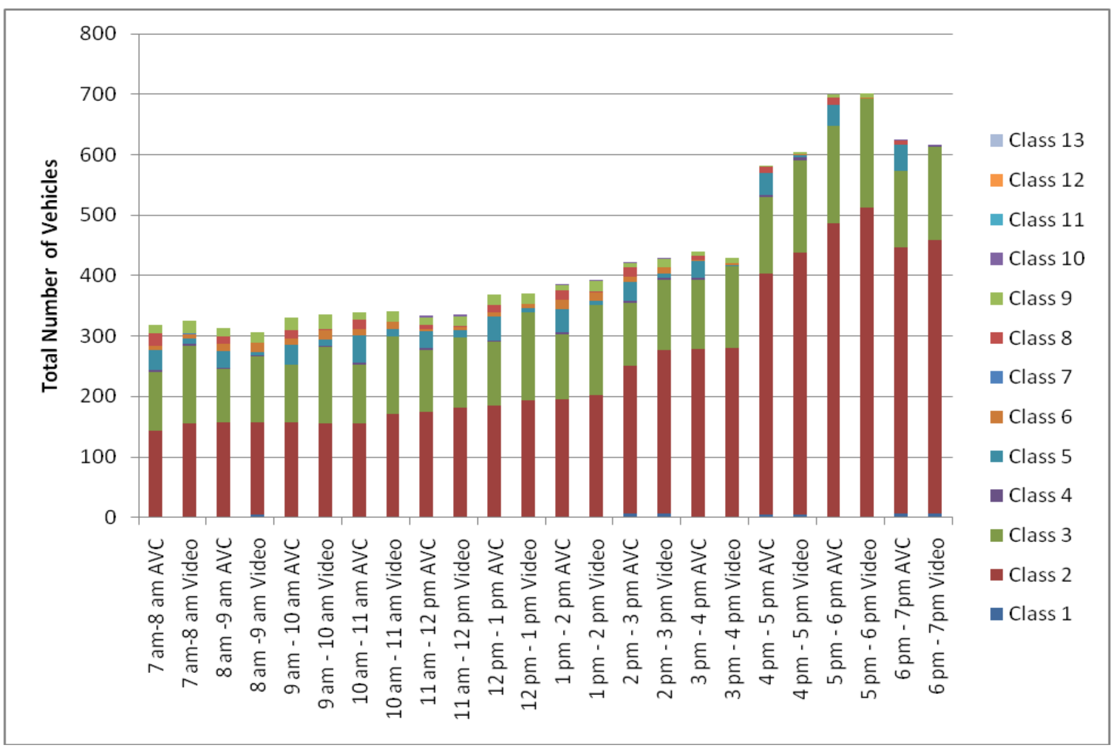


Figure 57. Site 4 Westbound – AVC vs Video Classification Counts by 1-Hour Interval.

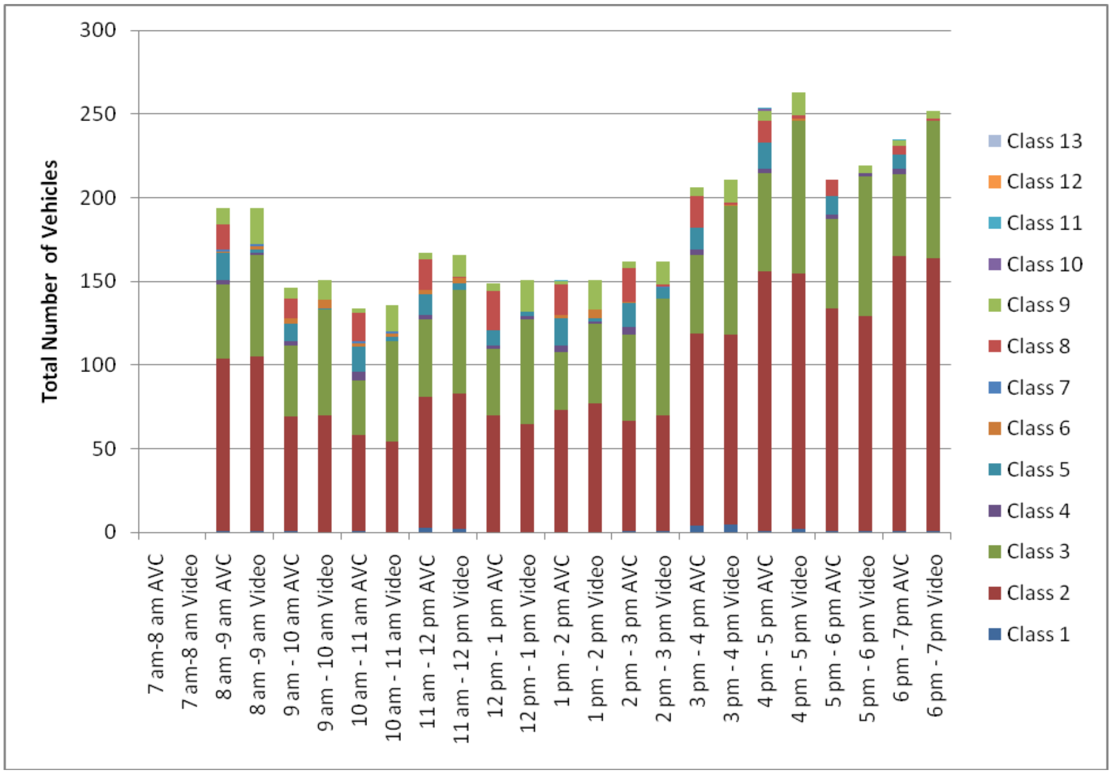


Figure 58. Site 5 Eastbound – AVC vs Video Classification Counts by 1-Hour Interval.

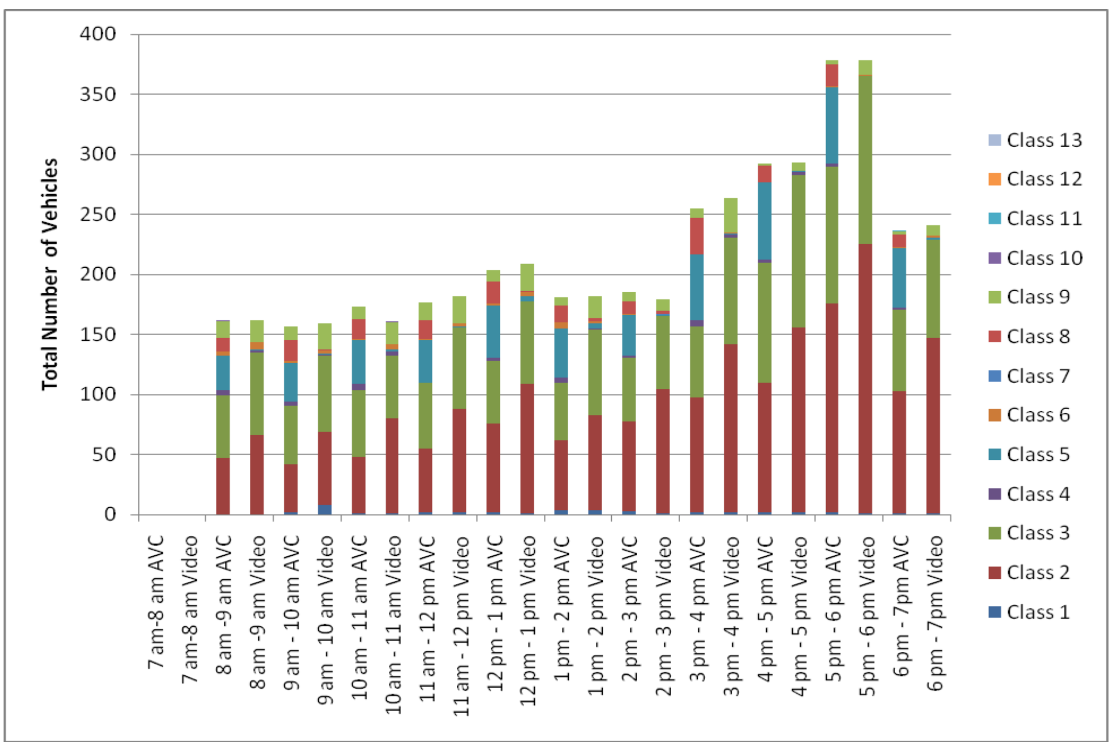


Figure 59. Site 5 Westbound – AVC vs Video Classification Counts by 1-Hour Interval.

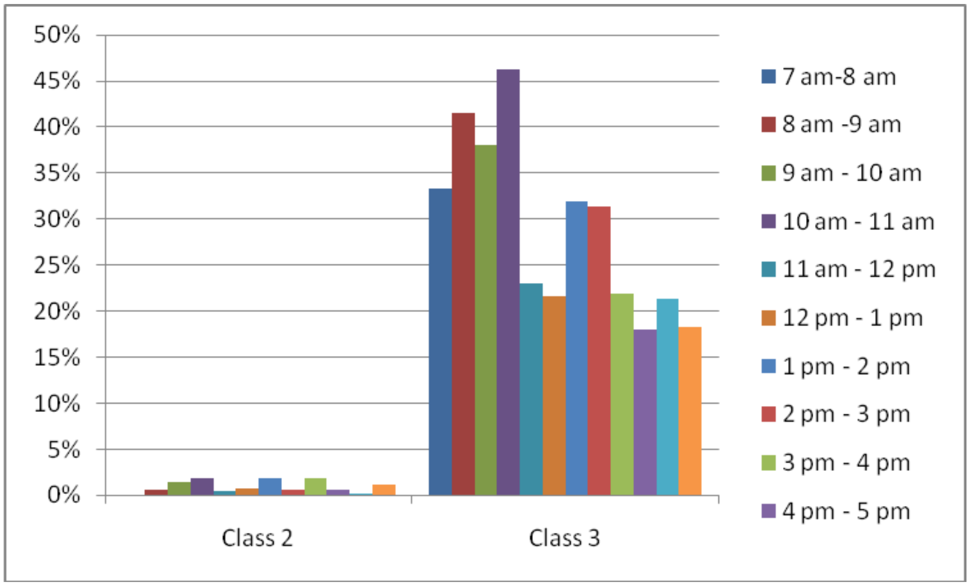


Figure 60. Site 1 Northbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

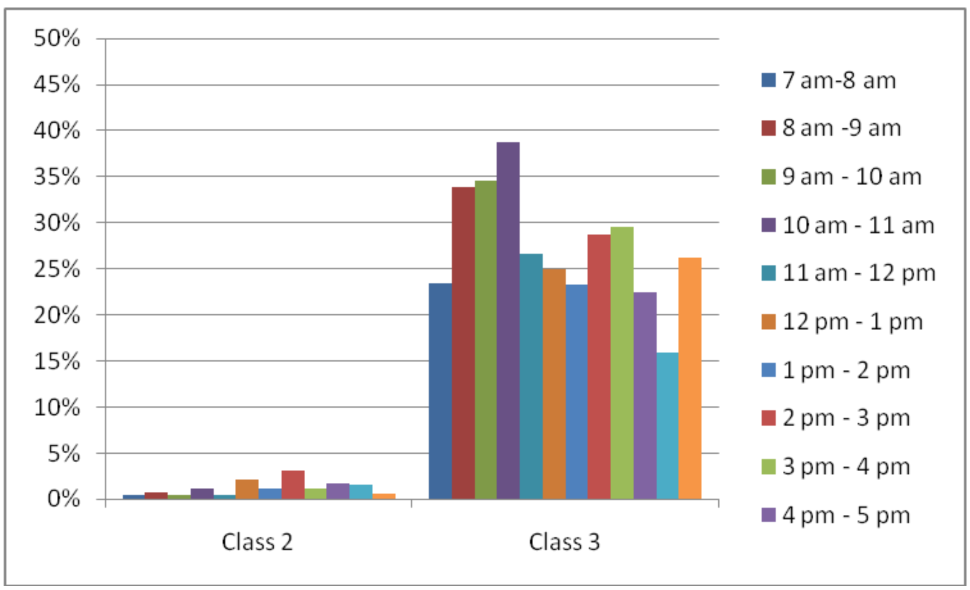


Figure 61. Site 1 Southbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

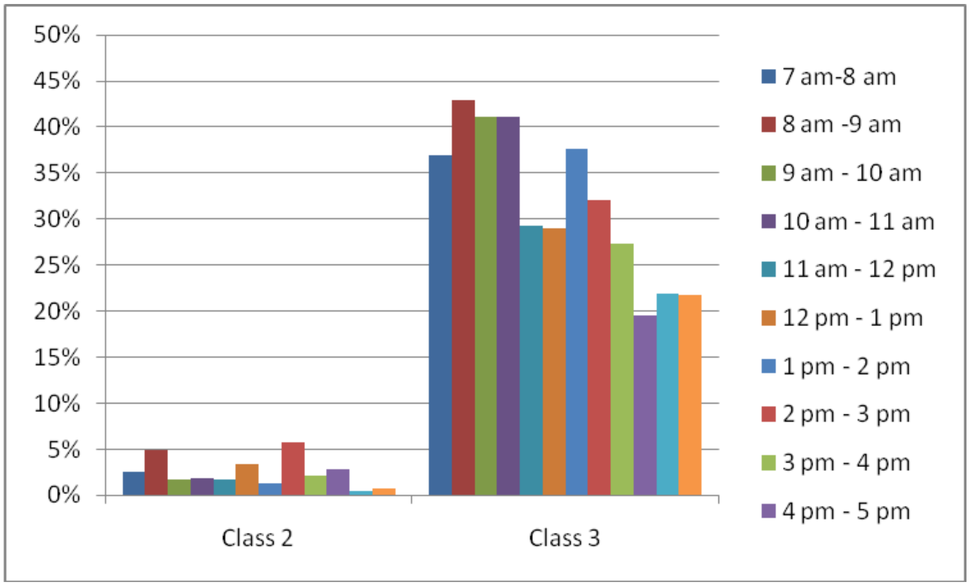


Figure 62. Site 2 Eastbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

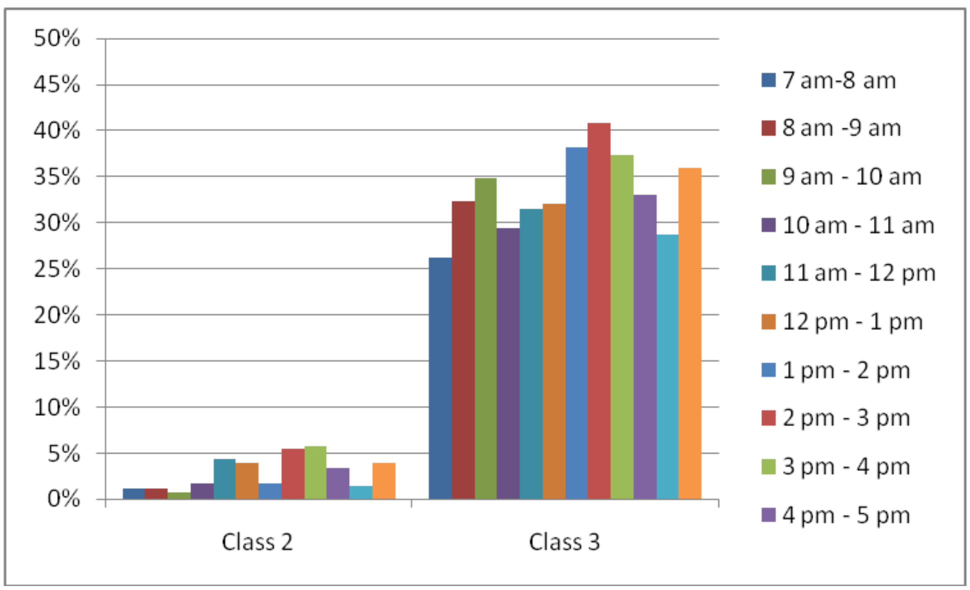


Figure 63. Site 2 Westbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

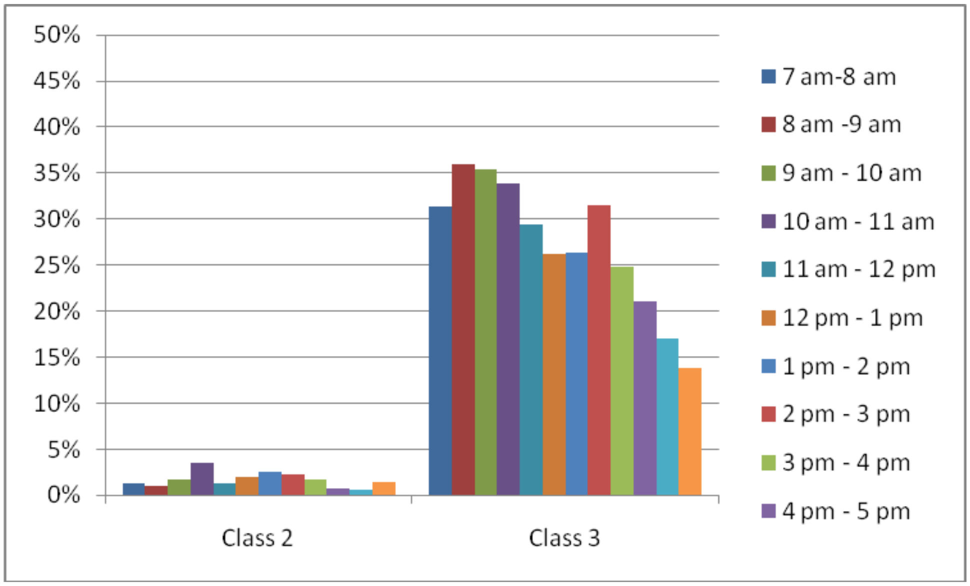


Figure 64. Site 3Northbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

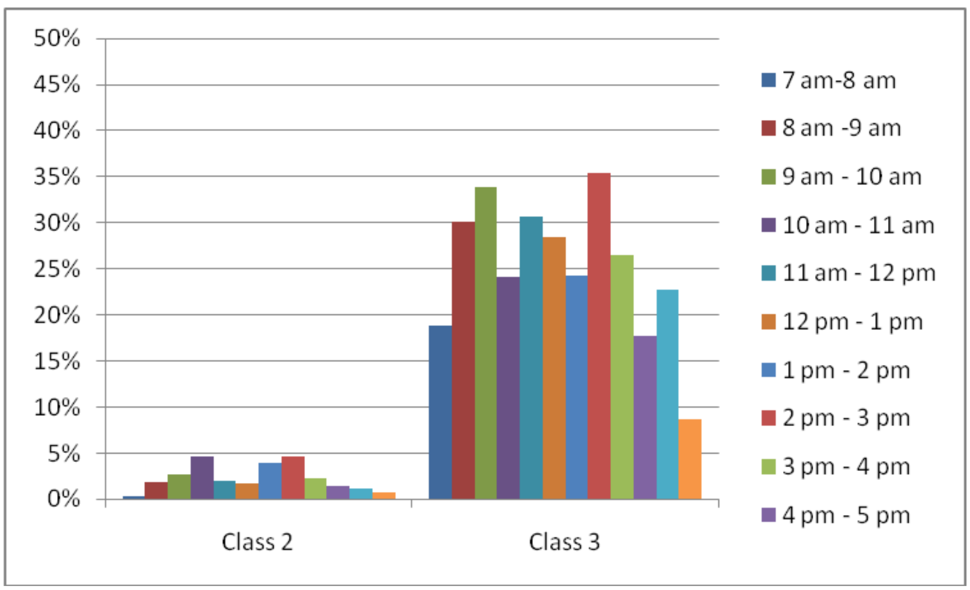


Figure 65. Site 3Southbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

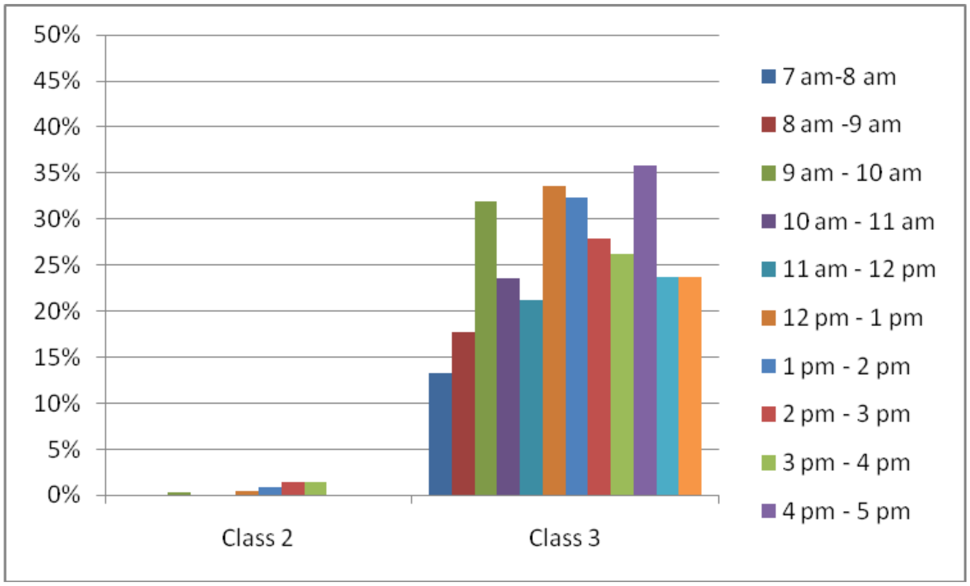


Figure 66. Site 4 Eastbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

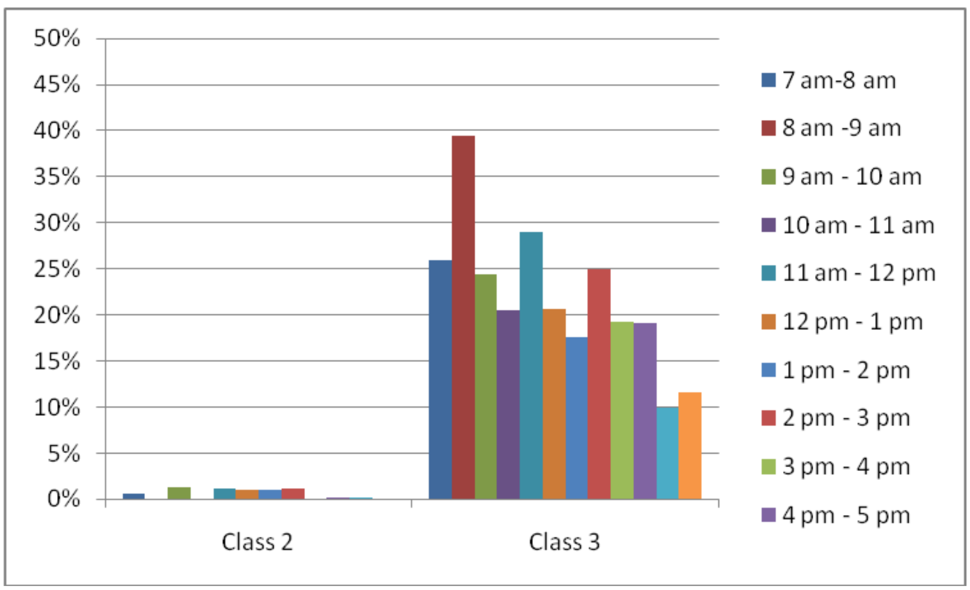


Figure 67. Site 4 Westbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

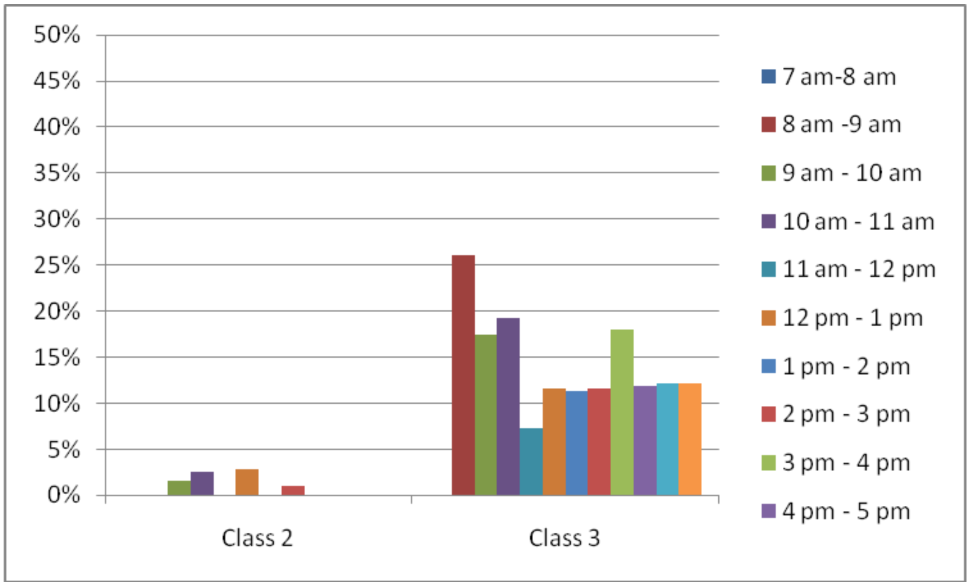


Figure 68. Site 5 Eastbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

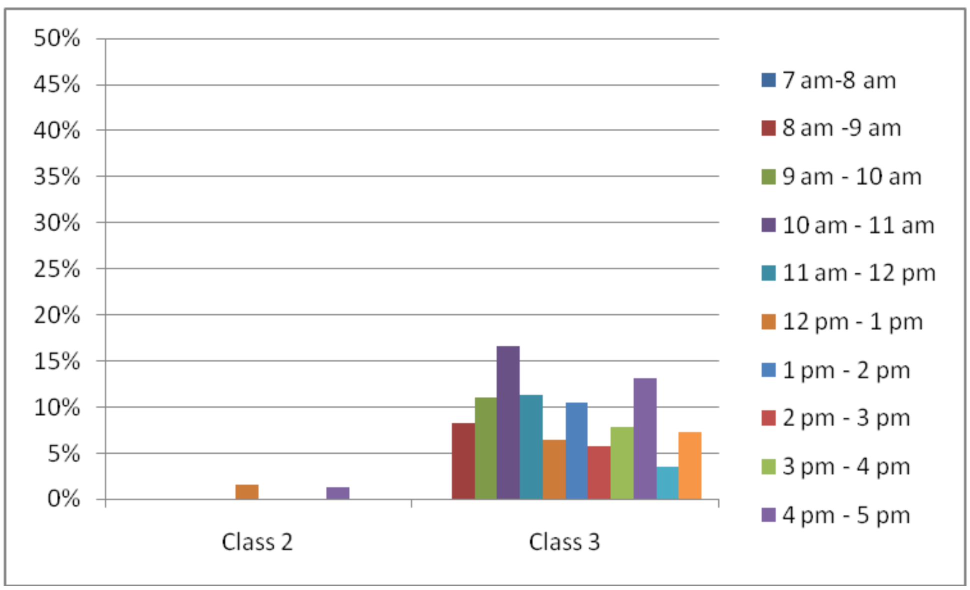


Figure 69. Site 5 Westbound – Percent Commercial Vehicles in Classes 2 and 3 by 1-Hour Interval.

EXTERNAL SURVEY DIRECTIONALITY EVALUATION

Using data from Austin-San Antonio, Sherman-Denison, Dallas-Fort Worth, and Tyler-Longview, analyze the data collected at two-way survey sites to determine differences and magnitude relative to the split between external local and external through, the split between commercial and non-commercial, and the average trip lengths of travel for survey periods. Also evaluate the extent that directional travel is the same over a 24-hour period.

Background

When conducting travel surveys for an urban area, it is important to develop an understanding of vehicle and person movements that occur not only within the area, but also those that are in and out of the area (external local), and those that are through (external through) the area. These movements are examined using external station surveys.

In travel demand models in Texas, estimates of external local and external through trips are developed at the external stations for each urban area. These estimates typically consist of the number of non-commercial and commercial vehicle trips, the number of vehicle trips that are external local and external through, and the average trip length for the external local vehicle trips. These data are developed from external station surveys. Since external station surveys are typically done in the outbound direction only, the assumption is made that the inbound movements are essentially a mirror image of the surveyed outbound movements. The question addressed in this research task is whether this assumption is valid relative to the data estimates used in travel demand models.

Methodology

Using external station survey data collected in three regional external surveys, data at the sites where surveys were done in both directions are evaluated to assess the similarity of movements in the inbound and outbound directions. The survey regions used in this analysis are Tyler-Longview, Austin-San Antonio, and Dallas-Fort Worth-Sherman Denison.

The primary data used in travel demand models from external surveys are the percentage of vehicle trips that are external local and through movements and the average trip length for the external local movements between the external station and the internal zones. The survey data are also used to develop external through vehicle trip tables for the travel demand models. Other estimates developed from these data are estimates of the number of residents and visitors to the urban area. These data may then be used to estimate the number of internal trips being made by non-residents in the area.

Description of Data

External station survey data are collected for both non-commercial and commercial vehicles. These data include the origin and destination of the trip, trip purpose, vehicle occupancy, and other specific data depending on whether the vehicle is non-commercial or commercial. In addition, directional 24-hour vehicle classification counts are conducted at each external station the day the surveys are done. These data form the basis for expanding the survey information to represent estimates for the 24-hour period. The three survey regions used in this analysis contained external stations that were shared by separate Metropolitan Planning Organizations. Since external surveys are done in the outbound direction (for each MPO), those stations shared by adjacent MPOs were surveyed in both directions. These data provide an opportunity to examine the inbound and outbound movements and determine the reasonableness of the assumption that the inbound movement is a mirror image of the outbound movements.

Data Analysis

The primary data from external surveys used in travel demand models are the percent local and through movements and the average trip length. The data from the two-way external station surveys were processed to generate these estimates as well as other data to assess the potential impact of these measures on the travel demand model results when applying the assumption of a mirror image.

Table 97 presents the vehicle count data for each two-way survey site. The 24-hour volumes are presented for all vehicles with the count data for non-commercial and commercial vehicles for the 7 a.m. to 6 p.m. time period. The 7 a.m. to 6 p.m. time period is generally the time period the surveys were conducted. All data are shown in terms of inbound and outbound direction relative to a specific urban area. It will be noted that the inbound and outbound volumes are the same (except in terms of direction) for sites that are shared by two urban areas (e.g., Tyler and Longview). To measure the similarity between the inbound and outbound movements, the correlation coefficient is computed to illustrate the strength of the linear relationship between the two sets of numbers. A perfect match (i.e., inbound and outbound volumes exactly the same) would be indicated by a correlation coefficient with a value of 1.0. For 24-hour inbound and outbound volumes, the correlation coefficient of 0.996 indicates a very close relationship between the inbound and outbound volumes of vehicles. This is also reflected in Figure 70, which plots the inbound versus the outbound movements against the straight line that would result if the movements matched exactly.

Table 97. Non-Commercial Vehicle Inbound and Outbound Volume Comparisons.

Urban Area	Facility	24-Hour Volume		Non-Commercial 24-hour Volume		Pct Dif	Non-Commercial Survey Period Volume		Pct Dif
		In	Out	In	Out		In	Out	
Tyler	US 271	2865	2841	2079	2082	0.1%	1656	1563	6.0%
	FM 1252	397	410	351	377	6.9%	245	262	6.5%
	FM 2767	601	593	514	541	5.0%	394	437	9.8%
	SH 31	2889	2719	2080	2270	8.4%	1519	1701	10.7%
	SH 64	2040	2345	1631	1963	16.9%	1255	1515	17.2%
	SH 155	2575	2516	2014	2021	0.4%	1538	1540	0.1%
	FM 850	437	437	270	324	16.7%	201	237	15.2%
Longview	US 271	2841	2865	2082	2079	0.1%	1563	1656	6.0%
	FM 1252	410	397	377	351	6.9%	262	245	6.5%
	FM 2767	593	601	541	514	5.0%	437	394	9.8%
	SH 31	2719	2889	2270	2080	8.4%	1701	1519	10.7%
	SH 64	2345	2040	1963	1631	16.9%	1515	1255	17.2%
	SH 155	2516	2575	2021	2014	0.4%	1540	1538	0.1%
	FM 850	437	437	324	270	16.7%	237	201	15.2%
Austin	FM 31	1373	1309	1196	1222	2.1%	885	882	0.3%
	SH 123	5296	5264	4840	4582	5.6%	3287	3161	4.0%
	FM 621	2560	2404	2471	2263	9.2%	1522	1538	1.0%
	US 90	986	982	850	800	6.3%	608	569	6.9%
	SH 80	1818	1904	1551	1559	0.5%	1091	1113	2.0%
San Antonio	FM 31	1309	1373	1222	1196	2.1%	882	885	0.3%
	SH 123	5264	5296	4582	4840	5.6%	3161	3287	4.0%
	FM 621	2404	2560	2263	2471	9.2%	1538	1522	1.0%
	US 90	982	986	800	850	6.3%	569	608	6.9%
	SH 80	1904	1818	1559	1551	0.5%	1113	1091	2.0%
Dallas Ft Worth	US 377	3872	3815	3666	3618	1.3%	2628	2816	6.7%
	SH 289	2203	2196	2048	2056	0.4%	1375	1637	16.0%
	SH 5	1503	1555	1442	1486	3.0%	1039	1141	8.9%
	SH 160	1777	1680	1402	1315	6.6%	916	1024	10.5%
Sherman Denison	US 377	3815	3872	3618	3666	1.3%	2816	2628	6.7%
	SH 289	2196	2203	2056	2048	0.4%	1637	1375	16.0%
	SH 5	1555	1503	1486	1442	3.0%	1141	1039	8.9%
	SH 160	1680	1777	1315	1402	6.6%	1024	916	10.5%

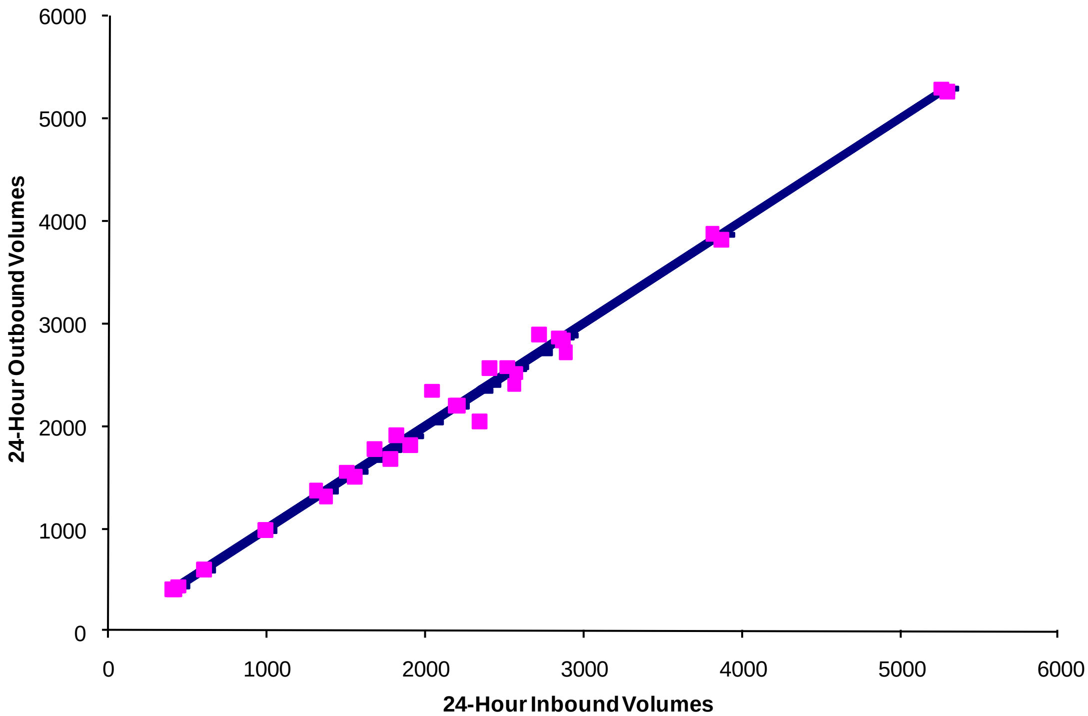


Figure 70. 24-Hour Inbound and Outbound Volume Comparisons.

The correlation coefficients computed for the 24-hour and survey period non-commercial vehicle volumes are 0.993 and 0.987, respectively. Figures 71 and 72 present plots of the inbound and outbound volumes. Straight lines representing perfect matches are also shown in the figures. In terms of traffic volumes for non-commercial vehicles, the inbound and outbound movements match very well. It should be noted that these data are double counted in that the inbound and outbound volumes are represented twice for each station (i.e., each station is shown for each urban area and therefore the volumes are shown twice).

Table 98 presents the comparison of inbound and outbound movements for commercial vehicles. In comparing the inbound and outbound volumes for the commercial vehicles, more variation and differences are noted. The correlation coefficients for the 24-hour and survey period volumes are 0.875 and 0.845, respectively. These values still indicate a close relationship between the inbound and outbound volumes. Figures 73 and 74 plot the inbound and outbound volumes with a straight line. It is obvious these volumes are considerably more different than those for non-commercial vehicles. The correlation coefficients are high enough to support the assumption that a mirror image will not result in significant errors.

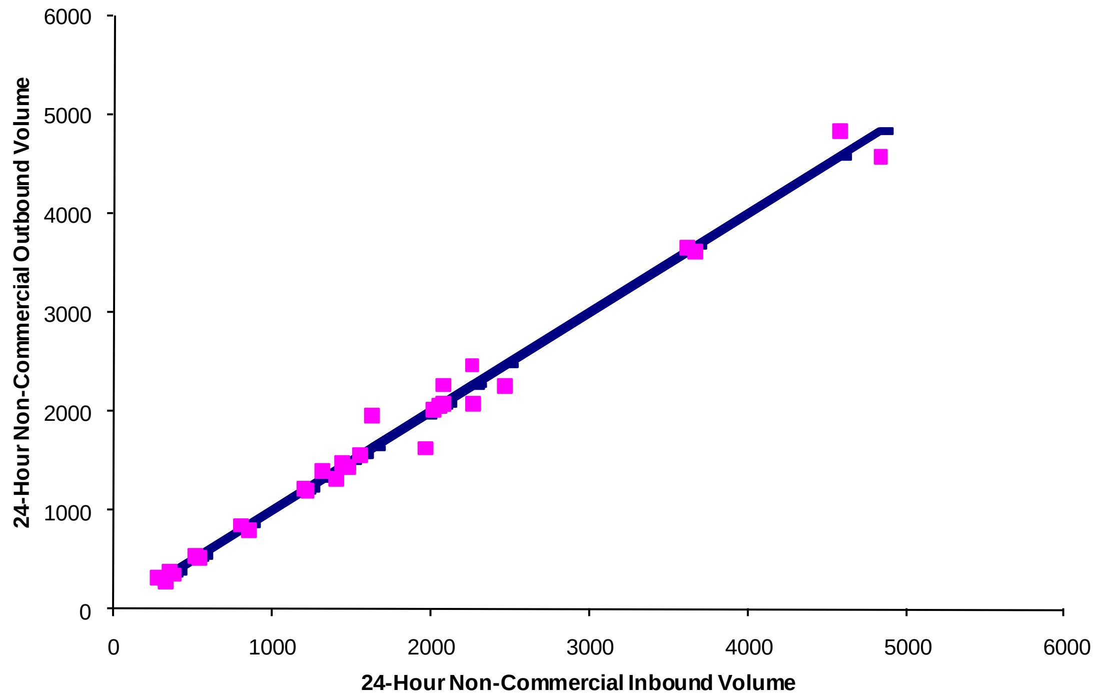


Figure 71. 24-Hour Inbound and Outbound Non-Commercial Vehicle Volumes.

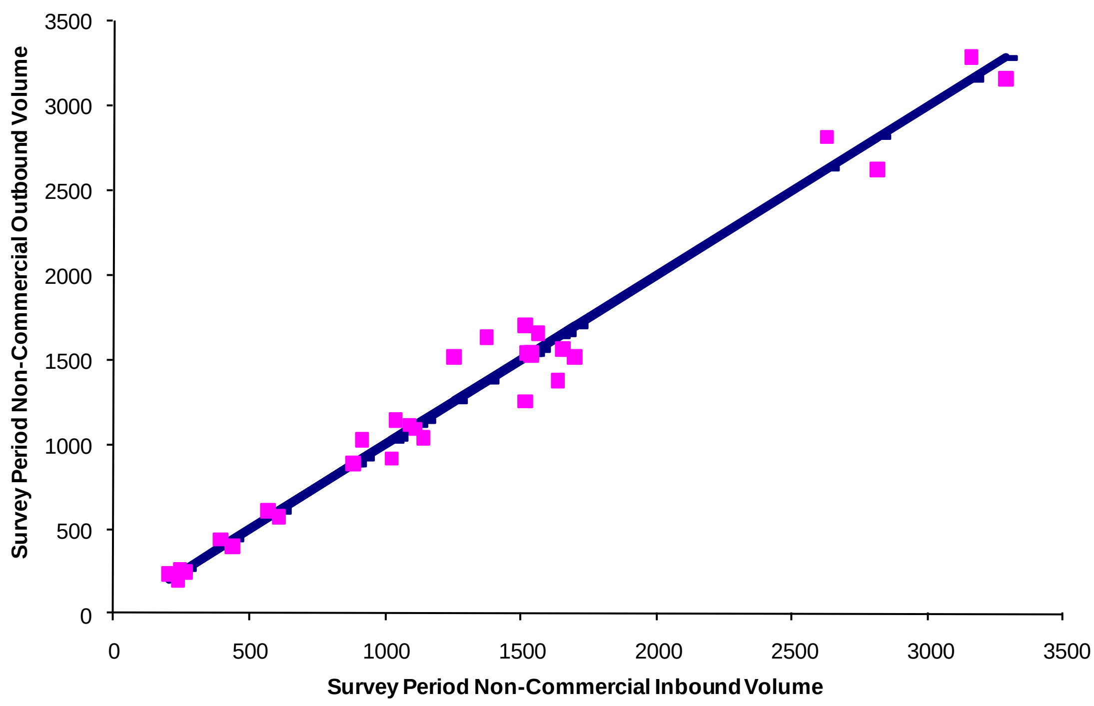


Figure 72. Survey Period Inbound and Outbound Non-Commercial Vehicle Volumes.

Table 98. Commercial Vehicle Inbound and Outbound Volume Comparisons.

Urban Area	Facility	24-Hour Volume		Commercial 24-hour Volume		Pct Dif	Commercial Survey Period Volume		Pct Dif
		In	Out	In	Out		In	Out	
Tyler	US 271	2865	2841	786	759	3.6%	615	560	9.8%
	FM 1252	397	410	46	33	39.4%	36	25	44.0%
	FM 2767	601	593	87	52	67.3%	76	45	68.9%
	SH 31	2889	2719	809	449	80.2%	640	360	77.8%
	SH 64	2040	2345	409	382	7.1%	326	312	4.5%
	SH 155	2575	2516	561	495	13.3%	410	362	13.3%
	FM 850	437	437	167	113	47.8%	132	86	53.5%
Longview	US 271	2841	2865	759	786	3.6%	560	615	9.8%
	FM 1252	410	397	33	46	39.4%	25	36	44.0%
	FM 2767	593	601	52	87	67.3%	45	76	68.9%
	SH 31	2719	2889	449	809	80.2%	360	640	77.8%
	SH 64	2345	2040	382	409	7.1%	312	326	4.5%
	SH 155	2516	2575	495	561	13.3%	362	410	13.3%
	FM 850	437	437	113	167	47.8%	86	132	53.5%
Austin	FM 31	1373	1309	177	87	103.4%	142	67	112.9%
	SH 123	5296	5264	456	682	33.1%	303	517	41.4%
	FM 621	2560	2404	89	141	36.9%	60	102	41.2%
	US 90	986	982	136	182	25.3%	87	144	39.6%
	SH 80	1818	1904	267	345	77.4%	178	256	30.5%
San Antonio	FM 31	1309	1373	87	177	103.4%	67	142	112.9%
	SH 123	5264	5296	682	456	33.1%	517	303	41.4%
	FM 621	2404	2560	141	89	36.9%	102	60	41.2%
	US 90	982	986	182	136	25.3%	144	87	39.6%
	SH 80	1904	1818	345	267	77.4%	256	178	30.5%
Dallas Ft Worth	US 377	3872	3815	206	197	4.6%	169	170	0.6%
	SH 289	2203	2196	155	140	10.7%	125	122	2.5%
	SH 5	1503	1555	61	69	11.6%	49	58	15.5%
	SH 160	1777	1680	375	365	2.7%	288	276	4.3%
Sherman Denison	US 377	3815	3872	197	206	4.6%	170	169	0.6%
	SH 289	2196	2203	140	155	10.7%	122	125	2.5%
	SH 5	1555	1503	69	61	11.6%	58	49	15.5%
	SH 160	1680	1777	365	375	2.7%	276	288	4.3%

Table 99 presents the percentage of residents and visitors (non-commercial vehicles only) that were surveyed by direction at each site. The number of surveyed trips is also shown in Table 99. Since the percentage of residents and visitors sum to one for each site, the correlation coefficient is the same for both, i.e., 0.821. Figure 75 shows the percentage of residents inbound and outbound. The distribution of sites by the percent difference (absolute value) range is shown in Figure 76. The majority of sites (41 percent) had a percent difference of less than five percent in the estimate of inbound versus outbound. Only four sites had a difference greater than 15 percent. Nearly two thirds of the sites had differences less than 10 percent. It is of interest to note that the sites with the largest differences were in the Austin-San Antonio area. Summing all of the site data for Austin and San Antonio together and computing an aggregate percent of residents inbound and outbound for each area resulted in a difference of 1 percent for Austin and just over 2 percent for San Antonio. This indicates that while the individual sites reflected differences, the overall aggregate estimates were very close. This implies that individuals may be using one facility for traveling into an area but then use another facility for the return trip.

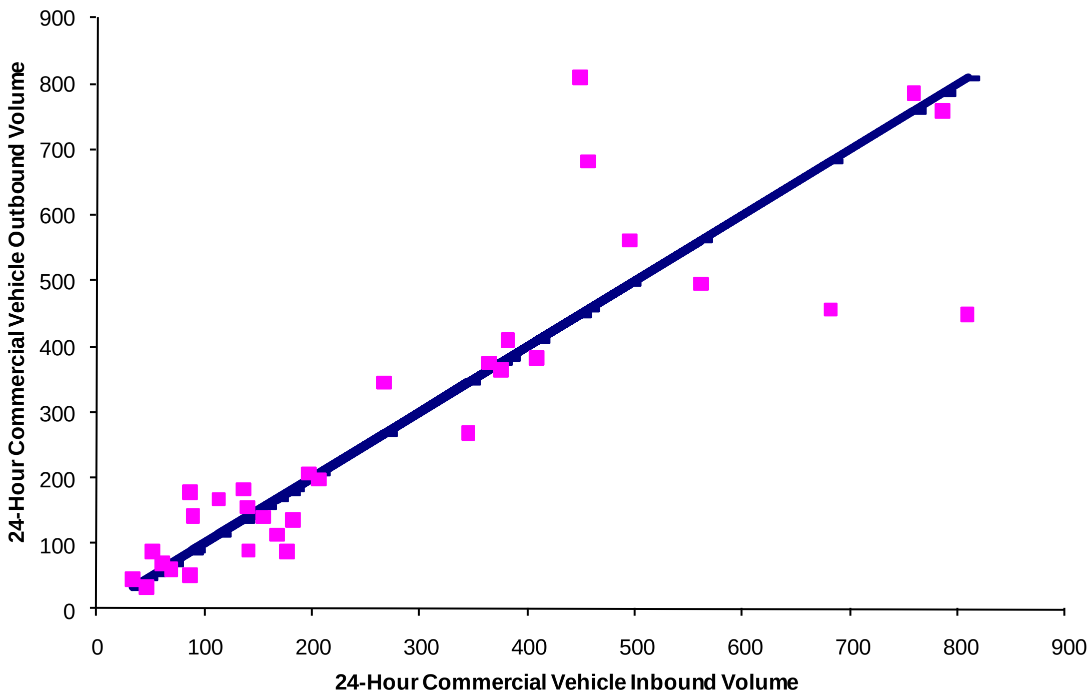


Figure 73. 24-Hour Inbound and Outbound Commercial Vehicle Volumes.

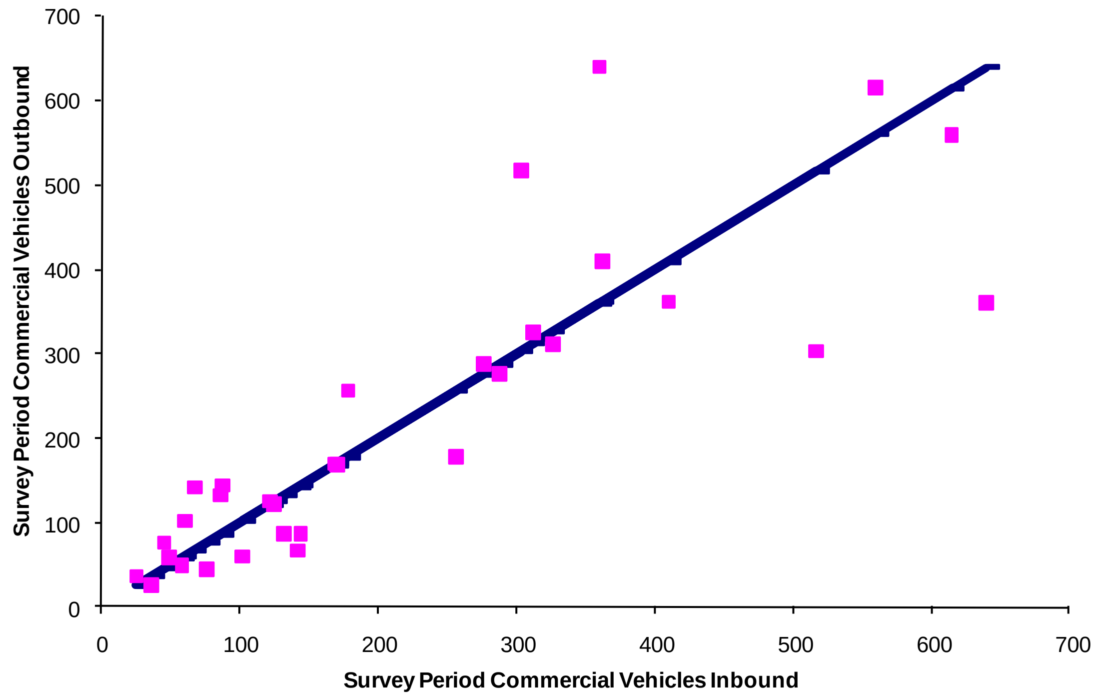


Figure 74. Survey Period Inbound and Outbound Commercial Vehicle Volumes.

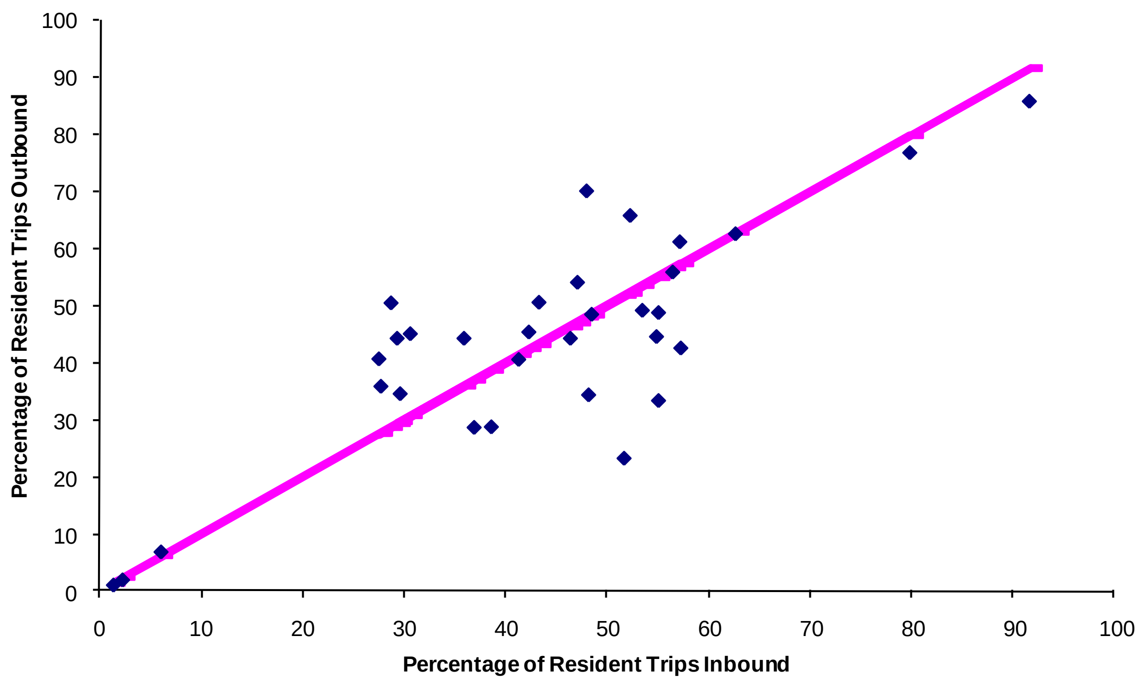


Figure 75. Percentage of Resident Trips Inbound and Outbound.

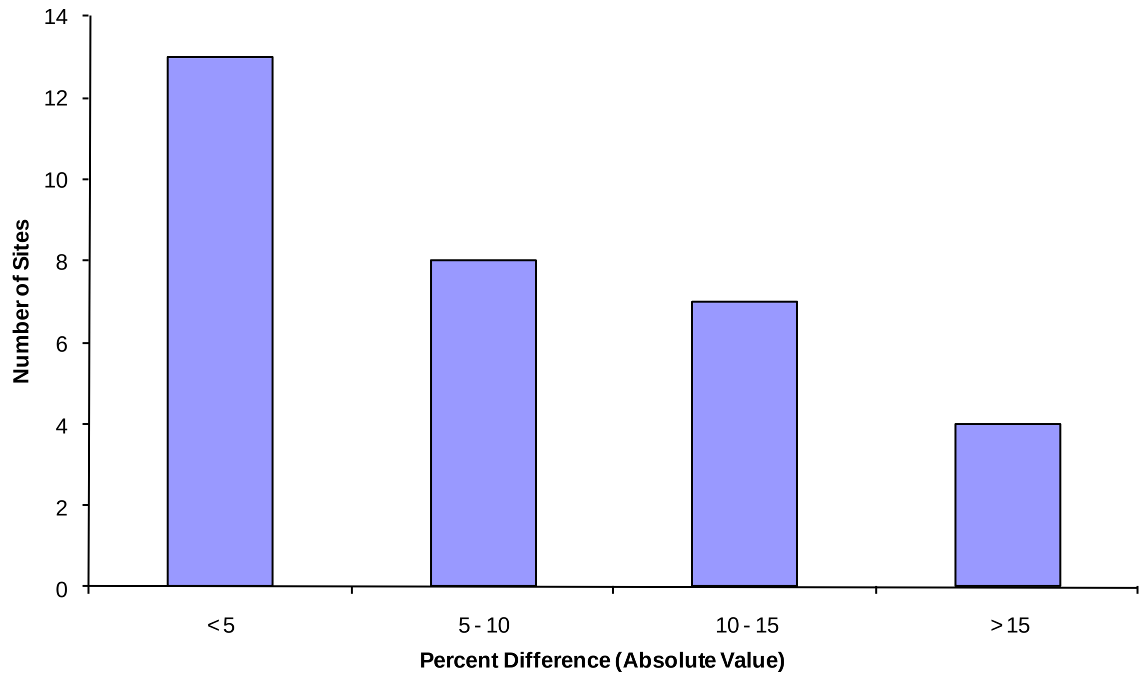


Figure 76. Distribution of Sites by Percent Difference in Percentage of Resident Trips.

Table 99. Non-Commercial Vehicle Percentage Residents and Visitors.

Urban Area	Facility	Surveyed Trips		Percentage Residents		Dif	Percentage Visitors		Dif
		In	Out	In	Out		In	Out	
Tyler	US 271	220	293	38.6%	28.7%	9.9%	61.4%	71.3%	- 9.9%
	FM 1252	131	104	56.5%	55.8%	0.7%	43.5%	44.2%	-0.7%
	FM 2767	224	138	46.4%	44.2%	2.2%	53.6%	55.8%	-2.2%
	SH 31	287	217	36.9%	28.6%	8.3%	63.1%	71.4%	-8.3%
	SH 64	301	308	1.3%	1.0%	0.3%	99.3%	99.0%	-0.3%
	SH 155	312	316	2.2%	1.9%	0.3%	97.8%	98.1%	-0.3%
	FM 850	133	132	6.0%	6.8%	-0.8%	94.0%	93.2%	0.8%
Longview	US 271	293	220	54.9%	44.5%	10.4%	45.1%	55.5%	-10.4%
	FM 1252	104	131	41.3%	40.5%	0.8%	58.7%	59.5%	-0.8%
	FM 2767	138	224	55.1%	48.7%	6.4%	44.9%	51.3%	-6.4%
	SH 31	217	287	53.5%	49.1%	4.4%	46.5%	50.9%	-4.4%
	SH 64	308	301	79.9%	76.7%	3.2%	20.1%	23.3%	-3.2%
	SH 155	316	312	62.7%	62.5%	0.2%	37.3%	37.5%	-0.2%
	FM 850	132	133	91.7%	85.7%	6.0%	8.3%	14.3%	-6.0%
Austin	FM 32	333	370	51.7%	23.2%	28.5%	48.3%	76.8%	-28.5%
	SH 123	368	432	29.6%	34.5%	-4.9%	70.4%	65.5%	4.9%
	FM 621	443	452	28.7%	50.4%	-21.7%	71.3%	49.6%	21.7%
	US 90	313	309	48.2%	34.3%	13.9%	51.8%	65.7%	-13.9%
	SH 80	310	358	30.6%	45.0%	-14.4%	69.4%	55.0%	14.4%
San Antonio	FM 32	370	333	55.1%	33.3%	21.8%	44.9%	63.7%	-21.8%
	SH 123	432	368	57.2%	61.1%	-3.9%	42.8%	38.9%	3.9%
	FM 621	452	443	48.0%	70.0%	-22.0%	52.0%	30.0%	22.0%
	US 90	309	313	57.3%	42.5%	14.8%	42.7%	57.5%	-14.8%
	SH 80	358	310	29.3%	44.2%	-14.9%	70.7%	55.8%	14.9%
Dallas Ft Worth	US 377	351	371	35.9%	44.2%	-8.3%	64.1%	55.8%	8.3%
	SH 289	432	453	27.5%	40.6%	-13.1%	72.5%	59.4%	13.1%
	SH 5	289	346	47.1%	54.0%	-6.9%	52.9%	46.0%	6.9%
	SH 160	310	324	27.7%	35.8%	-8.1%	72.3%	64.2%	8.1%
Sherman Denison	US 377	371	351	42.3%	45.3%	-3.0%	57.7%	54.7%	3.0%
	SH 289	453	432	52.3%	65.7%	-13.4%	47.7%	34.3%	13.4%
	SH 5	346	289	43.3%	50.5%	-7.2%	56.6%	49.5%	7.2%
	SH 160	324	310	48.5%	48.4%	0.1%	51.5%	51.6%	-0.1%

Tables 100 and 101 present comparisons of inbound and outbound movements for non-commercial and commercial vehicles, respectively. Comparisons are presents in terms of the percent of surveyed trips identified as external local and the average trip length in terms of miles based on the network distance between the external station and the internal zone where the trip originated or was destined. Three stations associated with the Longview study area did not have any network associated with them (due to their location) and no average trip length data are presented for those stations. In the Sherman-Denison study area, the zone system and associated network had not been developed at the time of this analysis. No data are presented for the four stations in terms of inbound estimates of external local trips and average trip lengths.

The correlation coefficients for the percentage of external local trips in terms of inbound and outbound movements for non-commercial and commercial vehicles were 0.89 and 0.92, respectively. This indicates the inbound and outbound percentages of external local trips match reasonably well for both types of vehicles. In terms of the average trip length, the coefficients of correlation were 0.997 for non-commercial vehicles and 0.91 for commercial vehicles. Again these indicate relatively good agreement in the estimates. Figures 77 and 78 present plots of these estimates with the straight line representing a perfect match. The data indicate that the assumption of a mirror image in the inbound direction for external station surveys does not result in a significant loss in accuracy in terms of the percent of external local trips and average trip length.

Table 100. Non-Commercial Inbound and Outbound External Trip Comparisons

Urban Area	Facility	24-Hour Volume		Non-Commercial Percent External Local		Dif	Non-Commercial Average Trip Length (Miles)		Pct Dif
		In	Out	In	Out		In	Out	
Tyler	US 271	2079	2082	89.1	95.6	-6.5	22.8	21.0	8.6%
	FM 1252	351	377	93.1	99.0	-5.9	22.0	19.4	13.4%
	FM 2767	514	541	97.3	97.1	0.2	19.8	22.2	-10.8%
	SH 31	2080	2270	90.9	29.0	61.9	21.8	20.7	5.3%
	SH 64	1631	1963	95.7	96.1	-0.4	21.7	21.8	-0.5%
	SH 155	2014	2021	84.6	88.3	-3.7	21.1	21.8	-3.2%
	FM 850	270	324	93.2	96.2	-3.0	20.7	20.4	1.5%
Longview	US 271	2082	2079	13.7	66.8	-53.2	8.7	8.7	0.0%
	FM 1252	377	351	95.2	96.2	-1.0	9.1	10.6	-14.2%
	FM 2767	541	514	88.4	87.5	0.9	9.4	10.1	-6.9%
	SH 31	2270	2080	84.8	78.7	6.0	12.5	12.1	3.3%
	SH 64	1963	1631	0.6	0.0	0.6	NA	NA	
	SH 155	2021	2014	0.6	3.2	-2.6	NA	NA	
	FM 850	324	270	5.3	7.5	-2.2	NA	NA	
Austin	FM 31	1196	1222	60.4	79.7	-19.4	68.7	65.9	4.2%
	SH 123	4840	4582	96.7	98.8	-2.1	15.2	12.9	17.8%
	FM 621	2471	2263	98.9	100.0	-1.1	10.5	9.8	7.1%
	US 90	850	800	100.0	99.4	0.6	74.5	72.1	3.3%
	SH 80	1551	1559	98.7	97.5	1.2	14.6	14.2	2.8%
San Antonio	FM 31	1222	1196	93.2	94.9	-1.7	52.8	52.0	1.5%
	SH 123	4582	4840	91.7	93.8	-2.1	18.9	17.5	8.0%
	FM 621	2263	2471	83.0	82.4	0.6	8.5	8.4	1.2%
	US 90	800	850	4.2	3.8	0.4	46.6	49.5	-5.9%
	SH 80	1559	1551	63.7	72.9	-9.2	24.7	24.1	2.5%
Dallas Ft Worth	US 377	3666	3618	97.4	98.4	-0.9	16.9	18.6	-9.1%
	SH 289	2048	2056	96.5	99.6	-3.0	24.3	23.9	1.7%
	SH 5	1442	1486	99.0	99.1	-0.2	15.3	13.2	15.9%
	SH 160	1402	1315	91.0	92.3	-1.3	28.6	28.3	1.1%
Sherman Denison	US 377	3618	3666	NA	71.2	NA	NA	NA	
	SH 289	2056	2048	NA	92.4	NA	NA	NA	
	SH 5	1486	1442	NA	97.6	NA	NA	NA	
	SH 160	1315	1402	NA	80.3	NA	NA	NA	

Table 101. Commercial Vehicle Inbound and Outbound External Trip Comparisons.

Urban Area	Facility	Commercial 24-Hour Volume		Commercial Percent External Local		Dif	Commercial Average Trip Length (Miles)		Pct Dif
		In	Out	In	Out		In	Out	
Tyler	US 271	786	759	78.6	78.3	0.3	23.5	25.2	-6.7%
	FM 1252	46	33	100.0	100.0	0.0	23.9	20.2	18.3%
	FM 2767	87	52	90.0	83.3	6.7	18.8	17.3	8.7%
	SH 31	809	449	82.4	88.4	-6.0	20.6	20.3	1.5%
	SH 64	409	382	87.5	76.7	10.8	21.1	21.4	-1.4%
	SH 155	561	495	66.7	63.0	3.7	21.3	22.5	-5.3%
	FM 850	167	113	60.0	71.4	-11.4	18.6	15.3	21.6%
Longview	US 271	759	786	21.7	53.6	-31.9	26.8	18.7	43.3%
	FM 1252	33	46	100.0	100.0	0.0	34.2	25.3	35.2%
	FM 2767	52	87	50.0	80.0	-30.0	25.1	25.3	-0.8%
	SH 31	449	809	74.4	82.4	-8.0	19.9	16.5	20.6%
	SH 64	382	409	4.7	4.2	0.5	NA	NA	
	SH 155	495	561	0.0	0.0	0.0	NA	NA	
	FM 850	113	167	28.6	0.0	28.6	NA	NA	
Austin	FM 31	177	87	53.6	50.0	3.6	67.2	72.4	-7.2%
	SH 123	456	682	84.2	88.9	-4.7	24.5	24.0	2.1%
	FM 621	89	141	100.0	100.0	0.0	28.8	11.1	159.5%
	US 90	136	182	93.1	93.2	-0.1	64.6	63.7	1.4%
	SH 80	267	345	87.8	84.6	3.2	21.2	23.6	-10.2%
San Antonio	FM 31	87	177	87.5	89.3	-1.8	44.9	53.1	-15.4%
	SH 123	682	456	88.9	77.2	11.7	21.7	24.6	-11.8%
	FM 621	141	89	76.9	83.3	-6.4	7.5	22.5	-66.7%
	US 90	182	136	10.2	12.1	-1.9	56.1	59.5	-5.7%
	SH 80	345	267	32.3	61.2	-28.9	25.7	37.8	-32.0%
Dallas Ft Worth	US 377	206	197	91.1	94.1	-3.0	29.0	26.4	9.8%
	SH 289	155	140	93.9	100.0	-6.1	22.0	17.4	26.4%
	SH 5	61	69	84.6	83.8	0.8	35.7	30.1	18.6%
	SH 160	375	365	100.0	100.0	0.0	35.9	34.5	4.1%
Sherman Denison	US 377	197	206	NA	60.0		NA	NA	
	SH 289	140	155	NA	46.9		NA	NA	
	SH 5	69	61	NA	100.0		NA	NA	
	SH 160	365	375	NA	39.0		NA	NA	

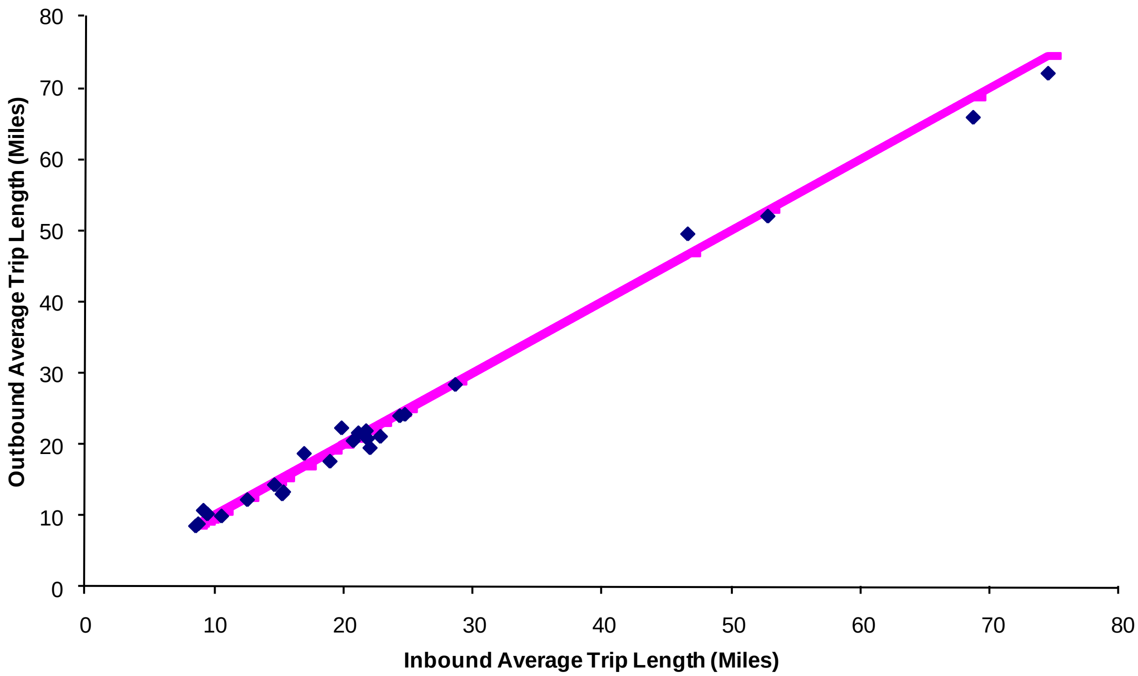


Figure 77. Inbound and Outbound Non-Commercial Vehicle Average Trip Length.

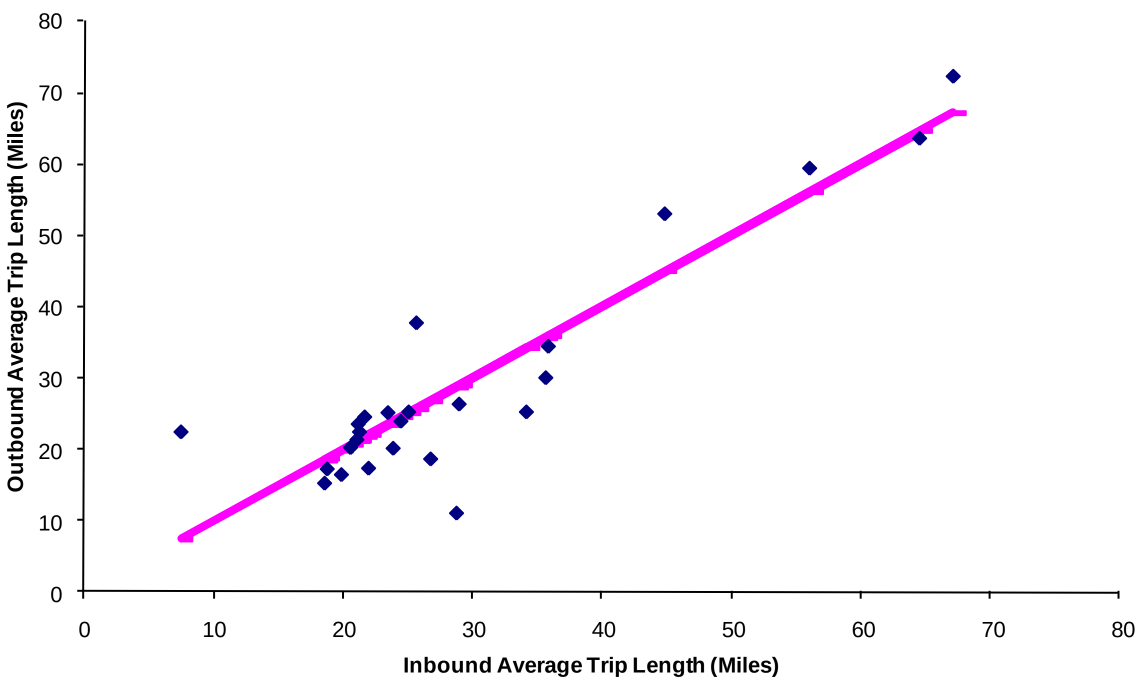


Figure 78. Outbound and Inbound Commercial Vehicle Average Trip Length.

EXTERNAL SURVEY TIME-OF-DAY EVALUATION

Objective

The objective of this task is to examine the difference between expanding external survey data using hourly count volumes versus the standard practice of expansion based on the 24-hour vehicle counts. Non-commercial and commercial vehicle surveys will be evaluated independently.

Background

Typical practice in external surveys is for a vendor to use the same number of surveyors in a crew for the entire period the survey is conducted (i.e., during daylight hours). This practice should result in a fairly consistent number of surveys being completed during the period of time interviews are conducted. It also means that during periods of low traffic volumes (e.g., off peak travel), a higher percentage of vehicles are surveyed than during periods of high traffic volumes (e.g., peak periods of travel). The concern raised by this practice is whether it may introduce error in the results when the survey data are expanded based on 24-hour volumes in lieu of expanding based on hourly volumes. Standard practice is to expand the external survey data to the 24-hour count of vehicles at the site. Several assumptions are inherent to this practice. One, it is assumed that the vehicles surveyed during the daylight hours are a representative sample of the vehicles that travel on the facility for the 24-hour period. In other words, vehicles are generally surveyed in one direction during daylight hours, typically a 10- to 12-hour period that begins around 7 a.m. Vehicles that travel through the site during the evening and early morning hours have no opportunity to be surveyed. The second assumption is that vehicles traveling in the outbound direction are a mirror image of vehicles traveling in the inbound direction. This assumption was found to be essentially valid in this research.

Methodology

The data elements to be evaluated in this task are the estimates of external local, external through, and average trip lengths for non-commercial and commercial vehicles. Ten external station sites were selected randomly from the external surveys conducted in the Dallas-Fort

Worth and Austin-San Antonio external surveys. The Dallas-Fort Worth external survey and the Austin-San Antonio external surveys were done in 2005. Surveys in both areas used essentially the same survey instruments for non-commercial and commercial vehicles. Table 102 lists the sites and the vehicle counts and number of surveys done at those sites.

Table 102. Survey Sites Selected for Analysis.

Facility	Area	Vehicle Count (24 Hr)		Number of Surveys	
		Non-Commercial	Commercial	Non-Commercial	Commercial
SH 5	Dallas-Ft Worth	1,486	69	195	37
US 77	Dallas-Ft Worth	770	103	269	50
SH 276	Dallas-Ft Worth	1,579	70	336	23
US 180	Dallas-Ft Worth	5,576	498	539	71
US 380	Dallas-Ft Worth	1,373	253	342	68
SH 80	Austin	1,559	345	358	65
SH 71	Austin	3,009	1,114	377	66
US 87	San Antonio	1,023	335	386	58
FM 1117	San Antonio	672	35	138	1
US 181	San Antonio	2,114	103	365	43

The survey data are normally expanded by computing an expansion factor that equates to the 24-hour count divided by the number of surveys done at the site. This factor is applied to the number of external local and external through trips to estimate the total number for each category at the site for the survey day. External local travel time and distance are computed using the network skims for the study area. Each survey site is identified as an external zone. The origin of each surveyed trip is geocoded to the internal zone based on the address or nearest two intersecting streets recorded in the survey. While not all locations may be geocoded, the majority (usually around 95 percent) are successfully geocoded to an internal zone. The network skims for each area are estimates of the travel time and distance between all zone pairs, including the external stations. Average trip length is computed only for external local trips because these data are used in the travel demand models to distribute external local trips. Total trip length for the surveyed trips is computed and then expanded using the expansion factor with the result divided by the total number of trips to yield the average trip length.

Expanding the data based on the hourly counts follows a similar process except the data are expanded for each hour that surveys are done, totaled for the entire time period surveys are done, and then expanded to the 24-hour totals. The time of day method of expanding the data may more accurately reflect the distribution of traffic as it occurs during the time period surveys are conducted.

Analysis Results

Data from the respective surveys were tabulated based on the time of arrival as recorded in the survey. Tables 103 through 112 present the non-commercial vehicle survey data by time of day with the expansion factors for all trips and geocoded trips. All trips are based on the number of surveys done while geocoded trips reflect the number of those trips surveyed that could be geocoded to an internal zone. Also included are the total travel time and distance by time of day based on network data for the urban area. Tables 113 through 122 present the same data for commercial vehicles at each station included in this analysis. Using these data, the trips were expanded by time of day, summed for the time period the surveys were collected, and the results expanded (based on the 24-hour traffic count) to represent an estimate for the 24-hour period at each station. The data were also expanded to estimate total travel time and distance in the same manner. In addition, for each station the data were aggregated over the time period the surveys were collected and expanded to the 24-hour time period in the same manner as typically done for each station in an external survey. This provided a base for comparing the difference in the results between the two methods. Tables 123 and 124 present these results for non-commercial and commercial vehicles, respectively.

Findings

Using data from 10 randomly selected external survey sites in the Dallas-Ft. Worth, Austin, and San Antonio external surveys, an alternative methodology for expanding the data was applied. The alternative methodology consisted of expanding the data by time of day versus the standard methodology of expanding the aggregate survey data based on the 24-hour traffic counts. The data elements examined in this task were the external local trips, external through trips, and the average trip lengths in time and distance for non-commercial and commercial vehicles. Data were examined for each site as well as all sites combined. The following are the findings from this analysis:

- Non-Commercial Vehicles
  - Differences in individual site estimates of external local trips varied from -0.61 percent to 0.46 percent. The difference for all sites combined was -0.03 percent.
  - Differences in individual site estimates of external through trips varied from -50.00 percent to 26.61 percent. The difference for all sites combined was 1.8 percent.
  - Differences in the average trip length in minutes varied from -6.87 percent to 7.73 percent for individual sites. The difference for all sites combined was 1.05 percent.
  - Difference in the average trip length in miles varied from -7.43 percent to 8.60 percent for individual sites. The difference for all sites combined was 1.05 percent.

- Commercial Vehicles
  - Differences in individual site estimates of external local trips varied from -18.97 percent to 2.63 percent. The difference for all sites combined was -1.10 percent.
  - Differences in individual site estimates of external through trips varied from -16.67 percent to 100.00 percent. The difference for all sites combined was 10.43 percent.
  - Differences in the average trip length in minutes varied from zero percent to 53.23 percent for individual sites. The difference for all sites combined was 13 percent.
  - Difference in the average trip length in miles varied from zero percent to 48.45 percent for individual sites. The difference for all sites combined was 13.12 percent.

In reviewing these findings, care should be exercised when dealing with percent differences. Large differences may occur when the results are based on small numbers. This was the case for estimates involving commercial vehicles. The numbers of through trips were in most cases small ranging from 0 to 99. In these cases, small numerical differences can result in large percent differences. The same situation was found for non-commercial vehicles when reviewing the through trip estimates where the numbers ranged from 0 to 157.

Recommendations

The findings from this analysis indicate the development of estimates of external local, external through, and average trip length using time of day vehicle counts will not yield a significant difference from estimates obtained from expanding the aggregate survey data to the 24-hour vehicle counts. The percent differences appear to be randomly distributed with the exception of average trip lengths for commercial vehicles. The differences in average trip lengths for commercial vehicles were all positive implying that the use of time of day vehicle counts for expanding the commercial vehicle survey data could yield different estimates. This result is not considered conclusive due to the small numbers of commercial vehicles surveyed and the knowledge that there may be inconsistent numbers between the commercial vehicles identified by surveyors versus the vehicles counted by machines and identified as commercial vehicles. It is recommended that external surveys continued to be expanded using aggregate survey data and the total 24-hour vehicle counts.

Table 103. Dallas-Ft. Worth – SH 5 Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	6.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
1:00	To	1:59	0.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
2:00	To	2:59	1.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
3:00	To	3:59	2.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
4:00	To	4:59	6.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
5:00	To	5:59	8.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
6:00	To	6:59	59.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
7:00	To	7:59	87.	8.	8.	10.875	10.875	8.	0.	153.98	116.47
8:00	To	8:59	82.	10.	10.	8.200	8.200	10.	0.	175.45	139.73
9:00	To	9:59	75.	16.	16.	4.688	4.688	16.	0.	283.74	231.72
10:00	To	10:59	61.	16.	16.	3.812	3.812	16.	0.	238.93	191.92
11:00	To	11:59	75.	18.	18.	4.167	4.167	18.	0.	380.52	297.54
12:00	To	12:59	62.	17.	17.	3.647	3.647	17.	0.	299.65	226.48
13:00	To	13:59	71.	8.	8.	8.875	8.875	8.	0.	111.66	88.16
14:00	To	14:59	80.	21.	21.	3.810	3.810	21.	0.	330.33	245.84
15:00	To	15:59	102.	34.	34.	3.000	3.000	34.	0.	684.89	548.32
16:00	To	16:59	160.	34.	34.	4.706	4.706	34.	0.	692.27	551.42
17:00	To	17:59	134.	13.	13.	10.308	10.308	13.	0.	216.46	170.25
18:00	To	18:59	152.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
19:00	To	19:59	121.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
20:00	To	20:59	72.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
21:00	To	21:59	35.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
22:00	To	22:59	24.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
23:00	To	23:59	11.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
Totals			**1,486.**	**195.**	**195.**	**7.621**	**7.621**	**195.**	**0.**	**3,567.88**	**2,807.85**

Table 104. Dallas-Ft. Worth – US Highway 77 Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
1:00	To	1:59	3.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
2:00	To	2:59	3.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
3:00	To	3:59	5.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
4:00	To	4:59	12.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
5:00	To	5:59	27.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
6:00	To	6:59	34.	3.	3.	11.333	11.333	3.	0.	62.86	48.99
7:00	To	7:59	74.	24.	23.	3.083	3.217	23.	1.	534.50	384.52
8:00	To	8:59	47.	26.	25.	1.808	1.880	25.	1.	536.56	379.24
9:00	To	9:59	24.	26.	26.	0.923	0.923	26.	0.	915.36	714.38
10:00	To	10:59	37.	28.	28.	1.321	1.321	28.	0.	716.72	544.69
11:00	To	11:59	61.	23.	22.	2.652	2.773	22.	1.	485.77	359.15
12:00	To	12:59	41.	15.	15.	2.733	2.733	15.	0.	338.24	253.78
13:00	To	13:59	50.	26.	25.	1.923	2.000	25.	1.	638.79	483.85
14:00	To	14:59	39.	22.	22.	1.773	1.773	22.	0.	455.75	334.22
15:00	To	15:59	53.	33.	32.	1.606	1.656	32.	1.	818.24	608.52
16:00	To	16:59	49.	37.	37.	1.324	1.324	37.	0.	1,105.74	848.17
17:00	To	17:59	67.	6.	6.	11.167	11.167	6.	0.	225.10	180.67
18:00	To	18:59	51.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
19:00	To	19:59	32.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
20:00	To	20:59	23.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
21:00	To	21:59	12.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
22:00	To	22:59	17.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
23:00	To	23:59	9.	0.	0.	1.00	1.00	0.	0.	0.00	0.00
Totals			**770.**	**269.**	**264.**	**2.862**	**2.917**	**264.**	**5.**	**6,833.63**	**5,140.18**

Table 105. Dallas-Ft. Worth – SH 276 Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	14.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	9.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	18.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	35.	6.	6.	5.833	5.833	6.	0.	198.02	151.70
7:00	To	7:59	62.	32.	32.	1.938	1.938	32.	2.	923.52	689.14
8:00	To	8:59	70.	26.	24.	2.692	2.917	24.	1.	663.81	503.03
9:00	To	9:59	87.	28.	27.	3.107	3.222	27.	1.	783.93	579.05
10:00	To	10:59	80.	30.	29.	2.667	2.759	29.	1.	743.59	561.39
11:00	To	11:59	74.	26.	25.	2.846	2.960	25.	0.	744.10	577.18
12:00	To	12:59	79.	35.	35.	2.257	2.257	35.	2.	1,093.24	830.96
13:00	To	13:59	86.	26.	24.	3.308	3.583	24.	0.	833.52	654.08
14:00	To	14:59	97.	32.	32.	3.031	3.031	32.	1.	760.09	557.30
15:00	To	15:59	111.	39.	37.	2.846	3.000	38.	1.	1,106.92	840.59
16:00	To	16:59	132.	45.	44.	2.933	3.000	44.	0.	1,770.38	1,388.26
17:00	To	17:59	193.	11.	11.	17.545	17.545	11.	0.	441.12	349.57
18:00	To	18:59	137.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	93.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	71.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	59.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	31.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	27.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**1,579.**	**336.**	**326.**	**4.70**	**4.84**	**327.**	**9.**	**1,0062.24**	**7,682.25**

Table 106. Dallas-Ft. Worth – Hwy. 180 Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	27.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	36.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	17.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	21.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	36.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	62.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	215.	24.	24.	8.958	8.958	24.	0.	886.80	659.76
7:00	To	7:59	392.	76.	75.	5.158	5.227	75.	1.	2,757.94	2,030.73
8:00	To	8:59	320.	51.	51.	6.275	6.275	51.	0.	1,983.26	1,494.70
9:00	To	9:59	275.	43.	41.	6.395	6.707	41.	2.	1,922.16	1,475.60
10:00	To	10:59	269.	48.	48.	5.604	5.604	48.	0.	1,950.99	1,479.27
11:00	To	11:59	288.	36.	36.	8.000	8.000	36.	0.	1,573.45	1,210.43
12:00	To	12:59	316.	56.	56.	5.643	5.643	56.	0.	2,272.40	1,714.79
13:00	To	13:59	289.	51.	51.	5.667	5.667	51.	0.	2,183.85	1,677.30
14:00	To	14:59	325.	41.	39.	7.927	8.333	39.	2.	1,787.38	1,386.25
15:00	To	15:59	374.	56.	52.	6.679	7.192	52.	4.	2,136.59	1,637.23
16:00	To	16:59	474.	39.	37.	12.154	12.811	37.	2.	1,460.64	1,092.77
17:00	To	17:59	544.	18.	17.	30.222	32.000	17.	1.	590.96	440.67
18:00	To	18:59	416.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	298.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	224.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	149.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	123.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	86.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**5,576.**	**539.**	**527.**	**10.35**	**10.58**	**527.**	**12.**	**21,506.42**	**16,299.50**

Table 107. Dallas-Ft. Worth – Hwy. 380 Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	11.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	18.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	58.	9.	8	6.444	7.250	8.	1.	472.24	328.61
7:00	To	7:59	67.	24.	24.	2.792	2.792	24.	0.	1,176.14	857.62
8:00	To	8:59	64.	34.	32.	1.882	2.000	32.	2.	1,770.99	1,294.69
9:00	To	9:59	78.	35.	35.	2.229	2.229	35.	0.	1,819.08	1,296.19
10:00	To	10:59	66.	23.	23.	2.870	2.870	23.	0.	1,255.56	914.05
11:00	To	11:59	77.	22.	22.	3.500	3.500	22.	0.	1,234.27	897.73
12:00	To	12:59	71.	21.	20.	3.381	3.550	20.	1.	1,008.90	731.18
13:00	To	13:59	82.	42.	41.	1.952	2000	41.	1.	2,355.69	1,723.95
14:00	To	14:59	104.	34.	32.	3.059	3.250	32.	2.	1,567.60	1,111.22
15:00	To	15:59	90.	42.	39.	2.143	2.308	39.	3.	1,821.58	1,290.99
16:00	To	16:59	148.	41.	41.	3.610	3.610	41.	0.	2,269.19	1,653.63
17:00	To	17:59	142.	15.	14.	9.467	10.143	15.	0.	863.44	646.65
18:00	To	18:59	100.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	65.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	44.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	38.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	23.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	12.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**1,373.**	**342.**	**331**	**4.01**	**4.15**	**332.**	**10.**	**17,614.68**	**12,746.51**

Table 108. Austin – SH 80 SB Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	9.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	41.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	86.	17.	17.	5.059	5.059	17.	0.	927.58	640.52
7:00	To	7:59	78.	50.	47.	1.560	1.660	47.	3.	2,378.83	1,638.60
8:00	To	8:59	72.	34.	33.	2.118	2.182	34.	0.	1,628.71	1,128.90
9:00	To	9:59	88.	34.	34.	2.588	2.588	34.	0.	1,638.63	1,136.13
10:00	To	10:59	58.	33.	31.	1.758	1.871	33.	0.	1,389.94	959.24
11:00	To	11:59	92.	33.	32.	2.788	2.875	33.	0.	1,675.92	1,154.28
12:00	To	12:59	88.	33.	33.	2.667	2.667	33.	0.	1,566.49	1,078.84
13:00	To	13:59	98.	38.	38.	2.579	2.579	38.	0.	1,782.10	1,239.52
14:00	To	14:59	95.	29.	27.	3.276	3.519	27.	2.	1,331.81	914.59
15:00	To	15:59	108.	25.	25.	4.320	4.320	25.	0.	1,202.33	825.40
16:00	To	16:59	166.	31.	30.	5.355	5.333	31.	0.	1,464.09	1,008.45
17:00	To	17:59	144.	1.	1.	144.000	144.000	1.	0.	10.29	5.74
18:00	To	18:59	108.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	84.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	57.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	29.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	23.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	11.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**1,559.**	**358.**	**348.**	**4.35**	**4.48**	**353.**	**5.**	**16,996.72**	**11,730.21**

Table 109. Austin – Hwy. 71 WB Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	14.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	21.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	10.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	38.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	133.	30.	30.	4.433	4.433	30.	0.	2,369.38	1,618.02
7:00	To	7:59	117.	55.	55.	2.127	2.127	55.	0.	4,543.48	3,135.56
8:00	To	8:59	97.	48.	47.	2.021	2.064	47.	1.	3,826.92	2,656.61
9:00	To	9:59	104.	45.	43.	2.311	2.419	45.	0.	3,544.21	2,448.27
10:00	To	10:59	103.	43.	43.	2.395	2.395	43.	0.	3,356.00	2,319.10
11:00	To	11:59	136.	43.	40.	3.163	3.400	43.	0.	3,322.54	2,306.75
12:00	To	12:59	153.	47.	47.	3.255	3.255	47.	0.	3,408.40	2,348.18
13:00	To	13:59	179.	40.	39.	4.475	4.590	40.	0.	3,061.93	2,098.62
14:00	To	14:59	178.	20.	20.	8.900	8.900	20.	0.	1,499.10	1,029.93
15:00	To	15:59	231.	6.	5.	38.500	46.200	6.	0.	357.45	242.15
16:00	To	16:59	313.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
17:00	To	17:59	385.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	309.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	179.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	137.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	81.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	43.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	34.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**3,009.**	**377.**	**369.**	**7.98**	**8.15**	**376.**	**1.**	**29,289.41**	**2,0203.19**

Table 110. San Antonio – US 87 EB Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	12.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	16.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	38.	1.	1.	38.000	38.000	1.	0.	16.51	12.91
7:00	To	7:59	65.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
8:00	To	8:59	64.	16.	15.	4.000	4.267	16.	0.	728.99	533.33
9:00	To	9:59	58.	41.	37.	1.415	1.568	39.	2.	1,848.71	1,369.09
10:00	To	10:59	57.	33.	29.	1.727	1.966	30.	3.	1,421.69	1,049.30
11:00	To	11:59	49.	47.	42.	1.043	1.167	43.	4.	2,138.50	1,576.21
12:00	To	12:59	45.	40.	38.	1.125	1.184	39.	1.	2,023.78	1,496.63
13:00	To	13:59	73.	52.	52.	1.404	1.404	52.	0.	2,599.65	1,921.21
14:00	To	14:59	52.	56.	53.	0.929	0.981	55.	1.	2,858.78	2,100.61
15:00	To	15:59	68.	46.	43.	1.478	1.581	45.	1.	2,075.58	1,538.24
16:00	To	16:59	84.	54.	49.	1.556	1.714	52.	2.	2,690.43	1,969.33
17:00	To	17:59	84.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	74.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	61.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	39.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	36.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	30.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**1,023.**	**386.**	**359.**	**2.65**	**2.85**	**372.**	**14.**	**18,402.62**	**13,566.86**

Table 111. San Antonio –FM 1117 SB Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	12.	3.	3.	4.000	4.000	3	0.	62.27	42.17
7:00	To	7:59	39.	10.	9.	3.900	4.333	10	0.	193.69	132.13
8:00	To	8:59	49.	11.	11.	4.455	4.455	11	0.	343.16	234.54
9:00	To	9:59	49.	6.	6.	8.167	8.167	6	0.	160.21	106.78
10:00	To	10:59	46.	9.	9.	5.111	5.111	9	0.	346.06	236.73
11:00	To	11:59	53.	14.	14.	3.786	3.786	14	0.	411.85	278.67
12:00	To	12:59	41.	16.	15.	2.562	2.733	16	0.	391.76	264.66
13:00	To	13:59	59.	14.	14.	4.214	4.214	14	0.	361.45	245.59
14:00	To	14:59	39.	17.	17.	2.294	2.294	17	0.	559.46	387.10
15:00	To	15:59	68.	17.	17.	4.000	4.000	17	0.	516.53	351.83
16:00	To	16:59	63.	21.	21.	3.000	3.000	21	0.	658.35	450.04
17:00	To	17:59	59.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	38.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	21.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	15.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	8.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**672.**	**138.**	**136.**	**4.87**	**4.94**	**138**	**0.**	**4,004.79**	**2,730.24**

Table 112. San Antonio –US 181 EB Non-Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	15.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	13.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	30.	12	12	2.500	2.500	12	0.	427.05	315.89
7:00	To	7:59	64.	18	18	3.556	3.556	18	0.	466.84	338.02
8:00	To	8:59	71.	40	39	1.775	1.821	39	1	1,566.94	1,138.47
9:00	To	9:59	48.	38	35	1.263	1.371	36	2	1,213.73	893.84
10:00	To	10:59	68.	39	39	1.744	1.744	39	0	1,512.07	1,109.17
11:00	To	11:59	87.	34	33	2.559	2.636	33	1	1,355.93	986.12
12:00	To	12:59	101.	35	33	2.886	3.061	34	1	1,355.40	1,001.91
13:00	To	13:59	100.	35	34	2.857	2.941	34	1	1,364.97	997.98
14:00	To	14:59	126.	34	31	3.706	4.065	33	1	1,218.74	892.29
15:00	To	15:59	144.	43	42	3.349	3.429	42	1	1,595.40	1,161.50
16:00	To	16:59	211.	37	37	5.703	5.703	37	0.	1,520.47	1,114.25
17:00	To	17:59	288.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	246.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	158.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	133.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	111.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	53.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	30.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**2,114.**	**365.**	**353.**	**5.79**	**5.99**	**357.**	**8.**	**13,597.54**	**9,949.44**

Table 113. Dallas-Ft. Worth – SH 5 NB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
7:00	To	7:59	4.	2.	2.	2.000	2.000	2.	0.	49.53	39.45
8:00	To	8:59	3.	6.	5.	0.500	0.600	6.	0.	192.98	172.23
9:00	To	9:59	5.	2.	1.	2.500	5.000	1.	1.	30.38	24.80
10:00	To	10:59	4.	3.	3.	1.333	1.333	3.	0.	111.69	96.22
11:00	To	11:59	8.	3.	2.	2.667	4.000	2.	1.	121.09	94.46
12:00	To	12:59	3.	3.	1.	1.000	3.000	1.	2.	11.64	9.15
13:00	To	13:59	5.	4.	4.	1.250	1.250	4.	0.	128.08	115.61
14:00	To	14:59	7.	7.	7.	1.000	1.000	7.	0.	258.86	213.04
15:00	To	15:59	9.	2.	1.	4.500	9.000	1.	1.	59.21	45.96
16:00	To	16:59	6.	1.	0.	6.000	1.000	0.	1.	0.00	0.00
17:00	To	17:59	2.	4.	4.	0.500	0.500	4.	0.	115.51	91.90
18:00	To	18:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**69.**	**37**	**30**	**1.86**	**2.3**	**31**	**6**	**1,078.97**	**902.82**

Table 114. Dallas-Ft. Worth – US 77 WB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
7:00	To	7:59	12.	6.	5.	2.000	2.400	5.	1.	63.21	43.48
8:00	To	8:59	11.	9.	8.	1.222	1.375	8.	1.	218.55	154.42
9:00	To	9:59	10.	8.	7.	1.250	1.429	7.	1.	198.31	149.51
10:00	To	10:59	7.	6.	4.	1.167	1.750	4.	2.	29.93	18.43
11:00	To	11:59	10.	4.	4.	2.500	2.500	4.	0.	52.38	35.84
12:00	To	12:59	7.	2.	2.	3.500	3.500	2.	0.	74.71	52.43
13:00	To	13:59	3.	3.	3.	1.000	1.000	3.	0.	97.53	68.42
14:00	To	14:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
15:00	To	15:59	10.	8.	7.	1.250	1.429	7.	1.	313.60	244.11
16:00	To	16:59	4.	3.	3.	1.333	1.333	3.	0.	115.03	86.99
17:00	To	17:59	9.	1.	1.	9.000	9.000	1.	0.	19.89	12.92
18:00	To	18:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**103.**	**50.**	**44.**	**2.06**	**2.34**	**44.**	**6.**	**1,183.14**	**866.55**

Table 115. Dallas-Ft. Worth – Hwy. 276 EB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	1.	3.	3.	0.333	0.333	3.	0.	54.69	38.81
7:00	To	7:59	11.	4.	4.	2.750	2.750	4.	0.	102.52	74.89
8:00	To	8:59	5.	3.	3.	1.667	1.667	3.	0.	34.33	23.79
9:00	To	9:59	8.	3.	3.	2.667	2.667	3.	0.	100.23	76.17
10:00	To	10:59	12.	2.	2.	6.000	6.000	2.	0.	42.14	30.52
11:00	To	11:59	4.	3.	2.	1.333	2.000	2.	1.	125.86	105.51
12:00	To	12:59	6.	1.	1.	6.000	6.000	1.	0.	78.66	59.78
13:00	To	13:59	2.	2.	2.	1.000	1.000	2.	0.	77.34	58.30
14:00	To	14:59	5.	1.	0.	5.000	1.000	0.	1.	0.00	0.00
15:00	To	15:59	6.	1.	1.	6.000	6.000	1.	0.	16.09	11.51
16:00	To	16:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
17:00	To	17:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**70.**	**23.**	**21.**	**3.04**	**3.33**	**21.**	**2.**	**631.86**	**479.28**

Table 116. Dallas-Ft. Worth – US 180 WB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	16.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	29.	2.	1.	14.500	29.000	1.	1.	26.23	18.08
7:00	To	7:59	24.	6.	6.	4.000	4.000	6.	0.	241.65	180.06
8:00	To	8:59	44.	12.	12.	3.667	3.667	12.	0.	579.12	466.75
9:00	To	9:59	30.	17.	17.	1.765	1.765	17.	0.	773.37	612.81
10:00	To	10:59	49.	5.	5.	9.800	9.800	5.	0.	242.04	191.58
11:00	To	11:59	34.	10.	9.	3.400	3.778	9.	1.	386.56	300.99
12:00	To	12:59	38.	6.	6.	6.333	6.333	6.	0.	386.92	310.96
13:00	To	13:59	33.	7.	7.	4.714	4.714	7.	0.	268.99	196.60
14:00	To	14:59	31.	2.	2.	15.500	15.500	2.	0.	157.60	135.88
15:00	To	15:59	27.	3.	3.	9.000	9.000	3.	0.	64.38	44.57
16:00	To	16:59	28.	1.	1.	28.000	28.000	1.	0.	58.19	47.92
17:00	To	17:59	18.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	30.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	22.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	8.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**498.**	**71.**	**69.**	**7.01**	**7.22**	**69.**	**2.**	**3,185.05**	**2,506.20**

Table 117. Dallas-Ft. Worth – US 380 WB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	10.	4	4	2.500	2.500	4	0	225.70	155.79
7:00	To	7:59	37.	12	11	3.083	3.364	11	1	615.11	454.72
8:00	To	8:59	17.	11	10	1.545	1.700	10	1	552.55	405.72
9:00	To	9:59	13.	10	9	1.300	1.444	9	1	562.71	410.20
10:00	To	10:59	10.	7	7	1.429	1.429	7	0	324.74	228.90
11:00	To	11:59	17.	2	2	8.500	8.500	2	0	123.98	90.69
12:00	To	12:59	20.	6	6	3.333	3.333	6	0	261.65	174.66
13:00	To	13:59	13.	7	6	1.857	2.167	6	1	320.79	227.28
14:00	To	14:59	15.	7	7	2.143	2.143	7	0	397.55	291.93
15:00	To	15:59	23.	0	0	1.000	1.000	0	0	0.00	0.00
16:00	To	16:59	17.	2	1	8.500	17.000	1	1	64.83	48.52
17:00	To	17:59	13.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	9.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**253.**	**68.**	**63.**	**3.72**	**4.02**	**63.**	**5.**	**3,449.61**	**2,488.41**

Table 118. Austin – SH 80 SB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	10.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	26.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
7:00	To	7:59	25.	4.	4.	6.250	6.250	4	0.	201.48	141.95
8:00	To	8:59	19.	3.	3.	6.333	6.333	3	0.	143.53	101.77
9:00	To	9:59	23.	6.	5.	3.833	4.600	5	1	157.23	107.62
10:00	To	10:59	19.	3.	3.	6.333	6.333	3	0.	170.09	117.60
11:00	To	11:59	20.	2.	2.	10.000	10.000	2	0.	95.72	66.09
12:00	To	12:59	25.	2.	2.	12.500	12.500	2	0.	124.85	87.27
13:00	To	13:59	14.	4.	4.	3.500	3.500	4	0.	171.35	118.77
14:00	To	14:59	24.	9.	9.	2.667	2.667	9	0.	389.71	270.00
15:00	To	15:59	27.	3.	1.	9.000	27.000	1	2	23.14	14.60
16:00	To	16:59	30.	15.	11.	2.000	2.727	11	4	437.71	297.95
17:00	To	17:59	24.	14.	11.	1.714	2.182	11	3	324.96	221.40
18:00	To	18:59	11.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	16.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**345.**	**65.**	**55.**	**5.31**	**6.27**	**55.**	**10.**	**2,239.77**	**1,545.02**

Table 119. Austin – Hwy. 71 Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	19.	0.	0.	12.000	15.000	0.	0.	0.00	0.00
6:00	To	6:59	60.	5.	4.	29.667	29.667	4.	1.	299.94	207.37
7:00	To	7:59	89.	3.	3.	8.556	9.625	3.	0.	294.48	201.96
8:00	To	8:59	77.	9.	8.	20.750	41.500	8.	1.	590.21	410.27
9:00	To	9:59	83.	4.	2.	15.600	15.600	2.	2.	135.99	96.47
10:00	To	10:59	78.	5.	5.	20.000	20.000	5.	0.	410.06	276.78
11:00	To	11:59	100.	5.	5.	26.250	26.250	5.	0.	435.69	301.67
12:00	To	12:59	105.	4.	4.	17.286	20.167	4.	0.	334.31	231.52
13:00	To	13:59	121.	7.	6.	7.077	7.077	6.	1.	497.34	344.54
14:00	To	14:59	92.	13.	13.	8.182	8.182	13.	0.	1,098.61	758.69
15:00	To	15:59	90.	11.	11.	1.000	1.000	11.	0.	886.09	612.66
16:00	To	16:59	45.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
17:00	To	17:59	59.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	36.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	22.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	13.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	8.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**1114.**	**66.**	**61.**	**16.88**	**18.26**	**61.**	**5.**	**4,982.72**	**3,441.93**

Table 120. San Antonio – US 87 EB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	9.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	7.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	20.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	14.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
7:00	To	7:59	24.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
8:00	To	8:59	26.	3.	2.	8.667	13.000	2.	1.	145.08	105.95
9:00	To	9:59	31.	10.	7.	3.100	4.429	7.	3.	430.52	314.80
10:00	To	10:59	22.	12.	6.	1.833	3.667	6.	6.	330.68	247.30
11:00	To	11:59	24.	7.	7.	3.429	3.429	7.	0.	319.94	239.01
12:00	To	12:59	19.	5.	5.	3.800	3.800	5.	0.	297.65	221.11
13:00	To	13:59	16.	8.	7.	2.000	2.286	7.	1.	427.79	315.95
14:00	To	14:59	17.	5.	5.	3.400	3.400	5.	0.	148.55	109.92
15:00	To	15:59	22.	6.	5.	3.667	4.400	5.	1.	344.33	254.17
16:00	To	16:59	10.	2.	2.	5.000	5.000	2.	0.	142.10	104.73
17:00	To	17:59	12.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	14.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	10.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	13.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**335.**	**58.**	**46.**	**5.78**	**7.28**	**46.**	**12.**	**2,586.64**	**1,912.94**

Table 121. San Antonio – FM 1117 SB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
7:00	To	7:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
8:00	To	8:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
9:00	To	9:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
10:00	To	10:59	1.	1	1	1.000	1.000	1.	0.	29.34	19.41
11:00	To	11:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
12:00	To	12:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
13:00	To	13:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
14:00	To	14:59	5.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
15:00	To	15:59	2.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
16:00	To	16:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
17:00	To	17:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
18:00	To	18:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**35.**	**1.**	**1.**	**35.00**	**35.00**	**1.**	**0.**	**29.34**	**19.41**

Table 122. San Antonio – US 181 EB Commercial Vehicle External Survey.

Time Period			Vehicle Count	Number Surveys	Number Geocoded	Expansion Factor	Geocoded Expansion Factor	External Local Trips	External Thru Trips	Total Travel Time (Min)	Total Travel Distance (Mi)
0:00	To	0:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
1:00	To	1:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
2:00	To	2:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
3:00	To	3:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
4:00	To	4:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
5:00	To	5:59	3.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
6:00	To	6:59	5.	2.	1.	2.500	5.000	1.	1.	59.13	44.23
7:00	To	7:59	8.	8.	8.	1.000	1.000	8.	0.	446.26	329.98
8:00	To	8:59	8.	5.	5.	1.600	1.600	5.	0.	210.88	158.03
9:00	To	9:59	10.	6.	5.	1.667	2.000	5.	1.	234.58	176.75
10:00	To	10:59	12.	1.	1.	12.000	12.000	1.	0.	62.53	46.64
11:00	To	11:59	5.	3.	3.	1.667	1.667	3.	0.	143.07	104.87
12:00	To	12:59	7.	4.	4.	1.750	1.750	4.	0.	175.57	129.17
13:00	To	13:59	6.	5.	4.	1.200	1.500	4.	1.	207.87	154.96
14:00	To	14:59	4.	2.	2.	2.000	2.000	2.	0.	34.49	24.87
15:00	To	15:59	7.	2.	1.	3.500	7.000	1.	1.	19.96	14.49
16:00	To	16:59	3.	4.	4.	0.750	0.750	4.	0.	182.23	134.47
17:00	To	17:59	5.	1.	1.	5.000	5.000	1.	0.	22.29	15.78
18:00	To	18:59	4.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
19:00	To	19:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
20:00	To	20:59	6.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
21:00	To	21:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
22:00	To	22:59	1.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
23:00	To	23:59	0.	0.	0.	1.000	1.000	0.	0.	0.00	0.00
Totals			**103.**	**43.**	**39.**	**2.40**	**2.64**	**39.**	**4.**	**1,798.86**	**1,334.24**

Table 123. Comparison of Non-Commercial Vehicle Estimates.

Site	Standard Estimate[1]		Time of Day Estimate		Percent Difference		Standard Estimate[1]		Time of Day Estimate		Percent Difference	
	Local Trips	Thru Trips	Local Trips	Thru Trips	Local Trips	Thru Trips	Avg Trip Time (Min)	Avg Trip Dist (Mi)	Avg Trip Time (Min)	Avg Trip Dist (Mi)	Avg Trip Time (Min)	Avg Trip Dist (Mi)
SH 5	1,486	0	1,486	0	0.00	0.00	18.30	14.40	18.02	14.17	-1.53	-1.60
US 77	756	14	755	15	-0.13	7.14	25.88	19.47	26.42	19.97	2.09	2.57
SH 276	1,537	42	1,541	38	0.26	-9.52	30.77	23.49	33.15	25.51	7.73	8.60
US 180	5,452	124	5,419	157	-0.61	26.61	40.81	30.93	41.43	31.36	1.52	1.39
US 380	1,333	40	1,336	37	0.23	-7.50	53.06	38.39	55.71	40.42	4.99	5.29
SH 80	1,537	22	1,544	15	0.46	-31.82	48.15	33.23	44.84	30.76	-6.87	-7.43
SH 71	3,001	8	3,005	4	0.13	-50.00	77.90	53.73	77.66	53.38	-0.31	-0.65
US 87	986	37	990	33	0.41	-10.81	49.47	36.47	50.37	37.16	1.82	1.89
FM 1117	672	0	672	0	0.00	0.00	29.02	19.78	29.29	19.94	0.93	0.81
US 181	2,068	46	2,074	40	0.29	-13.04	38.09	27.87	39.51	28.91	3.73	3.73
Totals	**18,828**	**333**	**18,822**	**339**	**-0.03**	**1.80**	**44.73**	**32.46**	**45.20**	**32.80**	**1.05**	**1.05**

[1]Estimate from expansion to 24 hour counts

Table 124. Comparison of Commercial Vehicle Estimates.

Site	Standard Estimate[1]		Time of Day Estimate		Percent Difference		Standard Estimate[1]		Time of Day Estimate		Percent Difference	
	Local Trips	Thru Trips	Local Trips	Thru Trips	Local Trips	Thru Trips	Avg Trip Time (Min)	Avg Trip Dist (Mi)	Avg Trip Time (Min)	Avg Trip Dist (Mi)	Avg Trip Time (Min)	Avg Trip Dist (Mi)
SH 5	58	11	47	22	-18.97	100.00	34.81	29.12	53.34	43.23	53.23	48.45
US 77	91	12	93	10	2.20	-16.67	26.89	19.69	27.46	19.82	2.12	0.66
SH 276	64	6	63	7	-1.56	16.67	30.09	22.82	33.08	25.00	9.94	9.55
US 180	484	14	474	24	-2.07	71.43	46.16	36.32	49.89	39.52	8.08	8.81
US 380	234	19	229	24	-2.14	26.32	54.76	39.50	61.71	44.69	12.69	13.14
SH 80	292	53	297	48	1.71	-9.43	40.72	28.09	49.54	34.18	21.66	21.68
SH 71	1,030	84	1,015	99	-1.46	17.86	81.68	56.43	90.11	62.30	10.32	10.40
US 87	266	69	273	62	2.63	-10.14	56.23	41.59	71.81	53.00	27.71	27.43
FM 1117	35	0	35	0	0.00	0.00	29.34	19.41	29.34	19.41	0.00	0.00
US 181	93	10	92	11	-1.08	10.00	46.12	34.21	50.79	37.69	10.13	10.17
Totals	**2,647**	**278**	**2,618**	**307**	**-1.10**	**10.43**	**59.63**	**42.69**	**67.38**	**48.29**	**13.00**	**13.12**

[1]Estimate from expansion to 24 hour counts

EXTERNAL SURVEY SAMPLE SIZES

Objective

Using external station survey data previously collected for five urban areas in Texas (shown in Figure 79), an assessment was made of the minimum sample sizes needed to estimate the proportion of external-local and external through trips at each station. Additionally, these external survey data were analyzed in the context of their functional class and volume level, in order to more precisely understand the relationship between these two variables and the required sample size. The results shown here can be used as a guideline for the modification of future external station surveys administered around the state.

Background

When conducting travel surveys for an urban area, it is important to develop an understanding of vehicle and person movements that occur not only within the area, but also those that occur out of (external local trip), into (external local), and through (external through) the area. These movements are most commonly tracked using tools such as external station surveys.

In the travel demand process, estimates of external local and external through trips at external stations play a key role. This is because poor estimates of these trips due to insufficient sampling levels could result in significant errors of the estimated external local vehicle miles of travel (VMT) and external through VMT during model application. Because external through trips are, on average, longer than external local trips, overestimates of the number of external through trips will result in an overestimate in external-related VMT. A similar opposite trend occurs with the underestimation of external through trips. These poor estimates of VMT also lead to poor estimates of the average trip length, a key factor in the modeling of external travel patterns.

When conducting external surveys, it is not possible to survey all vehicles. Instead, a desired sample size is specified prior to the survey, and the surveying crew attempts to match or exceed this level on the survey day. Because these surveys are only performed on a sample of the vehicles traveling through the external station, and only during daylight hours, it is important that this sample be accurate enough to be effectively applied at a much larger scale. The sample data must be representative not only of those vehicles not surveyed during survey hours, but also of all vehicles traveling during non-survey hours. This technical memorandum will assess the sample sizes required to perform external station surveys, more specifically with respect to estimating the number of external local and external through trips at each external station.

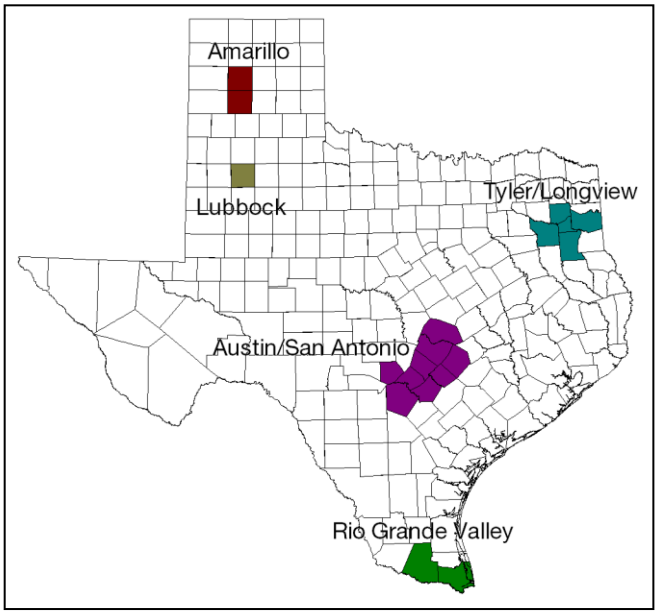


Figure 79. Map of Study Areas.

Estimating Sample Size

When estimating sample sizes for a proportional split between two categories, the following sample size equation is used (*59*).

$$n = \frac{{z_{\alpha/2}}^2 p(1-p)}{E^2} \qquad \text{(Eq 1)}$$

Where:

n = sample size;
z = statistic representing a desired level of confidence α;
p = proportion of the population; and
E = specified error level.

By specifying the desired level of confidence (α), the acceptable error level (E), in conjunction with survey data provided for estimates of p, the sample size (n) required to meet those criteria can be estimated. For this task, a confidence level of 90 percent was used. Using a two-tailed normal (z) distribution, this gives $z_{\alpha/2}$ a value of 1.645. Using previous data collected during external station surveys, estimates of p are provided in different testing scenarios (i.e., by functional class, by volume class, etc.). The acceptable error level established for this task is

10 percent (E = 0.10). Impacts of the effect the other variables have on the error also are explored.

The equation shown above is effective when dealing with a proportion from a single population. When dealing with unique proportions from multiple populations that must be combined to form a new single population, it is appropriate to apply an equation similar to Equation 1, but with additional values that allow these multiple populations to be weighted with respect to their total size on the new single population. This new equation will be useful when combining the data from both non-commercial and commercial populations to form a single population of both non-commercial and commercial. Equation 2, shown below, will be used to estimate the sample size requirements for the combined totals (non-commercial and commercial).

$$n = \frac{{z_{\alpha/2}}^2\left[\left(\frac{v_1}{v_1+v_2}\right)(p_1)(1-p_1)+\left(\frac{v_2}{v_1+v_2}\right)(p_2)(1-p_2)\right]}{E^2} \qquad \text{(Eq 2)}$$

Where:

n = sample size;
z = statistic representing a desired level of confidence α;
v_1 = volume (or size) of population 1;
v_2 = volume (or size) of population 2;
p_1 = proportion of population 1;
p_2 = proportion of population 2; and
E = specified error level.

Assessing Impacts of Error Levels at Different Sampling Levels

Using Equation 1, the terms can be rearranged to calculate the error level, assuming the values for the remaining variables are provided. The following equation achieves this:

$$E = \sqrt{\frac{{z_{\alpha/2}}^2 p(1-p)}{n}} \qquad \text{(Eq 3)}$$

This equation is useful is assessing how the error level can change in different sampling situations. This is very useful for external station surveys, because samples are collected from only a portion of the traveling population (vehicles traveling through the site during survey hours), but are then used for expansion to the entire population (vehicles traveling through the site for the entire 24-hour period).

One way of understanding how sample size affects error level is to look at pairs of sample sizes. In other words, how is the error level of a given sample size affected if the sample size is reduced? By comparing pairs of sample sizes at specified amounts, the difference in the error (E) relative to sample size (n) can be shown.

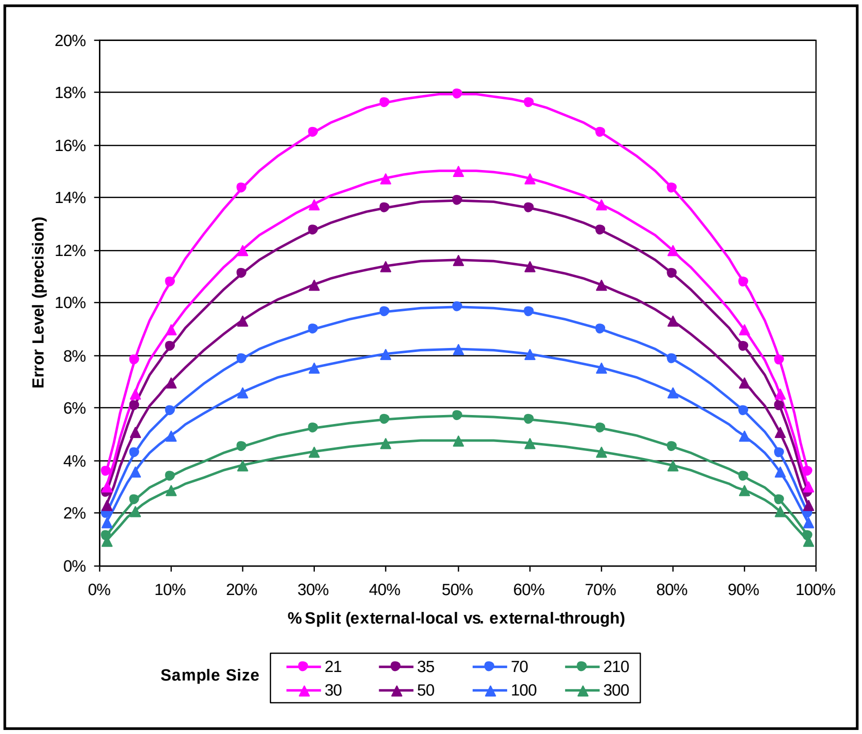


Figure 80. Estimated Error Levels.

Figure 80 shows the estimated error level (percent, y-axis) for a series of pairs of sample sizes, given the split between external local and external through trips (percent, x-axis). This figure uses a 70 percent rate as an example, with each pair of sample sizes (designated by the same color) representing a full sample, and a sample size at 70 percent (i.e., sample size 21 vs. 30, 35 vs. 50, 70 vs. 100, etc).

In this figure, it can be seen that a 50 percent split yielded the highest error levels for all sample sizes, which is an expected result. Comparing the pairs of sample sizes, the graphs for sample sizes 21 and 30 showed the greatest difference in estimated error level, which is also an expected result. As sample sizes increase, however, the error level goes down very quickly. This graph also reveals how the sample ―Percent Split" value (x-axis) used for a proportion between two groups can strongly affect the estimated error level for that sample data.

Estimating Potential Error Levels for Survey

A way of assessing the impacts of surveying only a portion of the total population traveling through a site is to look at the maximum potential error that could result from doing this. The following example will illustrate this point.

Suppose that a non-commercial vehicle survey was conducted at an external station between the hours of 7 a.m. and 7 p.m. and that a 24-hour vehicle count was also conducted at the same location. Additionally, suppose that 70 percent of the total number of non-commercial vehicles for the entire 24-hour period traveled through the station during the 12-hour survey period and that 90 percent of the vehicles surveyed indicated that they made external local trips. Assuming that this 90 percent value holds true for the entire 24-hour period, we would apply it to the full 24-hour count.

It is very possible, however, that this 90 percent does not hold true during non-survey hours. This introduces bias into the survey. This bias causes a new form of estimation error that can be calculated using data from the example described above, as well as one additional unknown piece of information—the percent of external local trips during non-survey hours. For this example, this value will be assumed to be worst-case scenario—0 percent external local trips during non-survey hours. Without conducting surveys in non-survey hours, however, there is no way of actually knowing what this value is. By using the worst-case scenario, we can determine what the maximum possible level of error that can occur by not surveying vehicles during non-survey hours.

In order to calculate the actual percentage of external local trips, and the resulting estimation error resulting from this, the following equations would be used. In this equation, $\%L_{NON-SURVEY}$ is the unknown value.

$$\%L_{ACTUAL} = (\%L_{SURVEY})(\%V_{SURVEY}) + (\%L_{NON-SURVEY})(\%V_{NON-SURVEY}) \qquad \text{(Eq 4)}$$

Where:

$\%L_{ACTUAL}$ = Actual percent external local trips for 24-hours
$\%L_{SURVEY}$ = Percent external local trips during survey hours
$\%V_{SURVEY}$ = Percent volume during survey hours
$\%L_{NON-SURVEY}$ = Percent external local trips during non-survey hours
$\%V_{NON-SURVEY}$ = Percent volume during non-survey hours

$$\%L_{ERROR} = \%L_{SURVEY} - \%L_{ACTUAL} \tag{Eq 5}$$

Where:

$\%L_{ERROR}$ = Percent estimation error of external local trips for 24-hours

Because it is estimated that 70 percent of the volume for the 24-hour period occurred during survey hours, the remaining 30 percent occurred during non-survey hours, yielding the following result for Equation 3.

$$\%L_{ACTUAL} = (0.90)(0.70) + (0.00)(0.30) = 0.63 = 63\%$$

Applying this value to Equation 4 yields the following result.

$$\%L_{ERROR} = 0.90 - 0.63 = 0.27 = 27\%$$

In this example, the survey estimated 27 percent greater external local trips than what actually occurred. Using this same formula with the assumed 0–100 percent split between external local and external through trips during non-survey hours generated Figure 81.

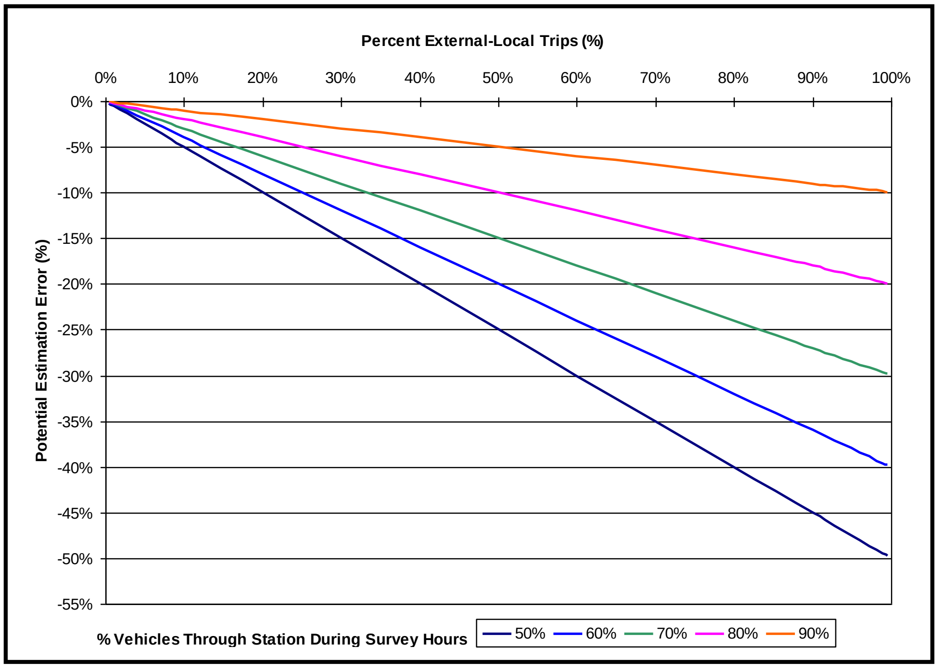


Figure 81. Potential Percent Error.

Figure 81 shows different trends about survey data assumptions to be considered when conducting external station surveys. First, this figure shows that the larger the percent of vehicles that travel through the station during survey hours, the smaller the level of error that may result. In this example, when only 50 percent of the vehicles travel through the station during survey hours, the error range for the percent of external local trips is 0–50 percent, but when 90 percent of the vehicles travel through the station during survey hours, the error range is only 0–10 percent. In this figure, all of the graphs converge to 0 percent error difference at 0 percent external local trips. This is because if the percent of external local trips during non-survey hours is 0 percent, and the percent of external local trips during survey hours is 0 percent, then a survey will result in no error, regardless of the percent of vehicles that traveled through the station during survey hours. As the percent of external local trips increase from 0 percent, the amount of potential estimation error increases.

Description of Data

In each urban area, external station data was collected for both non-commercial and commercial vehicles. Specifically, these data included the 24-hour vehicle classification count that occurred at the external station, the estimated number of external local and external through trips as determined through the analysis of the survey responses, and the total number of surveys administered at the site. Each of these sites has also been classified by its roadway functional class and its total volume. Tables 125 and 126 show these groups.

Table 125. Functional Classes and Descriptions.

Functional Class	Description
Collector	Primarily Farm-to-Market (FM) Roads
Arterial	Primarily US and State Highways
Freeway	Primarily Interstate Highways

Table 126. Volume Classes and Descriptions.

Volume Class	Description
Low Volume	24-hour volume $< 2{,}000$
Medium Volume	$2{,}000 \leq$ 24-hour volume $< 5{,}000$
High Volume	$5{,}000 \geq$ 24-hour volume

Table 127 shows the number of survey sites for each study area cross-classified by the classification schemes provided in Tables 125 and 126. Table 128 provides the sum of all study areas shown in Table 127.

Table 127. Number of Survey Sites per Urban Area by Functional Class and Volume.

	Class	Low	Medium	High	Total
Amarillo	Collector	3	0	0	3
	Arterial	1	5	0	6
	Freeway	0	1	2	3
	Total	**4**	**6**	**2**	**12**
Austin/ San Antonio	Collector	12	3	0	15
	Arterial	12	17	6	35
	Freeway	0	0	14	14
	Total	**24**	**20**	**20**	**64**
Lubbock	Collector	7	0	0	7
	Arterial	0	5	1	6
	Freeway	0	0	1	1
	Total	**7**	**5**	**2**	**14**
Tyler/ Longview	Collector	16	1	0	17
	Arterial	11	18	2	31
	Freeway	0	0	0	0
	Total	**27**	**19**	**2**	**48**
Rio Grande Valley	Collector	8	2	0	10
	Arterial	5	5	7	17
	Freeway	0	0	4	4
	Total	**13**	**7**	**11**	**31**

Table 128. Total Number of Survey Sites by Functional Class and Volume.

Functional Class	Low	Medium	High	Total
Collector	46	6	0	52
Arterial	29	50	16	95
Freeway	0	1	21	22
Total	75	57	37	169

As expected, the cross-classification in Table 128 indicates that two of the nine cells have zero sites. This is because there are no low volume freeways or high volume collectors. In general, the number of sites in each urban area is a reflection of the size of the urban area (e.g., Amarillo: 12 sites, Rio Grande Valley: 31 sites, Austin/San Antonio: 64 sites).

With the exception of a small number of international border crossing sites in the Rio Grande Valley, all of these sites were surveyed in the outbound direction. It should also be noted that some of these sites occurred internally within a study area and were used as two-way sites for multiple MPOs located within a single study area (e.g., Austin/San Antonio, Tyler/Longview). In these cases, surveys were conducted in both directions. For the purposes of this task, however, the direction the survey was conducted is not of great importance, but rather it is the degree to which external local and external through trips are split at each external station.

Analysis Results

The results shown here are presented with separate consideration for non-commercial and commercial trips, as well as combined. Although current practice does not divide the forecasted external station volume into these two categories for the development of external local and external through trips, the data presented here give evidence that there is a noticeable difference in these proportions for non-commercial and commercial trips. Additionally, because of the large differences in external station volume and external survey sample size between non-commercial and commercial vehicles, this separation is warranted.

Separate Non-Commercial and Commercial

The data described in the previous section was compiled for each of the urban areas, and sample size estimates were developed for each external survey station using the formulas shown previously. For this task, a confidence level of 90 percent was used, giving $z_{\alpha/2}$ a value of 1.645. The acceptable error level for this task is 10 percent ($E = 0.10$). On the following pages, Tables 129a through 129j show the sample size requirements for each station, for non-commercial and commercial vehicles. Using the expanded 24-hour volumes (by direction), the proportion of external local and external through trips was calculated by dividing the total number of each trip type by the total number external trips for these sites. At high volume locations where no roadside survey was performed, the estimates for external local and external through trips were based on survey results from nearby survey sites. For each site, the sample size requirement was considered to be met if the number of vehicles surveyed was equal to or greater than the minimum sample size calculated at a 90 percent confidence interval, given the proportions provided by the data. The estimated sample size values (shown in the grey column) were calculated using Equation 1.

Table 129a. Sample Size Requirements for Non-Commercial Surveys, Amarillo.

Facility	Functional Class	Volume Class	Non-Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 293	Collector	Low	92.8%	7.2%	18	56	Yes
FM 1151	Collector	Low	96.7%	3.3%	9	128	Yes
US 87	Arterial	Low	99.1%	0.9%	2	120	Yes
FM 1061	Collector	Low	97.0%	3.0%	8	341	Yes
SH 136	Arterial	Medium	97.0%	3.0%	8	399	Yes
US 287	Arterial	Medium	66.9%	33.1%	60	374	Yes
US 60	Arterial	Medium	97.5%	2.5%	7	359	Yes
US 87/287	Arterial	Medium	92.1%	7.9%	20	381	Yes
IH 27	Freeway	Medium	92.4%	7.6%	19	355	Yes
US 60	Arterial	Medium	97.8%	2.2%	6	452	Yes
IH 40	Freeway	High	74.8%	25.2%	51	314	Yes
IH 40	Freeway	High	86.1%	13.9%	32	330	Yes

Table 129b. Sample Size Requirements for Commercial Surveys, Amarillo.

Facility	Functional Class	Volume Class	Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 293	Collector	Low	80.0%	20.0%	43	1	No
FM 1151	Collector	Low	97.3%	2.7%	7	10	Yes
US 87	Arterial	Low	25.0%	75.0%	51*	12	No
FM 1061	Collector	Low	97.1%	2.9%	8	34	Yes
SH 136	Arterial	Medium	87.9%	12.1%	29	58	Yes
US 287	Arterial	Medium	83.9%	16.1%	36	56	Yes
US 60	Arterial	Medium	85.7%	14.3%	33	70	Yes
US 87/287	Arterial	Medium	78.4%	21.6%	46	88	Yes
IH 27	Freeway	Medium	83.1%	16.9%	38	71	Yes
US 60	Arterial	Medium	96.3%	3.7%	10	53	Yes
IH 40	Freeway	High	72.9%	27.1%	53*	59	Yes
IH 40	Freeway	High	72.6%	27.4%	54*	95	Yes

* denotes that sample size estimate exceeds currently required level (50 for Commercial).

Table 129c. Sample Size Requirements for Non-Commercial Surveys, Austin/San Antonio.

Facility	Functional Class	Volume Class	Non-Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 112	Collector	Low	99.1%	0.9%	2	144	Yes
FM 2115	Collector	Low	98.7%	1.3%	3	140	Yes
FM 2538	Collector	Low	100.0%	0.0%	0	136	Yes
SH 304	Arterial	Low	96.6%	3.4%	9	200	Yes
FM 2538	Collector	Low	100.0%	0.0%	0	77	Yes
SH 95	Arterial	Low	98.1%	1.9%	5	215	Yes
FM 1346	Collector	Low	99.6%	0.4%	1	289	Yes
SH 80	Arterial	Low	97.7%	2.3%	6	349	Yes
FM 1117	Collector	Low	100.0%	0.0%	0	138	Yes
FM 165	Collector	Low	100.0%	0.0%	0	254	Yes
SH 97	Arterial	Low	96.1%	3.9%	10	306	Yes
FM 696	Collector	Low	100.0%	0.0%	0	340	Yes
US 90	Arterial	Low	100.0%	0.0%	0	309	Yes
US 90	Arterial	Low	96.5%	3.5%	9	313	Yes
FM 1957	Collector	Low	98.5%	1.5%	4	334	Yes
US 90A	Arterial	Low	99.1%	0.9%	2	332	Yes
FM 32	Collector	Low	95.4%	4.6%	12	370	Yes
SH 123	Arterial	Low	99.4%	0.6%	2	322	Yes
US 87	Arterial	Low	96.4%	3.6%	9	386	Yes
FM 32	Collector	Low	100.0%	0.0%	0	333	Yes
FM 476	Collector	Low	98.7%	1.3%	3	307	Yes
US 281	Arterial	Low	99.1%	0.9%	2	330	Yes
SH 80	Arterial	Low	80.3%	19.7%	43	310	Yes
SH 80	Arterial	Low	98.6%	1.4%	4	358	Yes
SH 95	Arterial	Medium	98.1%	1.9%	5	376	Yes
SH 21	Arterial	Medium	98.6%	1.4%	4	344	Yes
US 183	Arterial	Medium	99.4%	0.6%	2	337	Yes
US 181	Arterial	Medium	97.8%	2.2%	6	365	Yes
FM 621	Collector	Medium	100.0%	0.0%	0	452	Yes
SH 27	Arterial	Medium	99.8%	0.2%	1	369	Yes
SH 46	Arterial	Medium	100.0%	0.0%	0	396	Yes
FM 621	Collector	Medium	99.6%	0.4%	1	443	Yes
US 183	Arterial	Medium	97.4%	2.6%	7	452	Yes
SH 16	Arterial	Medium	100.0%	0.0%	0	343	Yes
US 87	Arterial	Medium	98.7%	1.3%	3	405	Yes
US 290	Arterial	Medium	99.3%	0.7%	2	267	Yes
US 79	Arterial	Medium	99.7%	0.3%	1	375	Yes
FM 471	Collector	Medium	99.7%	0.3%	1	632	Yes
SH 195	Arterial	Medium	99.5%	0.5%	1	399	Yes
SH 71	Arterial	Medium	99.7%	0.3%	1	377	Yes
SH 29	Arterial	Medium	95.3%	4.7%	12	380	Yes
SH 71	Arterial	Medium	99.1%	0.9%	2	454	Yes
US 87	Arterial	Medium	98.8%	1.2%	3	326	Yes

Table 129c. Sample Size Requirements for Non-Commercial Surveys, Austin/San Antonio (continued).

Facility	Functional Class	Volume Class	Non-Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
US 281	Arterial	Medium	100.0%	0.0%	0	340	Yes
SH 123	Arterial	High	99.1%	0.9%	2	432	Yes
SH 123	Arterial	High	95.4%	4.6%	12	368	Yes
SH 16	Arterial	High	100.0%	0.0%	0	338	Yes
IH 10	Freeway	High	95.9%	4.1%	11	315	Yes
US 290	Arterial	High	97.8%	2.2%	6	404	Yes
US 181	Arterial	High	99.5%	0.5%	1	367	Yes

Table 129d. Sample Size Requirements for Commercial Surveys, Austin/San Antonio.

Facility	Functional Class	Volume Class	Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 112	Collector	Low	100.0%	0.0%	0	6	Yes
FM 2115	Collector	Low	85.5%	14.5%	34	13	No
FM 2538	Collector	Low	100.0%	0.0%	0	1	Yes
SH 304	Arterial	Low	77.5%	22.5%	47	40	No
FM 2538	Collector	Low	100.0%	0.0%	0	2	Yes
SH 95	Arterial	Low	73.1%	26.9%	53*	26	No
FM 1346	Collector	Low	100.0%	0.0%	0	6	Yes
SH 80	Arterial	Low	77.8%	22.2%	47	53	Yes
FM 1117	Collector	Low	100.0%	0.0%	0	1	Yes
FM 165	Collector	Low	85.3%	14.7%	34	7	No
SH 97	Arterial	Low	83.2%	16.8%	38	54	Yes
FM 696	Collector	Low	94.4%	5.6%	14	17	Yes
US 90	Arterial	Low	93.4%	6.6%	17	59	Yes
US 90	Arterial	Low	77.9%	22.1%	47	58	Yes
FM 1957	Collector	Low	100.0%	0.0%	0	10	Yes
US 90A	Arterial	Low	97.0%	3.0%	8	65	Yes
FM 32	Collector	Low	50.6%	49.4%	68*	24	No
SH 123	Arterial	Low	87.7%	12.3%	29	42	Yes
US 87	Arterial	Low	79.4%	20.6%	44	58	Yes
FM 32	Collector	Low	96.6%	3.4%	9	56	Yes
FM 476	Collector	Low	100.0%	0.0%	0	17	Yes
US 281	Arterial	Low	93.0%	7.0%	18	28	Yes
SH 80	Arterial	Low	65.2%	34.8%	61*	49	No
SH 80	Arterial	Low	84.6%	15.4%	35	65	Yes
SH 95	Arterial	Medium	88.2%	11.8%	28	67	Yes
SH 21	Arterial	Medium	95.1%	4.9%	13	62	Yes
US 183	Arterial	Medium	100.0%	0.0%	0	56	Yes
US 181	Arterial	Medium	90.3%	9.7%	24	43	Yes
FM 621	Collector	Medium	100.0%	0.0%	0	13	Yes

Table 129d. Sample Size Requirements for Commercial Surveys, Austin/San Antonio (continued).

Facility	Functional Class	Volume Class	Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
SH 27	Arterial	Medium	92.3%	7.7%	19	52	Yes
SH 46	Arterial	Medium	96.2%	3.8%	10	52	Yes
FM 621	Collector	Medium	100.0%	0.0%	0	6	Yes
US 183	Arterial	Medium	83.3%	16.7%	38	66	Yes
SH 16	Arterial	Medium	100.0%	0.0%	0	47	Yes
US 87	Arterial	Medium	88.7%	11.3%	27	53	Yes
US 290	Arterial	Medium	93.2%	6.8%	17	43	Yes
US 79	Arterial	Medium	95.3%	4.7%	12	64	Yes
FM 471	Collector	Medium	97.2%	2.8%	7	108	Yes
SH 195	Arterial	Medium	96.5%	3.5%	9	57	Yes
SH 71	Arterial	Medium	92.5%	7.5%	19	66	Yes
SH 29	Arterial	Medium	82.2%	17.8%	40	56	Yes
SH 71	Arterial	Medium	88.1%	11.9%	28	50	Yes
US 87	Arterial	Medium	95.7%	4.3%	11	47	Yes
US 281	Arterial	Medium	100.0%	0.0%	0	51	Yes
IH 10	Freeway	High	0.0%	100.0%	0	27	Yes
US 90	Arterial	High	79.8%	20.2%	44	114	Yes
IH 37	Freeway	High	83.9%	16.1%	37	31	No
IH 37	Freeway	High	47.5%	52.5%	67*	40	No
IH 10	Freeway	High	66.7%	33.3%	60*	3	No
IH 10	Freeway	High	65.7%	34.3%	61*	35	No
IH 10	Freeway	High	0.0%	100.0%	0	49	Yes
IH 35	Freeway	High	38.3%	61.7%	64*	47	No
IH 10	Freeway	High	70.0%	30.0%	57*	10	No
IH 35	Freeway	High	15.4%	84.6%	35	52	Yes
IH 35	Freeway	High	70.8%	29.2%	56*	48	No
IH 35	Freeway	High	0.0%	100.0%	0	44	Yes
SH 123	Arterial	High	88.9%	11.1%	27	54	Yes
SH 123	Arterial	High	78.9%	21.1%	45	57	Yes
IH 35	Freeway	High	36.8%	63.2%	63*	57	No
IH 35	Freeway	High	55.2%	44.8%	67*	67	Yes
SH 16	Arterial	High	92.3%	7.7%	19	52	Yes
IH 10	Freeway	High	77.3%	22.7%	47	53	Yes
US 290	Arterial	High	94.8%	5.2%	13	76	Yes
US 181	Arterial	High	98.3%	1.7%	4	59	Yes

* denotes that sample size estimate exceeds currently required level (50 for Commercial).

Table 129e. Sample Size Requirements for Non-Commercial Surveys, Lubbock.

Facility	Functional Class	Volume Class	Non-Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 179	Collector	Low	78.6%	21.4%	45	60	Yes
FM 2641	Collector	Low	98.2%	1.8%	5	51	Yes
FM 40	Collector	Low	98.8%	1.2%	3	91	Yes
FM 400	Collector	Low	89.3%	10.7%	26	85	Yes
FM 1730	Collector	Low	97.6%	2.4%	6	172	Yes
FM 400	Collector	Low	98.2%	1.8%	5	164	Yes
FM 1585	Collector	Low	97.8%	2.2%	6	233	Yes
US 82/62	Arterial	Medium	95.5%	4.5%	12	334	Yes
US 82/62	Arterial	Medium	97.7%	2.3%	6	349	Yes
US 87	Arterial	Medium	92.2%	7.8%	20	409	Yes
US 84	Arterial	Medium	92.3%	7.7%	19	325	Yes
US 84	Arterial	Medium	97.0%	3.0%	8	335	Yes
SH 114	Arterial	High	99.2%	0.8%	2	373	Yes
IH 27	Freeway	High	96.4%	3.6%	9	414	Yes

Table 129f. Sample Size Requirements for Commercial Surveys, Lubbock.

Facility	Functional Class	Volume Class	Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 179	Collector	Low	66.7%	33.3%	60*	11	No
FM 2641	Collector	Low	98.1%	1.9%	5	22	Yes
FM 40	Collector	Low	90.6%	9.4%	23	31	Yes
FM 400	Collector	Low	85.7%	14.3%	33	47	Yes
FM 1730	Collector	Low	94.1%	5.9%	15	11	No
FM 400	Collector	Low	94.6%	5.4%	14	18	Yes
FM 1585	Collector	Low	94.1%	5.9%	15	31	Yes
US 82/62	Arterial	Medium	78.0%	22.0%	46	59	Yes
US 82/62	Arterial	Medium	77.3%	22.7%	47	53	Yes
US 87	Arterial	Medium	83.9%	16.1%	36	62	Yes
US 84	Arterial	Medium	71.8%	28.2%	55*	71	Yes
US 84	Arterial	Medium	87.4%	12.6%	30	56	Yes
SH 114	Arterial	High	90.1%	9.9%	24	60	Yes
IH 27	Freeway	High	83.6%	16.4%	37	61	Yes

* denotes that sample size estimate exceeds currently required level (50 for Commercial).

Table 129g. Sample Size Requirements for Non-Commercial Surveys, Tyler/Longview.

Facility	Functional Class	Volume Class	Non-Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 1804	Collector	Low	95.2%	4.8%	12	183	Yes
FM 95	Collector	Low	80.2%	19.8%	43	196	Yes
FM 1252	Collector	Low	100.0%	0.0%	0	131	Yes
SH 135	Arterial	Low	69.6%	30.4%	57	155	Yes
FM 1252	Collector	Low	98.1%	1.9%	5	104	Yes
FM 850	Collector	Low	96.2%	3.8%	10	132	Yes
FM 850	Collector	Low	98.4%	1.6%	4	133	Yes
FM 2208	Collector	Low	96.1%	3.9%	10	182	Yes
SH 43	Arterial	Low	85.0%	15.0%	34	180	Yes
SH 154	Arterial	Low	88.3%	11.7%	28	146	Yes
FM 1968	Collector	Low	96.4%	3.6%	9	257	Yes
FM 2767	Collector	Low	97.0%	3.0%	8	138	Yes
FM 2767	Collector	Low	98.6%	1.4%	4	224	Yes
FM 13	Collector	Low	98.6%	1.4%	4	211	Yes
FM 31	Collector	Low	97.8%	2.2%	6	182	Yes
SH 315	Arterial	Low	30.7%	69.3%	58	114	Yes
US 84	Arterial	Low	42.3%	57.7%	66	296	Yes
FM 9	Collector	Low	95.8%	4.2%	11	217	Yes
US 84	Arterial	Low	71.1%	28.9%	56	180	Yes
US 80	Arterial	Low	94.2%	5.8%	15	105	Yes
FM 2493	Collector	Low	94.8%	5.2%	13	231	Yes
SH 43	Arterial	Low	76.3%	23.7%	49	287	Yes
FM 346	Collector	Low	97.2%	2.8%	7	283	Yes
SH 43	Arterial	Low	79.4%	20.6%	44	311	Yes
SH 110	Arterial	Low	96.3%	3.7%	10	323	Yes
US 79	Arterial	Low	67.8%	32.2%	59	242	Yes
FM 14	Collector	Low	93.1%	6.9%	17	318	Yes
US 79	Arterial	Medium	77.5%	22.5%	47	302	Yes
SH 64	Arterial	Medium	78.4%	21.6%	46	301	Yes
SH 155	Arterial	Medium	91.2%	8.8%	22	317	Yes
SH 64	Arterial	Medium	96.1%	3.9%	10	307	Yes
SH 155	Arterial	Medium	87.3%	12.7%	30	316	Yes
SH 155	Arterial	Medium	72.3%	27.7%	54	310	Yes
SH 31	Arterial	Medium	29.0%	71.0%	56	217	Yes
SH 149	Arterial	Medium	93.4%	6.6%	17	347	Yes
SH 64	Arterial	Medium	95.5%	4.5%	12	335	Yes
US 271 S	Arterial	Medium	94.9%	5.1%	13	292	Yes
US 271	Arterial	Medium	88.2%	11.8%	28	220	Yes
SH 31	Arterial	Medium	94.8%	5.2%	13	285	Yes
FM 2911	Collector	Medium	98.4%	1.6%	4	125	Yes
US 59	Arterial	Medium	88.3%	11.7%	28	283	Yes
US 271	Arterial	Medium	76.2%	23.8%	49	345	Yes
US 259	Arterial	Medium	92.0%	8.0%	20	400	Yes
US 259	Arterial	Medium	83.2%	16.8%	38	286	Yes

Table 129g. Sample Size Requirements for Non-Commercial Surveys, Tyler/Longview (continued).

Facility	Functional Class	Volume Class	Non-Commercial				
			% External-Local	% External-Through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
US 59	Arterial	Medium	77.2%	22.8%	48	333	Yes
SH 155	Arterial	Medium	94.7%	5.3%	14	322	Yes
US 69 N	Arterial	High	93.6%	6.4%	16	374	Yes
US 69 S	Arterial	High	94.5%	5.5%	14	328	Yes

Table 129h. Sample Size Requirements for Commercial Surveys, Tyler/Longview.

Facility	Functional Class	Volume Class	Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 1804	Collector	Low	82.6%	17.4%	39	6	No
FM 95	Collector	Low	67.2%	32.8%	60*	12	No
FM 1252	Collector	Low	100.0%	0.0%	0	4	Yes
FM 1252	Collector	Low	100.0%	0.0%	0	4	Yes
FM 850	Collector	Low	83.1%	16.9%	38	6	No
FM 850	Collector	Low	80.0%	20.0%	43	5	No
FM 2208	Collector	Low	100.0%	0.0%	0	14	Yes
SH 43	Arterial	Low	79.3%	20.7%	44	39	No
SH 154	Arterial	Low	73.3%	26.7%	53*	19	No
FM 1968	Collector	Low	74.5%	25.5%	51*	19	No
FM 2767	Collector	Low	83.3%	16.7%	38	12	No
FM 2767	Collector	Low	88.4%	11.6%	28	9	No
FM 13	Collector	Low	92.6%	7.4%	18	28	Yes
FM 31	Collector	Low	73.2%	26.8%	53*	30	No
SH 315	Arterial	Low	15.4%	84.6%	35	58	Yes
US 84	Arterial	Low	12.0%	88.0%	29	60	Yes
FM 9	Collector	Low	85.1%	14.9%	34	20	No
US 84	Arterial	Low	52.6%	47.4%	67*	34	No
US 80	Arterial	Low	61.6%	38.4%	64*	52	No
FM 2493	Collector	Low	75.2%	24.8%	50	24	No
SH 43	Arterial	Low	36.3%	63.7%	63*	44	No
FM 346	Collector	Low	100.0%	0.0%	0	14	Yes
SH 43	Arterial	Low	62.8%	37.2%	63*	51	No
SH 110	Arterial	Low	81.6%	18.4%	41	27	No
US 79	Arterial	Low	63.7%	36.3%	63*	44	No
FM 14	Collector	Low	63.9%	36.1%	62*	50	No
US 79	Arterial	Medium	69.8%	30.2%	57*	63	Yes
SH 64	Arterial	Medium	62.5%	37.5%	63*	48	No
SH 155	Arterial	Medium	62.2%	37.8%	64*	45	No
SH 64	Arterial	Medium	76.8%	23.2%	48	43	No
SH 155	Arterial	Medium	62.7%	37.3%	63*	51	No
SH 155	Arterial	Medium	34.0%	66.0%	61*	56	No

Table 129h: Sample Size Requirements for Commercial Surveys, Tyler/Longview (continued).

Facility	Functional Class	Volume Class	Commercial				
			% External-Local	% External-Through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
SH 31	Arterial	Medium	88.4%	11.6%	28	43	Yes
SH 149	Arterial	Medium	77.7%	22.3%	47	54	Yes
SH 64	Arterial	Medium	83.0%	17.0%	38	53	Yes
US 271 S	Arterial	Medium	81.8%	18.2%	40	22	No
US 271	Arterial	Medium	75.0%	25.0%	51*	28	No
SH 31	Arterial	Medium	94.1%	5.9%	15	34	Yes
FM 2911	Collector	Medium	100.0%	0.0%	0	2	Yes
US 59	Arterial	Medium	53.1%	46.9%	67*	64	No
US 271	Arterial	Medium	58.7%	41.3%	66*	46	No
US 259	Arterial	Medium	61.2%	38.8%	64*	90	Yes
US 259	Arterial	Medium	62.5%	37.5%	63*	80	Yes
US 59	Arterial	Medium	52.3%	47.7%	68*	65	No
SH 155	Arterial	Medium	72.6%	27.4%	54*	51	No
US 69 N	Arterial	High	56.8%	43.2%	66*	51	No
US 69 S	Arterial	High	88.1%	11.9%	28	50	Yes

* denotes that sample size estimate exceeds currently required level (50 for Commercial).

Table 129i. Sample Size Requirements for Non-Commercial Surveys, Rio Grande Valley.

Facility	Functional Class	Volume Class	Non-Commercial % External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 1420	Collector	Low	99.1%	0.9%	3	132	Yes
FM 1425	Collector	Low	98.5%	1.5%	4	126	Yes
FM 506	Collector	Low	98.7%	1.3%	4	154	Yes
FM 1015	Collector	Low	97.1%	2.9%	8	212	Yes
FM 88	Collector	Low	99.2%	0.8%	2	294	Yes
FM 1017	Collector	Low	90.1%	9.9%	24	313	Yes
FM 490	Collector	Low	90.5%	9.5%	23	241	Yes
SH 186	Arterial	Low	59.9%	40.1%	65	222	Yes
Bus. US	Arterial	Low	95.7%	4.3%	11	350	Yes
SH 107	Arterial	Low	86.8%	13.2%	31	350	Yes
SH 107	Arterial	Low	99.7%	0.3%	1	348	Yes
Bus. US 83	Arterial	Low	100.0%	0.0%	0	351	Yes
FM 106	Collector	Low	97.4%	2.6%	7	350	Yes
US 281	Arterial	Medium	100.0%	0.0%	0	363	Yes
US 281	Arterial	Medium	56.6%	43.4%	66	302	Yes
FM 509	Collector	Medium	98.4%	1.6%	4	433	Yes
US 77	Arterial	Medium	100.0%	0.0%	0	404	Yes
US 281	Arterial	Medium	96.2%	3.8%	10	427	Yes
US 281	Arterial	Medium	67.2%	32.8%	60	463	Yes
FM 1015	Collector	Medium	97.7%	2.3%	6	468	Yes
Spur 600	Arterial	High	99.4%	0.6%	2	353	Yes
US 281	Arterial	High	98.5%	1.5%	4	405	Yes
US 77	Arterial	High	98.7%	1.3%	3	399	Yes
US 83	Arterial	High	98.5%	1.5%	4	342	Yes
SH 4	Arterial	High	99.4%	0.6%	1	366	Yes
12th St.	Arterial	High	99.6%	0.4%	1	505	Yes
SH 115	Arterial	High	98.3%	1.7%	5	588	Yes

Table 129j. Sample Size Requirements for Commercial Surveys, Rio Grande Valley.

Facility	Functional Class	Volume Class	Commercial				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 1420	Collector	Low	100.0%	0.0%	0	8	Yes
FM 1425	Collector	Low	100.0%	0.0%	0	11	Yes
FM 506	Collector	Low	100.0%	0.0%	0	13	Yes
FM 1015	Collector	Low	100.0%	0.0%	0	16	Yes
FM 88	Collector	Low	100.0%	0.0%	0	52	Yes
FM 1017	Collector	Low	98.2%	1.8%	5	65	Yes
FM 490	Collector	Low	95.0%	5.0%	13	80	Yes
SH 186	Arterial	Low	71.3%	28.7%	55*	102	Yes
Bus. US	Arterial	Low	94.4%	5.6%	14	15	Yes
SH 107	Arterial	Low	83.8%	16.2%	37	68	Yes
SH 107	Arterial	Low	97.0%	3.0%	8	68	Yes
Bus. US 83	Arterial	Low	100.0%	0.0%	0	16	Yes
FM 106	Collector	Low	100.0%	0.0%	0	16	Yes
US 281	Arterial	Medium	91.1%	8.9%	22	56	Yes
US 281	Arterial	Medium	36.5%	63.5%	63*	41	No
FM 509	Collector	Medium	100.0%	0.0%	0	69	Yes
US 77	Arterial	Medium	100.0%	0.0%	0	224	Yes
US 281	Arterial	Medium	100.0%	0.0%	0	45	Yes
US 281	Arterial	Medium	29.7%	70.3%	56*	67	Yes
FM 1015	Collector	Medium	100.0%	0.0%	0	38	Yes
US 83	Freeway	High	49.0%	51.0%	68*	98	Yes
US 83	Freeway	High	97.8%	2.2%	6	45	Yes
US 83	Freeway	High	11.5%	88.5%	28	26	No
US 83	Freeway	High	91.6%	8.4%	21	83	Yes
Spur 600	Arterial	High	97.3%	2.7%	7	156	Yes
US 281	Arterial	High	97.3%	2.7%	7	72	Yes
US 77	Arterial	High	100.0%	0.0%	0	84	Yes
US 83	Arterial	High	84.6%	15.4%	35	84	Yes

* denotes that sample size estimate exceeds currently required level (50 for Commercial).

Table 130. Percent of External Stations Meeting Sample Size Requirements.

Study Area	Non-Commercial				Commercial			
	Yes	No	Total	% Yes	Yes	No	Total	% Yes
Amarillo	12	0	12	100%	10	2	12	83%
Austin/San Antonio	38	0	38	100%	36	14	50	72%
Lubbock	14	0	14	100%	12	2	14	86%
Tyler/Longview	47	0	47	100%	11	31	42	26%
Rio Grande Valley	24	0	24	100%	14	2	16	88%
Total	**135**	**0**	**135**	**100%**	**83**	**51**	**134**	**62%**

In Table 130, the sites that had a calculated minimum sample size of 0 were not included. In this table, there is a clear difference in non-commercial and commercial vehicles with regard to the percentage of stations meeting the estimated minimum sample size. For non-commercial vehicles, the minimum estimated sample size was met for every station in every study area. For commercial vehicles, however, none of the study areas had 100 percent of the sites meeting the sample size requirements.

The Tyler/Longview study area had the lowest percentage of sites meeting the sample size requirement, due to the large number of sites that had an even split between external through and external local trips. Based on the sample size formula in section 2, the more even the split between two groups is, the higher the minimum sample size required for that population and the more likely that this requirement was not met.

As stated above, at some sites, the percent of external local or external through trips was 100 percent, yielding a calculated minimum sample size of 0. These sites are not included in the totals provided in Tables 130, 131, and 132. This could be an indication that some sites do not need to be surveyed at all, and that conducting only a 24-hour vehicle classification count would be sufficient. There are other factors, however, to be considered when determining whether or not to conduct a survey at a specific site. These may include the total inbound/outbound volume at the site, the spatial distribution of local trip ends within the study area, and the percent of vehicles that are commercial/non-commercial. At sites where these other factors are important, it would be appropriate to select a minimum sample size for the site in lieu of the calculations presented here. Table 131 shows the same results as Table 130, but the data have been aggregated by road functional class instead of study area.

Table 131. Percent of External Stations Meeting Sample Size Requirements, Grouped by Functional Class.

Functional Class	Non-Commercial				Commercial			
	Yes	No	Total	% Yes	Yes	No	Total	% Yes
Collector	44	0	44	100%	13	17	30	43%
Arterial	86	0	86	100%	59	25	84	70%
Freeway	5	0	5	100%	11	9	20	55%
Total	**135**	**0**	**135**	**100%**	**83**	**51**	**134**	**62%**

For commercial vehicles, the results shown in this table indicates that survey stations occurring on arterial roads had the highest percentage for meeting calculated minimum sample sizes. Overall, functional classes ranged from 43–70 percent for commercial vehicles. Table 132 shows the same results as Table 130, but the data have been aggregated by road volume class instead of study area.

Table 132. Percent of External Stations Meeting Sample Size Requirements, Grouped by Volume Class.

Volume Class	Non-Commercial				Commercial			
	Yes	No	Total	% Yes	Yes	No	Total	% Yes
Low	66	0	66	100%	27	29	56	48%
Medium	51	0	51	100%	35	12	47	74%
High	18	0	18	100%	21	10	31	68%
Total	**135**	**0**	**135**	**100%**	**83**	**51**	**134**	**62%**

Similar to the results shown in Table 131, the results in Table 132 show that for commercial vehicles, all of the volume classes had multiple stations that failed to reach the minimum sample size. Also similar to Table 131, volume classes ranged from 48–74 percent, with stations on medium volume roadways having the highest percentage for meeting minimum calculated sample sizes. For some of the external stations with low volume, the amount of commercial traffic was so low for the 24-hour period, that it would have been difficult to reach the estimated minimum sample size required.

Combined Non-Commercial and Commercial

On the following pages, Tables 133a through 133e show the sample size requirements for each station using the combined total of non-commercial and commercial vehicles. Current practices do not split trip estimates between non-commercial and commercial vehicles. This section will present the same data as in the previous section, but will not separate non-commercial and commercial vehicles in the sample size calculation. Because it was shown in the previous section that there is a difference in the proportions of external through trips for non-commercial and commercial vehicles, their respective proportions (based on total volume) should be weighted in the new calculation of sample size, n. In most cases, this new combined sample size requirement for the number of vehicles to be surveyed at each station will be greater than the requirement calculated for commercial vehicles only and fewer than the requirement calculated for non-commercial vehicles only. The estimated sample size values (shown in the grey column) were calculated using Equation 2.

Table 133a. Sample Size Requirements for Combined Surveys, Amarillo.

Facility	Functional Class	Volume Class	Combined % External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 293	Collector	LV	92.5%	7.5%	19	57	Yes
FM 1151	Collector	LV	96.8%	3.2%	8	138	Yes
US 87	Arterial	LV	87.6%	12.4%	10	132	Yes
FM 1061	Collector	LV	97.0%	3.0%	8	375	Yes
SH 136	Arterial	MV	95.0%	5.0%	12	457	Yes
US 287	Arterial	MV	75.3%	24.7%	48	430	Yes
US 60	Arterial	MV	96.0%	4.0%	10	429	Yes
US 87/287	Arterial	MV	86.9%	13.1%	30	469	Yes
IH 27	Freeway	MV	90.2%	9.8%	24	426	Yes
US 60	Arterial	MV	97.6%	2.4%	6	505	Yes
IH 40	Freeway	HV	74.1%	25.9%	52	373	Yes
IH 40	Freeway	HV	79.9%	20.1%	42	425	Yes

Table 133b. Sample Size Requirements for Combined Surveys, Austin/San Antonio.

Facility	Functional Class	Volume Class	Combined % External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 112	Collector	LV	99.3%	0.7%	2	150	Yes
FM 2115	Collector	LV	96.2%	3.8%	9	153	Yes
FM 2538	Collector	LV	100.0%	0.0%	0	137	Yes
SH 304	Arterial	LV	93.3%	6.7%	16	240	Yes
FM 2538	Collector	LV	100.0%	0.0%	0	79	Yes
SH 95	Arterial	LV	92.3%	7.7%	16	241	Yes
FM 1346	Collector	LV	99.7%	0.3%	1	295	Yes
SH 80	Arterial	LV	94.3%	5.7%	13	402	Yes
FM 1117	Collector	LV	100.0%	0.0%	0	139	Yes
FM 165	Collector	LV	98.1%	1.9%	4	261	Yes
SH 97	Arterial	LV	93.9%	6.1%	15	360	Yes
FM 696	Collector	LV	99.5%	0.5%	1	357	Yes
US 90	Arterial	LV	98.8%	1.2%	3	368	Yes
US 90	Arterial	LV	93.9%	6.1%	14	371	Yes
FM 1957	Collector	LV	98.6%	1.4%	4	344	Yes
US 90A	Arterial	LV	98.6%	1.4%	4	397	Yes
FM 32	Collector	LV	92.4%	7.6%	16	394	Yes
SH 123	Arterial	LV	98.4%	1.6%	4	364	Yes
US 87	Arterial	LV	92.2%	7.8%	18	444	Yes
FM 32	Collector	LV	99.6%	0.4%	1	389	Yes
FM 476	Collector	LV	98.8%	1.2%	3	324	Yes
US 281	Arterial	LV	98.2%	1.8%	5	358	Yes
SH 80	Arterial	LV	78.1%	21.9%	45	359	Yes

Table 133b. Sample Size Requirements for Combined Surveys, Austin/San Antonio (continued).

Facility	Functional Class	Volume Class	Combined				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
SH 80	Arterial	LV	96.1%	3.9%	9	423	Yes
SH 95	Arterial	MV	97.0%	3.0%	8	443	Yes
SH 21	Arterial	MV	97.7%	2.3%	6	406	Yes
US 183	Arterial	MV	99.5%	0.5%	1	393	Yes
US 181	Arterial	MV	97.5%	2.5%	7	408	Yes
FM 621	Collector	MV	100.0%	0.0%	0	465	Yes
SH 27	Arterial	MV	98.4%	1.6%	4	421	Yes
SH 46	Arterial	MV	99.8%	0.2%	1	448	Yes
FM 621	Collector	MV	99.6%	0.4%	1	449	Yes
US 183	Arterial	MV	94.5%	5.5%	13	518	Yes
SH 16	Arterial	MV	100.0%	0.0%	0	390	Yes
US 87	Arterial	MV	96.3%	3.7%	9	458	Yes
US 290	Arterial	MV	99.1%	0.9%	2	310	Yes
US 79	Arterial	MV	98.9%	1.1%	3	439	Yes
FM 471	Collector	MV	99.0%	1.0%	3	740	Yes
SH 195	Arterial	MV	99.3%	0.7%	2	456	Yes
SH 71	Arterial	MV	97.8%	2.2%	6	443	Yes
SH 29	Arterial	MV	93.2%	6.8%	17	436	Yes
SH 71	Arterial	MV	97.8%	2.2%	6	504	Yes
US 87	Arterial	MV	98.5%	1.5%	4	373	Yes
US 281	Arterial	MV	100.0%	0.0%	0	391	Yes
SH 123	Arterial	HV	97.8%	2.2%	6	486	Yes
SH 123	Arterial	HV	94.0%	6.0%	15	425	Yes
SH 16	Arterial	HV	99.1%	0.9%	2	390	Yes
IH 10	Freeway	HV	91.5%	8.5%	19	368	Yes
US 290	Arterial	HV	97.3%	2.7%	7	480	Yes
US 181	Arterial	HV	99.4%	0.6%	2	426	Yes

Table 133c. Sample Size Requirements for Combined Surveys, Lubbock.

Facility	Functional Class	Volume Class	Combined				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 179	Collector	LV	77.7%	22.3%	47	71	Yes
FM 2641	Collector	LV	98.2%	1.8%	5	73	Yes
FM 40	Collector	LV	97.3%	2.7%	7	122	Yes
FM 400	Collector	LV	88.6%	11.4%	27	132	Yes
FM 1730	Collector	LV	97.4%	2.6%	7	183	Yes
FM 400	Collector	LV	97.1%	2.9%	7	182	Yes
FM 1585	Collector	LV	97.7%	2.3%	6	264	Yes
US 82/62	Arterial	MV	92.5%	7.5%	18	393	Yes
US 82/62	Arterial	MV	92.3%	7.7%	17	402	Yes
US 87	Arterial	MV	90.5%	9.5%	23	471	Yes
US 84	Arterial	MV	87.2%	12.8%	28	396	Yes
US 84	Arterial	MV	95.5%	4.5%	11	391	Yes
SH 114	Arterial	HV	98.9%	1.1%	3	433	Yes
IH 27	Freeway	HV	94.4%	5.6%	14	475	Yes

Table 133d. Sample Size Requirements for Combined Surveys, Tyler/Longview.

Facility	Functional Class	Volume Class	Combined				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 1804	Collector	LV	93.4%	6.6%	16	189	Yes
FM 95	Collector	LV	77.9%	22.1%	46	208	Yes
FM 1252	Collector	LV	100.0%	0.0%	0	135	Yes
FM 1252	Collector	LV	98.3%	1.7%	5	108	Yes
FM 850	Collector	LV	92.7%	7.3%	17	138	Yes
FM 850	Collector	LV	90.8%	9.2%	20	138	Yes
FM 2208	Collector	LV	96.7%	3.3%	9	196	Yes
SH 43	Arterial	LV	84.0%	16.0%	36	219	Yes
SH 154	Arterial	LV	85.8%	14.2%	32	165	Yes
FM 1968	Collector	LV	94.4%	5.6%	13	276	Yes
FM 2767	Collector	LV	95.8%	4.2%	10	150	Yes
FM 2767	Collector	LV	97.0%	3.0%	7	233	Yes
FM 13	Collector	LV	97.5%	2.5%	6	239	Yes
FM 31	Collector	LV	90.9%	9.1%	19	212	Yes
SH 315	Arterial	LV	28.8%	71.2%	55	172	Yes
US 84	Arterial	LV	36.6%	63.4%	59	356	Yes
FM 9	Collector	LV	93.7%	6.3%	15	237	Yes
US 84	Arterial	LV	68.6%	31.4%	57	214	Yes
US 80	Arterial	LV	80.0%	20.0%	36	157	Yes
FM 2493	Collector	LV	90.8%	9.2%	21	255	Yes
SH 43	Arterial	LV	66.1%	33.9%	52	331	Yes
FM 346	Collector	LV	97.5%	2.5%	7	297	Yes

Table 133d. Sample Size Requirements for Combined Surveys, Tyler/Longview (continued).

Facility	Functional Class	Volume Class	Combined				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
SH 43	Arterial	LV	75.0%	25.0%	49	362	Yes
SH 110	Arterial	LV	94.7%	5.3%	13	350	Yes
US 79	Arterial	LV	66.7%	33.3%	60	286	Yes
FM 14	Collector	LV	89.4%	10.6%	23	368	Yes
US 79	Arterial	MV	75.7%	24.3%	50	365	Yes
SH 64	Arterial	MV	75.0%	25.0%	50	349	Yes
SH 155	Arterial	MV	82.2%	17.8%	35	362	Yes
SH 64	Arterial	MV	92.9%	7.1%	16	350	Yes
SH 155	Arterial	MV	82.7%	17.3%	36	367	Yes
SH 155	Arterial	MV	63.7%	36.3%	56	366	Yes
SH 31	Arterial	MV	39.5%	60.5%	51	260	Yes
SH 149	Arterial	MV	90.0%	10.0%	23	401	Yes
SH 64	Arterial	MV	93.9%	6.1%	15	388	Yes
US 271 S	Arterial	MV	91.3%	8.7%	21	314	Yes
US 271	Arterial	MV	84.6%	15.4%	34	248	Yes
SH 31	Arterial	MV	94.6%	5.4%	14	319	Yes
FM 2911	Collector	MV	98.5%	1.5%	4	127	Yes
US 59	Arterial	MV	74.3%	25.7%	44	347	Yes
US 271	Arterial	MV	69.5%	30.5%	55	391	Yes
US 259	Arterial	MV	86.2%	13.8%	28	490	Yes
US 259	Arterial	MV	76.0%	24.0%	47	366	Yes
US 59	Arterial	MV	72.6%	27.4%	51	398	Yes
SH 155	Arterial	MV	91.1%	8.9%	20	373	Yes
US 69 N	Arterial	HV	87.7%	12.3%	24	425	Yes
US 69 S	Arterial	HV	94.3%	5.7%	15	378	Yes

Table 133e. Sample Size Requirements for Combined Surveys, Rio Grande Valley.

Facility	Functional Class	Volume Class	Combined				
			% External local	% External through	Sample Size (90% conf.)	Number Surveyed	Sample Size Met?
FM 1420	Collector	LV	99.1%	0.9%	2	140	Yes
FM 1425	Collector	LV	98.7%	1.3%	3	137	Yes
FM 506	Collector	LV	98.8%	1.2%	3	167	Yes
FM 1015	Collector	LV	97.3%	2.7%	7	228	Yes
FM 88	Collector	LV	99.3%	0.7%	2	346	Yes
FM 1017	Collector	LV	92.1%	7.9%	19	378	Yes
FM 490	Collector	LV	91.2%	8.8%	22	321	Yes
SH 186	Arterial	LV	61.7%	38.3%	63	324	Yes
Bus. US	Arterial	LV	95.7%	4.3%	11	365	Yes
SH 107	Arterial	LV	86.2%	13.8%	32	418	Yes
SH 107	Arterial	LV	99.2%	0.8%	2	416	Yes
Bus. US 83	Arterial	LV	100.0%	0.0%	0	367	Yes
FM 106	Collector	LV	97.6%	2.4%	6	366	Yes
US 281	Arterial	MV	99.0%	1.0%	3	419	Yes
US 281	Arterial	MV	54.9%	45.1%	66	343	Yes
FM 509	Collector	MV	98.4%	1.6%	4	502	Yes
US 77	Arterial	MV	100.0%	0.0%	0	628	Yes
US 281	Arterial	MV	96.5%	3.5%	9	472	Yes
US 281	Arterial	MV	64.0%	36.0%	59	530	Yes
FM 1015	Collector	MV	97.8%	2.2%	6	506	Yes
Spur 600	Arterial	HV	99.3%	0.7%	2	509	Yes
US 281	Arterial	HV	98.4%	1.6%	4	477	Yes
US 77	Arterial	HV	98.9%	1.1%	3	483	Yes
US 83	Arterial	HV	97.2%	2.8%	7	426	Yes

Table 134. Percent of External Stations Meeting Sample Size Requirements.

Study Area	Combined			
	Yes	No	Total	% Yes
Amarillo	12	0	12	100%
Austin/San Antonio	44	0	44	100%
Lubbock	14	0	14	100%
Tyler/Longview	46	0	46	100%
Rio Grande Valley	22	0	22	100%
Total	**138**	**0**	**138**	**100%**

As in the previous section, the totals for each study area shown in Table 134 do not include survey stations that had 100 percent external local trips. Similar to the results found for non-commercial vehicles in Table 130, the results for data from combining non-commercial and commercial in Table 134 also showed all of the stations meeting the estimated sample size requirements. This is because the combined number of non-commercial and commercial surveys conducted at each survey station was much greater than the estimated sample size requirement in even the worst-case scenarios. These results also show that the combining of non-commercial and commercial data at external stations masks deficiencies in the survey process that may be occurring with the commercial data but not the non-commercial data.

Recommendations

The following recommendations are made:

1. The minimum sample size required of 50 commercial vehicles needs to be higher. There are many cases in each study area where this number of surveys was not sufficient in satisfying the estimated minimum sample size based on the proportion of external through/local trips. It is being recommended the minimum number of surveyed commercial vehicles be increased from 50 to 70 or 25 percent of the commercial vehicles that traverse the survey station during the time period vehicles are being surveyed.
2. The minimum sample size required of 300 for non-commercial vehicles could be lower. This number exceeds the estimated minimum sample size based on the proportion of external through/local trips. It is felt, however, that this large number of surveys for non-commercial vehicles is needed to provide a good spatial distribution of trip ends for external local trips traveling through the survey station. No change in the minimum number of surveyed non-commercial vehicles is recommended.
3. The existing practice of combining non-commercial and commercial trips for modeling at external stations may be improved if these trips are modeled separately. External through and external local trip data presented here show that the proportion of each of these trip types is different when comparing commercial and non-commercial vehicles. This difference in the proportion of external through and external-local trips for commercial and non-commercial vehicles could have significant impacts on the total external VMT.

EXTERNAL SURVEY ERROR ANALYSIS

Objective

Using results of Tasks 1 through 7, evaluate the extent survey estimates provided to travel demand models are impacted by the potential sources of error that were identified and develop recommendations for their mitigation.

Background

The purpose for external surveys is to obtain information on the movement of vehicles and people into, out of, and through urban areas in Texas. The information provided for use in travel demand models consist of the estimated percent of local and through movements for non-commercial and commercial vehicles for each external station. External local and through trip tables are developed that contain the station to station movements (through trips) and station to internal traffic analysis zone movements. These trip tables are used to develop trip length frequency distributions for use in the travel demand models.

Methodology

Task 1 through 7 evaluated a number of issues with respect to external surveys. One task (Task 3) was not done, and another (Task 4) was modified to deal with unexpected events concerning the continuation of external surveys. Tasks 1 and 2 dealt with the review of external survey practice outside Texas and current Texas practice. Tasks 4, 5, 6, and 7 addressed specific issues with external surveys that had the potential to impact the accuracy of the data provided for use in the travel demand models. The following sections present an evaluation of the results of these tasks in terms of the potential impact on data provided for use in the travel demand model. The discussion for Tasks 1 and 2 are combined.

Tasks 1 and 2 – Literature Review and Texas Practice

The literature review and comparison to Texas practice examined 10 areas. These included survey methodology, technology, survey design, sample size, survey conduct time, vehicle classification, survey geocoding, quality control and training, data entry and checks, and expansion of survey data. The following sections discuss each area.

Survey Methodology

External survey methods that were found in areas outside Texas included traditional intercept interview, postcard mail back, and license mail back. The methods varied depending on volume of traffic and in some instances, a combination of methods were used. Texas practice is for the most part intercept interview except for high volume locations where license plates are recorded and matched to estimate through movements. All areas surveyed both non-commercial and commercial vehicles and the majority of surveys were done in the outbound direction (same as done in Texas). The impact of the survey method on data provided for use in the travel demand model is related to the sample size. The use of postcard mail back and license mail back generally results in smaller sample sizes due to low response rates. Traditional intercept methods are considered the most accurate. The use of license recording and matching for estimating through movements appears to be fairly accurate, but no comparable examples were found outside of Texas.

Technology

Most external surveys outside Texas used a paper survey instrument with color coding variations for direction, time of day, and distinguishing between non-commercial and commercial surveys. In Texas, tablet personal computers have been used almost exclusively since 2002. Paper surveys provide one advantage in having a hard copy that can be reviewed later if necessary whereas the tablet personal computers have the advantage of the data being entered directly into a file structure with internal checking to ensure higher accuracy levels. Use of a paper survey instrument provides two opportunities for errors, one when the data are recorded and one when the data are entered into a computer file. The use of tablet personal computers for recording data reduces the opportunity for data input errors by 50 percent and has the additional advantage of incorporating internal data checks so the data can be corrected in the field.

The recording of license plates varied from the use of video camcorders to digital cameras to visual observation. High speed video camcorders are used in Texas and have proven reliable and accurate. The data are reduced using software designed for that purpose but the software does not automatically identify and record the license in a computer record. That is still done manually. The procedure used in Texas is considered state of the practice and has been found to be reasonably accurate.

With respect to technology, nothing was found in the research that indicates the procedures used in Texas have any negative impact on the data provided for input to the travel demand models.

Survey Design

The design of surveys used in external surveys was found to be consistent outside of Texas as well as consistent with those used in Texas. The data elements captured are basically the same. Since most external surveys are designed to capture information on movements into, out of, and through urban areas, this seems logical. The use of postcard surveys and mail back surveys are by nature of the medium constrained in the amount of information that can be obtained. However, the core elements of trip origin, destination, purpose, and occupancy are still collected. Nothing in the survey design was found to have a negative impact on the information provided for use in the travel demand models.

Survey Sample Size

Survey sample size by its very definition has the potential to impact the accuracy of the data provided for input to the travel demand models. Outside of Texas, it was found that sample sizes for external surveys typically were higher than required in Texas. The sample sizes were typically based on a 95 percent statistical confidence level with an error of ±5 to 10 percent. None of the sample size requirements for external surveys outside of Texas differentiated between non-commercial and commercial vehicles. Texas practice is to establish a minimum number of samples for both non-commercial and commercial vehicles at sites with an ADT of more than 1,000. The sample size calculations for external surveys outside Texas were based on the sample requirements for developing estimates of percents assuming the worst case scenario of 50 percent for the variance. This element was specifically evaluated during the course of this research, and the findings are presented in a later section.

Survey Conduct Times

Nearly all external surveys outside Texas were conducted during daylight hours on a Monday through Thursday or Tuesday through Thursday. This was consistent with Texas practice. The potential impact the survey conduct times may have on the data provided for use in the travel demand model is in how the data are expanded and how representative the data collected during daylight hours are of vehicle movement during the non-daylight hours. Both of these potential impacts are evaluated in a later section.

Vehicle Classification Counts

In all of the external surveys reviewed outside Texas, vehicle counts were done by classification. The classification groups used did vary. Current Texas practice is to have classification counts done in both directions in 15-minute increments. The classification system used is the Federal Highway Administration (FHWA) Scheme F. While this classification system has 13 classes identified, the current practice in Texas is to group the classes into two categories, non-commercial and commercial. There have been instances where discrepancies have been noted between the number of commercial vehicles and the number of commercial vehicles surveyed for certain periods of time. This issue was evaluated under Task 4 of this research and the findings are presented in a later section.

Survey Geocoding

Survey geocoding is the process of coding the origin or destination of a trip to the longitude and latitude of the location based on the address or location name given in the survey. The importance of this element is that the longitude and latitude are used to locate the origin or destination to the traffic analysis zone in the urban area. This information is used to develop the respective trip tables that are provided for use in the travel demand model. External surveys in and outside Texas ask for the address or nearest two intersecting streets for the location the trip originated and the location the trip is destined. These data are used to geocode the locations to longitude and latitude, which are then used to identify the transportation analysis zone for the location. Generally, a greater percentage of locations are successfully geocoded in Texas surveys as compared to external surveys outside Texas. It was found, however, that when the tablet personal computers were used to perform geocoding in the field that some problems were encountered. Difficulty was encountered with the skill and capability required to quickly navigate local and regional maps, writing in address information, overcoming the obstacle of glare on the tablet personal computers, and being able to get the computer screen close enough the driver could see the map and pin point the location (especially with large commercial vehicles). These difficulties made it problematic to complete the survey interview within the time frame required. It was recommended that vendors not be permitted to use interactive GIS maps for geocoding at the time of the interview.

Survey Quality Control and Training

It was found that external surveys outside Texas are similar to those in Texas in that all of the surveys included a pilot survey to test the survey procedures and train personnel. In addition, surveyors received classroom training prior to working in the field and in some cases, field manuals were developed for the surveyors. External surveys outside Texas were consistent with Texas practice.

The majority of surveys reviewed required a team or crew leader or supervisor at each site to oversee data collection, traffic conditions, and monitor surveyor performance. This is standard practice for surveys in Texas. There are some differences in the staffing of surveys in Texas. In some cases, staffing was mostly in-house with few local temporary personnel while in another case nearly all of the personnel were temporary local hires. In both cases, in-house personnel were used for project management and site supervisor roles. Use of trained experienced surveyors is felt to contribute to the quality and consistency of the data collected in external surveys.

External surveys in Texas differ significantly from external surveys outside Texas in the method used to select the survey vendor. Texas uses a bid specification that includes the detailed requirements the vendor must meet in implementing the survey including traffic control requirements, survey design, data formats, etc. External surveys outside Texas are typically done by vendors selected through a Request for Proposals (RFP) process. This process allows considerable flexibility in determining the survey preparation, design, conduct, and data delivery as a part of the contract negotiation process. These details are all specified in the bid specification in Texas. Texas' use of pre-determined file formats and data review processes provide good quality control in the external surveys. It was also found that one vendor in Texas rotated surveyors hourly providing them the opportunity to go back and edit the surveys and check the addresses and other information to ensure they were correct. More accurate data resulted from this procedure.

Requirements for quality control and training in Texas appear to exceed those in surveys outside Texas. These requirements appear to positively impact the quality of the data and information provided as input to the travel demand models.

Survey Data Entry and Checks

As stated previously, most external surveys outside Texas use a paper and pencil method for data collection that required a separate data entry step to input the data into a computer file for processing. In some, this entry is a dual entry system where two files are created and then compared to identify differences and potential errors. This process in Texas is accomplished at the time of the survey through the use of tablet personal computers for data collection. These are programmed to perform data checks at the time of entry to reduce the number of entry errors. External data submitted by vendors in Texas is also checked using custom programs prior to being accepted for payment. The procedures used in Texas are positive in terms of the data provided for input to the travel demand models.

Expansion of Survey Data

The expansion of external survey data has a direct impact on the information provided for input to the travel demand models. In surveys outside Texas, this expansion was done in two ways. One way, the survey data were expanded based on the 24-hour traffic counts at each site. In another way, the hourly survey data were expanded to the hourly volumes, and then the results were expanded to the 24-hour volumes at each site. Texas practice has been to expand the survey data using the 24-hour volumes at each site. Given the potential impact that this step has on the information provided for input to the travel demand models, it was specifically evaluated in this research and is discussed in more detail in a later section.

External Survey Vehicle Classification Counts

Vehicle classification counts are a core element of external surveys. These counts provide two key elements of data used in travel demand models, the percent split between non-commercial and commercial vehicles and the total non-commercial and commercial vehicles entering and leaving the study area. These counts are also the basis by which the external survey data are expanded at each site for both non-commercial and commercial vehicles. In previous external surveys, there have been instances where some discrepancies were noted between the number of commercial vehicle surveys obtained and the count of commercial vehicles at a site. These discrepancies consisted of the vendor obtaining more commercial vehicle surveys that were counted at the site for certain periods of time. It was hypothesized that one explanation for this was the automatic vehicle classifier (AVC) counters being used. The counters if set up incorrectly could produce erroneous counts for certain categories of vehicles.

To evaluate this possibility, an experiment was set up to have vehicle classification counts done at five different locations using AVC counters. At each site, video cameras were set up to record the traffic during the same time period. The data from the video cameras were reduced manually to determine the actual number of vehicles by classification and to determine the number of commercial vehicles that were being classified as pickups and vans.

While the total number of vehicles counted by the AVC counters was relatively accurate, the number of vehicles counted as non-commercial was low and the number of vehicles counted as commercial vehicles was high. If these results are typical for external surveys, the estimates of percentage non-commercial and commercial vehicles are incorrect. This impacts the estimates of external commercial and non-commercial vehicles and the related vehicle miles of travel being used in the travel demand models. To mitigate this possible error in future external surveys, it was recommended vendors be required to calibrate and document the calibration of the AVC counters used at each site and video tape vehicles in both directions at the site during the time the survey was being done. Vendors would be required to manually classify the vehicles by direction for the time period the surveys are done.

External Survey Directionality Evaluation

One of the key assumptions made in the conduct of external surveys is that it is not necessary to survey vehicles in both directions. Surveys are conducted on vehicles in the outbound direction (except at international border crossings), and it is assumed the vehicles in the inbound direction are a mirror image of those in the outbound direction. This research examined this assumption and evaluated it accuracy.

Travel surveys in Texas are typically done for areas referred to as survey regions. A survey region may include more than one major urban area as well as contain more than one Metropolitan Planning Organization study area. As a result, in those areas involving more than one MPO study area, the external surveys are done in a manner that allows data to be developed for each MPO study area independent of the other. This means that for those external stations shared by each MPO, the external surveys are done in both directions. The sites where external surveys were done in both directions were evaluated in this research to examine the issue of whether one direction was a mirror image of the other.

The measures evaluated as part of this research included total 24-hour inbound and outbound volume (non-commercial and commercial), inbound and outbound volume (non-commercial and commercial) for the time period the surveys were conducted, and the average trip length inbound and outbound (non-commercial and commercial). The results of this research indicated that the assumption of a mirror image in the opposite direction does not results in a significant loss in accuracy in terms of the percent of external local trips and average trip length.

External Survey Time of Day Evaluation

For external surveys in Texas, the standard practice is to expand the survey data using the 24-hour counts at each site. The surveys are conducted during daylight hours, typically 10 to 12 hours. Vehicles traveling through a site during the evening and early morning hours do not have the opportunity to participate in the survey. The assumption is made that the vehicle surveyed during daylight hours are representative of those that travel through a site the rest of the day. The sampling rate varies throughout the day due to the vendor using the same number of interviewers throughout the day. The rate varies depending on the volume of traffic through the site. Review of external surveys outside of Texas found some where the data were expanded by hour for the time period the surveys were conducted and then expanded to the 24-hour counts at the site.

To examine this question, 10 sites were randomly selected from two recent external surveys. The data at each site were expanded hourly for the time period surveys were conducted and then expanded to the 24-hour counts at each site. The data were also expanded to the 24-hour counts as is normally done in Texas surveys. The results of the two expansion methods were compared to ascertain any difference. The data elements examined were estimates of external local, external through, and average trip lengths for non-commercial and commercial vehicles. The findings of this research indicate the development of these estimates using time of day vehicle counts would not yield a significant difference in the estimates obtained from expanding the aggregate survey data using 24-hour vehicle counts.

External Survey Sample Sizes

Current Texas practice establishes a minimum sample of 300 usable surveys for non-commercial vehicles and 50 usable surveys for commercial vehicles at sites have 1,000 or more vehicles a day in the direction being surveyed. Sites with less than 1,000 vehicles per day have no minimum sample size but the vendor is expected to survey as many as possible during daylight hours. In the review of external surveys outside Texas, it was found the survey design required sample sizes typically much larger than those used in Texas surveys. Data from surveys done in Texas were examined to determine if the samples were sufficient statistically. These were evaluated for non-commercial and commercial vehicles, specifically the estimates of percent external-local and external-through movements.

Using a confidence level of 90 percent and a desired error of ±10 percent, sampling requirements were developed for five urban areas for external stations stratified by volume and functional class for non-commercial and commercial vehicles. These sample sizes were compared against the number of samples obtained at the sites. All of the sites met and exceeded the sample requirements for non-commercial vehicles. Most of the sites met the sample size requirements for commercial vehicles. It was noted, however, that the minimum sample requirement for commercial vehicles in the current bid specifications was not sufficient and should be increased. It was recommended the minimum sample size for commercial vehicles be increased to 70 or 25 percent of the commercial vehicles traversing the site during the hours surveys were conducted. The minimum sample requirement for non-commercial vehicles was found to be more than adequate.

Summary and Recommendations

This task has examined the results of other research tasks to determine what if any impact the findings may have on the data provided for input to the travel demand models. This research has found a number of elements where the current practice has the potential to impact data being provided for use in travel demand models. Recommended changes to current practice in external surveys to mitigate these areas are as follow:

1. Require all vehicle classification counts be in 15-minute increments classified using the Federal Highway Administration (FHWA) Scheme F. These count data should be submitted in Excel.
2. Require vendors use tablet personal computers as primary means for conducting external intercept surveys with paper surveys to be used as backup.
3. Require vendor maintain log of the number of surveyors being utilized to conduct surveys by hour throughout the course of the survey and provide these data to TxDOT with the name of the site supervisor for each hour.
4. Prohibit the external survey project manager from serving as site supervisor on a full time basis. The project manager may serve temporarily to relieve a site supervisor.
5. Prohibit the use of interactive GIS maps for geocoding at the time of interview in intercept surveys unless it can be demonstrated to TxDOT's satisfaction the interviews can be done within the time frame allowed and addressed the concerns found in the research with this type of geocoding.
6. Require vendors to calibrate AVC counters used at external survey sites and provide documentation to TxDOT on the calibration.
7. Require vendors to video tape vehicles in both directions at external surveys during the time the surveys are conducted and manually classify the vehicles at the site by hour for the time period the surveys are conducted. Include in the classification the number of commercial vehicles classified as pickup trucks and vans.
8. Establish the minimum number of usable commercial vehicle surveys at each intercept external survey as 70 or 25 percent of the commercial vehicles traversing the site in the direction being surveyed for the time period surveys are conducted.

SUMMARY AND RECOMMENDATIONS

This research has examined a number of aspects of household and external travel surveys. It has included a review of the practice of these surveys outside Texas and how Texas practice compares relative to a number of measures. There were five objectives at the beginning of this research. Four of those were achieved and the one not achieved was due to circumstances involving the internal review of bid specifications and delays in the implementation of scheduled surveys. It is anticipated that as the bid specifications are finalized and surveys begin to be let for data collection a number of the recommendations from this research will be implemented. The following sections present brief summaries and the recommendations for household and external surveys. All of the recommendations may be accommodated by revising Attachment A-Special Requirements in the survey bid specifications.

Household Surveys

This research has found that household surveys as practiced in Texas are comparable to those done in other parts of the nation. Areas examined in this research included household participation, sampling frames, non-response, incentives, weighting and expansion of survey data, survey techniques, quality control, and survey geocoding. In-depth examination and analyses using survey data from Texas were done in evaluating the household survey sampling frame, non-response in household surveys, and proxy reporting in household surveys. The following recommendations are made for household surveys in Texas.

- Vendors should be required to document how the sample of households is selected and the randomness of the procedure maintained. Specifically, the documentation should include how cell phones are handled in the recruitment and data retrieval phases.
- Vendors should be required to document the disposition of all phone calls in the recruitment and retrieval phases and provide a computation of the response rate for the household survey.
- Vendors should be encouraged to use mixed modes for household recruitment and data retrieval. Mixed modes that should be considered include telephone, mail, and internet.
- Vendors should be required to incorporate into the survey design and execution a follow-up survey directed at households that have refused to participate and households that could not be contacted by phone. The method for this survey is mail based recruitment with data retrieval subject to the method best suited to the

participants. This recommendation may be done on an experimental basis initially with a follow-up evaluation to assess the benefits versus the costs involved.

- Vendors should be allowed to have proxy reporting for all minors in a household. Minors are defined as individuals under the age of 16. Proxy reporting for persons over the age of 15 should be limited to not exceed 20 percent of those individuals participating in the household survey.
- Analysis of household surveys should be expanded to include an evaluation of the trips per person for individuals being represented by proxy versus individuals responding personally. The results of that evaluation should be incorporated into the development of recommended trip production rates for use in travel demand models.
- Additional research is recommended to examine the feasibility of combining un-weighted household surveys from different areas and using the combined data to develop representative household trip rates for urban areas that do not have a household survey.

External Surveys

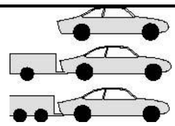
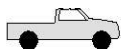
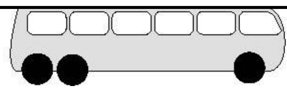
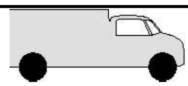
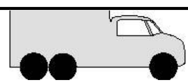
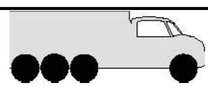
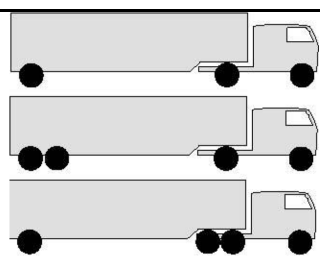
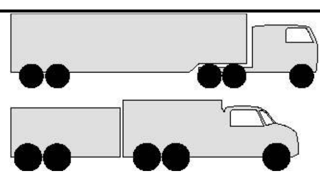
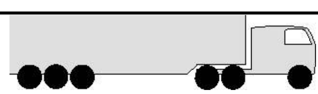
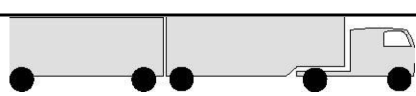
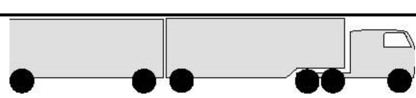
This research has found that external surveys as practiced in Texas are comparable to those executed in other parts of the nation. Areas examined in this research included survey methodology, technology, survey design, survey sample size, survey conduct times, vehicle classification counts, survey geocoding, survey quality control and training, survey data entry and checks, and the expansion of the survey data. The following recommendations are made for external surveys in Texas.

- Vendors should be required to provide all vehicle classifications counts by direction in 15-minute increments using the FHWA Scheme F for classifying vehicles. All data should be submitted in Excel files.
- Vendors should be required to use tablet personal computers as the primary means for conducting roadside intercept surveys with paper surveys available as a backup.
- Vendors should be required to maintain a log for each external survey that documents the number of interviewers being used and the name of the on-site supervisor for each hour the survey is in progress.
- Vendors should be prohibited from using the project manager as a site supervisor on a full time basis. The project supervisor can be allowed to serve as site supervisor in a temporary relief capacity.
- Vendors should be prohibited from using interactive GIS maps for geocoding at the time of interview unless it can be shown to TxDOT‘s satisfaction that the geocoding can be achieved within the time frame of the survey and the technical capability to accomplish the geocoding is possessed by all the vendor‘s surveyors.
- Vendors should be required to calibrate the AVC counters being used at all external survey sites and provide documentation of same.

- Vendors should be required to video tape vehicles in both directions passing through the survey site, manually classified the vehicles by hour for the time period surveys are conducted, and provide the data including video tapes to TxDOT as part of the requirements for each external station surveyed.
- The minimum sample requirement for commercial vehicles at external stations should be 70 useable commercial vehicle surveys or 25 percent of the commercial vehicles traversing the survey site during the time period the surveys are conducted. This minimum should be set for usable commercial vehicle surveys.

APPENDIX A

Table A-1. Illustration of Select FHWA F2 Vehicle Classification Combinations.

Class		Description	Axles
1		Motorcycles	2
2		Cars & SUVs (also with 1 or 2-axle trailer)	2, 3 or 4
3		Pickups & Vans (also with 1, 2 , or 3-axle trailer)	2, 3, 4 or 5
4		2 or 3-axle Bus or RV	2 or 3
5		2-axle rigid truck	2
6		3-axle rigid truck	3
7		4+ axle rigid truck	4 or more
8		Tractor trailer with 3 or 4 axles	3 or 4
9		Tractor trailer with 5 axles	5
10		Tractor trailer with 6 axles	6
11		Tractor multi trailer with 4 or 5 axles	4 or 5
12		Tractor multi trailer with 6 axles	6
13	ANY 7 OR MORE AXLE	Tractor multi trailer with 7 or more axles	7 or more

Adapted from: http://www.sarasota-manateempo.org/Figures/figure1.pdf

Table A-2. Site 1 Northbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	VEHICLE COUNT TOTALS (AVC/VIDEO)	
7:00:01 AM	7:15:00 AM		36 / 46	15 / 14	0 / 3	4 / 3			1 / 0						56 / 66	**85%**
7:15:01 AM	7:30:00 AM	1 / 1	44 / 40	25 / 27	6 / 2	7 / 6	1 / 1								84 / 77	**109%**
7:30:01 AM	7:45:00 AM	1 / 1	50 / 56	18 / 26	3 / 3	8 / 4			2 / 0						82 / 90	**91%**
7:45:01 AM	8:00:00 AM		59 / 73	19 / 14	1 / 3	3 / 0			3 / 1						85 / 91	**93%**
8:00:01 AM	8:15:00 AM	0 / 1	43 / 50	31 / 28	5 / 3	5 / 3	0 / 1		2 / 0	3 / 3					89 / 89	**100%**
8:15:01 AM	8:30:00 AM		27 / 39	29 / 23	6 / 4	9 / 12			3 / 1	2 / 2					76 / 81	**94%**
8:30:01 AM	8:45:00 AM	1 / 0	42 / 39	21 / 20	5 / 3	7 / 6	1 / 1		1 / 0	2 / 3					80 / 72	**111%**
8:45:01 AM	9:00:00 AM		28 / 33	21 / 23	6 / 4	6 / 4			3 / 0	1 / 2					65 / 66	**98%**
9:00:01 AM	9:15:00 AM		28 / 33	25 / 22	1 / 2	6 / 4	2 / 1		4 / 0	2 / 4					68 / 66	**103%**
9:15:01 AM	9:30:00 AM		26 / 30	17 / 20	9 / 5	8 / 7			1 / 0	1 / 0					62 / 62	**100%**
9:30:01 AM	9:45:00 AM		31 / 37	26 / 25	1 / 2	7 / 3									65 / 67	**97%**
9:45:01 AM	10:00:00 AM		29 / 35	26 / 25	2 / 1	7 / 2			1 / 0	1 / 1					66 / 64	**103%**
10:00:01 AM	10:15:00 AM		13 / 12	20 / 23	2 / 1	5 / 4	1 / 1		1 / 1	3 / 3					45 / 45	**100%**
10:15:01 AM	10:30:00 AM		31 / 37	21 / 25	6 / 4	7 / 2	2 / 2		1 / 1	1 / 1					69 / 72	**96%**
10:30:01 AM	10:45:00 AM		28 / 32	22 / 25	6 / 0	9 / 8	1 / 1		2 / 0	3 / 3					71 / 69	**103%**
10:45:01 AM	11:00:00 AM		30 / 27	19 / 33	8 / 2	6 / 5			2 / 1	0 / 1					65 / 69	**94%**
11:00:01 AM	11:15:00 AM	1 / 0	36 / 43	28 / 33	4 / 0	8 / 7	1 / 1		6 / 1	1 / 3					85 / 88	**97%**
11:15:01 AM	11:30:00 AM		49 / 50	36 / 36	8 / 4	8 / 5			2 / 1	3 / 3					106 / 99	**107%**
11:30:01 AM	11:45:00 AM		49 / 49	30 / 35	3 / 1	5 / 3	1 / 1		3 / 2	1 / 1					92 / 92	**100%**
11:45:01 AM	12:00:00 PM	1 / 1	51 / 66	33 / 26	4 / 3	5 / 7			3 / 1	1 / 1					98 / 105	**93%**
12:00:01 PM	12:15:00 PM	1 / 1	82 / 84	35 / 41	7 / 0	9 / 6			1 / 0	2 / 2					137 / 134	**102%**
12:15:01 PM	12:30:00 PM		68 / 68	26 / 30	6 / 5	6 / 1			2 / 0						108 / 104	**104%**
12:30:01 PM	12:45:00 PM		51 / 56	31 / 29	3 / 1	8 / 5	2 / 2		3 / 1	2 / 2					100 / 96	**104%**
12:45:01 PM	1:00:00 PM	2 / 1	67 / 71	22 / 20	3 / 1	4 / 3				2 / 2					100 / 98	**102%**
1:00:01 PM	1:15:00 PM		52 / 58	32 / 35	2 / 1	10 / 3			2 / 0	1 / 1					99 / 98	**101%**
1:15:01 PM	1:30:00 PM		54 / 65	26 / 24	9 / 4	10 / 6			1 / 1	3 / 4					103 / 104	**99%**
1:30:01 PM	1:45:00 PM		53 / 52	29 / 32	6 / 1	6 / 8	1 / 1		2 / 1	1 / 1					98 / 96	**102%**
1:45:01 PM	2:00:00 PM	1 / 0	37 / 43	32 / 28	1 / 2	8 / 7			1 / 0	5 / 6					85 / 86	**99%**
2:00:01 PM	2:15:00 PM		56 / 54	22 / 24	6 / 4	5 / 6	1 / 1		2 / 1	3 / 3					95 / 93	**102%**
2:15:01 PM	2:30:00 PM		45 / 48	32 / 35	6 / 2	8 / 5			1 / 0	1 / 2					93 / 92	**101%**
2:30:01 PM	2:45:00 PM		32 / 38	14 / 19	7 / 4	7 / 5			2 / 1	1 / 1					63 / 68	**93%**
2:45:01 PM	3:00:00 PM		44 / 44	22 / 21	8 / 3	6 / 7	1 / 1		4 / 0	2 / 2					87 / 78	**112%**
3:00:01 PM	3:15:00 PM	1 / 1	67 / 81	35 / 42	6 / 3	9 / 4			4 / 1	1 / 2					123 / 134	**92%**
3:15:01 PM	3:30:00 PM		53 / 55	22 / 21	5 / 3	4 / 4			2 / 1	3 / 3					89 / 87	**102%**
3:30:01 PM	3:45:00 PM		60 / 68	30 / 38	6 / 4	9 / 1		1 / 0	6 / 0	1 / 2					113 / 113	**100%**
3:45:01 PM	4:00:00 PM		50 / 57	28 / 31	6 / 4	6 / 2	1 / 1		5 / 3	1 / 1		1 / 0			98 / 99	**99%**
4:00:01 PM	4:15:00 PM		68 / 87	29 / 31	5 / 4	6 / 6			4 / 0	3 / 3					115 / 131	**88%**
4:15:01 PM	4:30:00 PM	1 / 1	55 / 66	26 / 25	11 / 5	3 / 2			6 / 2	3 / 3					105 / 104	**101%**
4:30:01 PM	4:45:00 PM		83 / 102	37 / 37	2 / 3	5 / 2	1 / 1		6 / 1	2 / 2					136 / 148	**92%**
4:45:01 PM	5:00:00 PM		78 / 78	21 / 24	4 / 4	6 / 3			4 / 0	2 / 2					115 / 111	**104%**
5:00:01 PM	5:15:00 PM	1 / 0	121 / 144	40 / 46	6 / 5	2 / 3			5 / 0						175 / 198	**88%**
5:15:01 PM	5:30:00 PM	0 / 1	92 / 90	31 / 27	8 / 4	4 / 2			4 / 1	3 / 3					142 / 128	**111%**
5:30:01 PM	5:45:00 PM		89 / 110	26 / 30	2 / 4	5 / 3			7 / 3	1 / 1					130 / 151	**86%**
5:45:01 PM	6:00:00 PM		63 / 68	25 / 19	6 / 5	6 / 3			2 / 0	1 / 1					103 / 96	**107%**
6:00:01 PM	6:15:00 PM		64 / 78	17 / 18	4 / 5	3 / 2			3 / 0						91 / 103	**88%**
6:15:01 PM	6:30:00 PM	0 / 1	43 / 36	16 / 19	3 / 2	4 / 1			1 / 0						67 / 59	**114%**
6:30:01 PM	6:45:00 PM		27 / 34	14 / 14	5 / 5	1 / 0			2 / 0						49 / 53	**92%**
6:45:01 PM	7:00:00 PM	1 / 1	18 / 18	11 / 9	1 / 1	1 / 0			1 / 0						33 / 29	**114%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		13 / 11	2402 / 2680	1213 / 1272	230 / 139	291 / 195	17 / 17	1 / 0	124 / 27	69 / 80		1 / 0			4361 / 4421	**99%**
		118%	**90%**	**95%**	**165%**	**149%**	**100%**	**#DIV/0!**	**459%**	**86%**		**#DIV/0!**			**99%**	

Table A-3. Site 1 Southbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	VEHICLE COUNT TOTALS (AVC/VIDEO)	
7:00:01 AM	7:15:00 AM	1 / 1	110 / 113	50 / 54	3 / 2	11 / 5			3 / 2						178 / 177	**101%**
7:15:01 AM	7:30:00 AM	2 / 2	158 / 174	32 / 46	11 / 6	9 / 4			7 / 0						219 / 232	**94%**
7:30:01 AM	7:45:00 AM		173 / 182	41 / 52	6 / 4	4 / 4			7 / 0	1 / 1		1 / 0			233 / 243	**96%**
7:45:01 AM	8:00:00 AM	0 / 1	163 / 179	49 / 57	12 / 5	10 / 4	0 / 1	1 / 0	6 / 0	0 / 4					241 / 251	**96%**
8:00:01 AM	8:15:00 AM		146 / 167	55 / 75	8 / 3	15 / 6			8 / 0	1 / 1		1 / 0		1 / 0	235 / 252	**93%**
8:15:01 AM	8:30:00 AM	3 / 2	122 / 132	45 / 51	5 / 3	13 / 12	1 / 1		5 / 0	2 / 3					196 / 204	**96%**
8:30:01 AM	8:45:00 AM	0 / 1	109 / 114	33 / 40	6 / 4	11 / 4			1 / 0	4 / 5			1 / 0		165 / 168	**98%**
8:45:01 AM	9:00:00 AM		104 / 108	31 / 47	4 / 1	15 / 4			7 / 0	5 / 9					166 / 169	**98%**
9:00:01 AM	9:15:00 AM		68 / 69	23 / 32	5 / 5	8 / 4			4 / 0						108 / 110	**98%**
9:15:01 AM	9:30:00 AM		59 / 57	29 / 35	3 / 1	7 / 6			2 / 0	2 / 3					102 / 102	**100%**
9:30:01 AM	9:45:00 AM		40 / 44	29 / 35	4 / 2	10 / 6			3 / 1	2 / 3					88 / 91	**97%**
9:45:01 AM	10:00:00 AM		40 / 34	26 / 40	2 / 3	10 / 2	2 / 2		3 / 1	2 / 3					85 / 85	**100%**
10:00:01 AM	10:15:00 AM		36 / 36	28 / 30	4 / 3	5 / 4			2 / 1	2 / 3					77 / 77	**100%**
10:15:01 AM	10:30:00 AM		34 / 34	23 / 29	5 / 0	11 / 12			3 / 2	2 / 2					78 / 79	**99%**
10:30:01 AM	10:45:00 AM		47 / 44	19 / 26	3 / 3	5 / 3			5 / 1	3 / 4					82 / 81	**101%**
10:45:01 AM	11:00:00 AM		48 / 54	27 / 31	2 / 0	10 / 4			2 / 0	2 / 4					91 / 93	**98%**
11:00:01 AM	11:15:00 AM	1 / 1	40 / 41	24 / 31	6 / 4	7 / 4			3 / 2	2 / 2					83 / 85	**98%**
11:15:01 AM	11:30:00 AM		51 / 47	23 / 27	1 / 0	7 / 8			3 / 2	1 / 1					86 / 85	**101%**
11:30:01 AM	11:45:00 AM	1 / 1	58 / 61	32 / 35	5 / 3	8 / 7			3 / 1	4 / 4					111 / 112	**99%**
11:45:01 AM	12:00:00 PM		62 / 67	33 / 31	3 / 0	8 / 8				3 / 3					109 / 109	**100%**
12:00:01 PM	12:15:00 PM		58 / 61	36 / 39	5 / 4	11 / 6	1 / 1		1 / 1	2 / 2					114 / 114	**100%**
12:15:01 PM	12:30:00 PM	2 / 2	69 / 71	30 / 35		5 / 1	1 / 1		2 / 1	4 / 4					113 / 115	**98%**
12:30:01 PM	12:45:00 PM		57 / 66	25 / 24	8 / 2	7 / 10	1 / 1		3 / 0	2 / 2					103 / 105	**98%**
12:45:01 PM	1:00:00 PM		77 / 86	26 / 42	7 / 2	11 / 5			7 / 0	1 / 2			1 / 0		130 / 137	**95%**
1:00:01 PM	1:15:00 PM		70 / 81	38 / 44	7 / 3	10 / 7			9 / 3						134 / 138	**97%**
1:15:01 PM	1:30:00 PM		60 / 68	34 / 37	1 / 1	3 / 1	1 / 1		2 / 0	1 / 1					102 / 109	**94%**
1:30:01 PM	1:45:00 PM		51 / 59	32 / 37	6 / 3	1 / 5			7 / 0		1 / 1				98 / 105	**93%**
1:45:01 PM	2:00:00 PM		56 / 57	14 / 24	1 / 0	10 / 3			5 / 3	1 / 1					87 / 88	**99%**
2:00:01 PM	2:15:00 PM		54 / 60	24 / 30	9 / 4	11 / 11			4 / 2	1 / 2		1 / 0			104 / 109	**95%**
2:15:01 PM	2:30:00 PM		55 / 61	22 / 29	2 / 2	7 / 3	1 / 1		1 / 1	1 / 1		1 / 0			90 / 98	**92%**
2:30:01 PM	2:45:00 PM		52 / 49	27 / 30	6 / 5	1 / 3	1 / 1		1 / 0	2 / 2					90 / 90	**100%**
2:45:01 PM	3:00:00 PM		57 / 55	23 / 40	3 / 2	9 / 5			5 / 0	2 / 3					99 / 105	**94%**
3:00:01 PM	3:15:00 PM		40 / 46	27 / 25	7 / 6	7 / 5			1 / 1	4 / 4					86 / 87	**99%**
3:15:01 PM	3:30:00 PM		56 / 59	24 / 26	2 / 2	9 / 5									91 / 92	**99%**
3:30:01 PM	3:45:00 PM	1 / 1	70 / 76	20 / 28	7 / 4	7 / 6			3 / 0			1 / 0			109 / 115	**95%**
3:45:01 PM	4:00:00 PM		67 / 73	21 / 26	6 / 4	6 / 6			5 / 0	0 / 1					105 / 110	**95%**
4:00:01 PM	4:15:00 PM	1 / 1	60 / 69	20 / 20	4 / 3	3 / 6			4 / 1			1 / 0			93 / 100	**93%**
4:15:01 PM	4:30:00 PM	1 / 1	57 / 61	24 / 33	3 / 4	5 / 1			6 / 1						96 / 101	**95%**
4:30:01 PM	4:45:00 PM		78 / 81	18 / 28	3 / 2	4 / 2			4 / 0			1 / 0			108 / 113	**96%**
4:45:01 PM	5:00:00 PM	1 / 1	60 / 71	22 / 26	8 / 3	4 / 4			4 / 2	0 / 1		1 / 0			100 / 108	**93%**
5:00:01 PM	5:15:00 PM	0 / 2	81 / 91	26 / 32	5 / 4	8 / 4	1 / 1		2 / 0			1 / 0			124 / 134	**93%**
5:15:01 PM	5:30:00 PM		79 / 84	26 / 28	3 / 3	4 / 3			3 / 0	1 / 1					116 / 119	**97%**
5:30:01 PM	5:45:00 PM	1 / 1	64 / 72	17 / 17	2 / 2				1 / 0						85 / 92	**92%**
5:45:01 PM	6:00:00 PM		68 / 76	21 / 17	3 / 3	2 / 2			2 / 0	1 / 2					97 / 100	**97%**
6:00:01 PM	6:15:00 PM		37 / 37	11 / 12	1 / 1	1 / 1									50 / 51	**98%**
6:15:01 PM	6:30:00 PM		43 / 51	17 / 15	4 / 4	3 / 0			2 / 1	1 / 1					70 / 72	**97%**
6:30:01 PM	6:45:00 PM		26 / 29	9 / 8	4 / 3	0 / 2									39 / 42	**93%**
6:45:01 PM	7:00:00 PM	1 / 1	36 / 37	6 / 7	2 / 3	1 / 0			1 / 0						47 / 48	**98%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		16 / 19	3306 / 3544	1292 / 1563	217 / 131	334 / 218	10 / 11	1 / 0	162 / 30	62 / 85	1 / 1	9 / 0	2 / 0	1 / 0	5413 / 5602	**97%**
		84%	**93%**	**83%**	**166%**	**153%**	**91%**	**#DIV/0!**	**540%**	**73%**	**100%**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**97%**	

Table A-4. Site 2 Eastbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM		21 / 41	14 / 33	4 / 0	15 / 4	1 / 2	0 / 1	2 / 0	1 / 2					58 / 83	**70%**
7:15:01 AM	7:30:00 AM	1 / 0	20 / 44	30 / 50	5 / 0	21 / 8	0 / 1		1 / 0	1 / 2					79 / 105	**75%**
7:30:01 AM	7:45:00 AM		37 / 54	13 / 32	4 / 0	18 / 6			3 / 0	1 / 1					76 / 93	**82%**
7:45:01 AM	8:00:00 AM	2 / 0	34 / 54	17 / 26	7 / 0	16 / 11	0 / 2		1 / 0	1 / 2					78 / 95	**82%**
8:00:01 AM	8:15:00 AM		24 / 45	22 / 49	6 / 0	22 / 7	1 / 1		5 / 1	1 / 3					81 / 106	**76%**
8:15:01 AM	8:30:00 AM	1 / 0	16 / 35	17 / 41	2 / 0	14 / 7	0 / 2		5 / 0	3 / 5					58 / 90	**64%**
8:30:01 AM	8:45:00 AM		26 / 46	30 / 34	4 / 0	17 / 7			3 / 2						80 / 89	**90%**
8:45:01 AM	9:00:00 AM		15 / 37	18 / 30	2 / 0	13 / 12	1 / 1		1 / 0						50 / 80	**63%**
9:00:01 AM	9:15:00 AM		16 / 26	20 / 40	1 / 1	18 / 3				1 / 1					56 / 71	**79%**
9:15:01 AM	9:30:00 AM	1 / 0	18 / 24	16 / 33	4 / 0	14 / 5	0 / 2		2 / 0	1 / 2					56 / 66	**85%**
9:30:01 AM	9:45:00 AM		13 / 27	15 / 33	3 / 0	11 / 6			2 / 1						44 / 67	**66%**
9:45:01 AM	10:00:00 AM		16 / 35	28 / 35	2 / 0	20 / 3			1 / 1	0 / 2					67 / 76	**88%**
10:00:01 AM	10:15:00 AM		14 / 32	20 / 27	5 / 0	7 / 3			1 / 1	3 / 2					50 / 65	**77%**
10:15:01 AM	10:30:00 AM	1 / 0	3 / 19	21 / 33	1 / 0	22 / 2	0 / 1			2 / 2					50 / 57	**88%**
10:30:01 AM	10:45:00 AM	2 / 0	16 / 26	24 / 31	6 / 0	15 / 6	1 / 1		3 / 2	0 / 2					67 / 68	**99%**
10:45:01 AM	11:00:00 AM		13 / 32	19 / 33	3 / 0	19 / 3			0 / 1						54 / 69	**78%**
11:00:01 AM	11:15:00 AM	2 / 1	19 / 39	22 / 42	1 / 0	23 / 4	2 / 2	1 / 0	0 / 1	1 / 2					71 / 91	**78%**
11:15:01 AM	11:30:00 AM		21 / 43	27 / 34	5 / 0	22 / 3		0 / 1	1 / 1	2 / 0		0 / 2			78 / 84	**93%**
11:30:01 AM	11:45:00 AM		20 / 51	21 / 53	3 / 0	31 / 6			5 / 1	0 / 1					80 / 112	**71%**
11:45:01 AM	12:00:00 PM	1 / 0	24 / 46	27 / 38	2 / 0	24 / 4	0 / 1		1 / 0	0 / 1					79 / 90	**88%**
12:00:01 PM	12:15:00 PM		19 / 51	25 / 48	1 / 0	21 / 2	1 / 1		1 / 0	0 / 1					68 / 103	**66%**
12:15:01 PM	12:30:00 PM		25 / 45	26 / 42	1 / 0	34 / 2			1 / 0	0 / 1					87 / 90	**97%**
12:30:01 PM	12:45:00 PM		22 / 47	17 / 33	1 / 0	8 / 1			3 / 1						51 / 82	**62%**
12:45:01 PM	1:00:00 PM		16 / 36	19 / 25		14 / 2	0 / 1		1 / 1	1 / 1					51 / 66	**77%**
1:00:01 PM	1:15:00 PM		19 / 49	25 / 43	4 / 0	23 / 2			2 / 0	2 / 2					75 / 96	**78%**
1:15:01 PM	1:30:00 PM		12 / 30	18 / 39	3 / 0	20 / 5		0 / 1	1 / 0	1 / 1					55 / 76	**72%**
1:30:01 PM	1:45:00 PM	1 / 0	20 / 35	19 / 22	2 / 0	11 / 6		0 / 1	0 / 1	2 / 2					55 / 67	**82%**
1:45:01 PM	2:00:00 PM	0 / 1	13 / 35	17 / 21	1 / 0	17 / 1									48 / 58	**83%**
2:00:01 PM	2:15:00 PM		19 / 32	22 / 43		18 / 4			4 / 2	1 / 1					64 / 82	**78%**
2:15:01 PM	2:30:00 PM		13 / 36	22 / 34		20 / 1	0 / 1		3 / 2	2 / 3					60 / 77	**78%**
2:30:01 PM	2:45:00 PM		22 / 44	25 / 32	3 / 0	25 / 13	1 / 1		3 / 1	1 / 1					80 / 92	**87%**
2:45:01 PM	3:00:00 PM	1 / 1	15 / 28	11 / 25	2 / 0	13 / 8	0 / 1								42 / 63	**67%**
3:00:01 PM	3:15:00 PM	2 / 1	13 / 33	20 / 31	3 / 0	17 / 3		0 / 1	1 / 1						56 / 70	**80%**
3:15:01 PM	3:30:00 PM		15 / 33	17 / 32	1 / 0	16 / 6									49 / 71	**69%**
3:30:01 PM	3:45:00 PM		14 / 38	18 / 34	2 / 0	14 / 2	0 / 2		2 / 0	0 / 1					50 / 77	**65%**
3:45:01 PM	4:00:00 PM	0 / 1	18 / 33	13 / 24	3 / 0	10 / 1			0 / 1						44 / 60	**73%**
4:00:01 PM	4:15:00 PM		24 / 64	30 / 37	1 / 0	19 / 1	0 / 1		2 / 0						76 / 103	**74%**
4:15:01 PM	4:30:00 PM		22 / 40	14 / 20		11 / 2									47 / 62	**76%**
4:30:01 PM	4:45:00 PM		34 / 59	25 / 42	1 / 0	14 / 1			1 / 0						75 / 102	**74%**
4:45:01 PM	5:00:00 PM	0 / 1	31 / 54	19 / 34		18 / 1									68 / 90	**76%**
5:00:01 PM	5:15:00 PM	2 / 1	42 / 74	36 / 49	1 / 0	22 / 2									103 / 126	**82%**
5:15:01 PM	5:30:00 PM		22 / 69	27 / 37	2 / 0	19 / 0			1 / 1						71 / 107	**66%**
5:30:01 PM	5:45:00 PM	0 / 2	22 / 39	17 / 22		8 / 1			2 / 0						49 / 64	**77%**
5:45:01 PM	6:00:00 PM	1 / 1	22 / 39	22 / 20		6 / 0									51 / 60	**85%**
6:00:01 PM	6:15:00 PM	0 / 1	17 / 45	17 / 16		7 / 1									41 / 63	**65%**
6:15:01 PM	6:30:00 PM		14 / 37	18 / 14		9 / 2									41 / 53	**77%**
6:30:01 PM	6:45:00 PM		19 / 28	7 / 8		11 / 1									37 / 37	**100%**
6:45:01 PM	7:00:00 PM		7 / 21	9 / 17		10 / 0									26 / 38	**68%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		18 / 11	937 / 1930	976 / 1571	102 / 1	797 / 181	8 / 24	1 / 5	65 / 23	28 / 44		0 / 2			2932 / 3792	**77%**
		164%	**49%**	**62%**	**10200%**	**440%**	**33%**	**20%**	**283%**	**64%**		**0%**			**77%**	

Table A-5. Site 2 Westbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM	1 / 1	30 / 31	30 / 38		8 / 2			1 / 0						70 / 72	**97%**
7:15:01 AM	7:30:00 AM		40 / 42	24 / 33	1 / 0	10 / 1	1 / 1		2 / 1						78 / 78	**100%**
7:30:01 AM	7:45:00 AM	1 / 1	53 / 52	27 / 34	2 / 0	8 / 4				1 / 1					92 / 92	**100%**
7:45:01 AM	8:00:00 AM	1 / 1	51 / 54	21 / 21	3 / 0	5 / 5									81 / 81	**100%**
8:00:01 AM	8:15:00 AM		39 / 37	18 / 30	6 / 1	11 / 6	0 / 1		3 / 2						77 / 77	**100%**
8:15:01 AM	8:30:00 AM	1 / 1	41 / 44	27 / 36	3 / 0	12 / 4	0 / 1			3 / 3					87 / 89	**98%**
8:30:01 AM	8:45:00 AM	2 / 2	46 / 45	22 / 39	1 / 0	13 / 4			6 / 0	1 / 2					91 / 92	**99%**
8:45:01 AM	9:00:00 AM		49 / 54	25 / 25	1 / 0	9 / 3	0 / 1			1 / 1					85 / 84	**101%**
9:00:01 AM	9:15:00 AM	1 / 1	50 / 55	32 / 35		9 / 4			2 / 1						94 / 96	**98%**
9:15:01 AM	9:30:00 AM		25 / 29	20 / 26	1 / 0	11 / 1	0 / 1								57 / 57	**100%**
9:30:01 AM	9:45:00 AM		34 / 34	21 / 31	4 / 0	12 / 4	0 / 1			1 / 1					72 / 71	**101%**
9:45:01 AM	10:00:00 AM		29 / 29	27 / 37	2 / 0	10 / 2			3 / 1	0 / 1					71 / 70	**101%**
10:00:01 AM	10:15:00 AM		29 / 29	31 / 41	1 / 0	12 / 2	1 / 2			2 / 2					76 / 76	**100%**
10:15:01 AM	10:30:00 AM		26 / 28	24 / 23	2 / 0	5 / 3			1 / 1	2 / 2					60 / 57	**105%**
10:30:01 AM	10:45:00 AM		26 / 25	20 / 35	7 / 0	13 / 6			5 / 4	1 / 1					72 / 71	**101%**
10:45:01 AM	11:00:00 AM		33 / 31	17 / 30	1 / 0	10 / 2	0 / 1	0 / 1	3 / 1	1 / 1					65 / 67	**97%**
11:00:01 AM	11:15:00 AM		34 / 29	14 / 25	4 / 0	7 / 2	0 / 1		1 / 0	1 / 1					61 / 58	**105%**
11:15:01 AM	11:30:00 AM		35 / 36	37 / 44	2 / 0	8 / 5	0 / 1		4 / 1	2 / 2					88 / 89	**99%**
11:30:01 AM	11:45:00 AM		34 / 39	31 / 39	1 / 0	16 / 5			3 / 2	0 / 1					85 / 86	**99%**
11:45:01 AM	12:00:00 PM		36 / 35	29 / 38	1 / 0	10 / 3			3 / 1						79 / 77	**103%**
12:00:01 PM	12:15:00 PM		46 / 50	26 / 34		15 / 7			2 / 0	1 / 1					90 / 92	**98%**
12:15:01 PM	12:30:00 PM		54 / 59	29 / 30	4 / 0	7 / 4	1 / 2		2 / 1						97 / 96	**101%**
12:30:01 PM	12:45:00 PM		45 / 45	29 / 35	1 / 0	8 / 4			3 / 2	3 / 3					89 / 89	**100%**
12:45:01 PM	1:00:00 PM		46 / 47	25 / 32	3 / 0	10 / 5			2 / 1						86 / 85	**101%**
1:00:01 PM	1:15:00 PM		54 / 54	24 / 32	5 / 0	12 / 5			1 / 1	1 / 2					97 / 94	**103%**
1:15:01 PM	1:30:00 PM		51 / 51	17 / 29	2 / 0	10 / 3			5 / 4						85 / 87	**98%**
1:30:01 PM	1:45:00 PM		38 / 37	19 / 22		5 / 2									62 / 61	**102%**
1:45:01 PM	2:00:00 PM		37 / 36	22 / 27	1 / 0	3 / 0	1 / 2		3 / 1	1 / 1					68 / 67	**101%**
2:00:01 PM	2:15:00 PM		38 / 41	29 / 36	3 / 0	11 / 4	0 / 1		3 / 2	1 / 1					85 / 85	**100%**
2:15:01 PM	2:30:00 PM		40 / 38	22 / 29	1 / 0	9 / 5	0 / 1	0 / 1	2 / 0	1 / 1					75 / 75	**100%**
2:30:01 PM	2:45:00 PM		34 / 31	10 / 15	1 / 0	7 / 8			2 / 1						54 / 55	**98%**
2:45:01 PM	3:00:00 PM	1 / 1	33 / 36	18 / 18		6 / 3			1 / 1						59 / 59	**100%**
3:00:01 PM	3:15:00 PM		38 / 35	25 / 30	2 / 0	6 / 6	1 / 2		1 / 1	1 / 1					74 / 75	**99%**
3:15:01 PM	3:30:00 PM		30 / 29	20 / 25	1 / 0	6 / 2			1 / 1	1 / 1					59 / 58	**102%**
3:30:01 PM	3:45:00 PM	1 / 1	31 / 27	20 / 29	1 / 0	6 / 1			1 / 1						60 / 59	**102%**
3:45:01 PM	4:00:00 PM		28 / 30	22 / 31	1 / 0	10 / 2			1 / 0	0 / 1					62 / 64	**97%**
4:00:01 PM	4:15:00 PM		43 / 41	19 / 25	2 / 0	8 / 5			5 / 1	0 / 2					77 / 74	**104%**
4:15:01 PM	4:30:00 PM		43 / 46	28 / 29	1 / 0	7 / 4	1 / 2			1 / 1					81 / 82	**99%**
4:30:01 PM	4:45:00 PM		47 / 51	25 / 24	1 / 0	6 / 3			3 / 1	0 / 1					82 / 80	**103%**
4:45:01 PM	5:00:00 PM		38 / 37	18 / 25		6 / 4			4 / 1						66 / 67	**99%**
5:00:01 PM	5:15:00 PM	1 / 1	36 / 38	21 / 23		4 / 1	1 / 1		1 / 1	2 / 2					66 / 67	**99%**
5:15:01 PM	5:30:00 PM		34 / 29	18 / 28		8 / 3	1 / 1								61 / 61	**100%**
5:30:01 PM	5:45:00 PM	1 / 1	28 / 29	8 / 8		2 / 1									39 / 39	**100%**
5:45:01 PM	6:00:00 PM		35 / 37	16 / 14	1 / 0	1 / 2				1 / 1					54 / 54	**100%**
6:00:01 PM	6:15:00 PM		28 / 29	10 / 9	1 / 0	1 / 2									40 / 40	**100%**
6:15:01 PM	6:30:00 PM		20 / 19	11 / 14		1 / 0	1 / 1								33 / 34	**97%**
6:30:01 PM	6:45:00 PM		26 / 26	10 / 17	2 / 0	6 / 2	1 / 1		2 / 0						47 / 46	**102%**
6:45:01 PM	7:00:00 PM	1 / 1	27 / 28	8 / 10	1 / 0	1 / 0			1 / 0	1 / 1					40 / 40	**100%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		12 / 12	1788 / 1814	1046 / 1340	78 / 1	381 / 156	10 / 25	0 / 2	83 / 36	31 / 39					3429 / 3425	**100%**
		100%	**99%**	**78%**	**7800%**	**244%**	**40%**	**0%**	**231%**	**79%**					**100%**	

Table A-6. Site 3 Northbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM		46 / 53	27 / 23	2 / 1	7 / 1	0 / 1		3 / 0	1 / 2					86 / 81	**106%**
7:15:01 AM	7:30:00 AM	2 / 0	50 / 62	24 / 26	9 / 2	11 / 2	4 / 7		2 / 0	1 / 1					103 / 100	**103%**
7:30:01 AM	7:45:00 AM		68 / 84	32 / 41	4 / 1	14 / 2			4 / 0	2 / 4					124 / 132	**94%**
7:45:01 AM	8:00:00 AM		78 / 102	39 / 28	2 / 3	12 / 3			3 / 0	1 / 1					135 / 137	**99%**
8:00:01 AM	8:15:00 AM	1 / 1	65 / 93	37 / 36	3 / 1	15 / 1			10 / 1	3 / 4					134 / 137	**98%**
8:15:01 AM	8:30:00 AM	1 / 0	65 / 80	35 / 39	4 / 1	23 / 6	0 / 2		3 / 0	3 / 3					134 / 131	**102%**
8:30:01 AM	8:45:00 AM		56 / 74	33 / 25	1 / 1	8 / 3		0 / 1	2 / 0	2 / 2					102 / 106	**96%**
8:45:01 AM	9:00:00 AM		56 / 59	25 / 25	3 / 0	7 / 2			1 / 0	1 / 2					93 / 88	**106%**
9:00:01 AM	9:15:00 AM		41 / 57	24 / 25	3 / 1	12 / 3	0 / 2		2 / 0	4 / 4					86 / 92	**93%**
9:15:01 AM	9:30:00 AM	2 / 1	48 / 51	23 / 37	5 / 0	20 / 5	0 / 3		5 / 2	2 / 3					105 / 102	**103%**
9:30:01 AM	9:45:00 AM	1 / 0	57 / 78	38 / 30	9 / 1	14 / 3			4 / 0	2 / 5					125 / 117	**107%**
9:45:01 AM	10:00:00 AM	1 / 0	43 / 53	34 / 41	3 / 1	18 / 4			6 / 1	5 / 5					110 / 105	**105%**
10:00:01 AM	10:15:00 AM	2 / 0	48 / 65	34 / 49	5 / 0	19 / 3	0 / 2		3 / 0	2 / 5					113 / 124	**91%**
10:15:01 AM	10:30:00 AM		63 / 72	45 / 46	12 / 1	20 / 6		0 / 1	4 / 1	3 / 6					147 / 133	**111%**
10:30:01 AM	10:45:00 AM	1 / 0	67 / 84	39 / 36	3 / 0	22 / 7	1 / 1		5 / 1	4 / 5					142 / 134	**106%**
10:45:01 AM	11:00:00 AM		59 / 86	46 / 55	7 / 0	23 / 6	0 / 2		8 / 1	6 / 7					149 / 157	**95%**
11:00:01 AM	11:15:00 AM		66 / 78	34 / 30	8 / 0	11 / 2	1 / 2		4 / 1	2 / 4					126 / 117	**108%**
11:15:01 AM	11:30:00 AM		66 / 84	47 / 52	6 / 1	22 / 6	0 / 2			1 / 2					142 / 147	**97%**
11:30:01 AM	11:45:00 AM	1 / 1	80 / 105	47 / 54	9 / 0	26 / 10	1 / 2	0 / 1	7 / 0	4 / 5					175 / 178	**98%**
11:45:01 AM	12:00:00 PM		78 / 106	40 / 44	7 / 0	16 / 2	1 / 2		8 / 0	3 / 5					153 / 159	**96%**
12:00:01 PM	12:15:00 PM		94 / 110	48 / 44	3 / 1	22 / 7				1 / 1					168 / 163	**103%**
12:15:01 PM	12:30:00 PM		77 / 99	43 / 56	7 / 0	19 / 4	1 / 2		10 / 1	4 / 2		2 / 0			163 / 164	**99%**
12:30:01 PM	12:45:00 PM	1 / 0	87 / 106	33 / 37	3 / 1	13 / 1	0 / 1		6 / 2	4 / 4		1 / 0			148 / 152	**97%**
12:45:01 PM	1:00:00 PM	2 / 0	83 / 126	48 / 54	13 / 1	22 / 1	0 / 1		12 / 1	4 / 3					184 / 187	**98%**
1:00:01 PM	1:15:00 PM	2 / 1	108 / 130	46 / 46	6 / 0	11 / 3	1 / 3		4 / 0	1 / 1					179 / 184	**97%**
1:15:01 PM	1:30:00 PM		90 / 120	44 / 44	3 / 0	19 / 1	1 / 1		9 / 1	4 / 6					170 / 173	**98%**
1:30:01 PM	1:45:00 PM	1 / 0	90 / 113	39 / 42	3 / 1	22 / 5			3 / 0	0 / 2				1 / 0	159 / 163	**98%**
1:45:01 PM	2:00:00 PM	1 / 1	97 / 119	47 / 46	3 / 0	13 / 2	1 / 1		8 / 1	5 / 6					175 / 176	**99%**
2:00:01 PM	2:15:00 PM	1 / 0	79 / 101	43 / 56	3 / 0	17 / 2			7 / 0	1 / 1		1 / 0			152 / 160	**95%**
2:15:01 PM	2:30:00 PM	1 / 0	85 / 89	40 / 45	6 / 1	10 / 1	1 / 1		6 / 2	3 / 6					152 / 145	**105%**
2:30:01 PM	2:45:00 PM	1 / 0	113 / 131	54 / 63	4 / 0	24 / 2	1 / 2		1 / 0	4 / 6			1 / 0		203 / 204	**100%**
2:45:01 PM	3:00:00 PM	1 / 0	100 / 125	42 / 42	8 / 1	21 / 5			5 / 1	2 / 5					179 / 179	**100%**
3:00:01 PM	3:15:00 PM		98 / 122	48 / 57	5 / 2	19 / 3	0 / 1		9 / 0	0 / 1					179 / 186	**96%**
3:15:01 PM	3:30:00 PM	2 / 2	97 / 121	52 / 43	3 / 0	18 / 5	1 / 4		7 / 1	2 / 2					182 / 178	**102%**
3:30:01 PM	3:45:00 PM	1 / 0	131 / 163	64 / 59	3 / 0	18 / 3	2 / 0		6 / 1						225 / 226	**100%**
3:45:01 PM	4:00:00 PM	2 / 2	112 / 139	55 / 58	4 / 1	21 / 2			8 / 1	2 / 2		1 / 0			205 / 205	**100%**
4:00:01 PM	4:15:00 PM	3 / 2	120 / 142	48 / 49	2 / 0	15 / 3			6 / 1	1 / 2					195 / 199	**98%**
4:15:01 PM	4:30:00 PM		111 / 137	46 / 41	4 / 2	16 / 2			8 / 0	1 / 0		2 / 0			188 / 182	**103%**
4:30:01 PM	4:45:00 PM	2 / 2	113 / 128	45 / 46	3 / 1	9 / 1			10 / 3						182 / 181	**101%**
4:45:01 PM	5:00:00 PM	0 / 1	98 / 138	40 / 40	4 / 1	16 / 1			7 / 0	4 / 5					169 / 186	**91%**
5:00:01 PM	5:15:00 PM	1 / 0	137 / 172	70 / 62	2 / 1	16 / 2			12 / 0	0 / 1		1 / 0			239 / 238	**100%**
5:15:01 PM	5:30:00 PM	1 / 1	131 / 169	49 / 34	6 / 0	10 / 2		1 / 0	6 / 1						204 / 207	**99%**
5:30:01 PM	5:45:00 PM		137 / 164	37 / 45	4 / 1	11 / 1	1 / 1		13 / 0	1 / 1					204 / 213	**96%**
5:45:01 PM	6:00:00 PM	2 / 0	125 / 150	41 / 35	4 / 1	15 / 0	0 / 1		5 / 0	0 / 1		2 / 0			194 / 188	**103%**
6:00:01 PM	6:15:00 PM		129 / 166	37 / 32	1 / 1	10 / 0			2 / 0			1 / 0			180 / 199	**90%**
6:15:01 PM	6:30:00 PM	1 / 1	124 / 132	36 / 24	4 / 0	9 / 0	0 / 1		5 / 0	0 / 1					179 / 159	**113%**
6:30:01 PM	6:45:00 PM	1 / 1	122 / 137	31 / 26	4 / 1	12 / 1			2 / 0						172 / 166	**104%**
6:45:01 PM	7:00:00 PM		122 / 138	33 / 27	1 / 1	8 / 1			2 / 0			1 / 0			167 / 167	**100%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		39 / 17	4210 / 5213	1962 / 1995	221 / 34	756 / 138	18 / 48	1 / 3	263 / 25	96 / 134		12 / 0	1 / 0	1 / 0	7580 / 7607	**100%**
		229%	**81%**	**98%**	**650%**	**548%**	**38%**	**33%**	**1052%**	**72%**		**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**100%**	

Table A-7. Site 3 Southbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM		80 / 78	34 / 44	4 / 2	13 / 0	1 / 3		3 / 1	0 / 1					135 / 129	**105%**
7:15:01 AM	7:30:00 AM		111 / 118	27 / 34	3 / 1	6 / 2	1 / 1	0 / 1	8 / 1	1 / 2					157 / 160	**98%**
7:30:01 AM	7:45:00 AM		151 / 159	42 / 46	2 / 1	9 / 2			9 / 1	1 / 3					214 / 212	**101%**
7:45:01 AM	8:00:00 AM	1 / 2	160 / 175	45 / 67	10 / 1	10 / 3			6 / 0	3 / 3					235 / 251	**94%**
8:00:01 AM	8:15:00 AM		144 / 152	42 / 37	4 / 1	2 / 1			9 / 1	3 / 4					204 / 196	**104%**
8:15:01 AM	8:30:00 AM	0 / 2	162 / 164	53 / 71	7 / 0	8 / 4	2 / 3		8 / 1	3 / 5					243 / 250	**97%**
8:30:01 AM	8:45:00 AM		113 / 117	47 / 62	4 / 1	12 / 5	2 / 2		7 / 1	5 / 7					190 / 195	**97%**
8:45:01 AM	9:00:00 AM	1 / 1	80 / 99	48 / 49	6 / 1	10 / 3	1 / 2		8 / 1	8 / 7					162 / 163	**99%**
9:00:01 AM	9:15:00 AM		80 / 83	24 / 39	2 / 0	10 / 1			4 / 1	0 / 1					120 / 125	**96%**
9:15:01 AM	9:30:00 AM	0 / 1	68 / 69	23 / 25	2 / 1	12 / 3	1 / 1		2 / 1	3 / 4					111 / 105	**106%**
9:30:01 AM	9:45:00 AM	0 / 1	93 / 103	32 / 47	5 / 0	12 / 7	0 / 2		5 / 1	0 / 1					147 / 162	**91%**
9:45:01 AM	10:00:00 AM		82 / 73	38 / 54	2 / 0	13 / 3	0 / 1		3 / 1	2 / 3					140 / 135	**104%**
10:00:01 AM	10:15:00 AM	0 / 1	72 / 70	42 / 60	10 / 1	14 / 6	0 / 2		7 / 2	4 / 6					149 / 148	**101%**
10:15:01 AM	10:30:00 AM		84 / 91	34 / 43	3 / 0	7 / 3	1 / 1		5 / 1	0 / 1					134 / 140	**96%**
10:30:01 AM	10:45:00 AM		95 / 92	40 / 51	10 / 0	10 / 9			8 / 1	3 / 6					166 / 159	**104%**
10:45:01 AM	11:00:00 AM		69 / 72	40 / 53	1 / 0	12 / 4	1 / 1		5 / 0	3 / 4					131 / 134	**98%**
11:00:01 AM	11:15:00 AM	1 / 0	103 / 106	47 / 58	3 / 1	12 / 6	1 / 2		3 / 0	4 / 4					174 / 177	**98%**
11:15:01 AM	11:30:00 AM	0 / 3	93 / 95	32 / 37	3 / 0	9 / 7			5 / 0	2 / 5					144 / 147	**98%**
11:30:01 AM	11:45:00 AM	1 / 1	106 / 126	26 / 50	7 / 0	12 / 4	2 / 3		15 / 2	1 / 1					170 / 187	**91%**
11:45:01 AM	12:00:00 PM		100 / 118	47 / 54	3 / 1	8 / 3	1 / 1		13 / 1	2 / 3					174 / 181	**96%**
12:00:01 PM	12:15:00 PM	2 / 1	115 / 124	36 / 56	6 / 0	9 / 4	1 / 2	0 / 1	12 / 1	5 / 7					186 / 196	**95%**
12:15:01 PM	12:30:00 PM		123 / 128	54 / 66	5 / 2	9 / 4			7 / 0	3 / 4					201 / 204	**99%**
12:30:01 PM	12:45:00 PM		127 / 129	26 / 33	3 / 0	5 / 1			7 / 1	3 / 4					171 / 168	**102%**
12:45:01 PM	1:00:00 PM		115 / 124	38 / 49	1 / 0	10 / 0	2 / 2		4 / 1	3 / 4					173 / 180	**96%**
1:00:01 PM	1:15:00 PM	0 / 1	111 / 121	35 / 43	5 / 1	13 / 4			10 / 2	4 / 5					178 / 177	**101%**
1:15:01 PM	1:30:00 PM		95 / 101	38 / 53	9 / 0	3 / 2	1 / 0		8 / 4	1 / 5		1 / 0			156 / 165	**95%**
1:30:01 PM	1:45:00 PM	0 / 1	102 / 91	31 / 48	2 / 0	8 / 4	0 / 1		1 / 0	3 / 3					147 / 148	**99%**
1:45:01 PM	2:00:00 PM	1 / 1	96 / 97	35 / 46	2 / 1	11 / 3	3 / 4		6 / 1	4 / 4					158 / 157	**101%**
2:00:01 PM	2:15:00 PM		101 / 111	32 / 41	3 / 0	9 / 5	1 / 2		6 / 0	1 / 1					153 / 160	**96%**
2:15:01 PM	2:30:00 PM		108 / 114	32 / 46	5 / 0	11 / 6	1 / 0		7 / 0	2 / 3					166 / 169	**98%**
2:30:01 PM	2:45:00 PM	0 / 1	75 / 81	35 / 43	3 / 1	10 / 5	2 / 2		2 / 0	0 / 2					127 / 135	**94%**
2:45:01 PM	3:00:00 PM		124 / 129	33 / 42	3 / 1	11 / 7	1 / 1		5 / 0	3 / 3					180 / 183	**98%**
3:00:01 PM	3:15:00 PM	0 / 1	117 / 115	40 / 56	2 / 1	7 / 3			2 / 1					1 / 0	169 / 177	**95%**
3:15:01 PM	3:30:00 PM	1 / 2	130 / 142	28 / 37	4 / 1	6 / 3	1 / 3		6 / 1	2 / 1					178 / 190	**94%**
3:30:01 PM	3:45:00 PM		114 / 124	43 / 41	4 / 2	6 / 3	2 / 2		8 / 3	0 / 1					177 / 176	**101%**
3:45:01 PM	4:00:00 PM	2 / 2	112 / 117	37 / 47	4 / 1	4 / 3	0 / 1		3 / 1	1 / 1					163 / 173	**94%**
4:00:01 PM	4:15:00 PM	0 / 1	128 / 138	30 / 40	3 / 3	15 / 6	1 / 1		9 / 2	1 / 1					187 / 192	**97%**
4:15:01 PM	4:30:00 PM		115 / 119	36 / 46	3 / 4	8 / 5			3 / 0						165 / 174	**95%**
4:30:01 PM	4:45:00 PM	0 / 1	131 / 125	26 / 34	2 / 1	5 / 1	1 / 1		4 / 1						169 / 164	**103%**
4:45:01 PM	5:00:00 PM	1 / 1	114 / 127	33 / 44	1 / 0	4 / 1	1 / 1		3 / 0			1 / 0			158 / 174	**91%**
5:00:01 PM	5:15:00 PM	0 / 1	126 / 121	19 / 31	5 / 1	8 / 3			2 / 0	2 / 2					162 / 159	**102%**
5:15:01 PM	5:30:00 PM		149 / 178	36 / 40	3 / 0	6 / 4			7 / 0						201 / 222	**91%**
5:30:01 PM	5:45:00 PM	0 / 1	158 / 176	35 / 41	7 / 1	5 / 5			10 / 0			1 / 0			216 / 224	**96%**
5:45:01 PM	6:00:00 PM	0 / 1	134 / 143	26 / 29	4 / 1	4 / 2	1 / 1		5 / 0						174 / 177	**98%**
6:00:01 PM	6:15:00 PM		112 / 134	24 / 29	4 / 1	5 / 1			5 / 0			1 / 0			151 / 165	**92%**
6:15:01 PM	6:30:00 PM		132 / 134	22 / 27	2 / 1	4 / 0			4 / 0						164 / 162	**101%**
6:30:01 PM	6:45:00 PM	1 / 0	129 / 143	22 / 32	1 / 0	5 / 1			3 / 0					1 / 0	162 / 176	**92%**
6:45:01 PM	7:00:00 PM		114 / 129	19 / 27	3 / 0	4 / 0	0 / 1		9 / 0	2 / 3					151 / 160	**94%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		12 / 28	5353 / 5675	1664 / 2148	190 / 36	406 / 162	33 / 50	0 / 2	291 / 37	88 / 125		4 / 0		2 / 0	8043 / 8263	**97%**
		43%	**94%**	**77%**	**528%**	**251%**	**66%**	**0%**	**786%**	**70%**		**#DIV/0!**		**#DIV/0!**	**97%**	

Table A-8. Site 4 Eastbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM	1 / 1	120 / 145	42 / 39	2 / 1	17 / 0			2 / 0	5 / 5					189 / 191	**99%**
7:15:01 AM	7:30:00 AM		84 / 93	39 / 40		8 / 0			2 / 0	3 / 3					136 / 136	**100%**
7:30:01 AM	7:45:00 AM		82 / 94	35 / 27	2 / 1	7 / 1	1 / 1		1 / 0	3 / 3					131 / 127	**103%**
7:45:01 AM	8:00:00 AM	1 / 1	80 / 102	35 / 29		9 / 0			2 / 0	1 / 2					128 / 134	**96%**
8:00:01 AM	8:15:00 AM	1 / 1	78 / 92	37 / 29		9 / 1				4 / 3					129 / 126	**102%**
8:15:01 AM	8:30:00 AM	1 / 1	58 / 64	27 / 22	1 / 0	8 / 2				5 / 5	0 / 1				100 / 95	**105%**
8:30:01 AM	8:45:00 AM	1 / 0	75 / 93	24 / 31		15 / 1	3 / 4		3 / 1	9 / 9	1 / 1				131 / 140	**94%**
8:45:01 AM	9:00:00 AM		59 / 66	30 / 25		7 / 1	4 / 3			8 / 7					108 / 102	**106%**
9:00:01 AM	9:15:00 AM	2 / 2	57 / 75	30 / 23	1 / 0	9 / 1	7 / 9		4 / 0	2 / 2					112 / 112	**100%**
9:15:01 AM	9:30:00 AM	1 / 1	66 / 76	31 / 43	1 / 0	17 / 0	6 / 5			6 / 7					128 / 132	**97%**
9:30:01 AM	9:45:00 AM		42 / 52	37 / 30		8 / 1	3 / 4		1 / 0	4 / 4					95 / 91	**104%**
9:45:01 AM	10:00:00 AM		51 / 65	30 / 23		17 / 4	4 / 3			4 / 3	1 / 1				107 / 99	**108%**
10:00:01 AM	10:15:00 AM		37 / 53	28 / 25		2 / 0	1 / 1		2 / 0	4 / 4					74 / 83	**89%**
10:15:01 AM	10:30:00 AM	0 / 1	39 / 49	31 / 32	1 / 0	9 / 2	4 / 5		2 / 0	5 / 5					91 / 94	**97%**
10:30:01 AM	10:45:00 AM		31 / 40	27 / 25		9 / 2	2 / 2		3 / 0	3 / 3					75 / 72	**104%**
10:45:01 AM	11:00:00 AM		41 / 50	24 / 20		5 / 2				9 / 9					79 / 81	**98%**
11:00:01 AM	11:15:00 AM		40 / 43	30 / 36	1 / 0	14 / 4	5 / 5		1 / 0	6 / 6					97 / 94	**103%**
11:15:01 AM	11:30:00 AM		33 / 41	30 / 32		12 / 1	1 / 1			1 / 1					77 / 76	**101%**
11:30:01 AM	11:45:00 AM		45 / 60	29 / 28		10 / 3	4 / 4		1 / 0	3 / 3					92 / 98	**94%**
11:45:01 AM	12:00:00 PM		43 / 54	26 / 27	3 / 0	15 / 3	2 / 3		2 / 0	4 / 4					95 / 91	**104%**
12:00:01 PM	12:15:00 PM	2 / 1	38 / 54	45 / 45	1 / 0	10 / 2			2 / 1	3 / 3	1 / 1				102 / 107	**95%**
12:15:01 PM	12:30:00 PM	1 / 0	40 / 42	24 / 32		14 / 2	3 / 2		4 / 0	5 / 6	1 / 1				92 / 85	**108%**
12:30:01 PM	12:45:00 PM	1 / 1	43 / 51	36 / 40	1 / 0	13 / 3	1 / 1	1 / 1	2 / 0	5 / 5					103 / 102	**101%**
12:45:01 PM	1:00:00 PM		33 / 41	29 / 29	1 / 0	8 / 4	5 / 6	1 / 0	1 / 0	5 / 5					83 / 85	**98%**
1:00:01 PM	1:15:00 PM		35 / 47	27 / 22	2 / 0	6 / 2	1 / 0		1 / 0	8 / 9					80 / 80	**100%**
1:15:01 PM	1:30:00 PM		51 / 63	25 / 27		10 / 0	5 / 5		2 / 0	8 / 7					101 / 102	**99%**
1:30:01 PM	1:45:00 PM		55 / 61	27 / 30	1 / 0	7 / 1	2 / 2		1 / 1	4 / 4					97 / 99	**98%**
1:45:01 PM	2:00:00 PM		35 / 42	21 / 23		7 / 3	2 / 2		3 / 0	4 / 4					72 / 74	**97%**
2:00:01 PM	2:15:00 PM		35 / 49	32 / 30		13 / 1	1 / 1		3 / 0	5 / 4	0 / 1				89 / 86	**103%**
2:15:01 PM	2:30:00 PM	1 / 2	49 / 54	28 / 29		7 / 1	2 / 2		6 / 2	2 / 2					95 / 92	**103%**
2:30:01 PM	2:45:00 PM		36 / 49	45 / 42		1 / 0	1 / 1		3 / 0	4 / 5					90 / 97	**93%**
2:45:01 PM	3:00:00 PM		47 / 53	28 / 32	2 / 1	12 / 2	1 / 2		3 / 0	2 / 1					95 / 91	**104%**
3:00:01 PM	3:15:00 PM		36 / 48	26 / 23		11 / 3				1 / 1	1 / 1				75 / 76	**99%**
3:15:01 PM	3:30:00 PM		54 / 60	41 / 37	3 / 3	8 / 3	2 / 2			2 / 2					110 / 107	**103%**
3:30:01 PM	3:45:00 PM		44 / 62	25 / 22	3 / 2	5 / 3	1 / 2		2 / 0	3 / 3					83 / 94	**88%**
3:45:01 PM	4:00:00 PM		44 / 43	40 / 40	1 / 0	13 / 4			2 / 0	4 / 3					104 / 90	**116%**
4:00:01 PM	4:15:00 PM		41 / 51	33 / 39	1 / 0	8 / 3	1 / 2		3 / 0	1 / 1					88 / 96	**92%**
4:15:01 PM	4:30:00 PM		51 / 61	21 / 19		8 / 1	3 / 2			2 / 2					85 / 85	**100%**
4:30:01 PM	4:45:00 PM		42 / 48	34 / 34	2 / 0	11 / 3	1 / 2		3 / 1	1 / 1					94 / 89	**106%**
4:45:01 PM	5:00:00 PM	1 / 1	60 / 59	22 / 31		5 / 0			4 / 0	3 / 3					95 / 94	**101%**
5:00:01 PM	5:15:00 PM		55 / 65	29 / 30	2 / 0	8 / 1	1 / 2		2 / 0	3 / 3					100 / 101	**99%**
5:15:01 PM	5:30:00 PM		48 / 61	33 / 25		4 / 0	2 / 2		1 / 0						88 / 88	**100%**
5:30:01 PM	5:45:00 PM	1 / 2	52 / 62	38 / 39	1 / 0	5 / 1	0 / 1		3 / 0		1 / 1				101 / 106	**95%**
5:45:01 PM	6:00:00 PM	1 / 0	63 / 88	31 / 24		7 / 2			4 / 0						106 / 114	**93%**
6:00:01 PM	6:15:00 PM	1 / 1	53 / 60	40 / 36		7 / 1			2 / 0						103 / 98	**105%**
6:15:01 PM	6:30:00 PM	1 / 1	59 / 70	34 / 31	1 / 0	5 / 2			5 / 0						105 / 104	**101%**
6:30:01 PM	6:45:00 PM		56 / 72	34 / 36		9 / 0			4 / 0						103 / 108	**95%**
6:45:01 PM	7:00:00 PM		56 / 65	22 / 15		3 / 0									81 / 80	**101%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		18 / 17	2472 / 2988	1492 / 1448	34 / 8	432 / 77	82 / 89	2 / 1	92 / 6	164 / 162	6 / 8				4794 / 4804	**100%**
		106%	**83%**	**103%**	**425%**	**561%**	**92%**	**200%**	**1533%**	**101%**	**75%**				**100%**	

Table A-9. Site 4 Westbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM		38 / 38	25 / 31	1 / 1	8 / 1	3 / 1	0 / 1	4 / 0	2 / 5					81 / 78	**104%**
7:15:01 AM	7:30:00 AM		32 / 37	16 / 26	2 / 1	6 / 2	1 / 2		5 / 0	1 / 3					63 / 71	**89%**
7:30:01 AM	7:45:00 AM		41 / 46	35 / 37	0 / 2	10 / 1	2 / 1		6 / 1	7 / 8					101 / 96	**105%**
7:45:01 AM	8:00:00 AM		32 / 35	21 / 33	1 / 0	8 / 5	1 / 3		6 / 0	4 / 4					73 / 80	**91%**
8:00:01 AM	8:15:00 AM		41 / 34	23 / 33	0 / 1	9 / 2	2 / 1		3 / 0	1 / 1					79 / 72	**110%**
8:15:01 AM	8:30:00 AM		42 / 48	27 / 37	1 / 0	8 / 2	5 / 6			4 / 7					87 / 100	**87%**
8:30:01 AM	8:45:00 AM	1 / 3	38 / 38	21 / 21	0 / 1	7 / 1	4 / 4		6 / 0	6 / 5					83 / 73	**114%**
8:45:01 AM	9:00:00 AM	0 / 1	36 / 33	16 / 18	1 / 0	4 / 1	2 / 4		3 / 0	2 / 4					64 / 61	**105%**
9:00:01 AM	9:15:00 AM	1 / 0	34 / 41	23 / 26		6 / 0	3 / 4		3 / 0	4 / 5					74 / 76	**97%**
9:15:01 AM	9:30:00 AM		34 / 23	22 / 40	0 / 1	7 / 1	3 / 4		3 / 0	4 / 3					73 / 72	**101%**
9:30:01 AM	9:45:00 AM		39 / 40	29 / 39		16 / 6	3 / 5		1 / 0	8 / 9					96 / 99	**97%**
9:45:01 AM	10:00:00 AM		49 / 51	21 / 22		4 / 4	2 / 2	0 / 1	7 / 1	4 / 7					87 / 88	**99%**
10:00:01 AM	10:15:00 AM		32 / 37	28 / 33	1 / 0	9 / 3	2 / 1		8 / 0	4 / 6					84 / 80	**105%**
10:15:01 AM	10:30:00 AM		38 / 41	23 / 31	1 / 0	12 / 5	4 / 4		3 / 0	1 / 1					82 / 82	**100%**
10:30:01 AM	10:45:00 AM		46 / 46	22 / 30		13 / 2	3 / 5		2 / 0	2 / 3					88 / 86	**102%**
10:45:01 AM	11:00:00 AM	0 / 1	40 / 47	23 / 33	2 / 0	11 / 3	1 / 2		3 / 0	5 / 7					85 / 93	**91%**
11:00:01 AM	11:15:00 AM		51 / 47	24 / 36	1 / 0	11 / 3			2 / 0	5 / 4	1 / 1				95 / 91	**104%**
11:15:01 AM	11:30:00 AM		40 / 39	22 / 24		4 / 2	2 / 2		4 / 1	4 / 7	2 / 2				78 / 77	**101%**
11:30:01 AM	11:45:00 AM	1 / 1	44 / 55	22 / 29	2 / 0	6 / 4	0 / 1		2 / 0	1 / 1					78 / 91	**86%**
11:45:01 AM	12:00:00 PM	1 / 1	38 / 38	34 / 28		7 / 3	1 / 2			2 / 4					83 / 76	**109%**
12:00:01 PM	12:15:00 PM		56 / 64	23 / 29		12 / 3	1 / 1		2 / 0	9 / 8					103 / 105	**98%**
12:15:01 PM	12:30:00 PM	1 / 1	37 / 33	25 / 48	1 / 0	12 / 2			5 / 0	2 / 4					83 / 88	**94%**
12:30:01 PM	12:45:00 PM	1 / 0	44 / 49	29 / 27		5 / 1	1 / 1		1 / 0	1 / 3					82 / 81	**101%**
12:45:01 PM	1:00:00 PM		46 / 47	29 / 41	1 / 0	11 / 1	4 / 5		5 / 0	4 / 3					100 / 97	**103%**
1:00:01 PM	1:15:00 PM	1 / 1	40 / 43	26 / 38		8 / 1	4 / 5		3 / 0	2 / 5					84 / 93	**90%**
1:15:01 PM	1:30:00 PM		51 / 56	29 / 37	1 / 0	11 / 1	7 / 6		5 / 0	3 / 5	1 / 1				108 / 106	**102%**
1:30:01 PM	1:45:00 PM		47 / 42	25 / 34	1 / 0	6 / 3	1 / 2		5 / 1	2 / 5					87 / 87	**100%**
1:45:01 PM	2:00:00 PM		56 / 61	28 / 39	2 / 0	13 / 2	3 / 2		3 / 0	2 / 3					107 / 107	**100%**
2:00:01 PM	2:15:00 PM		58 / 60	25 / 23		6 / 0	4 / 4		2 / 0	2 / 3					97 / 90	**108%**
2:15:01 PM	2:30:00 PM	1 / 1	52 / 53	26 / 31	1 / 0	7 / 4	1 / 1		4 / 0	2 / 4	1 / 1				95 / 95	**100%**
2:30:01 PM	2:45:00 PM	6 / 6	72 / 80	28 / 33	3 / 1	8 / 1	2 / 3		4 / 0	3 / 4					126 / 128	**98%**
2:45:01 PM	3:00:00 PM		61 / 77	26 / 29	0 / 2	9 / 2	2 / 2		5 / 0	0 / 3					103 / 115	**90%**
3:00:01 PM	3:15:00 PM	0 / 1	74 / 75	29 / 33	1 / 1	7 / 1			1 / 0						112 / 111	**101%**
3:15:01 PM	3:30:00 PM	1 / 0	67 / 69	25 / 33		6 / 0	1 / 1			3 / 4					103 / 107	**96%**
3:30:01 PM	3:45:00 PM		62 / 61	26 / 31	1 / 0	7 / 0			2 / 0	3 / 3					101 / 95	**106%**
3:45:01 PM	4:00:00 PM		74 / 74	35 / 38	1 / 0	8 / 0	1 / 2		3 / 0	1 / 3					123 / 117	**105%**
4:00:01 PM	4:15:00 PM	1 / 1	85 / 101	28 / 40	2 / 3	10 / 3			4 / 0	2 / 3					132 / 151	**87%**
4:15:01 PM	4:30:00 PM	1 / 1	97 / 90	38 / 42	0 / 2	10 / 2			2 / 0						148 / 137	**108%**
4:30:01 PM	4:45:00 PM		107 / 120	26 / 34	1 / 0	9 / 0			1 / 0						144 / 154	**94%**
4:45:01 PM	5:00:00 PM	2 / 2	111 / 123	34 / 36	1 / 0	6 / 0	0 / 1		4 / 0	0 / 1					158 / 163	**97%**
5:00:01 PM	5:15:00 PM	1 / 1	125 / 119	48 / 47	1 / 0	12 / 0	0 / 1		2 / 0	1 / 2					190 / 170	**112%**
5:15:01 PM	5:30:00 PM		107 / 126	30 / 33		7 / 0			3 / 0	1 / 3					148 / 162	**91%**
5:30:01 PM	5:45:00 PM		148 / 143	46 / 56		6 / 0			6 / 0	3 / 2					209 / 201	**104%**
5:45:01 PM	6:00:00 PM	0 / 1	105 / 122	37 / 45		9 / 0			1 / 0						152 / 168	**90%**
6:00:01 PM	6:15:00 PM	4 / 3	123 / 117	36 / 43	0 / 1	15 / 1			1 / 0		1 / 1				180 / 166	**108%**
6:15:01 PM	6:30:00 PM	1 / 1	112 / 112	32 / 44		12 / 0			3 / 0						160 / 157	**102%**
6:30:01 PM	6:45:00 PM	0 / 1	106 / 108	37 / 39		5 / 0			2 / 0						150 / 148	**101%**
6:45:01 PM	7:00:00 PM	1 / 1	100 / 115	22 / 29		10 / 0			2 / 0						135 / 145	**93%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		26 / 29	3008 / 3154	1325 / 1639	31 / 17	413 / 79	76 / 91	0 / 2	152 / 4	117 / 165	6 / 6				5154 / 5186	**99%**
		90%	**95%**	**81%**	**182%**	**523%**	**84%**	**0%**	**3800%**	**71%**	**100%**				**99%**	

Table A-10. Site 5 Eastbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13	VEHICLE COUNT TOTALS (AVC/VIDEO)	
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles		
7:00:01 AM	7:15:00 AM															
7:15:01 AM	7:30:00 AM															
7:30:01 AM	7:45:00 AM															
7:45:01 AM	8:00:00 AM															
8:00:01 AM	8:15:00 AM	1 / 1	37 / 38	11 / 17	2 / 0	5 / 2		1 / 1	4 / 0	3 / 5					64 / 64	**100%**
8:15:01 AM	8:30:00 AM		19 / 19	9 / 13	1 / 1	4 / 0			6 / 0	0 / 5					39 / 38	**103%**
8:30:01 AM	8:45:00 AM		26 / 27	12 / 14		2 / 0			4 / 0	6 / 10					50 / 51	**98%**
8:45:01 AM	9:00:00 AM		21 / 20	12 / 17		5 / 0	1 / 2		1 / 0	1 / 2					41 / 41	**100%**
9:00:01 AM	9:15:00 AM	1 / 0	20 / 19	15 / 19		3 / 0			2 / 0	0 / 2					41 / 40	**103%**
9:15:01 AM	9:30:00 AM		14 / 16	9 / 15	1 / 0	2 / 0	0 / 2		3 / 0	1 / 2					30 / 35	**86%**
9:30:01 AM	9:45:00 AM		17 / 18	11 / 15		2 / 0	1 / 1		4 / 0	3 / 4					38 / 38	**100%**
9:45:01 AM	10:00:00 AM		17 / 17	8 / 14	1 / 0	4 / 1	2 / 2		3 / 0	2 / 4					37 / 38	**97%**
10:00:01 AM	10:15:00 AM	1 / 0	16 / 15	7 / 13		5 / 0	1 / 1		4 / 0	1 / 5					35 / 34	**103%**
10:15:01 AM	10:30:00 AM		9 / 8	8 / 16	3 / 0	4 / 3	1 / 1		4 / 0	0 / 3					29 / 31	**94%**
10:30:01 AM	10:45:00 AM		12 / 12	5 / 10	2 / 0	3 / 0			5 / 0	1 / 6					28 / 28	**100%**
10:45:01 AM	11:00:00 AM		20 / 19	13 / 21		3 / 0		1 / 1	4 / 0	1 / 2					42 / 43	**98%**
11:00:01 AM	11:15:00 AM		17 / 18	15 / 19	1 / 0	2 / 2	1 / 1		10 / 0	1 / 7					47 / 47	**100%**
11:15:01 AM	11:30:00 AM		19 / 19	9 / 17		5 / 1	2 / 2		6 / 0	1 / 3					42 / 42	**100%**
11:30:01 AM	11:45:00 AM	2 / 2	23 / 25	10 / 10		2 / 0				1 / 1					38 / 38	**100%**
11:45:01 AM	12:00:00 PM	1 / 0	19 / 19	12 / 16	2 / 0	3 / 1			2 / 1	1 / 2					40 / 39	**103%**
12:00:01 PM	12:15:00 PM		20 / 18	11 / 20	1 / 2	4 / 0			5 / 0	0 / 3					41 / 43	**95%**
12:15:01 PM	12:30:00 PM		15 / 15	6 / 9	1 / 0	0 / 1			10 / 0	1 / 8					33 / 33	**100%**
12:30:01 PM	12:45:00 PM		12 / 12	13 / 16		2 / 2			4 / 0	3 / 5					34 / 35	**97%**
12:45:01 PM	1:00:00 PM		23 / 20	10 / 17		3 / 0			4 / 0	1 / 3					41 / 40	**103%**
1:00:01 PM	1:15:00 PM		19 / 19	7 / 10	2 / 0	4 / 0	1 / 3		2 / 0	0 / 3					35 / 35	**100%**
1:15:01 PM	1:30:00 PM		19 / 19	10 / 14	1 / 0	3 / 0	1 / 1		8 / 0	0 / 7					42 / 41	**102%**
1:30:01 PM	1:45:00 PM		17 / 19	9 / 11		4 / 0	0 / 1		5 / 0	1 / 5					36 / 36	**100%**
1:45:01 PM	2:00:00 PM		18 / 20	9 / 13	1 / 1	5 / 2			3 / 0	1 / 3		1 / 0			38 / 39	**97%**
2:00:01 PM	2:15:00 PM	1 / 1	12 / 17	12 / 15	3 / 0	3 / 1			7 / 0	1 / 5					39 / 39	**100%**
2:15:01 PM	2:30:00 PM		19 / 17	14 / 19	1 / 0	5 / 3			7 / 1	0 / 5					46 / 45	**102%**
2:30:01 PM	2:45:00 PM		19 / 22	14 / 17	1 / 0	1 / 2	1 / 0	0 / 1	6 / 0	2 / 3					44 / 45	**98%**
2:45:01 PM	3:00:00 PM		16 / 13	11 / 19		5 / 0				1 / 1					33 / 33	**100%**
3:00:01 PM	3:15:00 PM	1 / 2	27 / 25	11 / 24		6 / 0	0 / 1		5 / 0	1 / 4					51 / 56	**91%**
3:15:01 PM	3:30:00 PM	3 / 3	22 / 23	11 / 15	2 / 0	2 / 0			4 / 0	1 / 2					45 / 43	**105%**
3:30:01 PM	3:45:00 PM		33 / 31	13 / 21	1 / 0	3 / 0			7 / 1	2 / 6					59 / 59	**100%**
3:45:01 PM	4:00:00 PM		33 / 34	12 / 17		2 / 0			3 / 0	1 / 2					51 / 53	**96%**
4:00:01 PM	4:15:00 PM	0 / 1	36 / 39	11 / 17		2 / 0			4 / 1	2 / 3	1 / 0	1 / 0			57 / 61	**93%**
4:15:01 PM	4:30:00 PM		41 / 38	17 / 29		6 / 0	0 / 1		2 / 0	1 / 2					67 / 70	**96%**
4:30:01 PM	4:45:00 PM	1 / 1	42 / 41	17 / 22	1 / 0	4 / 0			3 / 0	1 / 4					69 / 68	**101%**
4:45:01 PM	5:00:00 PM		36 / 35	14 / 23	1 / 0	4 / 0			4 / 1	2 / 5					61 / 64	**95%**
5:00:01 PM	5:15:00 PM		33 / 33	15 / 24	1 / 1	7 / 0			2 / 0	0 / 1					58 / 59	**98%**
5:15:01 PM	5:30:00 PM		32 / 32	15 / 25	1 / 1	2 / 0			4 / 0	0 / 1					54 / 59	**92%**
5:30:01 PM	5:45:00 PM	1 / 1	32 / 27	10 / 16					2 / 0						45 / 44	**102%**
5:45:01 PM	6:00:00 PM		36 / 36	13 / 19	1 / 0	2 / 0			2 / 0	0 / 2					54 / 57	**95%**
6:00:01 PM	6:15:00 PM		36 / 34	14 / 19											50 / 53	**94%**
6:15:01 PM	6:30:00 PM		32 / 28	7 / 14		2 / 0			2 / 0	2 / 3					45 / 45	**100%**
6:30:01 PM	6:45:00 PM	1 / 1	57 / 62	15 / 27	2 / 0	4 / 0			1 / 0	1 / 1		1 / 0			82 / 91	**90%**
6:45:01 PM	7:00:00 PM		39 / 39	13 / 22	1 / 0	3 / 0			2 / 1	0 / 1					58 / 63	**92%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		14 / 13	1082 / 1077	500 / 760	35 / 6	142 / 21	12 / 19	2 / 3	170 / 6	48 / 151	1 / 0	3 / 0			2009 / 2056	**98%**
		108%	**100%**	**66%**	**583%**	**676%**	**63%**	**67%**	**2833%**	**32%**	**#DIV/0!**	**#DIV/0!**			**98%**	

Table A-11. Site 5 Westbound – AVC/Video Classification Counts by 15-Minute Interval.

TIME \ CLASS		1	2	3	4	5	6	7	8	9	10	11	12	13		
START TIME	END TIME	Motor-cycles	Cars & SUVs (also with 1 or 2 axle trailer)	Pickups & Vans (also with 1, 2 , or 3 axle trailer)	2 or 3 axle Bus or RV	2 axle rigid truck (heavy goods veh.)	3 axle rigid truck (heavy goods veh.)	4+ axle rigid truck (heavy goods veh.)	Tractor trailer 3 or 4 axles	Tractor trailer 5 axles	Tractor trailer 6 axles	Tractor Multi trailer truck 4 or 5 axles	Tractor Multi trailer truck 6 axles	Tractor Multi trailer truck 7 or more axles	**VEHICLE COUNT TOTALS (AVC/VIDEO)**	
7:00:01 AM	7:15:00 AM															
7:15:01 AM	7:30:00 AM															
7:30:01 AM	7:45:00 AM															
7:45:01 AM	8:00:00 AM															
8:00:01 AM	8:15:00 AM		12 / 18	18 / 18	1 / 0	5 / 0	2 / 2			1 / 1					39 / 39	**100%**
8:15:01 AM	8:30:00 AM		12 / 16	12 / 22	2 / 1	13 / 1	1 / 2		2 / 0	2 / 2					44 / 44	**100%**
8:30:01 AM	8:45:00 AM		12 / 19	12 / 17		5 / 0	1 / 1		4 / 0	8 / 9	1 / 0				43 / 46	**93%**
8:45:01 AM	9:00:00 AM		11 / 13	10 / 12	2 / 1	5 / 0	0 / 1		5 / 0	3 / 6					36 / 33	**109%**
9:00:01 AM	9:15:00 AM	2 / 2	9 / 19	12 / 14		9 / 0	0 / 2		6 / 0	3 / 7					41 / 44	**93%**
9:15:01 AM	9:30:00 AM	0 / 6	13 / 15	13 / 12	2 / 1	6 / 1	1 / 0		2 / 0	4 / 6					41 / 41	**100%**
9:30:01 AM	9:45:00 AM		5 / 10	10 / 21		12 / 0			4 / 1	3 / 4					34 / 36	**94%**
9:45:01 AM	10:00:00 AM		13 / 17	14 / 16	1 / 0	5 / 0	1 / 1		5 / 0	2 / 4					41 / 38	**108%**
10:00:01 AM	10:15:00 AM		10 / 17	13 / 18	3 / 2	10 / 1	0 / 2		9 / 0	3 / 7					48 / 47	**102%**
10:15:01 AM	10:30:00 AM		13 / 20	12 / 13		9 / 1	0 / 1		2 / 0	3 / 3					39 / 38	**103%**
10:30:01 AM	10:45:00 AM	1 / 1	10 / 18	14 / 1	1 / 1	4 / 0	1 / 1		3 / 0	3 / 5	0 / 1				37 / 28	**132%**
10:45:01 AM	11:00:00 AM		14 / 24	17 / 20	1 / 1	13 / 0			3 / 0	1 / 3					49 / 48	**102%**
11:00:01 AM	11:15:00 AM		9 / 13	10 / 17		10 / 1			1 / 0	1 / 3					31 / 34	**91%**
11:15:01 AM	11:30:00 AM	1 / 1	16 / 27	20 / 14		6 / 0	0 / 1		5 / 0	1 / 4					49 / 47	**104%**
11:30:01 AM	11:45:00 AM		12 / 18	11 / 18		8 / 0			4 / 0	6 / 8					41 / 44	**93%**
11:45:01 AM	12:00:00 PM	1 / 1	16 / 28	14 / 19		11 / 0	1 / 1		6 / 0	7 / 8					56 / 57	**98%**
12:00:01 PM	12:15:00 PM		15 / 21	8 / 9		4 / 0	0 / 1		3 / 1	4 / 6					34 / 38	**89%**
12:15:01 PM	12:30:00 PM	1 / 0	21 / 29	17 / 18		12 / 1	2 / 1		7 / 0	2 / 8					62 / 57	**109%**
12:30:01 PM	12:45:00 PM	0 / 1	20 / 29	15 / 26	1 / 0	15 / 0	0 / 1		4 / 0	1 / 4					56 / 61	**92%**
12:45:01 PM	1:00:00 PM	1 / 0	18 / 29	12 / 16	2 / 0	12 / 3			4 / 0	3 / 5					52 / 53	**98%**
1:00:01 PM	1:15:00 PM	1 / 1	19 / 18	11 / 16		5 / 1	1 / 0		3 / 1	1 / 3					41 / 40	**103%**
1:15:01 PM	1:30:00 PM	1 / 1	13 / 18	9 / 17	2 / 0	17 / 1	2 / 2		3 / 0	4 / 6					51 / 45	**113%**
1:30:01 PM	1:45:00 PM	1 / 1	11 / 21	14 / 12		5 / 1			5 / 1	2 / 4					38 / 40	**95%**
1:45:01 PM	2:00:00 PM	1 / 1	15 / 22	14 / 26	2 / 1	14 / 1	2 / 0		3 / 1	0 / 5					51 / 57	**89%**
2:00:01 PM	2:15:00 PM		20 / 23	12 / 15	1 / 0	9 / 1			3 / 1	2 / 1					47 / 41	**115%**
2:15:01 PM	2:30:00 PM	1 / 0	17 / 28	19 / 17		8 / 0		0 / 1	3 / 1	3 / 2					51 / 49	**104%**
2:30:01 PM	2:45:00 PM	2 / 1	21 / 30	13 / 16		8 / 0	1 / 0			2 / 4					47 / 51	**92%**
2:45:01 PM	3:00:00 PM		17 / 23	9 / 12		9 / 0			5 / 1	0 / 2					40 / 38	**105%**
3:00:01 PM	3:15:00 PM		13 / 17	9 / 15	3 / 1	8 / 0	0 / 1		3 / 0	2 / 4					38 / 38	**100%**
3:15:01 PM	3:30:00 PM		25 / 40	16 / 23	1 / 0	16 / 0			5 / 0	0 / 6					63 / 69	**91%**
3:30:01 PM	3:45:00 PM		29 / 41	17 / 36	1 / 0	22 / 1			18 / 0	5 / 15					92 / 93	**99%**
3:45:01 PM	4:00:00 PM	2 / 2	29 / 42	17 / 15	0 / 1	9 / 0			4 / 0	1 / 4					62 / 64	**97%**
4:00:01 PM	4:15:00 PM	1 / 1	29 / 36	18 / 30	2 / 1	17 / 1			3 / 0	1 / 2					71 / 71	**100%**
4:15:01 PM	4:30:00 PM	1 / 1	23 / 38	22 / 27	0 / 1	17 / 0			3 / 0	0 / 1					66 / 68	**97%**
4:30:01 PM	4:45:00 PM		20 / 29	21 / 24		11 / 0			3 / 0						55 / 53	**104%**
4:45:01 PM	5:00:00 PM		36 / 51	39 / 46		20 / 0			5 / 0	0 / 4					100 / 101	**99%**
5:00:01 PM	5:15:00 PM	1 / 1	42 / 60	33 / 42	1 / 0	17 / 0	0 / 1		3 / 0						97 / 104	**93%**
5:15:01 PM	5:30:00 PM		59 / 69	32 / 41		20 / 0			5 / 0	2 / 4					118 / 114	**104%**
5:30:01 PM	5:45:00 PM	1 / 0	37 / 47	23 / 27	1 / 0	11 / 0	1 / 0		4 / 0	0 / 2					78 / 76	**103%**
5:45:01 PM	6:00:00 PM		36 / 48	26 / 30		16 / 0			6 / 0	1 / 6					85 / 84	**101%**
6:00:01 PM	6:15:00 PM		34 / 48	19 / 29	1 / 0	21 / 0			1 / 0	0 / 2		1 / 0			77 / 79	**97%**
6:15:01 PM	6:30:00 PM	1 / 1	21 / 31	20 / 25		13 / 0			3 / 0	1 / 1					59 / 58	**102%**
6:30:01 PM	6:45:00 PM		25 / 32	11 / 12		7 / 1			4 / 0	1 / 4					48 / 49	**98%**
6:45:01 PM	7:00:00 PM		22 / 35	18 / 16		9 / 1	1 / 1		2 / 0	1 / 2					53 / 55	**96%**
VEHICLE CLASS TOTALS (AVC/VIDEO)		21 / 23	874 / 1247	706 / 890	31 / 12	483 / 18	18 / 23	0 / 1	176 / 8	90 / 187	1 / 1	1 / 0			2401 / 2410	**100%**
		91%	**70%**	**79%**	**258%**	**2683%**	**78%**	**0%**	**2200%**	**48%**	**100%**	**#DIV/0!**			**100%**	

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