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NCHRP REPORT 571

Standardized Procedures for Personal Travel Surveys

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TRANSPORTATION RESEARCH BOARD

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Academies was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

The Transportation Research Board of the National Academies, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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COOPERATIVE RESEARCH PROGRAMS

FOREWORD

By Kimberly M. Fisher
Staff Officer
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Over the past 40 years, significant resources have been spent on collecting data for transportation planning. Often transportation agency staff and their consultants struggle with the difficulties of collecting and analyzing the survey data. The transportation planning and data communities have become increasingly concerned about declining response rates and potential sample biases in transportation surveys. Resources are potentially wasted because standards are lacking in both survey methods and assessment procedures. This report contains an assessment of the aspects of personal travel surveys that could be standardized, resulting in improvements to the quality, consistency, and accuracy of the resulting data.

The results of this research will be useful to transportation practitioners in state departments of transportation (DOTs) and in Metropolitan Planning Organizations (MPOs) for preparing statistically sound data collection and management programs.

Transportation surveys are the most typical way to obtain personal travel behavior information used by the transportation community. These surveys serve two primary roles within the transportation planning process: First, they describe travel trends to support understanding of demands on the transportation system and to identify areas in which problems can be expected. Second, they provide information for travel forecasting and other models that are used to identify potential long-term problems and to test the efficacy of proposed solutions.

There are no standards for determining what constitutes an acceptable level of quality or reliability in the conduct and evaluation of these surveys. Thus, the quality and design of the surveys may vary widely. Currently, there are no consistent, objective standards applied throughout the transportation community (a) to the survey data and (b) to the conduct, analysis, and application of surveys. Some degree of standardization can improve the consistency of transportation-planning data, the accuracy of models, and the quality of transportation decisions. Additionally, comparisons of travel from one metropolitan area to another are difficult because of the differences in survey methods.

The objective of this project was to develop standardized procedures for improving the conduct, evaluation, and reliability of personal travel surveys. The project identified and prioritized those survey procedures (e.g., selecting samples, reporting results, and editing data) within the personal travel survey process that lend themselves to standardization. It defined assessment measures (e.g., standard errors, confidence intervals, response rates, and response bias) for those procedures and identified costs and tradeoffs to improve the reliability of survey results. Finally, the project tested and evaluated proposed procedures and their relative effectiveness.

CONTENTS

Standardized Procedures for Personal Travel Surveys

Introduction

Over the past 40 years, many millions of dollars have been spent on collecting household or person-based data for transportation planning. For most metropolitan areas, the largest routine expenditure made from planning budgets is to conduct household or person travel surveys. In some cases, the metropolitan regions that commission travel surveys do not have staff with in-depth knowledge and experience in that field. As a result, some Metropolitan Planning Organizations (MPOs) are unable to make informed selections of consultants to perform surveys and are also unable to assess whether a useful product was obtained. Subsequent work in using the data often reveals serious flaws in the data that could have been avoided if there were either a sufficient availability of expertise at the MPOs or a set of clearly defined procedures that could be followed by an MPO in guiding the process, selecting consultants, and assessing the work that was done.

Some consultants who undertake such work are also unaware of the difficulties involved in data collection and have a lack of knowledge and expertise in various aspects of collection and assessment of the data that are apparent neither to them nor to the MPOs that may select them. They, too, could benefit from a set of standardized procedures and measures that would aid them in determining the type of survey to undertake, the methods to be implemented, and the means to assess whether the survey was being executed satisfactorily.

Metropolitan planning staffs generally believe that data collected in one region have little relevance to another region. While there is no doubt that there will be local issues that may make transfer of data difficult or inappropriate at times, the major reason for this perception is that because each household travel survey is usually sufficiently different in design and execution from any other survey, comparisons from region to region are completely obscured by differences in method and implementation. If consistent procedures were used in the collection of such data, many of the apparent differences between regions would disappear. In addition, there are often slight variations in question phrasing that are sufficient to introduce major barriers to comparing data; appropriate standardization could remove these barriers. This could also lead to a greater willingness of regions to borrow data from each other and, thus, reduce the overall necessity to expend so much on collection of new data. It would also help the recognition and capture of travel among regions and, of particular importance, would enable the relating of local to national surveys.

Report Purpose

This report presents the results of a study of those aspects of personal transportation surveys that could potentially be standardized—resulting in improvements to the quality,

consistency, and accuracy of the resulting data. The report is aimed at those who undertake personal and household transportation surveys, those who commission them, those who interpret and use the results of such surveys, and those who conduct research into improving methods for such surveys.

The report is organized into two main parts—*NCHRP Report 571,* the printed report, and *NCHRP Web-Only Document 93,* the technical appendix. *NCHRP Report 571* is organized as follows:

- **Chapter 1:** introduction.
- **Chapter 2:** recommendations for all parts of a personal or household travel survey that could be standardized or areas where guidelines can be put forward that would produce greater consistency.
- **Chapter 3:** outline of recommendations on how to implement the results of this research and move it out into practice.
- **Chapter 4:** outline of those areas that were considered by the research team or that arose during the research, but which could not be accomplished in this research project; these areas could add further standardized procedures and consistency guidelines to surveys in the future.
- **Chapter 5:** sample template for a Request for Proposals to conduct a household travel survey, incorporating all of the recommendations of Chapter 2.
- **Glossary:** terms used in surveys, sampling, and related areas, which should be helpful for those with less knowledge about surveys.

The Technical Appendix contains detailed descriptions of the research that was undertaken to develop the recommendations in this report, including the results of extensive literature reviews undertaken early in the project. An extensive set of references is provided at the end of the Technical Appendix, which is available on the TRB website as *NCHRP Web-Only Document 93* (http://trb.org/news/blurb_detail.asp?id=8858).

Practitioners (both those who commission and those who undertake surveys of household and person travel) will find Chapters 2 and 5 to be of most use to them. The transportation profession at large should also find Chapter 3 to be useful in terms of how to move these standardized procedures into broad use in the profession. Researchers will find Chapter 4 and the Technical Appendix to be of particular value. Those who are relatively less well acquainted with travel surveys should find the Glossary to be of help in understanding the report and its Technical Appendix.

Both Chapter 2 of this report and the Technical Appendix are organized according to the chronology of undertaking a household travel survey. Initially, each of these deals with design aspects of a survey (survey instruments and data collection procedures), then pilot surveys and pretests, followed by the actual implementation of the survey. Next, they deal with the coding of data, including aspects of geocoding, and the analysis and reporting of the data, including documentation and archiving. Finally, they deal with the assessment of survey quality. Chapter 2 and the Technical Appendix's Chapters 4–10 are organized in parallel, and each provides cross references to the other. Thus, if a reader is reviewing a section of Chapter 2 of this report and wishes to examine the research that led to the recommendations in Chapter 2, a reference to the appropriate section of the Technical Appendix is provided. Likewise, a reader reviewing the research that was undertaken in the Technical Appendix is provided a reference to the recommendations that were developed and are reported in Chapter 2 of the report. To avoid unnecessary repetition of material, the recommended standardized procedures and guidelines have not been repeated in the Technical Appendix.

Summary of Recommendations

It is important to understand what we mean by standardized procedures. Standardized procedures represent procedures that, if practitioners voluntarily adopt, will improve the consistency of household travel surveys. In many cases, adoption of these standardized procedures will also result in improvements to the quality of surveys and improve comparability between surveys. They will also improve the reliability of the data resulting from such surveys and increase the accuracy of what is measured. However, standardized procedures are also only guidance. It is not intended that they be followed slavishly, nor that they should stifle innovation and improvement in surveys. However, they may be extremely helpful to those who are less knowledgeable about surveys in improving their ability to do, manage, or contract for such surveys.

These are ***not*** standards, which would imply requirements, certification, and similar attributes. While standards may be desirable, they cannot be instituted without a body that will continually update them, ensure that they are being followed, and certify organizations as meeting the standards. There would also be a requirement for ongoing funding of such an activity.

The research studied 40 different aspects in designing, implementing, analyzing, reporting, and assessing household and personal travel surveys. In almost all of these 40 aspects, recommendations were developed on elements of the survey that could be standardized or guidelines that could be put forth to assist in achieving consistency in survey practice. In the area of survey design, these include a minimum set of questions that all such surveys should include, with standardized categories for recording responses to many of those questions, and suggested standardized wordings for asking some of the questions.

In the design of data collection procedures, the issues addressed cover the number and type of contacts that should be made with potential respondents; how to handle proxy reporting; how to define what is a complete household; how to replace sample losses resulting from refusals, terminations, and ineligibility; how to handle item non-response and unit non-response; how to make the initial contact, providing incentives; and how to measure and reduce respondent burden.

In the area of pilot surveys and pretests, the research covered the necessity of doing such surveys and the sample sizes required. In survey implementation, the report addresses the ethics of undertaking a survey of a human population, how to design mailing materials, how to handle respondent questions, how to handle various forms of call screening, and what to do when reaching an answering machine or receiving repeated requests for a call back. It also covers ways to minimize the incorrect reporting of no travel, how to record the time of day in the data, what time the diary day should begin and end, and how to create useful ID numbers.

In the area of data coding, two aspects of geocoding are addressed: with what precision should data be geocoded and what level of geocoding should be performed. This section also deals with how to handle missing values, when zeroes should be used, and some other fundamental aspects of assigning coding values; it also addresses how to code complex variables where different levels of detail may be required in different surveys but comparability is to be maintained.

In discussing data analysis and expansion, the report addresses how to assess and minimize sample bias, how to weight and expand the data to the full population, what to do about imputing missing data, and how to archive the data and provide comprehensive documentation of the survey.

Finally, in the section on assessing survey quality, the thorny issue of how to calculate the response rate is dealt with, including how to consistently code the outcomes of the various contacts made to potential and actual respondents. This section also discusses transportation measures of quality, such as trip rates and non-mobility rates, and also outlines a number of standard assessment procedures that are used broadly in surveys: coverage error, proxy reporting, validation statistics, data cleaning statistics, the number of missing values, and overall adherence to quality standards.

It is probably true that no household travel survey has ever incorporated all of the recommended standardized procedures and consistency guidelines outlined in this report. Unfortunately, it is also probably true that most household travel surveys have not incorporated most of these recommendations. However, if many of these were to be incorporated in future surveys, considerable gains would be possible in the overall comparability and quality of transportation surveys.

Future Research

In the chapter on future research (Chapter 4), another 30 aspects of the design and conduct of household travel surveys are identified as having potential for standardized procedures or consistency guidelines. These include emerging areas such as global positioning system surveys, Internet or web-based surveys, and the collection of stated preference data. There were also 18 aspects that were identified in the early stages of this research, but which were not researched because of lack of time or resources. These include issues relating to the design of data collection procedures, survey execution, sampling, pilot surveys and pretests, and quality assessment. Finally, there are 11 areas of research that were only identified during the course of this research because there was not sufficient time or resources to undertake all of the research that was desired (i.e., these would be an expansion on areas that were addressed partially) or that arose as a result of the research undertaken.

Sample Request for Proposals Template

The sample request for proposals (RFPs) template offers a template that embodies all of the recommendations made in Chapter 2, requiring the contractor to follow the standardized procedures and guidelines. Tables and specifications are taken from the text of Chapter 2 and embodied in the RFP document. Places where the document needs to have inserted items specific to the region seeking proposals for a household travel survey are clearly indicated.

Introduction and Research Approach

1.1 Background

Personal travel surveys have been conducted for over 40 years, but during that time no attempt has been made to standardize the process or to institute consistent practices of acceptable quality or reliability. Two TRB conferences—"Household Travel Surveys: New Concepts and Research Needs," in 1995 and "Information Needs to Support State and Local Transportation Decision Making into the 21st Century" in 1997 (TRB, 1996 and 1997)—and *NCHRP Synthesis of Highway Practice 236: Methods for Household Travel Surveys* (Stopher and Metcalf, 1996) emphasized the need for improved standardization in survey data collection. The contention is that standardization of the survey process can lead to efficiencies in the planning and execution of surveys, in the assessment of data quality, and in the comparison of data between one metropolitan area and another.

Over the past 40 years, many millions of dollars have been spent on collecting household or person-based data for transportation planning. For most metropolitan areas, the largest routine expenditure made from planning budgets is for the conduct of household or person travel surveys. In 1996, it was reported (Stopher and Metcalf, 1996) that the average survey cost was $400,000 for consultant services for the conduct of household travel surveys. Assuming that only half of the about 350 Metropolitan Planning Organizations (MPOs) in the United States conduct travel surveys within any decade, this represents a total expenditure of $74 million in a decade, or about $7.4 million per year. In spite of this huge level of activity and expenditure, there is no consistency in the process of executing surveys, nor are there recognized procedures for assessing the quality of the end product. Nevertheless, even larger sums of money are subsequently spent on developing and using travel-demand models based on these data and in investments into major capital projects, implementation of far-reaching policies, and other related decisions.

In some cases, the metropolitan regions that commission travel surveys do not have staff with in-depth knowledge and experience in that field. As a result, some MPOs are unable to make informed selections of consultants to perform surveys and are also unable to assess whether a useful product was obtained. Subsequent work in using the data for situation descriptions and modeling often reveals serious flaws in the data that could have been avoided if there were either a sufficient availability of expertise at the MPOs or a set of clearly defined procedures that could be followed by an MPO in guiding the process, selecting consultants, and assessing the work that was done. Some consultants who undertake such work are also unaware of the difficulties involved in data collection and have a lack of knowledge and expertise in various aspects of collection and assessment of the data that are apparent neither to them nor to the MPOs that may select them. They, too, could benefit from a set of standardized procedures and measures that would aid them in determining the type of survey to undertake, the methods to be implemented, and the means to assess whether the survey was being executed satisfactorily.

It has long been held by most metropolitan regions that data collected in one region has little relevance to another region. While there is no doubt that there will be local contextual issues that may make transfer of data difficult or inappropriate at times, the major reason for this perception is that each household travel survey is usually sufficiently different in design and execution from any other survey, the result of which is that comparisons from region to region are completely obscured by methodological and implementation differences. If consistent procedures were applied in the collection of such data, many of the apparent differences between regions may well disappear. In addition, there are often slight variations in question phrasing that are sufficient to introduce major barriers to comparing data; appropriate standardization could remove these barriers. This could also lead to a greater willingness of regions to borrow data from each other, and thus reduce the overall necessity to expend so much on collection of new data. It would also help the recognition and capture of travel among regions and, of particular importance, enable relating local to national surveys.

The issue of standardizing personal travel surveys was investigated in this study. This involved reviewing past practice, conducting analyses on data sets collected in past travel surveys, conducting new travel surveys, identifying individual aspects of personal travel surveys that potentially could be standardized, evaluating these candidate procedures, and then compiling a set of recommended standardized procedures. The execution of this process is documented in the following pages. Forty procedures in travel surveys are recommended for standardization in this study. An additional 20 were identified for possible standardization but were either considered to be less important than those selected or beyond the scope of the project. Included in the report is a sample Request for Proposals (RFPs) to assist metropolitan areas in commissioning travel surveys that are consistent with the proposed standardization.

1.2 Study Objectives

The objectives of this project are to develop recommended travel survey procedures that would lead to an overall increase in the quality and reliability of transportation surveys performed at household and person levels and would also improve the comparability between surveys. These recommendations will provide guidance on how to select cost effective survey methods, how to implement the survey, how to analyze the results, and how to report measures that allow the assessment of the quality of the data. By standardizing the travel survey process, comparability of data from place to place and time to time will be enhanced. The reliability of the data will be increased, and doubts as to the applicability of data should be able to be removed. It is also an objective of this research to identify the costs and tradeoffs for the procedures and assessment measures that are identified in this research and to establish whether specific procedures and assessment measures are cost-effective.

There can be negatives to standardization: namely, the stifling of innovation or the creation of stagnation in a field. Over the past 30 years, many changes have occurred in the conduct of personal travel surveys, and what constitutes *best* practice has clearly evolved during this time. If rigid standards had been applied early in this process, this evolution may well have been prevented from occurring. Indeed, imposition of rigid standards at the current stage of development of travel survey procedures would likely retard further development. On the other hand, survey practice has not evolved all that far during this period of open practice, and there are too many instances where surveys are conducted that repetitively perpetrate the same errors. In addition, travel survey professionals have often remained ignorant of developments and improvements from other fields of survey practice. Standardization might have prevented certain known pitfalls and errors and raised the average quality level of travel surveys. The research team was cognizant of these two aspects of standardization while developing the recommendations included in this research.

1.3 Scope

The research conducted in this study has focused on the design, execution, and management of personal travel surveys as conducted in the United States. This does not mean that survey practice in other countries was not considered nor that the experience of survey professionals in other countries was not drawn upon, but merely that standardizing personal travel surveys in the United States was the subject of research in this study. The study team included professionals from Germany, Austria, Canada, Australia, and the United States, and survey practice in these countries was considered in developing the recommendations included in this report.

The research included the review of past practice, the analysis of survey data, and the execution of special purpose data collection efforts to investigate specific issues. Of the research targeted at U.S. practice, the investigation involved review of more than 50 past surveys, analysis of travel survey data from 12 surveys conducted between 1990 and 2000, execution of a non-response survey, and execution of a survey to measure the impact on response rate and respondent satisfaction of a household having the same interviewer throughout the interview process. As implied by the title of the study, the research conducted in this study was limited to the consideration of personal travel surveys and excluded freight, vehicle, and inventory surveys.

All forms of reporting were considered in this study including mail, telephone, face-to-face interview, Internet, and instrumented surveys such as the use of global positioning system (GPS) devices in tracking vehicle and person movements. However, Internet and GPS surveys were considered beyond the scope of the study because they are a new and rapidly developing form of data collection that has not matured to the point where standardization or standardized procedures would be appropriate. Similarly, all data considered in this study have been of revealed travel behavior, rather than of stated behavior as typically collected in stated preference surveys. Stated preference surveys were also considered a developing field and not recommended for standardization in this study.

A sample RFP serves as a guide in the commissioning of future personal travel surveys. The sample RFP describes the scope of work recommended in a travel survey and the relationship between individual components of the survey process and the standardized procedures and measures recommended in this study.

1.4 Research Approach

The approach adopted in this study was to conduct the research in two consecutive phases. In the first phase, potential areas for standardization were identified, the level of effort to research each estimated, and a subset selected for potential work in the second phase. In the second phase, those areas selected for investigation were formulated into standardized procedures or guidelines, depending on the level of specificity thought to be appropriate. It must be stressed that it was not the intention in this study to establish standards. Rather, the goal of the study was to develop recommended standardized procedures or guidelines for consistent practice that agencies could require in the surveys conducted in their areas or that survey practitioners would voluntarily apply.

The research in this study was initiated by a literature review on personal travel surveys, as well as a review of relevant research and current practice of state Departments of Transportation (DOTs) and MPOs. Standardized procedures used or promoted by survey research organizations or associations—such as the Council of American Survey Research Organizations (CASRO), the European Society for Opinion and Marketing Research (ESOMAR), and the International Standards Organization (ISO)—were also reviewed.

The procedures and assessment measures were identified as candidate procedures for standardization in the study using information from two sources. First, candidate procedures and

measures were identified from the literature and practice review. Second, they were identified by considering the chronological steps in survey planning and execution, similar to that defined by Richardson et al. (1995) and shown in Figure 1. In reviewing each step of the process, the elements that appeared susceptible to standardization were identified based on the literature review, on team members' experience, and on the potential for standardization to aid or stagnate the design of personal travel surveys.

Once identified, the candidate procedures for standardization were evaluated. The criteria used to evaluate them included extent of current use, perceived value, affordability, common definition, uniform method of application, and whether there were interdependencies between the procedure or measure and other procedures or measures. Weights were assigned to the criteria, and each candidate procedure or measure was scored on the criteria. A total score for each candidate process was established by summing the product of the weight and score on each criterion. These scores were used to prioritize the candidate procedures for review in the remainder of the project.

Some survey procedures and assessment measures required no further work before being recommended as a standardized procedure, but most required further analysis to assess their effectiveness and applicability. Some procedures and measures were tested using existing data sets, such as the 1995 Nationwide Personal Transportation Survey (NPTS), or recent metropolitan travel surveys. Two surveys were specifically conducted to address issues that could not be answered using existing data. The first survey involved testing the impact of having the same interviewer (or at least a limited number of interviewers) deal with the same household throughout the survey. The results were compared with those using regular interviewing procedures where there was no attempt to keep the same interviewer in consecutive contact with the same household. The second survey involved undertaking a non-response survey to determine the probable reasons for refusing to respond or for terminating part way through the survey process. The results were used to suggest strategies that could be used to increase response rates by changing aspects of the design and conduct of the survey.
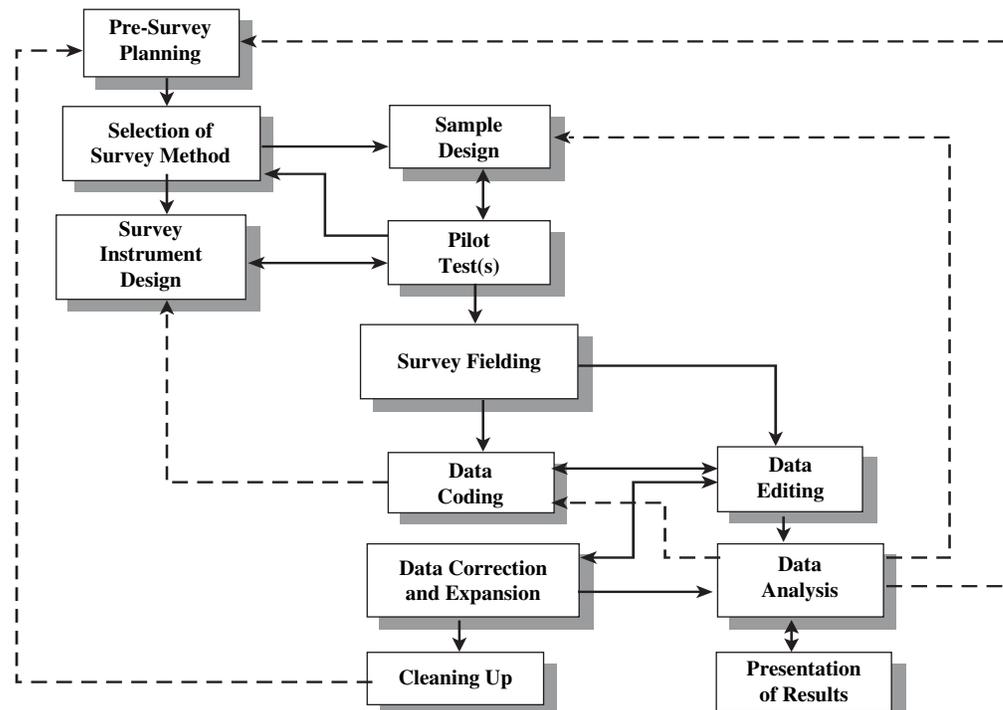
Figure 1.   The transportation survey process (Richardson et al., 1995).

The results of the study have been publicized and disseminated in several ways. First, *NCHRP Research Results Digest No. 261: The Case for Standardizing Household Travel Surveys* (TRB, 2002) was prepared to summarize the findings of Phase 1 of the project. It was distributed at the 2002 Annual Meeting of the Transportation Research Board and through the normal channels by NCHRP thereafter. The digest includes a list of candidate procedures and measures considered in Phase 2 of the project. Second, an interim report documenting Phase I of the project was completed in June 2001. Third, papers on results emerging from this study have been presented at several conferences (Alsnih and Stopher, 2004; Stopher, Wilmot, Stecher, and Alsnih, 2004; Nilufar and Wilmot, 2003; Stopher et al., 2004; Stopher and Wilmot, 2002). Last, the issue of identifying appropriate procedures for standardization of personal travel surveys was the topic of the first half of the 7th International Conference on Travel Survey Methods held in Costa Rica in August 2004. At the conference, the results of the NCHRP study were related to the delegates in a presentation and resource paper, and individual aspects of the travel survey process were discussed in eight workshop sessions.

It is expected that the information in this report will be useful to transportation practitioners in state DOTs and MPOs in preparing statistically sound data collection and management programs. It is also expected to be useful to travel survey professionals in designing their surveys, training their staff, managing the survey process, reporting the results, and archiving the data. The opportunity to compare results among travel surveys and to assess the potential of transferring data from one location and time period to another will be enhanced with the application of the recommendations in this report. At the same time, these recommendations should not prevent introduction of new procedures to thereby stifle innovation; a balance must be maintained between standardization and new development. Also, allowance should be made to amend or update the recommendations of this report as new and improved information is gained.

1.5 Report Organization

This report has been produced in two parts—*NCHRP Report 571,* the printed report, and *NCHRP Web-Only Document 93,* the technical appendix. *NCHRP Report 571* is organized as follows:

- **Chapter 1** is an introduction to research and an outline of the report.
- **Chapter 2** summarizes the recommendations that have been developed. The reader who desires to know why specific recommendations are made or what research and reviews were undertaken should consult Chapters 4–10 in the Technical Appendix.
- **Chapter 3** outlines recommendations for training and dissemination of the research results.
- **Chapter 4** provides a description of the areas that are recommended for further research for the development of standardized procedures in personal travel surveys.
- **Chapter 5** is sample template for RFPs that embodies all of the standardized procedures and guidelines that are summarized in Chapter 2.
- **Glossary** provides terms used in surveys.

The reference section contains references cited in this report. Intentionally, these have been kept to a minimum. An exhaustive set of references is to be found in Chapter 11 of the Technical Appendix. The Technical Appendix is available on the TRB website as *NCHRP Web-Only Document 93* (http://trb.org/news/blurb_detail.asp?id=8858).

Summary of Recommended Standardized Procedures and Guidelines

This chapter provides a summary of the recommended standardized procedures and guidelines detailed in Chapters 4–10 of the Technical Appendix, which is published on the TRB website as *NCHRP Web-Only Document 93*. The intention is to provide a practical, stand-alone guide that can be used by agencies in designing and implementing surveys. The chapter is arranged according to the original categories used to classify the items researched in the project and also follows the chronology of the development, design, and execution of a survey:

1. Design of survey instruments (see Chapter 4 of Technical Appendix);
2. Design of data collection procedures (see Chapter 5 of Technical Appendix);
3. Pilot surveys and pretests (see Chapter 6 of Technical Appendix);
4. Survey implementation (see Chapter 7 of Technical Appendix);
5. Data coding including geocoding (see Chapter 8 of Technical Appendix);
6. Data analysis and expansion (see Chapter 9 of Technical Appendix); and
7. Assessment of survey quality (see Chapter 10 of Technical Appendix).

It was not possible to recommend specific procedures for each item researched in this project because either there was insufficient information available or the amount of research required for a particular task proved to be much greater than originally anticipated. In light of this, broad guidelines were often recommended rather than specific standardized procedures. In certain cases, however, it was not even possible to recommend guidelines. Table 1 shows the type of recommendation made for each item examined in this project.

The following sections provide a brief description of each item and summary of the recommended standardized procedures and guidelines in point form. Chapters 4–10 of the Technical Appendix provide more detailed information on the methods used to determine the procedures recommended in this project.

This report provides recommendations on standardized procedures and guidelines. Standards are a formal controlling process, with the requirement that they must be implemented as a minimum requirement. If there were an agency that could take on the establishment of standards for household and personal travel surveys, then it would be a task of that agency to develop a set of standards. On the other hand, standardized procedures represent people doing the same thing consistently. There is no mandatory imposition of these; they are adopted voluntarily in the interests of improving quality, accuracy, and comparability. The purpose of this project was to identify those elements of the travel survey process that could be standardized to improve the quality, accuracy, and comparability of the results of personal travel surveys. Thus, the recommendations in this report are of procedures that could be adopted consistently by all those who design, develop, execute, and commission surveys to bring consistency into the way in which such surveys are done. In addition, in some areas where it was not found possible to put forward suggestions for standardized procedures, the report offers guidelines or guidance on how a particular element of a person travel survey might be handled.

Table 1.   Summary of items examined in project.

Categories	Ref	Item	Type of Recommendation	Section
Design of Survey Instruments	I-1	Minimum Question Specification	Standardized Procedures	2.1.1
	I-2	Standardization of Categories	Standardized Procedures	2.1.2
	I-5	Standard Question Wordings	Standardized Procedures	2.1.3
Design of Data Collection Procedures	D-1	Number and Type of Contacts	Standardized Procedures	2.2.1
	D-3	Proxy Reporting	Standardized Procedures	2.2.2
	D-4	Complete Household Definition	Standardized Procedures	2.2.3
	D-6	Sample Replacement	Guidelines	2.2.4
	D-7	Item Non-response	Standardized Procedures	2.2.5
	D-8	Unit Non-response	Standardized Procedures	2.2.6
	D-10	Initial Contacts	More Research	2.2.7
	D-13	Incentives	Guidelines	2.2.8
	D-14	Respondent Burden	Standardized Procedures	2.2.9
Pilot Surveys and Pretests	P-2	Requirements for Pretests or Pilots	Standardized Procedures and Guidelines	2.3.1
	P-3	Sample Sizes for Pretests and Pilots	Standardized Procedures	2.3.2
Survey Implementation	E-2	Ethics	Standardized Procedures	2.4.1
	E-3	Mailing Materials	Standardized Procedures	2.4.2
	E-4	Respondent Questions	Standardized Procedures	2.4.3
	E-5	Caller ID	Standardized Procedures	2.4.4
	E-9	Answering Machines and Repeated Call-Back Requests	Standardized Procedures	2.4.5
	E-10	Incorrect Reporting of Non-Mobility	Standardized Procedures	2.4.6
	E-11	Recording Time of Day	Standardized Procedures	2.4.7
	E-12	Time of Day to Begin and End Reporting	Standardized Procedures	2.4.8
	E-13	Creation of Identification Numbers	Standardized Procedures and Guidelines	2.4.9
Data Coding Including Geocoding	C-1	Geocoding Standards	Standardized Procedures	2.5.1
	C-2	Level of Geocoding to be Performed	Standardized Procedures	2.5.2
	C-4	Missing Values, Use of Zero, Etc.	Standardized Procedures	2.5.3
	C-5	Coding Complex Variables	Standardized Procedures and Guidelines	2.5.4
Data Analysis and Expansion	A-1	Assessing Sample Biases	Standardized Procedures	2.6.1
	A-2	Weighting and Expansion of Data	Standardized Procedures	2.6.2
	A-3	Missing Data Imputation	Standardized Procedures	2.6.3
	A-4	Data Archiving	Standardized Procedures	2.6.4
	A-6	Documentation	Standardized Procedures	2.6.5
Assessment of Survey Quality	Q-1	Computing Response Rates	Standardized Procedures	2.7.1
	Q-2	Transportation Measures of Quality	Standardized Procedures	2.7.2
	Q-3	Coverage Error	Standardized Procedures	2.7.3
	Q-5	Proxy Reporting as a Quality Indicator	Standardized Procedures	2.7.4
	Q-6	Validation Statistics	Standardized Procedures	2.7.5
	Q-7	Data Cleaning Statistics	Standardized Procedures	2.7.6
	Q-8	Number of Missing Values	Standardized Procedures	2.7.7
	Q-9	Adherence to Quality Guidelines	Standardized Procedures	2.7.8

In making these recommendations, it is also hoped that those who are less well-informed will find this to be a useful way to define how a survey might be done that would meet current expectations of quality, accuracy, and comparability. To this end, also, an RFP template has been developed that incorporates the majority of the suggested standardized procedures. To be consistent with normal RFP language, the narrative is written in prescriptive language. This should not be misinterpreted by the casual reader as implying establishment of standards; rather, it is simply a way of presenting an RFP in its normal form.

2.1 Design of Survey Instruments

2.1.1 I-1: Minimum Question Specification

This item addresses the issue of the *minimum* question content of a household or personal travel survey. It covers what is considered to be essential information about the demographics

of the household and its members, the attributes of the vehicles owned, and the attributes of the travel and activities that are recorded by household members.

Based on the discussion in Section 4.1 of the Technical Appendix, the recommended minimum question specifications are shown in Table 2. These represent the minimum set of questions recommended in all future household travel surveys. Additional questions may be asked in many surveys, however. For example, income is not included for reasons that are discussed in Section 4.1 of the Technical Appendix. Many recent surveys would not conform to this specification, which is also indicative of the problems of comparability and completeness in current surveys.

2.1.2 I-2: Categories for Minimum and Other Questions

For the minimum questions suggested in the preceding question, a number are subject to considerable variability in the categories that might be used to record the data. Proposing a set of standardized categories for those questions and also for one or two other questions that are likely to be included in many surveys would seem useful in pursuing the goal of improving comparability, accuracy, and quality. The variables selected for standardization of categories are type of dwelling (H2), relationship (H4), housing tenure (H7), education level attained (P10), disability (P11), race (P12), vehicle body type (V1), vehicle ownership (V5), trip purpose (A2), means of

Table 2.   Recommended minimum question specifications.

Category	*Ref.*	*Item*	*Description*
Household	H1	Location	Home address or home position in geographic terms
	H2	Type of Building	Detached, semi-detached, terraced, flat, etc.
	H3	Household Size	Number of household members
	H4	Relationships	Matrix of relationships between all members of the household
	H6	Number of Vehicles	Summary of number of vehicles from vehicle data
	H7	Housing Tenure	Own or rent status
	H8	Re-contact	Willingness to be contacted again for further surveys, etc.
Personal	P1	Gender	
	P2	Year of Birth	(Preferable to requesting age)
	P4	Paid Jobs	Number of paid positions and hours worked at each in the past week
	P6	Job Classification	Employee, self-employed, student, unemployed, retired, not employed, etc.
	P7	Driving License	Whether a current drivers license is held
	P8	Non-mobility	Indication of why no out-of-home activity was performed on a survey day including work-at-home days
	P10	Education Level	Highest level of education achieved
	P11	Disability	Types of mobility disability, both temporary and permanent
	P12	Race[a]	Defined as currently measured in the U.S. Census
	P13	Hispanic Origin	Defined as currently measured in the U.S. Census
Vehicle	V3	Body Type	e.g., car, van, RV, SUV, etc.
	V4	Year of Production	
	V5	Ownership of Vehicle	Household/person, lease, institution
	V6	Use of Vehicle	Main user of vehicle
Activity	A1	Start Time[b]	
	A2	Activity or Purpose	
	A3	Location	Where the activity was performed, unless traveling
	A4	Means of Travel	If activity is travel, what mode(s) was used (including specifying if a car passenger or driver)
	A5	Mode Sequence	Unless collected as fully segmented data
	A6	Group Size	Number of persons traveling with respondent as a group
	A7	Group Membership	Number of persons in the group who live in respondent's household
	A8	Costs	Total amount spent on tolls, fares, and respondent's share
	A9	Parking	Amount spent to park

[a] All surveys would use the U.S. Census Bureau definition of Race and Hispanic Origin.
[b] Only start time needs to be ascertained in a time-use or activity survey because, by definition, the start time of an activity is the end time of the previous activity. Only the last activity should need an end time. In a trip-based survey, start and end time should be included.

travel (A4), fuel type, and employment status. Most of the other questions either do not require categories or the categories are self evident and already standardized (e.g., gender [P1]). More details concerning this issue are to be found in Section 4.2 of the Technical Appendix.

To devise recommended standardized categories, definitions of seven international statistical agencies for the specific variables were looked at and compared with the seven data sets examined as well as two other survey definitions. The results are shown in Table 3. Where less detail is desired, the primary categories are recommended to be used and these should suffice in the majority of surveys; where more detail is required, the secondary categories should be used. It is also possible to selectively add secondary categories—for example, housing tenure might be used with Categories 1, 2, 31, and 32, if the additional level of detail were desired only for Category 3. Similar mixing of category levels could be used with any of the variables in Table 3—for example, splitting rail (A4-71) into different submodes in an area such as New York may be desirable.

Standardization of the activities to be included in designs that provide an activity list would also be useful and has been requested by some professionals involved in transportation surveys. The grouping of activities into common trip purpose–related categories would also be a useful element of this aspect of standardization. This is addressed in Section 2.5.4.

2.1.3 I-5: Standard Question Wordings

To permit comparisons across surveys conducted in different locations at different times, it is essential that certain key questions be asked in the same manner. It is also important that the question wording or response definitions in a local survey be consistent with the wording (and definitions) used in a national survey or census, especially for variables that may serve as the basis for sampling, expansion, and checking for bias. Again, the focus of this issue is the minimum questions proposed in Section 2.1.1, but with the addition of some other questions that are frequently used in travel surveys, such as income. Only those questions where the wording is not necessarily self-evident and where variations that could affect the responses given are offered for standardization in Table 4. Details on this issue are provided in Section 4.3 of the Technical Appendix.

2.2 Design of Data Collection Procedures

2.2.1 D-1: Number and Type of Contacts

This issue relates to the number of times and the manner in which households should be contacted to obtain complete household responses. In terms of recruitment, the question arises as to the number of times a household should be contacted to obtain a complete recruitment response, especially if initial contact results in the household requesting to be called back or simply a non-contact (answering machine, busy, and modem/fax). Analysis conducted as part of this project and results from previous studies (which are described in Section 5.1 of the Technical Appendix) indicate that there is no significant reduction in non-response bias if more than six attempts are made to call a household during either recruitment or retrieval. There are also no real changes in the conversion to complete interviews for households that requested to be called back or that were not contacted initially.

The following standardized procedures are recommended to be followed:

1. *A survey should include the use of reminders,* which should be planned and programmed in the initial stages of the survey. The form of the reminders will depend on the methods used for the survey. However, some mix of telephone, mail, and e-mail reminders would normally be appropriate.

Table 3. Recommended standardized categories.

Variable	Primary Category	Code	Secondary Category	Code
Type of Dwelling (H2)	Single family house detached	1	Single family house detached	10
	Single family house attached	2	Townhouse	21
			Row house	22
			Duplex	23
			Triplex/fourplex	24
			Apartment/mother-in-law suite	25
	Apartment/condominium	3	Condominium	31
			Rented apartment	32
	Mobile home/trailer	4	Mobile home	41
			Trailer/camper	42
	Dorm/group quarters	5	Dormitory	51
			Hostel	52
			Nursing home	53
			Military barracks	54
	Hotel/motel	6	Hotel/motel	60
	Other	9	Other	90
Relationship (H4)	Self	1	Self	10
	Spouse/partner	2	Husband/wife	21
			De facto husband/de facto wife	22
	Son/daughter	3	Natural son/daughter	31
			Adopted son/daughter	32
			Stepson/stepdaughter	33
			Son-in-law/daughter-in-law	34
	Father/mother	4	Natural father/mother	41
			Adopted father/mother	42
			Stepfather/stepmother	43
			Father-in-law/mother-in-law	44
	Brother/sister	5	Natural brother/sister	51
			Adopted brother/sister	52
			Stepbrother/stepsister	53
			Brother-in-law/sister-in-law	54
	Grandfather/grandmother	6	Paternal grandfather/grandmother	61
			Maternal grandfather/grandmother	62
	Grandchild	7	Grandson	71
			Granddaughter	72
	Other relative	8	Male	81
			Female	82
	Not related	9	Boarder	91
			Housemate/ room mate	92
			Other non-relative	93
Housing Tenure (H7)	Own	1	Owned with mortgage	11
			Owned without mortgage	12
	Rent	2	Rent paid	21
			Occupied without rent	22
	Provided by job/military	3	Provided by job	31
			Provided by military	32
Education Level (P10)	No school completed	1	No school completed	10
	Elementary school	2	Preschool/nursery	21
			Kindergarten–4th grade	22
	High school	3	5th–8th grade (junior high)	31
			9th–12th grade (no diploma)	32
			High school diploma	33
	College/university	4	Some college but no degree	41
			Associate degree in college	42
			Bachelor's degree	43
	Post graduate studies	5	Some graduate school, no degree	51
			Master's degree	52
			Professional school degree	53
			Doctorate degree	54
Disability (P11)	Difficulty standing	1	Difficulty standing	10
	Difficulty climbing	2	Difficulty climbing	20
	Visually impaired/blind	3	Visually impaired/blind	30
	Hearing impaired/deaf	4	Hearing impaired/deaf	40
	Require wheelchair	5	Require wheelchair	50
	Require cane/walker	6	Require cane/walker	60
	Other (specify)	9	Other (specify)	90

Table 3.   (Continued).

Variable	Primary Category	Code	Secondary Category	Code
Race (P12)	White (alone)	1	White (alone)	10
	Black/African American (alone)	2	Black/African American (alone)	20
	American Indian/Alaskan Native (alone)	3	American Indian	31
			Alaskan Native	32
	Asian (alone)	4	Asian Indian	41
			Chinese	42
			Filipino	43
			Japanese	44
			Korean	45
			Vietnamese	46
			Other Asian	47
	Native Hawaiian or Pacific Islander (alone)	5	Native Hawaiian	51
			Guamanian or Chamorro	52
			Samoan	53
			Other Pacific Islander	54
	Some other race (alone)	6	Some other race (alone)	60
	Two or more races	7	Two or more races	70
Vehicle Body Type (V1)	Auto	1	Auto	10
	Van	2	Van	20
	Recreational vehicle (RV)	3	Recreational vehicle (RV)	30
	Utility vehicle	4	Utility vehicle	40
	Pick-up truck	5	Pick-up truck	50
	Other truck	6	Other truck	60
	Motorcycle	7	Motorcycle	70
	Other (specify)	9	Other (specify)	90
Vehicle Ownership (V5)	Household member owned or leased	1	Household member owned or leased	10
	Employer owned or leased	2	Employer owned or leased	20
	Other (specify)	3	Other (specify)	30
Trip Purpose (A2)	Home	1	Home – domestic activity	10
			Home – paid work	11
	Work and work-related	2	Main job	21
			Other job	22
			Volunteer work and community services	23
			Looking for work	24
	Education/childcare	3	Attendance at childcare	31
			Attendance at school	32
			Attendance at college	33
	Eating out	4	Restaurant/café	41
			Fast food	42
			At friends' home	43
	Personal business/medical	5	Availing of/shopping for administrative services	51
			Availing of/shopping for professional services	52
			Availing of/shopping for government/public services	53
			Availing of/shopping for personal services	54
			Availing of/shopping for medical and health care services	55
	Shopping	6	Purchasing food and household supplies (groceries)	61
			Purchasing clothes, shoes, personal items	62
			Purchasing household appliances, articles, equipment	63
			Purchasing capital goods (cars, houses etc.)	64
			Comparison shopping	65
			Window shopping	66
	Social/recreational	7	Communication/ correspondence	71
			Socializing activities	72
			Participating in religious/community/cultural events/activities	73
			Visiting entertainment and cultural venues	74
			Indoor and outdoor sporting activities	75
			Games/hobbies/arts/ crafts	76
			Print/audio/visual media	77

Table 3.   (Continued).

Variable	Primary Category	Code	Secondary Category	Code
	Accompanying others/travel related	8	Accompanying children to places	81
			Accompanying adults to places	82
			Pick up or drop off other people/get picked up or dropped off (private car, car/van pool, shuttle/limousine)	83
			Activities related to bus, public transit and group rides (except car/van pool and shuttle/limousine)	84
			Change travel mode	85
	Other (specify)	9	Not further defined (n.f.d.)	90
Means of Travel (A4)	Car/van/truck driver	1	Car driver	11
			Van driver	12
			Truck driver	13
	Car/van/truck passenger	2	Car passenger	21
			Van passenger	22
			Truck passenger	23
	Motorcycle/moped	3	Motorcycle	31
			Moped	32
			Scooter	33
	Bicycle	4	Bicycle	40
	Walk/wheelchair	5	Walk	51
			Skate/roller skate/ roller board	52
			Motorized wheelchair	53
			Non-motorized wheelchair	54
	Bus/school bus	6	Regular bus	61
			Intercity bus	62
			Express bus	63
			School bus	64
	Train	7	Train	71
			Trolley/streetcar	72
	Taxi/shuttle	8	Taxi	81
			Shared-ride taxi/jitney	82
			Commuter van/shuttle bus: employer paid	83
			Commuter van/shuttle bus: pay fare	84
			Dial-a-Ride	85
			Shuttle/limousine	86
	Other (specify)	9	Other (specify)	90
Fuel Type	Gasoline	1	Gasoline	10
	Diesel	2	Diesel	20
	LPG/LNG	3	LPG/LNG	30
	Dual Fuel	4	Dual Fuel	40
	Other (specify)	9	Other (specify)	90
Employment Status	Full-time	1	35–45 hours	11
			46–55 hours	12
			Greater than 56 hours	13
	Part-time	2	Less than 20 hours per week	21
			Greater than 20 hours per week	22
	Retired	3	Retired	31
			Semi-retired	32
	Full-time homemaker	4	Full-time homemaker	40
	Unemployed seeking employment	5	Unemployed seeking employment	50
	Unemployed not seeking employment	6	Unemployed not seeking employment	60
	Full-time student	7	Full-time student	70
	Child not in school/infant*to be specified if skip mechanism not in place	8	Child not in school/infant*to be specified if skip mechanism not in place	80
	Volunteer work (unpaid)	9	Volunteer work (unpaid)	90

Table 4.   Recommended standardized question wordings.

Question	Recommended Question Wording
Household Size (H3)	"Including yourself, how many people live at this address? Please do not include anyone who usually lives somewhere else or is just visiting, such as a college student away at school. (If further clarification is needed, include infants and children, live-in domestic help, housemates, roomers.)"
Number of Vehicles (H6)	"How many vehicles are owned, leased, or available for **regular use** by the people who currently live at this address? Please be sure to include motorcycles, mopeds and RVs." (As clarification, regular use means "are in working order.") It is recommended that travel surveys include a separate question regarding the availability of bicycles for daily travel: "How many bicycles in working condition are available to members of your household for use in their daily travel?"
Owner or Renter Status (H7)	"Do you own or rent your home? 1 Own/buying (e.g. paying off a mortgage) 2 Rent/lease or 3 Provided by job or military"
Gender (P1)	"Are you (is this person) male or female?"
Disability (P11)	A question should be asked about disabilities that impact travel. "Do you have a disability or condition that has lasted 6 or more months and which makes it difficult to go outside the home alone—for example, to shop or visit a doctor's office?"
Activity or Trip Purpose (A2)	For work or work-related activities: • Volunteer work should be specifically excluded from the definition; • The clarification should be added that work means work for pay or profit; and, • Questions should be asked about a second job. When asking for activities, at a minimum include a category "Other at-home activities." Advanced practice is to ask separately for activities that could be performed either at or away from home, such as meals, work, shopping (using the Internet).
Number in Traveling Party (A6)	"Including yourself, how many people were traveling with you? How many of these were household members?" If computer-assisted telephone interviewing (CATI) is used, it is suggested that the follow-up question regarding number of household members only be asked when the household size is greater than one. At a minimum, the number in the traveling party should be asked whenever a private car, van, or truck is the mode of travel.
Income	"Please stop me when I get to the category that best describes the total combined income for everyone living at this address for last year:" Income response categories should match the start and end points used by the U.S. Census, although collapsing across income categories is acceptable. See Section 2.5.4.

2. *A schedule of contacts and reminders, based on Table 5, should be put in place* for a household travel survey, at least up to Step 6. The use of the reminders to Step 11 should be recommended except where response rates have already fallen below the point of cost effectiveness for further reminders.

3. *The number of attempts to call back to a household that is not reached on the first call or where a request is made for a call back should be limited to five* (i.e., a maximum of a total of six calls made to a household). These call-back attempts should be made at different times on different days of the week. This would apply separately to the initial attempt at recruitment and to the attempt to retrieve data.

2.2.2 D-3: Proxy Reporting

In surveys that use telephone or personal interviews as the method to retrieve completed data, there is a continual issue regarding who provides the activity or travel information: the person performing the activity or travel (direct respondent) or someone else. Those instances in which

Table 5.   Recommended schedule of contacts and reminders.

Step	Day	Contact Type	Content	Received by Household
1	Advance letter (R – 7)	Mail	Pre-notification letter	A week before recruitment is scheduled to commence
2	Recruitment (R)	Telephone	Recruitment interview	Recruitment day
3	R+1	Mail	Survey package sent out	R+3 to R+5
4	Day before diary day (D – 1)	Telephone	Pre-diary day reminder (motivation call)	D-1
5	D+1	Telephone	Reminder to return completed survey (motivation call)	D+1
6	D+2	Mail	Postcard reminder/reset of diary day to D+7	D+4 to D+6
7	D+6	Telephone	Reminder and check on second opportunity for diary day	D+6
8	D+9	Mail	Postcard reminder and reset of diary day to D+14	D+11 to D+13
9	D+13	Telephone	Reminder and check on third opportunity for diary day	D+13
10	D+15	Mail	Re-mailing of survey package and reset of diary day to D+21	D+17 to D+19
11	D+20	Telephone	Reminder and check on fourth opportunity for diary day	D+20

the activities or travel are reported by someone other than the person who actually performed the activity are referred to as having been reported by "proxy." There is a relatively large body of research that concurs that the number of trips is lower when reported by proxies. Analysis of this issue is reported in detail in Section 5.2 of the Technical Appendix.

It is recommended that all surveys, at a minimum, establish the following policies with regard to proxy reporting:

1. For all persons, include a code for whether the activity/travel report was provided directly by the individual conducting the activities or travel, or by a proxy.
2. For persons aged 14 and under, require parental or other adult proxy reporting.
3. For persons aged 15 to 17, permit proxy reporting unless the individual is available to report their activities directly with parental permission.
4. All persons aged 18 or older should be asked directly for their activities or travel.
5. The survey methods report should include the percent of adult respondents (persons aged 18 or older) whose activities or travel were reported by proxies (regardless of whether a completed diary was available), excluding from the denominator persons who were physically or mentally unable to provide direct reporting at the time of retrieval (illness, incapacitation, etc.). See also Section 2.7.4.
6. Establish a calling protocol that requires at least one call back attempt to obtain a direct report from each adult household member aged 18 or older.

Once sufficient surveys have been conducted using these guidelines, it may be possible to develop factors to adjust for under- or over-reporting by proxies of certain types of trips.

2.2.3 D-4: Complete Household Definition

The definition of what is a complete household is important because it determines when the sample size specified for a survey is met. There is considerable variability in what has been used as the definition in past household travel surveys: some surveys specifying that every member of the household must complete travel information and personal details for the household to be considered complete, while others specify that only 50% of household members have to complete the survey for the household to be considered complete. There are important trade-offs in this. The more stringent definitions will lead to many households being excluded, especially large

households, with potential sample biases arising. On the other hand, too lenient a definition will likely result in poor estimation of household travel. Further discussion of this is to be found in Section 5.3 of the Technical Appendix.

The following standardized procedures are recommended:

1. At least key household, person, and vehicle information be obtained. In other words, the minimum set of questions outlined in Section 2.1.1 of this report should be answered for a household response to be considered acceptable or valid. Other key information may also be required for the response to be considered complete, but this is dependent on the specific objectives of the survey.
2. At least an adult from every age group represented in the household, as well as younger household members if eligible, should complete the trip/activity data items specified in Section 2.1.1. These age groups may be the following:
   - 15–17 (if household members under the age of 18 are eligible),
   - 18–64 years,
   - 65–74 years, and
   - over 74 years.
3. For the last three age groups, proxy reports should not count towards determining completeness of the household.
4. Partial responses should not be eliminated from the data set. Partial information can be useful and these households may be re-contacted in various follow-up exercises. Complete person information from incomplete households can be used in various applications. Also, it is a waste of resources to remove households from the data set. This is important given increasing survey costs.

2.2.4 D-6: Sample Replacement

Refusals result in lost sample and require some sample make up or replacement. Procedures for sample replacement are critical in preserving the integrity of the initial sample. Two questions arise:

1. When should a sampled household or person be considered non-responsive and a replacement make-up household or person be selected?
2. How should replacements for the sample be provided?

Detailed discussion of this issue is to be found in Section 5.4 of the Technical Appendix.

The following standardized procedures are recommended:

1. *Conduct a pilot survey.* A pilot survey should be conducted to enable the estimation of the expected non-response rate. This will help with developing the required sample size. (See also Section 2.3.1 of this report.)
2. *Draw a large initial sample.* To overcome unanticipated sample loss, it is suggested that the initial sample that is drawn be much larger than the final required sample, taking into account the expected non-response rate, and then increasing beyond this to allow for unforeseen problems.
3. *Preserve the draw order of numbers.* The order in which numbers are drawn needs to be preserved and contact made strictly in that order. For example, for a random digit dialing (RDD) list, numbers listed later in the list should not be recruited before numbers listed earlier in the list have either been recruited or discarded.
4. *Create additional sample.* If using RAND (RAND Corporation, 1955) random numbers, additional sample may be created and drawn after the initial sample has been exhausted. If using RDD lists, this should not be done because the two random samples will not be related and bias may be introduced.

5. *Conduct refusal conversion.* Refusal conversion should be conducted, with a maximum of five attempts to convert initial soft refusals. This recommendation is also stated for initially non-contactable households and is shown in Section 2.2.1 of this report.

2.2.5 D-7: Item Non-Response

Item non-response has been defined as either the failure to obtain an answer to a specific question or the failure to obtain a true and complete answer. Thus, item non-response occurs not only as a result of data being missing but also when incorrect data are provided. Invalid data are data items whose values are beyond the possible or feasible range of that item. Inconsistent data are data items whose values are inconsistent with the values of other data items of the respondent.

Item non-response is closely linked to several other items discussed in this report. First, it is linked to the definition of a complete household addressed in Section 2.2.3 because it is only when item non-response is within tolerable limits that a responding household is considered complete. Second, it relates to survey design and survey execution because the form in which the questions are posed and the manner in which the survey is conducted are known to have a significant impact on item non-response. A more detailed discussion of this issue is to be found in Section 5.5 of the Technical Appendix.

The overall approach should be that item non-response should be minimized by good survey design and good survey execution. To achieve this, the following standardized procedures are recommended:

1. For CATI, computer-assisted personal interviewing (CAPI), and Internet surveys, administration of the survey should be programmed to require that a response is obtained on each item.
2. Mail-back surveys should be edited immediately upon receipt so that respondents can be re-contacted to query missing or incorrect data items while the survey is still fresh in their memory.
3. Item non-response should be considered to include items where values are missing, where the respondent has indicated that they "don't know," and where the respondent has refused to answer.
4. An overall estimate of item non-response should be obtained from the level of non-response on each of the following items:
    - Travel mode;
    - Driver license status;
    - Start time and end time of trip *or* travel time of trip (if only travel time of trip is reported); and
    - Vehicle occupancy.

A statistic, which is the average item non-response among the above items, should be used as the overall measure of non-response in the data and should be expressed as a percentage.

2.2.6 D-8: Unit Non-Response

There are two broad categories of unit non-response: refusals (hard refusals, soft refusals, and terminations) and non-contacts (for CATI surveys, these are busy, no reply, and answering machines). High rates of unit non-response are generally associated with non-response error. Non-response error is a function of the non-response rate and the difference between respondents and non-respondents on any statistic of interest. A lower unit non-response rate is desired because this reduces the incidence of non-response bias. This issue is discussed at length in Section 5.5 of the Technical Appendix, together with the results of a non-response survey conducted as part of this research.

Unit non-response is a significant and growing problem in household travel surveys. A number of standardized procedures and guidelines are recommended as a means to attempt to reduce this phenomenon. Some of these overlap or duplicate those found elsewhere in this report. The following standardized procedures are recommended:

1. *Use pre-survey monetary incentives.* The positive effect of incentives has been clearly demonstrated in the research reviewed and undertaken here. In contrast to the findings of Section 2.2.8, it appears that larger incentives may be required to convince those who usually refuse or terminate the survey to complete it. This may require a second round of attempts to convert non-responders to responders in which a higher incentive is offered to induce conversion.

2. *Use a pre-notification letter and reminders.* Special care is required in formulating the pre-notification letter so that it is simple in language, appealing to a wide range of people, and clearly sets forth the importance of responding. Care must also be taken in determining who should sign the letter and in the affiliations shown in the letterhead used.

3. *Special train interviewers.* Where interviewers are used, special training of interviewers has been shown to have substantial effects on response. Therefore, considerable effort should be paid to developing thorough and complete training of interviewers.

4. *Increase efforts to contact households that are difficult to contact.* This may be done by increasing the number of calls for non-contacted units, designating specific times to call non-contacted units, expanding the data collection period, and conducting face-to-face interviews.

5. *Undertake non-response surveys.* Non-response surveys should be undertaken as a standard element of all household travel surveys, rather than as the exception that is the present situation.

The following guidance is also offered, based on the research undertaken on this topic:

1. *Efforts should always be undertaken to reduce respondent burden* in the design of any survey. This often has more to do with the ease with which people can complete the survey task than the actual length of the survey per se.

2. *Shorter surveys should be used wherever possible.* This raises difficult issues as the need for more detailed data emerges in the transportation profession. Pilot surveys offer a useful mechanism for testing alternative designs, and focus groups should also be used in the design process to determine how to make a survey design shorter while still being effective.

3. *Options should be provided on how and when to respond.* These options appear likely to increase the number of terminators who will complete the survey. However, more research is needed on the effect of mixed-mode surveys.

2.2.7 D-10: Initial Contacts

The subject of this section is the first contact made with a potential respondent in a survey. Contact can be by telephone, mail, e-mail, or possibly even personal interview. In telephone surveys and personal interviews, it involves the very first few words uttered following contact with a prospective respondent. When the initial contact is by mail, it is the envelope in which the material is mailed, the documentation in the envelope, and the opening sentence on the cover letter.

The primary need is to design the introduction to surveys in such a fashion that refusals are avoided as much as possible. Currently, the proportion of refusals that occur during initial contact is surprisingly high. The factors that influence the rate at which people hang up seem to have received relatively little research in the past. Further discussion of this is to be found in Section 5.7 of the Technical Appendix.

Standardized procedures on script formulation would be advantageous in limiting the growing trend in hang ups with telephone surveys. However, further research is required before any

standardized procedures or guidelines can be recommended in this area. It is suggested, however, as an interim procedure that the opening statement on the telephone should

1. Be as brief as possible;
2. State as early as possible that it is not a marketing call; and
3. Start with the words "Hello, this is _____ . . ." rather than "Hello, my name is _____ . . . ," the latter of which seems to signal that it is probably a marketing call.

2.2.8 D-13: Incentives

Incentives are offered in some surveys to induce respondents to complete the survey. Many surveys do not offer incentives, but among those surveys where incentives are offered, considerable variability in type and magnitude are found.

There is considerable difference of opinion among transportation professionals as to whether incentives should be offered. There is also substantial diversity in what is offered for an incentive. Incentives have ranged from a gift to a significant payment of money ($10 and more per household, particularly for GPS surveys, where incentives as high as $50 have been offered). Some are offered only to those completing the survey, while others are offered to all potential respondents. The extent of current information about the use of incentives generally and in personal travel surveys particularly is provided in Section 5.8 of the Technical Appendix.

Several recommendations are offered for standardized procedures on this topic:

1. Incentives should be offered in all personal travel surveys unless a pilot survey is able to demonstrate clearly that a final response rate in excess of 70% can be achieved without any incentive.
2. Incentives should be offered only as pre-completion incentives—that is, they are offered to all recruited units of the sample and are not offered in return for respondents returning a completed survey.
3. Incentives should be indicated as being provided for completing the survey task, but not conditioned on a return being received.
4. Incentives should be monetary in form except where local laws or ordinances prohibit offering money. In such cases, a small gift should be offered.
5. Monetary incentives should generally be small and on the order of $1–$2 per person except in cases where attempts are being made to obtain responses from those who typically fail to respond to a survey. In the latter case, a larger incentive may be worthwhile.
6. Incentives should be offered to each individual and not to the household as an entity.
7. Entry into a sweepstakes, provision of lottery tickets, and other similar forms of incentives are not recommended. The literature does not provide support that such incentives are effective.

It is recommended that alternative incentives be tested, whenever possible, in a pilot survey to establish whether a particular population will be responsive to specific incentives. Such tests may compare alternative monetary levels, as well as comparing between a gift and money, although existing tests of gifts versus money have clearly shown the supremacy of money.

2.2.9 D-14: Respondent Burden

Respondent burden is both tangible and intangible. In tangible terms, it can be measured as the amount of time, cost, etc., that is involved in a respondent complying with the requests of a survey. It could also be measured in terms of the number of times a respondent is contacted and asked to provide information. The intangible aspects of respondent burden are much less easily measured and may be subsumed under the general title of perceived burden.

There is general agreement that efforts should be made to reduce the data collection burden for respondents to travel surveys. There is less agreement as to what constitutes respondent bur-

den, and how reductions in burden may be achieved. Respondent burden is examined in Section 5.9 of the Technical Appendix.

It is recommended that an estimate of measured respondent burden be routinely reported as part of any travel survey method documentation. This estimate should include the actual or estimated time in minutes for

- Review of printed materials, including instructions.
- Recordkeeping (as applicable to survey design).
- Use of "memory jogger" to record trips.
- Recording odometer readings from household vehicles.
- Actual average call time for (as applicable)
  - Recruitment;
  - Reminder;
  - Retrieval; and
  - Other calls (verification, re-contact for incomplete data, odometer readings, etc.).
- Completing diaries and other requested data (mail-back or Internet).
- Gathering the completed surveys from responding household members.
- Mailing the surveys back to the survey firm/sponsoring organization (if applicable).

To permit comparisons across surveys, it is recommended that the measured respondent burden be reported at the household level, using the average number of persons per household to factor person-level response times to an estimate for the entire household.

2.3 Pilot Surveys and Pretests

2.3.1 P-2: Requirements for Pretests or Pilot Surveys

Pretests and pilot surveys are the process of testing various aspects of the survey design, protocol, instruments, analysis, etc., on a small sample of the population prior to fielding the main survey. The intention of pretests and pilot surveys is to determine whether everything in the intended survey will work and produce the expected results. In some instances, pretests or pilot surveys may be conducted to compare two or more methods for some element of the survey process and to determine which to choose. In other cases, there is no comparison test involved, although it may be anticipated that some refinements to elements of the survey process will result. Further elaboration on pretests and pilot surveys can be found in Section 6.1 of the Technical Appendix.

It is recommended that the terms *pilot survey* and *pretest* be defined as follows:

1. **Pilot Survey**—a complete run through or dress rehearsal of the entire survey process, including drawing the sample, conducting the survey, coding the data, and performing basic analysis of the data. A pilot survey is conducted on a small sample of the same population that will be sampled for the main survey. As distinct from a *pretest,* the pilot survey involves a test of every element of the main survey, conducted in exactly the same way as is planned for the main survey. A pilot survey may also be used to test two or more different survey procedures and compare the results in order to assist in selection of one for the main survey. In such a case, each version to be tested is subjected to every step of the main survey.
2. **Pretest**—a test of any element, or sequence of elements of a survey, but comprising less than the full survey execution. For example, the instrument may be pretested by having a small subsample of respondents complete the instrument and then reviewing limited aspects of the completed instruments to determine whether any design changes are warranted. Any aspect of survey design and implementation may be subjected to a pretest. Pretests may also be used to compare alternatives for an element or elements of a survey. The main distinction between a pretest and a pilot survey is that pretests do not involve testing all aspects of the planned main survey, but may be limited to subsets of the protocol,

instrument, sampling, etc. During the design phase, several sequential pretests could be conducted to test various refinements of the instrument, protocol, sampling, etc.

Second, it is recommended that one or more pretests and/or one or more pilot surveys should be an essential step in *all* transportation surveys unless there are specific circumstances that render such a step unnecessary and unlikely to produce useful information.

It is further recommended that the following guidelines with respect to pilot tests and pretests be adopted:

1. In any survey in which interviewers will interact with respondents, the pilot survey or pretest should include listening in to interviewers to determine how they interact with potential respondents, how well they keep to the script of the survey, and whether the script causes difficulties in conversational style.
2. In any survey that uses interviewers or observers, there should be a debriefing with those used in the pilot survey or pretest to determine whether difficulties were experienced in handling survey procedures, questionnaires or other materials, scripts, etc.
3. If it has been 10 years or more since the last time a survey was done, a pilot survey should always be undertaken because the changes in population that will have occurred will render any past experience irrelevant.

2.3.2 P-3: Sample Sizes for Pretests and Pilot Surveys

Because we recommend that pretests and/or pilot surveys be conducted in all future travel surveys, it is appropriate to establish the required sample size of these initial tests or surveys. For further discussion, the reader is referred to Section 6.2 of the Technical Appendix.

It is recommended that the following standardized procedures be adopted by the profession:

1. *Whenever possible, the main sample should be drawn first and the pilot survey or pretest sample drawn only from those households or persons who were not drawn for the main sample.* When the pilot survey or pretest is being conducted to determine the sample size required for the main survey, two options are possible. The first option is that a main sample can be drawn that is expected to be more than sufficient in size. The pilot survey or pretest sample can then still be drawn subsequently from those households or persons who will not be included in the main sample under any likely circumstances. The second option is to draw the pilot survey or pretest sample at random from the total population and then be sure to exclude all such drawings from the population for drawing the main sample. The former of these two is the preferred method.
2. *No pretest or pilot survey should use a sample of less than 30 completed households or respondents.* Exercises using smaller samples than this should be regarded as preliminary tests and pre-pilot surveys and should always be followed by a pretest or pilot survey with at least a 30 respondent sample size.
3. *The minimum sample sizes shown in* Table 6 *should be used in all pilot surveys and appropriate pretests.*

2.4 Survey Implementation

2.4.1 E-2: Ethics

Ethics describe minimum acceptable standards of conduct or practice. In travel surveys, this relates to how a survey agency conducts itself with respect to those interviewed, the client, any subcontractors, and the public as a whole. It also relates to a survey agency's actions following the data collection process when data are cleaned, coded, analyzed, and archived.

Table 6.   Sample sizes required for specified levels of accuracy.

Measure	Assumed Value	Desired Accuracy	Sample Size	Measure	Assumed Value	Desired Accuracy	Assumed Variance	Sample Size
Response Rate	50%	±5%	384	**Household or Person Trip Rate**	10	±1	100	384
	50%	±10%	96		10	±2	100	96
	50%	±15%	43		10	±3	100	43
	50%	±20%	24		10	±4	100	24
	60% or 40%	±5%	369		10	±1	50	192
	60% or 40%	±10%	92		10	±2	50	48
	60% or 40%	±15%	41		10	±3	50	21
	60% or 40%	±20%	23		10	±4	50	12
	75% or 25%	±5%	288		7	±0.5	70	1076
	75% or 25%	±10%	72		7	±1	70	269
	75% or 25%	±15%	32		7	±1.5	70	120
	75% or 25%	±20%	18		7	±2	70	67
Non-response to a Question	10%	±3%	384		7	±0.5	50	768
	10%	±5%	138		7	±1	50	192
	10%	±8%	54		7	±1.5	50	85
	10%	±10%	35		7	±2	50	48
	20%	±3%	683		4	±0.4	40	960
	20%	±5%	246		4	±0.8	40	240
	20%	±8%	96		4	±1	40	154
	20%	±10%	61		4	±1.5	40	68
	30%	±3%	896		4	±0.4	16	384
	30%	±5%	323		4	±0.8	16	96
	30%	±8%	126		4	±1	16	61
	30%	±10%	81		4	±1.5	16	27

Ethics reflect what all stakeholders may consider "fair" or "reasonable" conduct by those involved. In practical terms, the application of ethics involves implementation of precautions to protect those affected from adverse effects. Ethics protect the rights of individuals and groups and serve to reduce public disapproval and criticism of what is done. A review of the ethics standards used in various other areas of surveying is provided in Sections 2.2.2 and 7.1 of the Technical Appendix.

After reviewing documents prepared by various associations on different aspects of ethical conduct in the execution of travel surveys, it is recommended that the following ethical conduct be observed in all future travel surveys:

1. The anonymity of the persons surveyed, and the confidentiality of the information they provide, must be protected at all times;
2. A survey respondent may not be sold anything or asked for money as part of the survey;
3. Persons must be contacted at reasonable times to participate in the survey and must be allowed to reschedule participation in the survey to a different time if that is more convenient for them;
4. Survey personnel must be prepared to divulge their own name, the identity of the research company they represent, the identity of the agency that commissioned the study, and the nature of the survey being conducted, if requested by a respondent;
5. Children under the age of 15 may not be interviewed without the consent of a parent or responsible adult;
6. A respondent's decision to refuse participation in a survey, not answer specific questions in the survey, or terminate an interview while in progress must be respected if that is the respondents' firm decision;
7. Respondents may not be surveyed or observed without their knowledge: methods of data collection such as the use of hidden tape recorders, cameras, one-way mirrors, or invisible identifiers on mail questionnaires may only be used in a survey if the method has been fully disclosed to the respondent and the respondent agrees to its use.

8. A research agency may not release research findings prior to the public release of the findings by the organization that commissioned the study, unless approval of the client organization is obtained to do so; and

9. A research agency must ensure the reasonable safety of its fieldworkers during the execution of a survey.

2.4.2 E-3: Mailing Materials

Most surveys involve some activity of mailing materials to respondents, whether this is just an initial contact letter telling about the survey to be done, the sending of recruitment materials, or the full survey form. There is evidence to suggest that the materials used to mail to households, as well as materials for households to mail back, have an effect on response rates. Further discussion of this issue is provided in Section 7.2 of the Technical Appendix.

It is recommended that the following standardized approaches be adopted with regard to format and appearance of mailing materials for travel surveys:

1. The use of a *stamped return envelope,* ideally with instructions on which materials need to be mailed back, and not the use of reply-paid envelopes;
2. The use of a *large white envelope* (4″ × 9.5″ or larger), with the *address printed directly onto the envelope,* rather than the use of address labels;
3. Print a *recognizable return address* on the envelope and *indicate the contents* of the envelope— at least the survey name; and
4. Affix *postage stamps,* especially commemorative stamps, rather than using a franking machine or pre-printed bulk mail.

2.4.3 E-4: Respondent Questions

In virtually any travel survey, respondents have concerns regarding the legitimacy of the survey and those conducting it. While some of these concerns may be addressed in a cover letter, the typical survey has more nuances than may be explained in a single- (or even double-) page letter. The state of the practice has evolved three methods for respondents to verify the survey, and obtain answers to frequently asked questions. These include the use of

1. Telephone contact numbers;
2. Informational brochures, with frequently asked questions (FAQs); and
3. Internet websites.

The use of each of these methods to answer respondent questions and the potential to develop standardized procedures for using these methods are discussed in Section 7.3 of the Technical Appendix.

As a standardized procedure for respondent questions, it is recommended that the execution of a travel survey include

- A telephone contact within the sponsoring agency;
- A toll-free telephone contact within the data collection entity (if different from sponsoring agency); and
- Detailed instructions in the form of an informational brochure or fact sheet; care should be taken to ensure that the information is presented in an easy to read manner, with appropriate use of graphics where possible.

Where possible, a website with information about the survey, links to sponsoring agencies, answers to FAQs, email and telephone contact for assistance or further information, and the ability to download survey materials should be provided.

If non-respondents to household interview surveys tend to travel more than respondents, then providing an additional alternative that permits responding when convenient to the respondent may increase the response rate. Accordingly, providing respondents with online response capabilities is encouraged.

2.4.4 E-5: Caller ID

"Caller ID," "Caller Line Identification," and "Caller Display" are different names for the service provided by many telephone companies that allows the customer to see the telephone number, and sometimes the directory listing, of the person who is calling. With the addition of Call Blocking, telephone customers may automatically block incoming telephone calls that do not permit the display of a telephone number.

In light of the general decline in telephone survey response rates, it is incumbent upon legitimate survey researchers to provide any information that may encourage responses from the full range of households. One of the primary uses of Caller ID is for households to screen out unwanted telephone calls by simply ignoring calls that do not display a known number or identity of the caller. Further information on this is provided in Section 7.4 of the Technical Appendix.

It is recommended as a standardized procedure that Caller ID be provided by the entity conducting the telephone calls—whether a contracted survey firm, university, or government agency—because existing data indicate that providing any ID at all may assist response rates more than being unrecognized. However, after careful review, it is concluded that there are no standardized procedures that can be recommended regarding Caller ID listings.

2.4.5 E-9: Answering Machines and Repeated Call-Back Requests

There are two related issues encountered by every telephone-based survey: first, when an answering machine is reached, does it assist completion rates if a message is left? Second, when a household requests an interviewer call them back at another time, is there a point beyond which repeated call backs do not increase completion rates? Each of these issues is discussed in Section 7.5 of the Technical Appendix.

It is recommended that a standardized procedure be adopted that messages be left on answering machines, as follows:

1. When an answering machine is reached on the initial recruitment/screening call, a message should be left at least once in the call rotation before classifying the number as nonresponding. The message should identify the client organization and the nature of the survey and provide a toll-free number for the household to contact should they desire to participate. The message should be short (no more than 15 seconds) and preferably provided by a "live" interviewer as opposed to a recorded message.
2. When an answering machine is reached on a reminder telephone call, a message should always be left.
3. When an answering machine is reached during telephone retrieval of travel information, a message should always be left.

It is also recommended that telephone survey protocols include a process for complying with call back requests, whether they occur in the recruitment or retrieval portion of a telephone survey. After the fifth request for a call back from the same household, the household should be categorized as a "soft" refusal and therefore eligible for any "soft refusal" conversion techniques in use.

2.4.6 E-10: Incorrect Reporting of Non-Mobility

In any travel survey, it is to be expected that some portion of respondents will not have traveled from their home during the survey period. However, a claim of non-mobility on the diary day or days also may be a form of non-response. Some potential respondents may realize that a claim of non-mobility will shorten significantly the length of the interview. The issue addressed in this section, and elaborated in Section 7.6 of the Technical Appendix, is to reduce the incorrect reporting of non-mobility that is made as a form of non-response. Standardized procedures are recommended in three portions of the travel survey process: data collection, data recording, and reporting.

In Data Collection

It is recommended that a question to verify reported non-mobility be asked of all persons who report they did not travel (stayed in one place/did not leave home) during the entire travel period. The question wording in the 2001 National Household Travel Survey (NHTS) ("Does this mean {you/subject} stayed at {the same place/home} all day?") should suffice. To explore the issue of non-mobility further, it is recommended to include questions that gently challenge persons who report non-mobility by asking for the reason(s) why no travel was made during that day.

In Data Coding

At a minimum, it is recommended that the data set include an indicator to distinguish between cases where a person indicated that he or she did not travel and those where a person refused to provide travel data.

In Reporting

It is recommended that the survey results report include the percent of non-mobile person days. In single day surveys, this would be determined by the number of persons reporting that they did not travel, divided by the total number of persons reporting. If questions are asked regarding the reasons why no travel was asked, as advanced practice, the report should include analyses of these reasons and the characteristics of persons who reported no travel.

2.4.7 E-11: Recording Time of Day

This item refers to standards for coding time-of-day values for database entry and relates to how data are recorded (i.e., entered by the interviewer) and stored, rather than how respondents provide the information. Further discussion is provided in Section 7.7 of the Technical Appendix. It is recommended that time of day for data entry and storage be undertaken using two fields: one for the day number, and one for the time in military time (00:00–23:59).

2.4.8 E-12: Time of Day to Begin and End Reporting

Surveys use various different times at which to start and end the time for a 24-hour (or longer) diary. The aim is usually to choose a time that is expected to interrupt relatively little travel so that respondents will not be put in the awkward situation of trying to respond about travel that had started before the start time of the diary. However, there is wide discrepancy in the selection of this time, which appears to range anywhere from midnight to 5 A.M. The research for this item is described in Section 7.8 of the Technical Appendix.

It is recommended that start and end times for 24-hour diaries should be 03:00 A.M. to 02:59 A.M. In the case of diaries that cover more than 1 day, end times are extended by 24 hours for each additional day.

2.4.9 E-13: Creation of ID Numbers

Each completed survey requires a unique identification number. In addition, if data are retained on incomplete households, then all contacted households require a unique identification number. The primary issue with respect to identification numbers is that the numbers should permit ready retrieval of specific records and should provide a unique identification for each unit in the survey. In addition, there is the potential to provide some additional information through the identification number, such as the membership in a specific sampling category, thereby permitting easy checking of the sampling progress during the survey and ready identification for purposes of expansion and weighting after the survey is completed. These ideas are explored in detail in Section 7.9 of the Technical Appendix.

It is recommended that

1. An ID number should be assigned at the outset to each eligible address or telephone number in the contact list and this number should remain attached to the person or household for the duration of the survey. Telephone numbers or addresses that are established to be non-household numbers should not be assigned an ID number.
2. A stratification-based ID number should be used for all stratified samples, while date-based ID numbering should be used for surveys where sampling is performed by simple random sampling or systematic sampling.

2.5 Data Coding Including Geocoding

2.5.1 C-1: Geocoding Standards

Geocoding is the process of identifying the geographic location of a trip end and coding a number—e.g., a traffic analysis zone (TAZ), census tract or block, or latitude and longitude—to represent that location. This item is concerned with developing standards for the methods used to geocode travel data in household travel surveys. It is discussed at length in Section 8.1 of the Technical Appendix.

It is recommended that

- All travel surveys should geocode trip ends to latitude/longitude.
- U.S. State Plane and other North American Datum coordinate systems (e.g., NAD27, NAD83) be used in geocoding unless there is a specific need to use another format.
- TIGER/Line files be used as reference databases for address matching.
- 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.
- Interviewers should have a good knowledge of the survey area or have access to gazetteers containing accurate addresses for shopping centers and schools. Online address directories (e.g., www.infoseek.com, www.usps.com) should be used to locate addresses in situations where supplementary information is not available.
- Pre-tests and evaluations should always be performed to assess the success of geocoding using one or all of the following methods:
    - Aggregation checks on the location of geocodes;
    - Checking addresses against other information such as telephone exchanges;

     – Verifying that one trip starts where the other finishes; and
     – Cross checking reported distances and times with those calculated from geocoded points.

2.5.2 C-2: Level of Geocoding To Be Performed

It is theoretically possible to geocode 100% of all trip ends in a survey, but in practice this is difficult, if not impossible. Most travel surveys will encounter some difficulties in geocoding, so there is a need to determine a reasonable minimum match rate that could be achieved in most survey settings. The reader is referred to Section 8.2 of the Technical Appendix for further information on this topic.

It is recommended that standardized procedures be adopted so that

1. Surveys should successfully geocode no less than 99% of household addresses, 95% of school and workplace addresses, and 90% of other locations to latitude/longitude.
2. Any locations that cannot be geocoded to latitude/longitude should be referenced at least to a TAZ to avoid systematic bias.
3. Where it is not possible to match out of region locations with a TAZ, it is proposed they be assigned to a representative point outside the study area.

2.5.3 C-4: Missing Values, Use of Zero, Etc.

There is considerable variability in how missing data are recorded in transport surveys and even variability within the same survey. The issues in this item, which are discussed in detail in Section 8.3 of the Technical Appendix, relate to standardizing the ways in which missing data are flagged and how zeroes and blanks are to be used in coding.

It is recommended that the following standardized procedures be adopted together as a group because adoption of some without others will actually increase ambiguities in the data:

1. *No blanks:* Blanks should never be a legitimate code, and all data fields must contain alphanumeric data.
2. *Missing data:* Missing data—whether as the result of a respondent refusal, an indication that the respondent does not know the answer, or a legitimate skip of the question—should receive a coded numeric value. These values should be negative values (because negative values will not normally occur in a data set) and should be −99 for a refusal. For "don't know" responses, it should be set as −98. For legitimate skips or non-applicability of a question, the value −97 should be entered.
3. *Correspondence between numeric values and codes:* In any question where a legitimate response could be zero, the code for that response will be the number zero (0). This will normally apply to any question requesting a count of elements, where a count of zero is possible—e.g., number of workers in the household, number of children in the household, number of infants in the household, number of cars available to the household, etc. In like manner, the count that is the response will be the coded value in all cases.
4. *Coding the number of person trips reported:* In all personal travel surveys that seek to ascertain trip-making behavior of individuals, the person record should contain a count of the number of trips reported by the individual. A count of 0 is to be used only to indicate the response that the person did not travel on the diary day. If no travel information was provided, then the value coded should be −99.
5. *Coding binary variables:* The principal binary variables in personal travel surveys are yes/no responses and responses to gender. For questions to which the response is either "yes" or "no," the response of "yes" is coded as 1 and the response of "no" is coded as 2. For response to the gender question, "male" is 1 and "female" is 2.

2.5.4 C-5: Coding Complex Variables

This item is concerned with how to code the responses to certain types of questions involving categories that may vary from survey to survey, depending on the level of detail required for a specific survey. Among the questions that fit within this item are income and activity.

There are a number of complex variables where it would be useful to adopt a consistent procedure for the values used to report the data. This would enhance comparability of surveys and remove potential ambiguities. It is also contingent on standardizing response categories to certain questions, as discussed in Section 2.1.2. These proposed procedures should be developed not only for any appropriate questions in the minimum question specifications, but also for additional questions that may be used in many travel surveys. Further discussion may be found in Section 8.4 of the Technical Appendix. It is recommended that

1. Multi-digit codes for complex variables, similar to the codes shown in Table 7, be adopted in all future travel surveys. For income, the codes specified in Table 7 are recommended to be used for consistency across surveys.
2. The activity categories shown in Table 8 be adopted for general use in future travel surveys. These categories are based on more or less commonly used trip-purpose categories, but provide for a much more detailed breakdown into activity types that can be used in activity surveys.

Table 7.   Possible coding for varying income detail.

Minimum Detail for Income Categories	Minimum Coding	More Detailed Categories	More Detailed Coding
Under $10,000	00	Under $5,000	000
		$5,000–$9,999	005
$10,000–$19,999	01	$10,000 –$14,999	010
		$15,000–$19,999	015
$20,000–$29,999	02	$20,000–$24,999	020
		$25,000–$29,999	025
$30,000–$39,999	03	$30,000–$34,999	030
		$35,000–$39,999	035
$40,000–$49,999	04	$40,000–$44,999	040
		$45,000–$49,999	045
$50,000–$59,999	05	$50,000–$54,999	050
		$55,000–$59,999	055
$60,000–$69,999	06	$60,000–$64,999	060
		$65,000–$69,999	065
$70,000–$79,999	07	$70,000–$74,999	070
		$75,000–$79,999	075
$80,000–$89,999	08	$80,000–$84,999	080
		$85,000–$89,999	085
$90,000–$99,999	09	$90,000–$94,999	090
		$95,000–$99,999	095
$100,000–$109,999	10	$100,000–$104,999	100
		$105,000–$109,999	105
$110,000–$119,999	11	$110,000–$114,999	110
		$115,000–$119,999	115
$120,000–$129,999	12	$120,000–$124,999	120
		$125,000–$129,999	125
$130,000–$139,999	13	$130,000–$134,999	130
		$135,000–$139,999	135
$140,000–$149,999	14	$140,000–$144,999	140
		$145,000–$149,999	145
$150,000 and over	15	$150,000 and over	150
Legitimate skip	–997	Legitimate skip	–997
Don't know	–998	Don't know	–998
Refused	–999	Refused	–999

Table 8.   Guidelines for trip-purpose/activity categories.

Primary Category	Code	Secondary Categories	Code	Tertiary Categories	Code
Home	01	Sleeping/napping	011	Sleeping	0110
		Preparing/eating meals/snack/drinks	012	Preparing a meal/snack	0121
				Eating a meal/snack	0122
				Other specified food-related activities	0129
		Home maintenance/cleaning	013	Indoor cleaning	0131
				Outdoor cleaning	0132
				Gardening/ tending plants	0134
				Care of textiles and footwear	0138
				Other specified home maintenance and cleaning	0139
		Household management	014	Paying household bills	0141
				Budgeting, organizing, planning	0142
				Selling, disposing of household assets	0143
				Other specified household management	0149
		Personal care activities	015	Showering, bathing, personal grooming	0151
				Health/medical care to oneself	0152
				Receiving personal care from others	0153
				Other specified personal care activities	0159
		Using computer/telephone	016	Using telephone (fixed line) (not incl. telephone shopping)	0161
				Using cell phone (not incl. telephone shopping)	0162
				Sending/reading/receiving email	0163
				Internet browsing (not incl. online shopping)	0164
				Shopping for goods and services using telephone (fixed line)	0165
				Shopping for goods and services using cell phone	0166
				Shopping for goods and services using Internet	0167
				Other specified use of computer/telephone	0169
		Caring for others	017	Caring for children	0171
				Teaching, training, helping children	0172
				Caring for adults	0173
				Other specified caring for others	0179
		Paid work	018	Paid work – main job	0181
				Paid work – other job	0182
				Other specified at home paid work	0189
		Other specified at home activities	019	Not further defined (n.f.d.)	0190
Work	02	Main job	021	Regular hours	0211
				Overtime hours	0212
				Extra hours (not paid as overtime)	0213
				Other specified main job activities	0219
		Other job	022	Regular hours	0221
				Overtime hours	0222
				Extra hours (not paid as overtime)	0223
				Other specified job activities	0229
		Work in internship, apprenticeship, etc.	023	Regular hours	0231
				Overtime hours	0232
				Extra hours (not paid as overtime)	0233
				Other specified internship/apprenticeship activities	0239
		Unpaid work in family business	024	n.f.d.	0240
		Breaks and interruptions from work	025	n.f.d.	0250
		Training and studies in relation to work	026	n.f.d.	0260
		Volunteer work and community services	027	n.f.d.	0270
		Looking for work/setting up business	028	Looking for work	0281
				Looking for/setting up business	0282
		Other specified work-related activities	029	n.f.d.	0290

Table 8.   (Continued).

Primary Category	Code	Secondary Categories	Code	Tertiary Categories	Code
Education/ Childcare Activities	03	Attendance at childcare	031	n.f.d.	0310
		Attendance at school	032	n.f.d.	0320
		Attendance at college	033	n.f.d.	0330
		Breaks/waiting at place of general education	034	n.f.d.	0340
		Self study for distance education course work	035	n.f.d.	0350
		Homework, study, research	036	n.f.d.	0360
		Career/professional development training and studies	037	n.f.d.	0370
		Other specified activities relating to education/childcare	039	n.f.d.	0390
Eating Out	04	Restaurant/café	041	Restaurant	0411
				Café/snack bar/cafeteria	0412
		Fast food	042	Take out	0421
				Eat in	0422
		At friends' home	043	n.f.d.	0430
		Picnicking	044	n.f.d.	0440
		Other specified eating out	049	n.f.d.	0490
Personal Business	05	Availing of/shopping for administrative services	051	Post Office	0511
				Other specified administrative service	0519
		Availing of/shopping for educational services	052	n.f.d.	0520
		Availing of/shopping for professional services	053	Banking/credit union	0531
				Insurance	0532
				Real Estate	0533
				Tax or accountant	0534
				Legal services	0535
				Other specified professional services	0539
		Availing of/shopping for government/public services	054	n.f.d.	0540
		Availing of/shopping for personal services	055	Hairdresser/barber/beautician	0551
				Other specified personal service	0559
		Availing of/shopping for medical and health care services	056	Medical	0561
				Dental	0562
				Eye care	0563
				Physiotherapy	0564
				Other specified healthcare service	0569
		Availing of/shopping for rental services	057	n.f.d.	0570
		Availing of/shopping for repair and maintenance services	058	n.f.d.	0580
		Other specified activities relating to personal business	059	n.f.d.	0590
Shopping	06	Purchasing food and household supplies (groceries)	061	n.f.d.	0610
		Purchasing clothes, shoes, personal items	062	n.f.d.	0620
		Purchasing school supplies	063	n.f.d.	0630
		Purchasing medical supplies	064	n.f.d.	0640
		Purchasing household appliances, articles, equipment	065	n.f.d.	0650
		Purchasing capital goods (cars, houses, etc.)	066	n.f.d.	0660
		Comparison shopping	067	n.f.d.	0670
		Window shopping	068	n.f.d.	0680
		Purchasing other specified goods.	069	n.f.d.	0690

Table 8.   (Continued).

Primary Category	Code	Secondary Categories	Code	Tertiary Categories	Code
Social and Recreational Activities	07	Communication/ correspondence	071	n.f.d.	0710
		Socializing activities	072	Doing activities/going to places and events together	0721
				Receiving visitors	0722
				Visiting friends and relatives	0723
				Other specified socializing activities	0729
		Participating in religious/community/ cultural events/activities	073	Participating in community celebration of historical/cultural events	0731
				Participation in non-religious community rites of weddings, funerals, births, etc.	0732
				Participating in community social functions	0733
				Participating in religious activities	0734
				Participating in other specified religious/community/cultural activities	0739
		Visiting entertainment and cultural venues	074	Attendance at movies/cinema	0741
				Attendance at concerts	0742
				Attendance at sporting events	0743
				Attendance at library	0744
				Attendance at amusement park	0745
				Attendance at museum/exhibition/art gallery	0746
				Attendance at zoo/animal park	0747
				Attendance at other specified entertainment and cultural venues	0749
		Indoor and outdoor sporting activities	075	Organized sport	0751
				Informal sport	0752
				Exercise (excludes walking)	0753
				Walking, hiking, bushwalking	0754
				Fishing, hunting	0755
				Driving for pleasure	0756
				Participation in other specified indoor and outdoor sporting activities	0759
		Games/hobbies/arts/crafts	076	Card, paper, board games, crosswords	0761
				Gambling	0762
				Arcade games	0763
				Home computer games	0764
				Hobbies, handwork, crafts	0765
				Other specified activities relating to games/hobbies/arts/crafts	0769
		Print/audio/visual media	077	Reading	0771
				Watching/listening to television/video programs/radio	0774
				Other specified activities using print, audio or visual media	0779
		Other specified social and recreational activities	079	n.f.d.	0790
Accompanying/ helping others and travel-related	08	Accompanying children to places	081	Accompanying children to receive personal services	0811
				Accompanying children to receive medical/health services	0812
				Accompanying children to school, daycare centers	0813
				Accompanying children to sports lessons, etc.	0814
				Accompanying children to other specified places	0819
		Accompanying adults to places	082	Accompanying adults to receive personal services	0821
				Accompanying adults to receive medical/health services	0822
				Accompanying adults for shopping	0823
				Accompanying adults for social activities	0824
				Accompanying adults to cultural, sports and entertainment venues	0825
				Accompanying adults to other specified places	0829

Table 8.   (Continued).

Primary Category	Code	Secondary Categories	Code	Tertiary Categories	Code
		Pick up or drop off other people/get picked up or dropped off (private car, car/van pool, shuttle/limousine)	083	Pick up someone or get picked up	0831
				Drop off someone or get dropped off	0832
		Activities related to bus, public transit, and group rides (except car/van pool and shuttle/limousine)	084	Wait for/get on vehicle	0841
				Leave/get off vehicle	0842
		Change travel mode	085	n.f.d.	0850
		Other specified activity related to accompanying others or travel-related	089	n.f.d.	0890
No activity	09	No activity	091	n.f.d.	0910
		No recorded activity	092	n.f.d.	0920
		No further activity recorded	093	n.f.d.	0930
Other	99	n.f.d.	990	n.f.d.	9900

Table 3 used in Section 2.1.2 also provides categories for a number of questions which are consistent with the coding procedure proposed here. It is recommended that the codes in that table also be adopted as a consistent set of codes for the variables listed therein.

2.6 Data Analysis and Expansion

2.6.1 A-1: Assessing Sample Bias

Sample bias is a systematic error in sample survey data. It reflects a consistent deviation of sample values from true values in the population. Bias can occur within individual observations when, for example, a faulty measurement device is used and a consistent error is introduced into each observation. Of course, bias in individual observations is carried through to aggregate values of the sample such as means and proportions. However, even if individual observations are not biased, if the sample is not representative of the population, assumptions that it is produces biased estimates of the population. This is a condition that can occur quite readily because drawing a truly random sample from the population is complicated by factors such as the practical difficulty of establishing a perfect sampling frame, having an equal likelihood of contacting each sampling unit, and obtaining full response from each sampling unit. The issues of sample bias and its assessment are discussed in detail in Section 9.1 of the Technical Appendix.

It is recommended that the following standardized procedures be adopted with respect to bias in travel surveys:

1. Each travel survey should test for bias.
2. The following variables should be used to test for bias:
    – Household size;
    – Vehicle availability;
    – Household income (if collected);
    – Race of each person in the household;
    – Age of each person in the household; and
    – Gender of each person in the household.
3. The variables should be measured as follows:
    – Household size: mean value;
    – Vehicle availability: categories of 0, 1, 2, and 3+;

– Household income: categories corresponding to those in Table 7 in Section 2.5.4;
– Race: categories of white, black/African American, American Indian/Alaska native, Asian, Native Hawaiian/Pacific Islander, other single race, and two or more races;
– Age: categories of 0–5, 6–10, 11–14, 15–17, 18–64, 65–74, 75 and over;
– Gender: male and female.

4. Total error should be measured using the Percentage RMSE statistic defined in Equation 1.

$$Percent\ RMSE = \sqrt{\frac{1}{n_i}\sum_i^{n_i}\frac{1}{n_{ji}}\sum_j^{n_{ji}}\left(\frac{r_{ij}-s_{ij}}{r_{ij}}\right)^2} \times 100 \qquad (1)$$

where

n_i = number of variables i;
n_{ji} = number of categories j in variable i;
r_{ij} = reference value of variable i in category j; and
s_{ij} = sample value of variable i in category j.

2.6.2 A-2: Weighting and Expansion of Data

Weighting is the process of assigning weights to observations in a sample so that the weighted sample accurately represents the population. Expansion is the multiplication applied to each observation in a sample so that the expanded sample is an estimate of the population. Weighting is determined by comparing values of variables within the sample with values of corresponding variables from a reliable external source such as the census. Expansion factors are the inverse of the sampling rate.

Weighting and expansion are often combined into a single factor or weight, which reflects both the relative representativeness of each observation in the sample and the number of similar cases each observation in the sample represents in the population. Separate weights are usually assigned to households, persons, and trips. These weights sum to the number of households, persons, and trips in the population, respectively. The reader is referred to Section 9.2 of the Technical Appendix for further elaboration.

It is recommended that the following standardized procedures be adopted:

1. Each travel survey should conduct a weighting and expansion exercise to include the weights in the data set and to include a description of the weighting process in the metadata;
2. The weights should include expansion factors so that the sum of the weights match population estimates; and
3. The two-stage procedure, described in the technical appendix, Section 9.2.2, should be adopted as the standard method of calculating weights.

2.6.3 A-3: Missing Data Imputation

As discussed in Section 9.3 of the Technical Appendix, imputation is the substitution of values for missing data items or for values of data items that are known to be faulty. Data values are known to be faulty if they are infeasible (e.g., a 5-year old with a driver's license) or are inconsistent with other information known of an individual or their household. There are two mechanisms for substituting values for missing or faulty data items—deductive imputation (or inference) and regular imputation. Inference involves deriving the value of a missing or faulty data item from the information known of a respondent or their household, when such a derivation can be made with relative certainty. For example, the gender of a person can often be inferred from their first name, and a person 16 years of age or older who reports making multiple trips alone by car probably has a driver's license. Imputation, on the other hand, is the generation of

a likely value for missing data with no assurance that the imputed value is correct on a case-by-case basis. For example, if the number of vehicles owned by a household is missing, a likely number could be imputed by considering the household income, number of licensed drivers, and age of the members of the household. Imputation is expected to produce the correct distribution of values for each variable even though individual imputed values are not necessarily correct.

Imputation is the last resort in replacing missing or faulty data items with valid values. Every effort is first made to limit missing or faulty data through good survey design, well-managed survey execution, and aggressive editing and call-back to respondents. However, when the best efforts to obtain accurate reported information on each item fails, inference—followed by imputation—should be applied. Inference should always precede imputation because inferred values are more accurate than imputed values.

It is recommended that the following standardized procedures be adopted with respect to imputation in household travel surveys:

1. Data editing should be conducted in all travel surveys;
2. Inference should always precede imputation;
3. Any imputation procedure with the exception of overall mean imputation may be used;
4. If hot-deck imputation is employed, it should be conducted without replacement; and
5. Every inferred and imputed value should be flagged in the data to clearly indicate its nature.

2.6.4 A-4: Data Archiving

Archiving data preserves the data for future use; it is considered a method for maintaining the value of data and allows space to be freed on expensive data storage mediums. Archiving was not conducted in the past because transport agencies did not feel this was part of their responsibility, agencies were reluctant to make their data readily available to the public, and archiving was not accounted for in initial budgets of projects. A key to effective data archiving is the assignment of responsibility and adequate funding in the initial stages of project design. The issue of archiving data is discussed at some length in Section 9.4 of the Technical Appendix.

It is recommended that the transportation profession adopt the following principles to archive transportation data:

1. The sponsoring agency should be the primary organization responsible for archiving the data, associated metadata, and any relevant archiving auxiliary data.
2. Maps of zones, locations, and networks should be included in the archive. The recognized standard for storing travel behavior data is the ASCII format in order to overcome problems associated with archived spatial data networks due to rapidly changing software.
3. Adequate documentation of the data should be archived. Any changes made to the data should be documented, and codebooks and documentation of sampling and weighting procedures need to be archived with the data.
4. Transportation documentation, preservation metadata, and archives should utilize the document type definition (DTD) such as extended markup language (XML).
5. Raw data should be archived. Modified data sets do not need to be stored as long as statistical tests and modifications made to the data are thoroughly documented.
6. Telephone recruitment and telephone or mail-back data retrieval and call history files describing call dispositions of sampled households during the recruitment process should also be archived.

2.6.5 A-6: Documentation

This section, and Section 9.5 of the Technical Appendix, deals with how to document a household travel survey. Currently, very little has been written about documentation of travel data. The

term "metadata" in European literature is what is generally referred to in U.S. transportation literature as "data documentation." There has been some writing on metadata in recent literature, but there are no standardized procedures for documentation of household travel surveys.

The following is a comprehensive list of the ideal requirements for travel survey documentation and is recommended for adoption as a consistent procedure for household travel survey documentation:

1. *Sponsorship for the survey*—name of the agency, ministry, or organization sponsoring the travel survey and, if the data were collected by an external research organization, the name of fieldwork agency.
2. *Survey purpose and objectives*—description of why the survey is being conducted, what it hopes to achieve, and expected results.
3. *Questionnaire and other survey documents*—wording of all questions including specific interviewer and respondent instructions. It also includes aids such as recruitment scripts, interview script (telephone and personal interview), maps, travel diaries, memory joggers, etc. These should be provided as an appendix.
4. *Other survey materials*—interviewer instruction manuals, validation of results (techniques employed), codebooks, incentive descriptions (pre or post; type of incentive; if monetary, the level offered).
5. *Population and sampling frame*—a description of the population that the survey is intended to represent as well as why this population was selected and a description of the sampling frame used to identify this population.
6. *Sample design*—a complete description of the sample design: sample size, sampling frame, information on eligibility criteria, and screening procedures.
7. *Sample selection procedures*—methods by which respondents were selected by the researcher, details of how the sample was drawn, the levels of proxy reporting tolerated, what constituted a complete household, and the sample size.
8. *Sample disposition*—refusals, terminations, ineligibles, completed interviews, and non-contacts. Also a description of the level of item non-response accepted for key variables and why.
9. *Response rates*—how the eligibility rate for the unknown sample units was determined, a description of the response rate formula used, and the calculation of the overall response rate for a two or more stage survey.
10. *Processing description*—editing, data adjustment, and imputing procedures used.
11. *Precision of estimates*—sampling error, including other possible sources of error to inform user of accuracy or precision, and a description of weighting or estimating procedures.
12. *Basic statistics*—a description of all base percentages or estimates on which conclusions are made.
13. *Data-collection methods*—survey mode and procedures.
14. *Survey period*—dates of interviews of fieldwork or data collection and reference dates for reporting—e.g., time, day, and date when calls or other forms of contact were made.
15. *Interviewer characteristics*—number and background of fieldwork staff.
16. *Quality indicators*—results of internal validity checks and any other relevant information such as external research.
17. *Contextual information*—any other information required to make a reasonable assessment of the findings and data.
18. *Conduct of geocoding*—a description of how geocoding was conducted, including the level of data imputation and inference and how these values are flagged, etc.

It is also important for the documentation to incorporate organizational documentation. This includes the request for proposals and proposal submission, contracts and modifications, all progress reports, key meetings results, costs, key personnel, and information about situations

that occurred during the period of the survey. This may include both positive and negative information, with respect to the overall survey process. Preserving this information will allow agencies to improve on future research projects and proposal submissions because staff writing such documents may consult older examples of these types of documents (Sharp, 2003).

2.7 Assessment of Survey Quality

2.7.1 Q-1: Computing Response Rates

Proper calculation of response rates is important because response rates are used by analysts to assess survey quality. Higher response rates are usually desired to reduce the likely incidence of non-response bias. Until recently, CASRO was the only organization with its own method for calculating response rates. However, some years after the development of the CASRO method, the American Association of Public Opinion Research (AAPOR) developed another method for calculating response rates. Both the CASRO and AAPOR formulas are commonly used by survey practitioners. These response rate calculations and related issues are discussed in Section 10.1 of the Technical Appendix.

Standardized procedures are proposed regarding the definitions of the components used in the calculation of response rates. Final disposition codes should be divided into four major groups, regardless of the survey modes to be used:

1. Complete interviews;
2. Eligible cases that were not interviewed (non-respondents);
3. Cases of unknown eligibility; and
4. Ineligible cases.

These categories can be sub-classified further, depending on the level required by the survey firm and the survey execution method employed. Final disposition codes, adapted from the AAPOR standards, suggested for consistency among transportation surveys, are shown in Table 9.

We recommend that the AAPOR (RR3A) formula be adopted for the calculation of response rates for all household and personal travel surveys (Equation 2):

$$RR3A = \frac{SR}{(SR+PI)+(RB+O)+e_A(UH+UO+NC)} \tag{2}$$

where

SR = number of complete interviews/questionnaires,
PI = number of partial interviews/questionnaires,
RB = number of refusals and terminations,
O = other,
NC = number of non-contacts,
UH = unknown if household occupied,
UO = unknown other, and
e_A = estimated proportion of cases of unknown eligibility that are eligible (AAPOR eligibility rate: the same formula for calculating the eligibility rate is used).

The eligibility rate for the unknown sample units will vary from survey to survey. It is recommended that careful consideration is given to disposition codes, that the bounds of the research are clearly defined, and that the eligibility rate for the unknown sample units should be defined from this analysis. In transport surveys (as recommended as a standard by AAPOR), it is recommended that

1. The estimation of the eligibility rate be left to the discretion of the organization(s) and individual(s) undertaking the research;

Table 9. Final disposition codes for RDD telephone surveys (adapted from AAPOR, 2004).

Eligibility	Eligibility Code	Disposition			Disposition Code
Eligible Interview	1.0	Complete			1.1
		Partial			1.2
Eligible Non-Interview	2.0	Refusal and termination			2.10
		Refusal	2.11	Household-level refusal	2.111
		Termination			2.12
		Respondent never available after call back request			2.21
		Telephone answering device (message confirms residential household)			2.22
		Miscellaneous			2.35
Unknown Eligibility, Non-Interview	3.0	Unknown if housing unit			3.10
		Not attempted or worked			3.11
		Always busy			3.12
		No answer			3.13
		Telephone answering device (don't know if housing unit)			3.14
		Telecommunication technological barriers, e.g., call blocking			3.15
		Technical phone problems			3.16
		Housing unit, unknown if eligible respondent			3.20
		No screener completed			3.21
		Other			3.90
Not Eligible	4.0	Out of sample			4.10
		Fax/data line			4.20
		Non-working number			4.31
		Disconnected number			4.32
		Temporarily out of service			4.33
		Special technological circumstances			4.40
		Number changed			4.41
		Cell phone			4.42
		Cell forwarding			4.43
		Business, government office, other organization			4.51
		Institution			4.52
		Group quarters[1]			4.53
		No eligible respondent			4.70
		Quota filled			4.80

[1] If specified as ineligible in the survey design.

2. The estimate for eligibility from unknown cases should be based on the best available scientific information; and
3. The basis of the estimate should be stated explicitly and explained.

It is recommended not to use the terms resolved and known, and unresolved and unknown, interchangeably. Depending on the bounds of the study conducted, cases labeled as eligible may not be resolved. This arises when call backs are given eligible status. Clearly, however, these calls have not been resolved; therefore, using the terms interchangeably in this situation would be incorrect.

2.7.2 Q-2: Transportation Measures of Quality

A variety of data quality measures have been proposed in this study but, in this section, we consider variables that have not been used elsewhere. The types of variables considered are those that are temporally and spatially stable and, therefore, should acquire similar values among surveys. Special circumstances may cause values to deviate from the norm but, generally, deviations from standard values are an indication that the data are not of the expected quality.

As documented in Section 10.2 of the Technical Appendix, past studies suggest that typical non-mobile rates are 20% at the person level and 1% at the household level. It is recommended that these values serve as reference values against which new surveys are measured. Person non-mobile rates less than 20% and household non-mobile rates of less than 1% suggest data

Table 10.   Recommended reference trip rates for travel surveys.

Trip rate	*Purpose*	*Mean Value*	*Range*
Household	All	9.2	8 – 11
	HBW	1.7	-
	HBO	4.7	-
	NHB	2.8	-
Person	All	3.4	-

quality that is better than average although no clear interpretation of data quality vis-à-vis the non-mobile rate is available at this time. Similarly, person non-mobile rates in excess of 20%, and household non-mobile rates in excess of 1%, indicate below average data quality.

Because of the lack of standardization of activity classification and the variety of activity classification schemes used in transportation at this stage, it is not recommended that activity rates be used to measure data quality. If future travel surveys adopt consistent definitions of activities, as proposed elsewhere in this document, activity rates could be reconsidered as an indicator of data quality.

Trip rates from numerous studies show reasonable stability among studies. As expected, trip rates at the person level demonstrate less variability than trip rates at the household level due to the influence of household size. However, household trip rates are frequently quoted and have formed the basis of validation checks in the past. Therefore, it is recommended that the trip rates in Table 10, which include household trip rates, serve as reference values for future travel surveys. Deviations from these values must be interpreted by the analyst because the specific relationship between trip rates and data quality has not been established. Note that the trip rates shown in Table 10 are linked, unweighted, person trips per day.

2.7.3 Q-3: Coverage Error

Coverage error in surveys is the error incurred by having a sampling frame that deviates from the survey population. It is usually considered to represent the failure to include all the units of the target population. However, in addition to the "under-coverage" that results from exclusion of valid units in the sampling frame, it is also the unintentional inclusion of units in the survey sample (including duplication of units) that do not belong there. This "over-coverage" can occur, for example, when telephone numbers are used as a sampling frame in an RDD sampling process and, as a consequence, households with multiple telephone lines are sampled at a higher rate than those with a single line. Similarly, "under-coverage" can occur in the same type of survey because some households do not own a telephone or have interrupted telephone service.

Coverage error is distinct from non-response error although both result from not obtaining information from units in the survey population. Coverage error results from not having some units in the sampling frame or from having units in the sampling frame that do not belong there. Non-response is failing to obtain a response from units that are within the sampling frame. Further discussion is to be found in Section 10.3 of the Technical Appendix.

It is recommended that

1. Coverage error should be estimated in each future travel survey, using Equation 3:

$$CE = \left(1 - \frac{F_x}{\tilde{X}}\right)100 \qquad\qquad (3)$$

where:

CE = coverage error in percent;

F_x = sample population multiplied by the inverse of the sampling rate; and

$\tilde{X}$ = population estimate from an external (reliable) source.

2. Coverage error should be estimated as the percentage deviation of the population of the study area estimated using the planned sample, from that of the population of the same area using a reliable external source. That is, coverage error must be estimated using the definition of coverage error in Equation 3 above.
3. Each future survey should include descriptions of the survey population and the sampling frame, and coverage error should be reported.

2.7.4 Q-5: Proxy Reporting as a Quality Indicator

Proxy reporting in a travel survey is the reporting of one person on behalf of another, as discussed in Section 2.2.2 of this report. While proxy reporting is unavoidable in some cases, it is also susceptible to survey design and the method of survey execution.

Because proxy reporting affects the accuracy of the data, it is reasonable to suggest that more proxy reporting is likely to lead to less accuracy in the data. Accuracy is an important component of data quality and, therefore, it is suggested that the incidence of proxy reporting can be used as a measure of data quality of the data set. This is addressed in more detail in Section 10.4 of the Technical Appendix.

It is recommended as a standardized procedure that

1. Each travel survey should include questions on the age of each person in the household (see also Section 2.1.1) as well as the capability of each member over the age of 14 to complete the survey.
2. Only those individuals 15 years of age or older and those capable of completing the survey should be included in estimating the level of proxy reporting in the data.
3. For each individual in the household, it should be established whether the information being reported for that individual was
   – Prepared by the individual and
   – Reported by the individual.
4. Each travel survey should report the percentage of proxy reports in the data based on the above conditions relating to what represents a proxy report for this purpose.

2.7.5 Q-6: Validation Statistics

Validation is the process of verifying the authenticity of collected data by recontacting a sample of households. It is used in interview-based surveys to determine whether the interviewer actually conducted the interview and whether the information obtained is accurate. It can also be used in self-administered questionnaires where the validation survey then usually involves a face-to-face or telephone interview to check the quality and completeness of data.

Validation surveys typically involve a limited set of key questions only. These usually include identifying and trying to make contact with the person involved in the original survey and verifying a few trips reported by the respondent. Validation surveys are conducted to ensure the authenticity and integrity of the data. Further discussion is provided in Section 10.5 of the Technical Appendix.

The following recommendations are proposed with respect to validation surveys:

1. Each travel survey should conduct a validation survey.
2. The validation survey should use the following three questions:
   – Question 1: Did you complete the initial survey? (yes or no)
     ▪ If "yes," go to Question 3 below.
     ▪ If "no," go to the second question below.

    – Question 2: Did someone else in your household complete the survey? (yes or no)
- If "yes," go to Question 3 below.
- If "no," terminate the validation survey.

    – Question 3: Select a trip that the respondent is likely to remember from among the trips reported in the initial survey and note the time spent at the destination. Ask the respondent to recall the trip in question and to report the approximate time spent at the destination.

3. A statistic should be prepared indicating the percent of validated surveys that provided a negative answer to each of the first two questions or a mismatch on the third question.
4. The commissioning agency should establish at the outset what is considered to be a tolerable level of failure on validation.

Acceptance of a 1% failure on the first two questions and 5% on the third might be considered to represent a reasonably good quality.

2.7.6 Q-7: Data Cleaning Statistics

Data cleaning or data checking is an activity that is conducted almost routinely in travel surveys. It involves checking and, where possible, correcting data values that can be identified as being incorrect. It is usually performed as soon as possible after the data are retrieved. This is to enable queries to be made while the information is still fresh in the memories of the respondents. For errors that are caused or accentuated by the survey process, it also allows timely correction. This is elaborated on in Section 10.6 of the Technical Appendix.

The following data cleaning statistic (DCS) provides a mechanism to measure the incidence of cleaned data items in a data set:

$$DCS = \frac{\sum_{n=1}^{N}\sum_{i=1}^{I} count(x_{i,n})}{N \times 1}$$

where:

$$x_{i,n} = i\text{th data item of respondent } n$$
$$count(x_{i,n}) = \begin{cases} 1 \text{ if } i^{th} \text{ data item of respondent } n \text{ was cleaned} \\ 0 \text{ otherwise} \end{cases}$$
$$N = \text{number of respondents in survey}$$
$$I = \text{number of minimum (core) questions}$$

It is recommended that all transportation surveys compute and report the DCS statistic and that, based on experience with this statistic, future ranges be established to indicate the quality of the data based on the amount of cleaning required.

2.7.7 Q-8: Number of Missing Values

The number of missing values in a data set is a measure of how much information was not collected. If expressed as a proportion of the total number of data items in the data set, it serves as a measure of the relative information content of the data. Thus, it could be used as a measure of data quality.

It is important to define what a missing data item is and what it is not. As described in Section 2.5.3, recommended coding practice is to distinguish between non-responses that are refusals—those in which a respondent does not know the answer to the question—and those in which a response would not be applicable. Among these categories, only responses where a respondent either refuses or does not know the answer are truly missing values. Further information is to be found in Section 10.7 of the Technical Appendix.

It is recommended that

1. The definition of missing data indicated in Section 10.7 of the Technical Appendix be adopted as a standard definition in transportation surveys;
2. The missing value index (MVI), shown below, be computed for all transportation data sets; and
3. Values representing various levels of data quality be established based on experience with the MVI over time.

The MVI is defined as

$$MVI = \frac{\sum\limits_{n=1}^{N}\sum\limits_{i=1}^{I} x^{*}_{i,n}}{\sum\limits_{n=1}^{N}\sum\limits_{i=1}^{I} x_{i,n}}$$

where

MVI = Missing Value Index,

$x^{*}_{i,n} = \begin{cases} 1 \text{ if data item i of respondent n is missing} \\ 0 \text{ otherwise} \end{cases}$

$x_{i,n} = \begin{cases} 1 \text{ if a response to variable i is applicable to respondent n} \\ 0 \text{ if a response is not applicable} \end{cases}$

I = number of variables, and

N = number of respondents in data set.

2.7.8 Q-9: Adherence to Quality Standards and Guidelines

One of the ways to improve the quality of data is to have a checklist of actions that must be performed or standards that must be met in each survey. Such a checklist is not currently accepted or used in reporting on household and personal travel surveys. The reader is referred to Section 10.8 of the Technical Appendix for further information.

Ten questions have been compiled to assess the quality of the survey process. It is recommended that the following questions be answered for each future travel survey:

1. Has the survey agency an active quality control program in operation?
2. Is a senior, independent staff member responsible for quality control in the organization?
3. Have pretests been conducted?
4. Has a pilot survey (or surveys) been conducted?
5. Have validation surveys been conducted?
6. Have data reported by proxy been flagged to indicate they were obtained by proxy reporting?
7. Have data values obtained through imputation been flagged to indicate the nature of their origin?
8. Has the survey report been prepared and submitted to the client?
9. Has a coding manual and other metadata that accompanies the data been prepared and submitted to the client?
10. Have the survey data been adequately archived in a safe, accessible, and well-recognized data storage location?

Answers in the affirmative are favorable; if each affirmative is allowed to count one point, then a score out of 10 would indicate the level of adherence to principles of good survey practice. It is recommended that this statistic be produced for all future travel surveys.

Training Approaches and Priorities

The most important element with respect to the implementation of the findings of this NCHRP project is that the survey public—consisting of MPOs, survey consultants, state DOTs, and other agencies involved in the commissioning and execution of surveys—should become knowledgeable of the recommended standardized procedures and that they should be accepted as a starting point for the improvement of survey quality in transportation surveys.

3.1 Workshops

We suggest that there should be one or more workshops on the standardized procedures and guidelines. Ideally, one such workshop should take place in conjunction with the TRB Annual Meeting. It is also important that as many survey firms and consultants who use survey firms also be involved in the workshops. Another potential manner of holding the workshop would be to organize it as a stand-alone conference/workshop, to be held at an appropriate time and place.

3.2 Adoption by the Transportation and Development Institute of the ASCE

The recently formed Transportation and Development Institute (TDI) of ASCE has appointed a standards committee in the area of transportation economics and planning. At present, it has not been completely clear for what standards this committee would become responsible. However, initial discussions with committee chairs in the TDI have indicated some considerable interest that this committee might take a responsibility for promulgating standards and guidelines developed out of the standardized procedures of this document. Again, however, the main problem is one of funding, if the committee's role is also seen as one of continually updating and promulgating standards. ASCE is not in a position to provide significant funding to its committees for such activities. Like the TRB, it tends to rely heavily on volunteer efforts of the professionals associated with it. Therefore, it will again be necessary to consider how a source of funds might be made available to the committee.

However, it would seem that a joint committee effort of the ASCE and TRB might provide an appropriate mechanism for promulgating standardized procedures of this type. Furthermore, the ASCE will bring an additional dimension, in terms of likely audiences for the standards.

3.3 National Highway Institute Course

A regular training course should be developed from the materials in this report to form one of the National Highway Institute (NHI) courses. Development of the course would necessarily be at

the expense of the NHI, but these costs should be recovered through offering the course around the country.

3.4 Presentation of Results at Professional Conferences

This has already been initiated by the authors of this research. Early elements of the research were used as the basis of a keynote paper to the 6th International Conference on Travel Survey Methods at Berg-en-Dal, South Africa in August 2001. Similarly, one of the keynote papers at the 7th International Conference on Travel Survey Methods, Playa Herradura, Costa Rica, was based on the recommended standards and guidelines from this report. A paper was offered on the materials from some sections of this report at the 10th International Conference on Travel Behaviour Research in Lucerne, Switzerland in July of 2003. In addition, presentations have been made at the 83rd Annual Meeting of the Transportation Research Board and at the mid-year meeting of the Planning Committees of TRB in Park City, UT in July 2004. Further presentations will be made at conferences, as opportunities permit.

As a result of these various presentations, it appears that it is now fairly well known that this work exists and a number of professionals have indicated that they welcome the work and are looking forward to the opportunity to make use of it. We propose to continue this.

3.5 Demonstration Projects

It is always useful to be able to demonstrate that better products are achieved by applying the procedures than by business as usual. Initially, demonstration projects will have only limited ability to show benefits until there are sufficient demonstrations to compare with situations where the procedures have not been used so that the benefits are clearly identifiable. Such demonstrations could be handled as an add-on to future MPO surveys, by additional funding provided through the U.S.DOT Bureau of Transportation Statistics, together with FHWA, and other interested agencies. We understand that several large MPOs may be planning major household travel surveys in the next few years, and these would provide an opportunity to showcase the application of the standards and guidelines.

3.6 Potential Funding for the Promulgation and Maintenance of the Standardized Procedures and Guidelines

There appear to be two obvious potential sources of funding for the continuing promulgation and maintenance of these procedures. The first of these is AASHTO. As the agency that has funded the research in the first place, it would seem that it would certainly be appropriate to look for a continuing funding source to AASHTO in the first instance. The second of these is the U.S.DOT Bureau of Transport Statistics. This agency is clearly one that is positioned to be able to take on ongoing support of standards and guidelines for travel surveys and which, if it did so, would also add significantly to the standing of such standards and guidelines in the profession at large.

It is also appropriate to consider what level of funding may be needed for the promulgation and maintenance of standards. There are probably a number of activities that need to be funded for this, which are listed here, along with our approximate assessment of what they might cost:

1. Maintenance of a website for the report material;
2. Sponsorship of appropriate workshops, short courses, or training courses, all of which would partially generate their own funding through fees and registrations;
3. Add-on funding for application of the standardized procedures to household travel surveys, which would be a variable amount, depending on what specific aspects would not have been done anyway; and
4. An ongoing research program to add to the standards and guidelines, and to update them.

Procedures and Measures for Further Research

The items in this section could not be examined in this project and require further research. These items can be classified into the following three groups:

1. Items that were initially identified to be beyond the scope of the project;
2. Items included in the original project plan, but were not analyzed because of time and budgetary constraints; and
3. Other areas identified during the course of the project.

These are shown in Table 1 and are discussed in the following sections. An overview is provided of each item, together with a discussion of its relative importance. Recommendations are made about specific research areas that should be examined in the future. The items detailed in Section 4.1 were originally discussed in the interim report, but have been reproduced here for convenience. Items in Section 4.2 have also been extracted from the interim report, but have been modified and shortened in most cases. The information presented in Section 4.3 is based mainly on comments made by members of the research team.

4.1 Items Initially Identified as Beyond the Scope of this Project

4.1.1 D-11: GPS Surveys

There is growing interest in the use of GPS devices to collect data on sub-samples of households in household travel surveys. GPS is capable of providing very precise information about the locations to and from which people travel, the times of their travel, the routes used, and even the traffic conditions along the route of travel at the time of travel. At present, this is largely an experimental procedure although it is moving rapidly forward as a mainstream activity in household travel surveys. There are at least 20 ongoing surveys that have a GPS component in the United States at the time of this report.

Clearly there is potential for defining standardized procedures and providing guidance on a number of aspects of such surveys. This includes sample sizes and methods of drawing samples, geographic and socio-demographic distribution of the sample, the number of days for which GPS data should be collected, minimum hardware specifications for the GPS devices, the use of incentives, methods for deployment of the devices, methods of return of the devices, etc. However, at this time, it is probably too early in the development of such surveys, and there is too little experience to define standardized procedures. Therefore, this is an area that should be considered as being currently out of scope, but necessary to add within the next 2 or 3 years. It also may require extensive field experimentation to develop good standardized procedures through comparative studies that clearly show which are the preferred methods. Also, as personal GPS devices (as opposed to in-vehicle GPS devices) become more practicable and available, the nature of the survey may change quite rapidly.

Table 1.   Procedures and measures for further research.

Category	Original reference	Item
Items beyond scope of project	D-11	GPS surveys
	D-12	Internet surveys
	I-8	SP data
Items originally identified and not researched	D-2	Who should be surveyed?
	D-9	Times of day for contacts
	E-6	Retention of data on incomplete households
	E-7	Cross checks in data collection and data review
	E-8	Days and periods to avoid data collection
	I-3	Collection of in-home activities
	I-4	Ordering of questions
	I-6	Instrument design
	I-7	Multitasking of activities
	S-1	Sample size
	S-2	Sizes and procedures for surveying augment samples
	S-3	Collecting augment samples
	S-4	Stratification options for samples
	S-5	Specification of sampling error requirements
	S-6	Development of default variances
	P-1	Focus groups
	P-5	Reporting of pretests and pilot surveys
	Q-4	Sampling error
Other items identified during research	–	Cell phones
	–	Incentives
	–	Personalized interview techniques
	–	Geocoding methods
	–	Impacts of the national "do not call" registry
	–	Initial contacts
	–	Refusal and non-contact conversions
	–	Effect of interview mode on recruitment and non-response rates
	–	Unknown eligibility rates
	–	Data archiving in transportation

4.1.2 D-12: Internet Surveys

Internet surveys are similar to GPS surveys in that it is a data collection mechanism that is emerging at the present and has yet to undergo extensive field testing. Nevertheless, like GPS surveys, it is likely to be a technique that will evolve rapidly and, if successful, be incorporated more and more frequently as a potential means for a household to provide the data for a household travel survey. Again, it is an experimental procedure that is not yet in the mainstream although several current surveys are working to offer Internet as an alternative means of response for a number of households.

Again, there is enormous potential for defining standardized procedures and providing guidelines. These may address such issues of how to provide access to websites, the type of graphics and other materials to be provided, building in cross checks on data and cross-referencing travel of other household members, encryption, and a variety of ethical issues that will arise with Internet surveys. As with GPS, however, this area is considered too under-developed for this project. Standardized procedures should be considered during the next 2 or 3 years and may, again, require a number of comparative studies in order to determine what consistent practice should be.

4.1.3 I-8: SP Data

Many recent travel surveys have included collection of stated-choice data, more commonly referred to as "stated-preference" or SP data. Assuming that such data will become more and more a standard element of many surveys, standardized procedures and guidelines are almost certainly

needed relating to these data. These would relate to the size of the task that can and should be presented to respondents (Stopher and Hensher, 2000), as well as issues of how alternative attribute levels are set in a stated-choice survey (Stopher, 1998). There is also a need to determine whether attribute levels should be generated in real time or can be pre-set and committed to a printed survey.

Consistent instrument designs for the collection of stated-choice data are clearly needed. Many survey firms understand this area relatively poorly, and the whole field of stated-choice research is subject to potential discredit if poor designs are fielded and erroneous conclusions drawn from the data. There are enormous differences of opinion in such areas as

- The need for contextual data to be collected at the same time;
- The number of possible alternatives that respondents can be asked to handle;
- The number of attributes that can be included in the design;
- The number of levels of each attribute that can be included;
- How far the levels of the attributes can depart from current experience of the respondent;
- The number of treatments that an individual respondent can be asked to handle;
- Whether the order in which treatments are offered has an effect on choices;
- The need for orthogonality in the design; and
- How to administer the SP experiment—that is, by paper and pencil, on laptop computer, etc.

In addition, there are some survey researchers who do not believe that stated-choice experiments are valid and would argue against their use.

Research is clearly needed into these various issues. In this case, it appears from the literature that transportation applications of stated-choice surveys are ahead of marketing and other fields that may also use the techniques. As a result of a review of the literature on this topic, the transportation field appears to be addressing issues that other researchers have not considered (Louviere et al., 2000). However, these listed issues have not been researched in transportation or elsewhere to date. Hence, to develop standardized procedures for SP data, it will be necessary to undertake research on all of these issues. For the most part, this will require a battery of alternative SP survey designs to test various options in each of the bullets listed above. Several of these can be tested together; the results, in the form of some measure of the quality of the SP survey, can be analyzed through models that seek to explain differences in the quality as a function of the various design variants. At the outset this area was considered to be beyond the scope of this project; it is, therefore, up to future research to establish standards.

4.2 Items Originally Identified and Not Researched

4.2.1 D-2: Who Should Be Surveyed?

There is no general consensus about the minimum age for persons included as part of a household travel survey. Traditionally, data have been collected on all household members over the age of 5 years on the assumption that any young children will travel with the non-working mother, who would, therefore, provide complete data on the movements of any very young children. In current society, both parents now work in most households, and it is becoming increasingly difficult to deduce the travel of younger children in the household. In light of this, more household travel surveys are collecting data on all family members, irrespective of age. Another issue that arises in household travel surveys is whether to survey persons living in group quarters. In many instances, those living in group quarters do not travel (e.g., prison inmates, those in hospital, some types of elderly and infirm care facilities); however, other types of group quarters may produce large amounts of travel (e.g., university dormitories and military facilities). Some guidance is

needed on whether to survey these persons or whether some group quarters should be included and others not.

It is recommended that research be conducted on these issues using existing surveys for analysis. By examining a survey for which there is no minimum age, the data obtained on children under 5 years of age could be compared with data from adults in the same household. From this, it would be possible to determine the extent to which the infant's data could have been inferred from the parents' data. It would also be useful to determine whether trip rates and other related information are ever corrected for infants when analyzing those data sets that did not include infants in the collection of travel data because this may have significant impact on mode-choice and automobile occupancy. Parents with infants are often restricted to using an automobile available to the household, and this decreases the potential for transit use. Failure to include infants will result in incorrectly lower average automobile occupancy rates that will probably not match occupancy rates from other sources.

It is also recommended that analyses be done on surveys that include persons from group quarters. Specifically, it is suggested that level of tripmaking be compared between persons living and not living in group quarters. It would also be worthwhile to look at what fraction of total trips are represented by people living in group quarters (through examining census data) to determine the effect of inclusion or exclusion on overall regional travel statistics. It is anticipated that standardized procedures would suggest specific conditions that need to be met to warrant the inclusion of group quarters in surveys. These might include situations in which the retired elderly people exceed a certain fraction of the population of the study region or where there might be a military or other mobile institutional presence (e.g., colleges or universities with dormitory accommodations) in excess of some proportion of total population.

4.2.2 D-9: Times of Day for Contacts

Within telephone surveys, the time of day when contact is attempted has a critical influence on response rates. There is a wide range of practices in existing surveys, however, and these have never been formally documented. In some surveys, the client agency may stipulate the hours between which telephone contacts can be made by the contract firm. Because different cities show markedly different habits with respect to work times and times at which people retire for the night, this may not be an area in which consistency of practice will be possible. It may be possible, however, to specify a core period of time when calling would normally be productive and to specify other times when calling is almost certainly not productive. For example, calling is generally productive between 6 and 8:30 P.M. on weekday evenings. It is recommended that recent surveys be reviewed to determine what has been set as appropriate times. By examining call attempts and outcomes in call histories, it would be possible to determine the relative productivity of calls made at different times of the day. Particular attention should be paid to determining the most productive and acceptable hours for calling on weekends.

A second issue that needs to be addressed in this area is how to determine when to re-contact households that have either requested a non-specific call-back or are considered to be soft refusals. It seems possible that some consistent rules can be established on how to distribute times for callbacks to try to resolve previously incomplete surveys. There appears to be a lack of common practice on when to make a subsequent attempt after finding the number is busy, there is no answer, or an answering machine picks up the call. In some instances, the protocol appears to be to recall the household at least once, and sometimes more than once, on the same evening as the initial call. In other cases, the call may be re-rostered for the same time on the next day or the same time in the next week. By reviewing procedures that have been used in prior surveys and also those that may be used in other areas of market research, it may be possible to recommend guidelines for re-contacting sample units.

4.2.3 E-6: Retention of Data on Incomplete Households

Data on incomplete households have the potential to provide extremely useful information that can be used in analysis of survey results and to improve the quality of surveys in the future. With these data, it is possible to examine the design of certain questions that may result in premature terminations of interviews and information on the biases in non-respondents. Despite the apparent usefulness of such data, in many surveys it is destroyed after the full sample is obtained either because it is automatically done by CATI software or because of specific desires of survey firms or clients. Many agencies are ignorant of the value of partial data and will either not specify in the contract that such data should be turned over or may even specify that such data are to be destroyed. In addition to this, many agencies would not know what to do with such data if retained and need help in knowing how to make optimal use of it.

Again, there was insufficient time in this project to develop standardized procedures on the retention of data on incomplete households. It is recommended that several tasks be performed in any future research. As a starting point, one needs to define what constitutes a partially complete household. This would not be difficult in light of the work done in this project to define a complete household (see Section 2.2.3). At a minimum, households could be classified into the following basic categories:

1. Refused recruitment;
2. Terminated recruitment prematurely;
3. Completed recruitment, but refused mail-out survey;
4. Completed recruitment, accepted mail-out survey, but refused diary completion or retrieval of diary data;
5. Partially completed diaries and related information; and
6. Completed all survey materials.

There is also a need to determine whether all incomplete household records should be retained or only those meeting some minimum criterion of completion. To do this, one would need to demonstrate the potential uses of such data through analysis of incomplete records from a variety of surveys. This might include examining the questions at which surveys are terminated and the distribution of household characteristics for households that are partially complete and those that are fully complete. A few key areas for analysis should be recommended to help determine what specific data should be retained. In developing data retention standards, it may be necessary to specify modifications that need to be made to some commercial CATI software packages. While subsequent analysis may determine that there is no useful information to be gained from some partially complete surveys, it would be prudent to err on the side of keeping too much rather than too little data. With the current low costs for data storage and the small overheads resulting from increasing the overall size of data sets, there is no reason to try to minimize retention of data by throwing out such data as that on incomplete households.

4.2.4 E-7: Cross-Checks in Data Collection and Data Review

In any survey, cross-checks should always be undertaken on data to ensure that results are meaningful and certain information is not contradictory. For example, a survey in California a few years ago reported a substantial proportion of school children, under the legal minimum age for holding a driver's license in California, apparently driving alone to school. There are other problems to be avoided: almost every travel survey includes instances of people forgetting to report a trip back to home at the end of the day or failing to report an activity at home after the last trip of the day. Work trips by people who report that they are not workers are another common occurrence in surveys. Another problem in activity and time-use diaries arises when people do not include activities at a place between trip segments—for instance, waiting at a bus stop or parking a vehicle.

In most cases, these problems are completely avoidable with appropriate checks. CATI and CAPI surveys offer enormous potential for cross checks on data quality in real time as a survey progresses and, in most such surveys, at least limited cross-checks are usually programmed in. Anecdotal information and recent experience of some of the research team suggests, however, that cross-checks are not always built in to survey data-collection procedures or that they are built in, but overridden or ignored by interviewers.

Because of time constraints, it was not possible to develop consistent procedures in this project for cross-checks that should be built in to CATI or other types of interviews or to develop standardized procedures for checking data after they have been retrieved. In our opinion, future research should focus on two main tasks. First, there is a need to develop a general list of the various checks that should be included in any travel survey. In part, these would need to be based on the minimum question specifications already developed as part of this project (see Section 2.1.1). Second, once a list has been compiled, standards for cross-checks that can apply to CATI and CAPI surveys should then be developed. Based on the experiences of the team working on this project, some of the better known problems include the following:

1. Children below minimum driving age reporting a drive-alone trip;
2. Children below minimum working age reporting work activities and travel;
3. People failing to report trips back to home both during and at the end of the day;
4. People failing to include activities at a place in transit trips (e.g., waiting and transferring) in a time-use or full activity survey;
5. People who are not employed reporting trips to or from work;
6. People failing to report other family members who accompanied them on travel;
7. Head of household reporting being under the age of 16;
8. People reporting more workers in the household than adults; and
9. People reporting more adults or more children in the household than the total household size.

It is recommended that unprocessed data from recent surveys be reviewed to compile as complete a list of these types of problems as possible. Second, once a list has been compiled, standards for cross-checks that can apply to CATI and CAPI surveys should then be developed. To this end, it is recommended that available CATI scripts and programs be reviewed to determine that checks have been built in and to examine the effectiveness of these checks. Structuring the received data into a snapshot of the actual behavior of a person over the course of the survey day is likely to be a very productive way of detecting errors and illogical responses. In most instances, the same checks that would be appropriate in a CATI or CAPI survey can also be used in a non-computerized survey to review data as they are obtained on paper diaries or other media. This may not be possible in all situations, however, and it is likely that some standards developed for CATI and CAPI surveys will need to be adjusted for application in paper-and-pencil interviewing (PAPI) and related surveys.

4.2.5 E-8: Days and Periods to Avoid Data Collection

While there are unwritten conventions about days on which household surveys should or should not be undertaken, no specific guidelines exist on this issue. Most household travel surveys are conducted in the Spring and Fall, but in some areas of the South, Spring may be defined as beginning earlier in February or even mid-January once schools are back in session. Most surveys generally avoid Thanksgiving and New Year because of the perception that travel is abnormal at this time of the year. Similarly, there is usually an attempt to avoid the period from the end of May through the middle of August because people are taking annual vacations and schools are not in session. There are inconsistencies however on whether surveying should be temporarily suspended for such times as Spring Break (either for schools or universities), Columbus Day, and Presidents Day. In addition to this, there is a more general issue that relates to whether data from just Fall or Spring, or a

combination of both, are really appropriate for modeling purposes and for the decisions to be made from data and subsequent models.

Whether this is an appropriate item for standardized procedures is somewhat questionable although it would appear that guidance would, at least, be appropriate on this issue. The extent to which travel differs during holiday periods and at certain times of the year is not entirely clear. If travel is significantly different during these times then it may be appropriate to avoid these periods in the interests of ensuring comparability among surveys. To the extent that is it possible to obtain data, it would be worthwhile to examine the effect of such time periods on survey findings and determine whether they present a problem in relation to the usual goals of household travel surveys. While guidelines may suggest periods that should be avoided during data collection, they may, on the other hand, recommend that no period needs to be excluded. There is a real question as to whether this issue of "atypical travel" is appropriate and whether the exclusion of certain days will result in serious biases in survey findings and transport models.

4.2.6 I-3: Collection of In-Home Activities

While there appears to be general agreement among most travel-demand modelers that more detail needs to be collected about in-home activities, many agencies avoid collecting in-home information based on the perception or expectation that it would reduce response rates and lead to (greater) incompleteness of data. There are fears of how the public would react to a transportation agency asking questions about what people do in their homes. As a result, most surveys do not ask about in-home activities or ask only about work at home and everything else at home. The perceptions associated with this issue have never been proved in any structured test. It would be worthwhile, in our opinion, to conduct a side-by-side survey in which some respondents are asked for full details of in-home activities while others are asked only for abbreviated data on working at home and everything else.

When information is collected on in-home activities, there are great inconsistencies in the level of detail of information that is obtained. For example, the Oregon and Southwest Washington household travel survey, which attempted to collect detailed in-home data, set a minimum time of 30 minutes for an activity to be reported in detail. Another strategy, used in the Baton Rouge Area Household Time-Use Survey (Stopher and Wilmot, 2001) was to instruct people to use "Other at Home" to designate any personal and intimate activities that they do not wish to report on in detail. While both of these approaches are valid, there appears to be significant potential for consistency in this area. It is recommended that recent activity surveys be examined to evaluate the different options that have been used to collect in-home activities, (e.g., time limit in Portland and the minimal description of in-home activities in Dallas–Fort Worth). The usefulness of the activity data that resulted from these alternative procedures should be evaluated before any standardized procedures are suggested. It may also be useful to examine recent surveys for additional evidence as to whether requests for this detail appear to have had impacts on response rates. The literature on time use (Robinson, 1977 and 1991; Robinson and Godbey, 1997) should also be helpful in this regard because this is presumably an issue that has been faced and dealt with in time-use surveys in sociology and psychology.

4.2.7 I-4: Ordering of Questions

The ordering of questions can be crucial in obtaining good responses in a survey. Although little empirical research has been done on the ordering of questions, there are a few basic principles that are considered good practice in most survey settings. Sensitive questions—income, race, etc.—are generally placed as near to the end of the survey as practicable to minimize the potential of non-response. "Fun" questions, particularly those that ask respondents for their opinion on a

certain issue or satisfaction with a service, should be asked as early as possible to make respondents feel as though their input and participation is valued. It is also considered good practice to ensure that questions follow a logical and appealing sequence that helps respondents understand what is being sought from them. For example, in asking about travel or activity details, one should begin with the starting time of the travel or activity, the location of the activity or the means of travel used first, and so proceed through a logical sequence of details. Sequencing is also important for questions on occupation and working at home. There are many occupations (retail clerk, air-traffic controller, sanitation worker, etc.) that do not permit working at home. Therefore, care needs to be taken not to ask a question about working at home following a question on occupation. These ordering procedures are valid for all types of surveys because, even in self-administered surveys, respondents generally work through the survey from the beginning and answer as they go as they would using a different methodology.

Although these issues are generally well understood in the transportation planning community, very little research has ever been done to investigate the extent to which ordering of questions appears to be correlated with non-response. It was intended that such research would be conducted in this project using a collection of survey instruments dating back to the 1960s. However, the scale of this task became very large, and there was insufficient time to conduct a thorough investigation of the area. It is recommended that future research be focused on meeting two main objectives. First, to determine what aspects of question ordering are important to the creation of respondent-friendly surveys and what question ordering seems to be most beneficial to response. Second, where applicable, a practical list of "do's and don'ts" should be developed on the ordering of questions which can be observed by practitioners during the survey design process. Standardized procedures should suggest an order for certain blocks of questions within a survey (e.g., those relating to recruitment, travel/activity recall) and should provide guidance on what questions should be considered as part of each group—for example, the household information, vehicle information, person information, and travel/activity information. It is also recommended that work be done to develop some alternative orderings of sensitive questions and to include these within some comparative pilot tests. Future research should also consider the possibility that some questions should be asked more than once and in different ways, such as asking income in both recruitment and retrieval calls in a CATI survey, and asking one time with categories and one time with a more than/less than question format.

4.2.8 I-6: Instrument Design

Developing consistency in instrument design is not a trivial task, and it was known from the outset of this project that there would probably not be enough time for sufficient research on this item. The potential for variations in instrument design is unlimited. There are many different formats that can be adopted (booklet, leaflet, two-sided card, etc.) and the length of the instruments themselves can vary, depending on the level of information sought. Tests to date of different formats in this respect have been inconclusive, and it seems likely that rather extensive further tests will be needed to provide any type of conclusive results on this issue.

In addition to considerations about the physical form of the instruments themselves, there is also the issue of what fonts should and should not be used. Hundreds, if not thousands, of different fonts are available in modern word processing programs, and there is limitless potential for other formatting features to be used for directing respondents—bold, underline, italics, use of color, arrows, boxes, and other devices. One of the main difficulties in defining consistent designs relates to the fact that design is a relatively subjective process and relies heavily on personal preferences. A design considered by one person as bad may be considered good by another. While it may be important to develop consistency in this area, recommendations should not be prescriptive about the way instruments should be designed because instrument design is an area that should

see much innovation in the future. There is a diversity of opinion about some specific aspects of instrument design, which are very difficult to resolve without extensive research.

In the planning stages of this project, it was suggested that standardized procedures be developed around three main areas. First, it was considered necessary to address some basics of design such as typefaces and sizes, use of color, arrows, boxes, and other devices to direct respondents; the use of clip art; and the survey instrument length, etc. It was intended that a primer document would be developed to provide some basic guidelines in survey instrument design, which would be supported by an example survey instrument developed in accordance with such guidelines. In our opinion, this idea has considerable merit and is worth pursuing in the future. It is important to note that any such work should incorporate the results of other tasks performed as part of this project such as minimum questions, consistent categories for answers, and consistent question wordings. Guidelines on ordering of questions, although not developed as part of this project, should be observed even if only in the form of the basic principles outlined in the previous section.

The second major issue that needs to be examined is whether printed surveys used in CATI or CAPI surveys should contain all questions that will be asked in the interview or if it is necessary only to ask a sub-set of questions with the remaining questions being asked at the time of the interview. To test this, it would appear to be necessary to conduct some focus-group testing, together with a series of pilot tests of the two options, to see both what respondents prefer and whether there is any noticeable difference in the responses obtained. Evidence from focus groups conducted for surveys in Dallas and Southern California suggests that respondents prefer not to have all questions in travel diaries and that this might increase response rates. Further research is required to examine trade-offs in completeness of responses and response rates.

Finally, there is a need for some consistency to be developed in the design of instructions for respondents. Many past transportation surveys have included extensive written instructions, which a review of the survey results shows either were not read or at least were not understood and applied by respondents. It appears to be clear that people simply will not bother to read extensive instructions, and intuitively this suggests there is a need to move toward more graphic instructions, requiring fewer specific instructions to be read. It is recommended that a specific survey be developed to evaluate the impact of different types of instructions on responses.

4.2.9 I-7: Multitasking of Activities

All survey instruments in transportation continue to ask questions as though people only undertake a single activity at a time. It is very apparent that people perform various multi-tasked activities throughout the day. These include such activities as driving and talking on a cellular phone; eating and watching TV; traveling on public transit and performing work activities such as reading, reviewing, using a laptop, etc. By asking questions on a single activity only, much information is missing from typical surveys, and purposes are probably misstated by this simplification.

This item was not considered in any detail in this project and it is suggested that recent and current travel surveys and the literature on time use (Robinson, 1977 and 1991; Robinson and Godbey, 1997) be consulted to determine whether it is possible and reasonable to define a standard question format for obtaining information on multitasking of activities. If such standards are approached, it will be necessary to undertake field testing and possible focus-group testing of the question structure and wording and to investigate its overall effect on instrument design and complexity. From the viewpoint of the blurring of work and other activities, the increasing ability of people to multitask as a result of technological advances, and the potential impacts of these on daily travel and activity patterns, this would appear to be an important area for further research and the development of standardized procedures.

4.2.10 S-1: Sample Sizes

Sample size 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 much as 20,000 households. Even though there have been a number of documents providing guidance on sampling (TMIP, 1996b; Smith, 1979; Stopher, 1982), there seems to be either ignorance of the existence of these documents or the guidance that they suggest are not accepted. It was hoped to develop minimum sample sizes, based on the purpose of the personal travel survey (model estimation, model updating, regional description, and policy testing and formulation), that would be different from previous guidance, which either offered formulas for calculating minimum samples or provided some possible default values to use in sample-size calculations. Procedures to develop appropriate sample sizes are not lacking either in the transportation field or in the survey sampling literature. Clearly, the fact that there is such a wide variation in chosen sample sizes for household travel surveys arises from at least two issues: (1) available budget and (2) political rather than statistical justification of a particular sample size.

Costs for household travel surveys are large compared with any other planning activity. Many smaller MPOs will undertake a household travel survey because the staff feels it is essential, but the sample size will be dictated by available funds. This often leads to a decision to collect data with an inadequate sample because it is felt to be a better option to collect less than the optimal amount of data than to collect no data at all. Furthermore, even though an inadequate sample size may result in modeling problems, models will still be built with what data are available, and too rarely are problems with the models and their forecasts correctly attributed to lack of sufficient data in the first place. It is very possible that no amount of effort in defining adequate or minimum sample sizes will ever completely change this situation.

Political issues may range from multiple jurisdictional contributions to the survey costs, resulting in pressures for the sample to be large enough for each contributing jurisdiction to obtain reliable results to a belief that neither politicians nor the public will accept that a statistically adequate sample will actually be sufficient for the purposes of the survey. An example of both of these issues arose in Southern California in 1990. A statistically adequate sample of the region would be in the range of 3,500 to 5,000 households. However, because funds were being derived from various counties and other jurisdictions in the region, it was essential that each of those jurisdictions receive sufficient sample to be able to conduct independent analyses and, in some cases, modeling. At the same time, it was felt that people in the region would not accept that adequate information could be provided for a region with a population of 12 million from a sample of 5,000 or fewer households. The end result was a decision to draw a political sample of about 15,000 households rather than a statistical sample of 3,500 to 5,000 households.

Notwithstanding that such situations will arise, it still seems reasonable to specify standardized procedures in sample design that are based on statistical requirements rather than unknown political requirements. To proceed with this task, it will be necessary to take into account the issues of stratification, error levels, and augment samples and develop simple guidance for sample size from this. Sample sizes should be examined from recent surveys—particularly those that have been used for model estimation, model updating, and policy testing and formulation—and a determination made of the adequacy of the sample for these purposes. Again, we note here that the 15,000 household sample in Southern California turned out to be less than adequate for mode-choice modeling in that region because there were no augment samples and the decision on how to stratify the sample resulted in very few transit trips in the final data set—too few, in fact, to allow reliable mode-choice models to be built with the intended specifications.

One of the important issues to consider in setting the sample-size standards is to deviate from previous guidance and not tie the sample size to regional size, except in very broad terms. The

reason for this is that unless the finite population correction factor is large, which will rarely be the case in urban area surveys, the error levels of a sample will not be dependent on the regional population. The specifics of the sample size will be dependent, however, on the use to which the data will be put and the sample design—that is, stratification, clustering, or other sampling method.

4.2.11 S-2: Sizes of and Procedures for Surveying Augment Samples

Household travel surveys often require augmentation because of a lack of rare behaviors in the collected data and the problems of sampling to include them. Rare behaviors in the United States and other countries include transit riding and bicycling, among others. In most metropolitan areas in the United States, the proportion of transit riders varies between about 0.5% and 5% of all trips. These low percentages may mean that small samples will contain very few transit trips for generalization to the entire population and are certainly too small for modeling mode choice. Research is needed to determine when an augment sample is necessary. A review of various regional statistics and also past reported problems with insufficient observations on specific aspects of a household travel survey would help identify the types of situations where an augment sample would be required and how such data could be used.

There is also a need for guidance on the size of the augment samples. Because augment samples are generally collected for modeling purposes, there is usually a focus on collecting data on specific rare mode choices for estimating mode-choice models. In light of this, guidelines would probably need to be based on sample sizes required for reliable estimation of current mode-choice models. It would be important to consider that the sample needed must support segmentation by trip purpose, at least into home-based work, home-based non-work, and non-home-based. It is therefore suggested that research examine the split of purposes within such trips as transit, bicycle, and walk and develop recommendations on sample sizes from this.

For example, it has been suggested in the past that at least 300 observations are needed on each mode to obtain reasonable estimates of mode-choice model parameters in a logit model. Assume that models of the three trip purposes mentioned above are to be estimated and that approximately 60% of transit trips are home-based work, 25% are home-based non-work, and 15% are non-home-based. In this case, the need is to have 300 samples in the non-home-based category for that model, which would generate the requirement that 2,000 transit trips are measured in total. If we were to find that the average rate of transit trip making by transit-riding households is 4 transit trips per day, then this would translate to the requirement for a total sample of 500 transit-riding households. If it is further assumed that the general household sample will produce about 50 transit-riding households, then the augment sample would need to be 450 transit-riding households. This provides an example of how the guidance would be developed for augment samples.

4.2.12 S-3: Collecting Augment Samples

In addition to the sample sizes and procedures for surveying augment samples, there is also a need to examine how data should be collected on the augment sample. For example, a number of past household surveys have used an on-board bus survey to augment the sample for transit trips. However, the nature of the on-board survey is usually significantly different from the nature of the household travel survey. In the event that such a mechanism is to be used, there are certain requirements that need to be spelled out for the on-board transit survey. Similar issues would apply if special surveys are conducted with other subgroups of the population on a choice-based or other sampling basis.

There are generally five approaches one can take to the problem of under-representation of rare behaviors in a random household survey. The first is to over-sample in certain sub-areas of the region. The second and similar approach is to target a portion of the sample into such areas as would have been over-sampled. A third approach is to use a secondary sampling procedure, such as an intercept survey, to find transit riders (or other relevant rare behaviors), and to obtain telephone numbers for the households of those encountered in the intercept survey. The fourth approach is to organize an independent survey, such as an on-board transit survey, and obtain the augment sample from this source. The fifth approach is to stratify the population into the groups of interest, and then use screening to fill the samples for each stratum.

While benefits and problems associated with each of these methods are generally well understood, there is a need to review recent practice and productivity of the different methods of augmentation. There is a need to look at other possible ways to augment household and personal travel surveys for rare travel behaviors and specific rare socio-demographic characteristics. Future research would need to examine the costs of the different approaches and determine some measure of cost-effectiveness for them.

4.2.13 S-4: Stratification Options for Samples

Although the usual aim of stratification in household and personal travel surveys is to ensure coverage of household characteristics, it will generally have the effect of reducing the sampling error. This aspect of stratification has been largely ignored in travel survey sample designs. While the aim of stratification is to ensure that the sample contains households in specific geographic subdivisions of the region and that each household size and vehicle ownership combination of significance is represented in the final sample, there does not appear to have been any investigation of the effects of this on model estimation.

It would appear to be useful and valuable to provide guidance on the stratification designs. As far as the literature reveals, little attention has been paid to the effects of stratification on the error properties of modeling steps beyond trip generation. Second, it has not been established that stratifying on the variables of trip generation necessarily produces more efficient samples and samples with desirable error properties. Third, there has been little or no investigation of whether there may be good alternative stratification schemes that can be used. Fourth, there is little guidance on what sample sizes to choose for each cell of the stratification matrix. In the absence of information on the variances in trip rates for each cell, there is no guidance on whether choosing equal samples in each cell is appropriate or whether there is some other possible method of determining an appropriate sample size for each cell. Finally, the relative advantages and disadvantages of stratified sampling versus simple random sampling have not been investigated for household travel surveys. Because there is a cost to stratified sampling—which cannot generally be done based on prior identification of households as to the stratum to which each belongs—the use of stratified sampling generally requires contacting households to determine membership in a stratum and then qualifying or disqualifying the household on the basis of the required sample in a cell. The costs of this method over increasing the sample size for a simple random sample are not known for household travel surveys.

Standardized procedures are probably not appropriate in this area. Rather, what appears to be needed is guidance. As discussed above, it is recommended that future research examine the impacts of stratification by the variables of trip generation modeling on both subsequent modeling steps and on the sample properties. Recent surveys should be reviewed to determine whether other stratification schemes have been used and to determine what effect these have had on sample properties. Research should develop guidance as to how to choose sampling strategies and how to choose the sample sizes in the cells of a stratification matrix.

4.2.14 S-5: Specification of Sampling Error Requirements

Frequently, RFPs specify that the required sample must provide no more than, say, ±10% error with 95% confidence in something such as a trip rate. Generally, this appears to be specified with little understanding of what it means. It would be reasonable to question whether 10% error is acceptable compared with 5% error and whether the significance level should be set to 90% or 95%. Also, the error is almost always specified for trip rates, while the data will be used for much more than trip-rate estimation. The implications of a particular error level for trip rates on estimation of such elements as mode choice or network volumes are largely unknown.

The first issue that needs to be addressed is to determine an appropriate specification of the level of error and confidence level to be used in designing samples. This issue could be researched by using existing data sets. In this case, variations in data caused by differences in survey protocols, firms, survey instruments, etc., would be irrelevant. It may be most useful to present graphs showing the effects of changing each of the error levels and the confidence level so that the implications of each can be seen. This should, ideally, be done using actual computations of sampling error from recent surveys. The implications of the level of error can be investigated by examining simple trip-production models and showing the implications in terms of ability to distinguish statistically between the trip rates for different population sub-groups.

The second issue is to determine the implications for other variables that may be estimated from the data of setting an error level on trip rates. To do this, one would need to select certain other variables of interest—the proportions of trips by mode and purpose, the average trip length by purpose, trip rates by purpose, average household size, average vehicle ownership, etc.—and estimate the sampling errors on these attributes. These would need to be related to the sampling errors for the overall trip rates to show how the sampling errors on the other attributes relate to the trip-rate sampling error. If there is insufficient variability in the overall error of trip rates, it may be necessary to sub-sample from some existing surveys since the sub-samples will have much larger sampling error for all characteristics.

The third issue is to investigate the potential to use other attributes, such as mode shares, for the design sampling error. Existing data sets could be used to determine the error properties of such attributes as mode shares and possibly other attributes like average trip lengths by purpose.

If the attribute on which the sampling error is specified is changed, then a different type of sampling will be required to achieve the desired sample. This would require investigation of what would be required and how it could be attained. Existing data sets could be used for this—for example, a secondary data source like Public Use Microdata Sample (PUMS) could be sampled to replicate the procedure that would need to be used.

4.2.15 S-6: Development of Default Variances

Estimation of error requires an estimate of the variance of crucial variables. One of the issues that has made sampling strategies relatively simplistic in household travel surveys is the lack of information on variances for those variables that are normally considered crucial in transportation planning analysis. This has implications on all aspects of sampling because the error levels are determined by the variance; hence, sample size and stratification procedures are also determined by the variance. In the absence of information about the variance, survey designers either assume constant variances across all strata in a sampling scheme or make some other working assumption that will allow sample size calculations to be made.

Default variances could be used to determine appropriate sample sizes and other issues in the absence of actual local data on these values. They could also be used subsequently to assist in

assessing the quality of any given survey by comparing the variance measured in a specific survey to the default value for each attribute of interest. Variances either much smaller or much larger might indicate potential problems in the survey.

It is recommended that research on this issue be undertaken in conjunction with work on stratification options (see Section 4.2.13) and the specification of sampling error requirements (see Section 4.2.14). It is suggested that variances be estimated for a variety of relevant variables and from as many different data sets as possible. These could include trip rates by purpose and overall per person and per household, mode shares by purpose, and average trip lengths by purpose. Recommendations should suggest a mean or median variance that could be used as a default for sample design for each appropriate variable. The implications of using default variances for setting sample sizes would need to be checked by comparing them with the results of using actual variances for several recent surveys. In the absence of any local information, these variances could be used to estimate stratification, sampling rates, and sampling errors. Perhaps of even greater use would be to determine default values of coefficients of variation (cv) that could be used in determining sample size because sample size and error computation also require knowledge of the mean.

4.2.16 P-1: Focus Groups

The transportation profession has only recently begun to understand and appreciate the potential of focus groups. These have been a mainstay of the marketing profession for quite some time and have enormous applicability to various aspects of survey design. While some personal travel surveys are conducted by marketing firms that may be familiar with focus groups, many surveys are conducted by transportation engineering and planning firms who are not familiar with them. Only a small minority of transportation surveys has used focus groups to help with the design of the survey; yet, this is a powerful mechanism to improve the design and quality of a survey. In the design process, one or more focus groups can provide important information in an effective manner and may be much more cost-effective than a number of pretests. While extremely useful, focus groups can probably be considered as good or better practice rather than basic practice in transportation surveys.

Guidelines or a primer on how focus groups could be set up and used in household and personal travel surveys would appear to be very useful. Among the issues that need to be addressed are the following:

- How many focus groups are needed?
- What is the optimum size of a focus group?
- How should focus groups be used to test a travel survey?
- How can a focus group be recruited?
- How much is it necessary or desirable to pay focus group members to participate?
- Should focus group members receive survey materials prior to meeting?
- How should a meeting location and time be arranged?
- What qualifications are needed to facilitate a focus group?
- Should focus group discussions be recorded?
- What benefits arise from using focus groups?
- How is a focus group conducted?

Literature from marketing and other areas should be consulted to prepare responses to these and other important questions and could help determine the extent to which focus groups are subject to standardized procedures. If possible, it may be useful to field test a small focus group to provide additional information for any proposed standards or guidelines.

4.2.17 P-5: Reporting of Pretests and Pilot Surveys

From a review of previous surveys, it appears that there is no consistency in reporting whether a pretest or pilot survey was performed. This would lead one to suppose that pretests or pilot surveys have not been conducted. There should be a standardized procedure here that the final report of a survey should document whether a pilot survey or any pretests were conducted. If none was conducted, there should also be a clear statement as to the reason why this was the case.

The other major issue relates to what should be reported from a pretest or pilot survey—for example, details on how the sampling was done, sample sizes determined, elements tested and results of the tests, and any specific statistical tests of significance that were performed. There is a need for minimum reporting standards to be developed here. It is suggested that reports on recent surveys be reviewed to determine what has been documented in the past. Some of the items to be considered here should be

- Sample sizes and methods of drawing the samples for any pretests and pilot surveys;
- Nature of the design that was tested;
- Results of the tests, including response rate(s) and other measures of quality; and
- Conclusions drawn from any pretests and pilot surveys and changes implemented as a result of the pretests or pilot surveys.

The documentation should include any statistical test performed to establish whether to make changes to the final survey, and anecdotal information should also be included that may have led to changes in the design of the survey and its protocols. For example, problems encountered by interviewers in using the scripts provided and questions raised by prospective respondents are all appropriate items to be included in the documentation. A report outline should be developed as the means to convey the standard for documentation of any pretests and pilot surveys conducted.

4.2.18 Q-4: Sampling Error

Sampling error not only is a part of the specification of the required sample size and an input to the design of the sample, but also is an important measure of the quality of the resulting survey. Sampling error of individual variable estimates is measured by the Standard Error of the Estimate (SEE). However, the magnitude of the measure is affected by the units of measurement of the variable under consideration, making interpretation of the value and comparison of values among data sets difficult. To eliminate this effect, the coefficient of variation (SEE divided by the estimate) provides a dimensionless measure of variation of the estimate about the mean and allows meaningful comparison among data sets. However, this does not alter the fact that sampling errors need to be calculated separately for each variable in question.

Given the difficulties that survey planners have in communicating information about sample-size calculations to clients (Richardson et al., 1995), one would ideally like to obtain one measure of sampling error for a data set as a whole, which could be derived from an average or weighted average value calculated for a number of key variables. Unfortunately, it was not possible to devise such a measure in this project. A practical approach for assessing overall survey quality would be to use the highest sampling error obtained among a list of key variables. This idea is consistent with the idea of "total design" promoted by Dillman (1978), which suggests that the quality of a process is only as good as the weakest link in the process.

It is recommended that research be conducted to determine the most appropriate variables for a combined measure of sampling error. These may include activity rates per person and household; trip rates by purpose per person and household; mode shares by trip purpose; and selected household and person attributes such as vehicle ownership, household size, driver's license status, etc. Two specific approaches could be taken to determine such variables. One approach could involve

selecting a set of key variables from among the core variables required in any survey. An alternative approach could be to identify those variables most relevant to the purpose, or purposes, of the survey and to measure the sampling error on each variable (TMIP, 1996a). Regardless of the approach taken, the determination of the key variables should be related back also to the minimum specification of questions already developed as part of this project (see Section 2.1.1). To illustrate the effects of the standardized procedure and its interpretation, it is recommend that sampling errors be calculated for two or three recent surveys on the key variables specified.

4.3 Other Research Directions

In this section, we outline briefly ideas that surfaced during the execution of this research. A number of these have been partially researched in this project, but further work is seen as being warranted to complete what has been started and to develop standardized procedures or consistent guidelines.

4.3.1 Cell Phones

Cell phone usage has grown at a phenomenal rate over the past decade and has profound implications for the way in which surveys are conducted. In 2003, cell phones composed about 43% of all U.S. phones, which represented an increase of 37% since the year 2000 (USA Today, 2003). In addition to this, many households are now moving away from landline phones and using cell phones exclusively. In June 2003, the Federal Communications Commission reported that in the period since the year 2000, landline phones decreased by more than 5 million, or around 3% (USA Today, 2003). The majority of cell phones are unlisted, which means that it will become increasingly difficult to contact large sections of the population through RDD.

In our opinion, research on the use of cell phones should be focused on two key areas. First, there is a need to determine the effects that growing cell phone use will have on household travel surveys. Specifically, more needs to be known about members of the population who are moving toward exclusive use of cell phones. It is likely that such information could be obtained from a federal government agency such as the Federal Communications Commission or a communications industry group such as the Cellular Telecommunications and Internet Association.

Second, once it is known which segments of the population will become increasingly difficult to contact, alternative strategies will need to be developed to find new ways of reaching such groups. Although the increased take up of cell phones may create difficulties in reaching certain sections of the population, it is worth noting they may also create some new opportunities. Once initial contact has been made and a person has agreed to take part in a survey, they may actually be easier to contact (e.g., for recall interviews) than would have previously been the case. If a personalized interview technique were adopted, such as the Brög method, a relationship could even be established whereby the interviewer would deal with their contacts as "clients," who would be free to call their interviewer or "agent" whenever they felt it necessary. It is recommended that these kinds of opportunities be explored as part of any research conducted on the impacts of increasing cell phone use among the population.

One of the problems with using cell phones is that calls received incur the same cost as a call placed and, therefore, the use of cell phones in a survey would impose a cost on survey respondents, which is generally considered a violation of ethical standards for surveys. In the past, it has been relatively easy to exclude cell phones because certain blocks of numbers were reserved by telephone companies for allocation to cell phones. However, this is eroding as number portability allows people to shift their landline number to a cell phone. One possibility is that this trend will further damage the potential of using the telephone as a means to recruit and retrieve

survey information. It is certainly beyond the scope of this present report to examine the potentials for using or not using cell phones in the future and to potentially recommend changes to ethics standards that would permit the use of such phones.

4.3.2 Incentives

Standardized procedures for the type of incentives to be used have been described in Section 2.2.8. However, it is unknown how different types of survey methodologies would effect the reception of the cash incentive. For example, it is unknown how a $10 cash incentive would be received amongst those who respond to a CATI versus those who respond to a face-to-face interview. This issue may become greater for survey practitioners wanting to use multi-modal surveys: what level of incentive is likely to reduce non-response across the different survey modes? This needs to be investigated before any standardized procedures or guidelines could be suggested. Further, as noted in Section 5.8 of the Technical Appendix, there has been no comprehensive test of the effect of incentives. It is not known how much of an increase in response rate can be obtained with incentives of different sizes, nor what biases may result from their use. This is research that would be warranted.

To determine the effect of incentives, it would be necessary to undertake a survey in at least two locations in which varying incentives were offered (including no incentive) in a random pattern and in such a way that comparisons could be made on the response rates and on who responds with and without an incentive. In addition, a non-response survey could be conducted in which the survey is repeated to respondents who refused or terminated on the first occasion, but offering either an incentive where none was offered before, or a larger incentive where a small one was offered before.

It may even be worth exploring incentives from a completely different angle. Instead of attempting to establish an "invisible" sense of reciprocation through an obligation-free incentive, one could go a step further and enter a formal agreement which establishes an explicit connection between the reward being offered and tasks required on the part of the respondent. This could possibly develop a greater sense of reciprocation, which would move the role of the respondent away from that of a "donor" to something resembling more of an "employee." It is recommended that research be done to evaluate the impact of such an approach on the recruitment process, as well as on response and completion rates. Offering a more substantive gift such as a football ticket, manicure, etc., may appear exorbitantly expensive on one hand, but the additional money costs may be justifiable if they result in significant improvements in quality of data or if the survey itself runs more quickly and smoothly. It may not even be necessary to offer a large incentive. There is some evidence to suggest that response rates improve simply through the act of having respondents sign a document to say they will complete it.

4.3.3 Personalized Interview Techniques

In this project, it was not possible to explore personalized interview techniques and the impacts they have on the response rates, completion rates, and the quality of data. The most well-known alternative approach to interviewing respondents is known as the "Brög technique." This approach differs from conventional interviewing techniques in that it stresses the importance of trust between the interviewer and the respondent. Instead of being contacted by several interviewers through the course of a survey, the respondent is instead given the name and phone number of a specific member of the interviewing staff who will serve as a "motivator" (Brög, 2000). Respondents are given the freedom to communicate using their own terms rather than those specified in a questionnaire, and a certain amount of dynamics are permitted in the interview while maintaining a coverage of essential topics. In general, the survey is made to be respondent-friendly

even if that means that it is not necessarily interviewer-friendly. Personalized interviewing techniques are also becoming increasingly popular through travel behavior modification programs such as TravelSmart® and Travel Blending®.

As part of NCHRP Project 8-37, Westat undertook a pilot study of a modified version of the Brög interviewing technique on a sub-sample of around 100 households participating in the 2002 wave of the Metropolitan Washington DC Council of Governments Longitudinal Household Travel Survey (COG LHTS) (Freedman and Machado, 2003) (see Section 5.1 of the Technical Appendix). In this CATI survey, a three-person team of interviewers was assigned to each household through its participation period. This approach was adopted to establish a high level of rapport between interviewers and participants and to create a situation where respondents would feel comfortable to call interviewers at any time during the daily interview hours (Freedman and Machado, 2003). Although it was found that the procedures adopted in the study showed promise, operational difficulties made it difficult to make any firm conclusions regarding the effectiveness of the method (Freedman and Machado, 2003). It is recommended that more work be done to evaluate the effectiveness of the Brög method. The test undertaken by Westat, while useful, was limited by constraints imposed by the COG LHTS of which it was a part. It is suggested that in future work, the method be tested in a stand alone survey.

4.3.4 Geocoding Methods

A number of general standards relating to geocoding were recommended in this project (see Sections 8.1 and 8.2 of the Technical Appendix). However, there is further work that can be done. The success of geocoding data depends on three issues: the quality of reference data (address information stored in GIS); the quality of target data (addresses reported by respondents); and the method adopted to match addresses. The limitations of reference data have been well documented (Greaves, 1998 and 2003), as have the problems that respondents have in accurately reporting addresses (Stopher and Metcalf, 1996). However, very little work has been done to evaluate the effectiveness of different techniques that can be used for dealing with partial matches (e.g., criteria relaxation and scoring-based systems). While Drummond (1995) provided a general overview of geocoding techniques, it is largely unknown what approach produces the best results. Also, decisions about what soundex score should be accepted or the extent to which matching criteria should be relaxed are generally very subjective. In future research, it is recommended that geocoding be performed on a number of common data set using a variety of different GIS packages.

In addition, a more thorough evaluation could also be conducted of systems capable of geocoding in real time. In this project, it was not possible to do any meaningful analysis of the costs and benefits associated with real-time geocoding. Anecdotal evidence suggests that significant improvements can be made when reported addresses can be instantaneously validated and cross-checked during the interview process through specialized CATI systems that incorporate address gazetteers (for schools, shopping malls, and other commonly visited locations). Although such systems have now been used in a substantial number of surveys, it is difficult to quantify the benefits of the technology because of the difficulties in comparing different types of surveys and different CATI systems. However, with a more detailed review of these surveys, it would be possible to at least determine what types of addresses can be included on online gazetteers.

4.3.5 Impacts of the National Do Not Call Registry

The National Do Not Call Registry was set up to protect households from being bombarded with telemarketing calls. It would be useful to know whether this has had a positive impact on the recruitment rates to household travel surveys. If so, then survey firms would need to draw smaller samples than in the past, and this would represent a cost saving in terms of the number of households that

would need to be called and also in relation to the number of pre-notification letters that would need to be mailed out. However, it would also be useful to know the characteristics of households that respond positively to recruitment calls after subscribing to the registry and whether their characteristics differ from the characteristics of households that respond negatively to survey recruitment calls. This will give an understanding of the non-response bias and is important to account for in household travel survey results. A possibility is to determine whether it is possible to obtain a list of households subscribed to the registry and then to compare response rates, characteristics, etc., among households recruited that are on the registry and those that are not.

4.3.6 Initial Contacts

Initial contacts are discussed in Section 2.2.7 of this report and Section 5.7 of the Technical Appendix. However, due to limited information, standardized procedures and guidelines could not be suggested. Thus, further research is required that investigates the phrasing of recruitment scripts and other contact materials to enable the development of a suggested consistent approach for the wordings of such materials. This will also depend on the nature of the survey and client requirements.

Again, the method that would be preferred is to test several different alternatives in a side-by-side comparison in actual surveys in more than one location. The goal would be to compare refusal and termination rates according to the alternative methods of initial contact, including the effects of pre-notification letters, and alternative ways of phrasing the opening of the recruitment script.

4.3.7 Refusal and Non-Contact Conversions

It has been well documented that response rates have been declining and that it is becoming increasingly difficult to get households and individuals to agree to participate in travel surveys. Among other things, this may be attributed increasingly to lengthy and complex surveys (increased respondent burden), more physical barriers inhibiting contact with prospective participants such as call-screening devices (telephone surveys), and gated communities (face-to-face surveys) (Kalfs and van Evert, 2003; Kam and Morris, 1999; Melevin et al., 1998; Oldendick and Link, 1999; Vogt And Stewart, 2001). Also, increasing numbers of marketing surveys have led people to perceive increased respondent burden; therefore, these individuals no longer even consider participating (Black and Safir, 2000; Kalfs and van Evert, 2003).

There are two broad categories for unit non-response: refusals (hard refusals, soft refusals, and terminations) and non-contacts (busy, no reply, and answering machines). Unit non-response becomes problematic if the responses of refusers and non-contacts differ significantly from the responses of contacts because this will add to non-response bias (Zmud, 2003). For example, it has been found that younger households and households with higher incomes require more calls to complete an interview due to telephone-screening devices. These households also tend to have higher refusal rates (Zmud, 2003). Evidence suggests that non-contacts lead active lifestyles and are highly mobile. In terms of travel surveys, absence of data from these households results in an under-estimation of trip rates. In addition, potential refusers possess different demographic characteristics than non-contacts. Higher refusal rates have been found among the elderly and low-educated persons (Kurth et al., 2001).

As part of this project, research was undertaken to gain some insight into demographic and travel characteristics of non-respondents, why they do not respond, and whether there are any particular elements in survey design and execution that would appeal to non-respondents. Analysis of a call-history file confirmed that households that require fewer call attempts to establish contact and result in a complete response differed, both in terms of mobility and socio-

demographics, from households that were more difficult to contact. Although this research was able to confirm characteristics of non-respondents found in other work, it was not possible to draw any definitive conclusions about how many refusals/non-contacts should be converted for every call attempt to reduce the overall incidence of bias in data set. It is recommended this issue be examined in greater depth in the future. It is suggested that multiple call-history files be analyzed as part of any future research effort. One of the main difficulties in comparing different call history files is that disposition codes are inconsistently defined among travel surveys. In light of this, it is suggested that future analysis should use files from contemporary surveys that are able to adopt the definitions proposed in this project.

4.3.8 Effect of Interview Mode on Recruitment and Non-Response Rates

The effect of interview mode on recruitment and non-response rates is related to the section on personalized interview techniques, Section 4.3.3, except that the focus is different. In this case, the issue is whether different modes of survey will have different impacts on recruitment rates and on eventual non-response rates. The same experiment probably could be conducted for this as would be envisaged for Section 4.3.3. However, the difference in this case will be that the focus is on whether different interview modes used in recruitment are associated with significantly different recruitment rates and what effect the different modes have on actual completion rates for the survey.

4.3.9 Unknown Eligibility Rates

In defining standardized procedures for computing response rates, the issue of the estimated rate of eligibility for those contacts that remained with unknown eligibility was recommended as being left to the survey firm. However, better guidance would be preferred for this issue because it has a critical impact on the calculation of response rates. Effectively, this requires the acquisition of a number of additional call-history files from which analysis can be conducted on the eligibility rates at different points in the calling. Ideally, these files should be obtained from surveys that have used 10 or more calls as the limit for trying to recruit households so that it is possible to determine an eligibility rate for a 5-call limit from information obtained from calls made beyond the fifth attempt.

4.3.10 Data Archiving in Transportation

In this report, we have proposed standardized procedures for data archiving for household travel surveys (see Section 2.6.4). However, past transportation surveys have not been archived according to the standards. The research that is needed is to archive data, using the standardized procedures, and then test the usefulness and effectiveness of the archiving. This may then result in modifications to the proposed procedures.

Sample Request for Proposals Template

5.1 Introduction

This RFP presents sample language for household travel surveys that are based on the recommended standardized procedures and guidance in this report (see Chapter 2). Intentionally, the language is prescriptive, as it would be in an RFP. It should not be misinterpreted as advocating that this is how travel surveys must be done. Footnotes are provided that reference the relevant sections of Chapter 2. Where an agency-specific number or value is required (e.g., number of presentations to management), a blank is shown in which each agency should substitute its desired value or number.

To make it easier to use the material in this chapter in preparing an actual RFP, the table and equation numbering are restarted at 1. Note that this template is intended to address only the Scope of Work section of an RFP. There are other documents that include complete RFPs, notably *Travel Survey Manual* published by the Transportation Model Improvement Program (TMIP, 1996b).

5.2 Request for Proposals

5.2.1 Scope of Work

This section defines the minimum scope of work to be accomplished by the Survey Contractor. It is presented in this RFP in two subsections: Task Plan and Schedule.

Task Plan

Task 1: Project Work Program and Management Plan
Within _____ days of contract execution, the Contractor will meet with Agency staff to initiate the project, discuss the work plan and schedule, and define project management roles and responsibilities. The outcome of this meeting is a revised work program and project management plan as initial deliverables.

The Agency internal project management staff includes

- _____, with overall project management responsibility;
- _____, responsible for day-to-day project coordination; and,
- _____, responsible for on-going data quality assurance.

The Contractor will be expected to

- Designate a Project Manager who will serve as the single point of contact for all survey issues;
- Make _____ presentations to Agency staff regarding survey progress and issues;
- Make presentations to and attend _____ meetings of the Study Steering Committee;

- Make a presentation of survey results to Agency management and staff;
- Prepare drafts of press releases regarding the survey effort for review and dissemination by Agency staff; and,
- Attend other meetings on an occasional basis as requested by the Agency Project Manager.

Task 2: Develop Survey Sampling Plan

The Contractor will prepare a survey sampling plan for review and discussion with Agency staff and the Steering Committee. The proposal should include a preliminary definition of the sampling plan and a discussion of

- Definition of the sampling frame for the main household travel survey;
- The number of households to be sampled, and the expected number of completed surveys, by cell of the main survey sampling frame;
- Need for augment samples (households that are recruited specifically for certain characteristics that are relatively rare in the local general population). These could include
  – Households using specific transit modes (e.g., local bus, express bus, rail, ferry, or bicycle);
  – Households using specific road facilities (e.g., certain highways, toll roads, or HOV lanes);
  – Households using park-and-ride to a transit mode; and/or
  – Households that represent other special population groups.
- Time dimensions of samples, including a discussion of
  – 24-, 48-, or other hour period for main sample;
  – Weekdays only (all days or only a subset);
  – Weekend sub-sample (Saturday/Sunday only, or as 48-hour pairs, such as Friday/Saturday and Sunday/Monday pairs); and
  – Summer sub-sample.

The Contractor shall use the following guidelines in drawing a sample[1]:

1. To overcome unanticipated sample loss (refusals, etc.), a large random sample should be drawn. The sample size should be based on the expected non-response rate (which may be determined during the pretest).
2. When a telephone sample is used, the order in which telephone numbers are drawn must be preserved. For example, for a Random Digit Dialing (RDD) list, numbers generated later in the list must not be recruited before numbers listed earlier in the list.
3. If using RAND Corporation (1955) random numbers, additional sample may be created and drawn after the initial sample has been exhausted. If using RDD lists, this must not be done because the two random samples will not be related.
4. Refusal conversion should be conducted, with a maximum of five call attempts to convert an initial soft refusal (therefore six calls to the household, in total).

Task 3: Survey Instruments and Data Collection Procedures

Survey Questions   Data elements that must be included in the survey are shown in Table 1.[2] It is further expected that the Contractor shall use the response categories shown in Table 2[3] and the standard question wordings shown in Table 3.[4] With respect to Table 2, at least the primary categories must be used. However, discussion with the agency should occur to determine whether any secondary categories must be used.

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[1] Sample Replacement, Section 2.2.4
[2] Minimum Question Specification, Section 2.1.1
[3] Standardization of Categories, Section 2.1.2
[4] Standard Question Wordings, Section 2.1.3

Table 1. Minimum questions.[a]

Category	Item	Description
Household	Location	Home address or home position in geographic terms
	Type of Building	Detached, semi-detached, terraced, flat, etc.
	Household Size	Number of household members
	Relationships	Matrix of relationships between all members of the household
	Number of Vehicles	Summary of number of vehicles from vehicle data
	Housing Tenure	Own or rent status
	Re-contact	Willingness to be contacted again for further surveys, etc.
Personal	Gender	
	Year of Birth	(Preferable to requesting age)
	Paid Jobs	Number of paid positions and hours worked at each in the past week
	Job Classification	Employee, self-employed, student, unemployed, retired, not employed, etc.
	Driving License	Whether a current driver's license is held
	Non-mobility	Indication of why no out-of-home activity was performed on a survey day including work-at-home days
	Education Level	Highest level of education achieved
	Handicap	Types of mobility handicap, both temporary and permanent
	Race[b]	Defined as currently measured in the U.S. Census
Vehicle	Body Type	For example, car, van, RV, SUV, etc.
	Year of Production	
	Ownership of Vehicle	Household/person, lease, institution
	Use of Vehicle	Main user of vehicle
Activity	Start Time[c]	
	Activity or Purpose	
	Location	Where the activity was performed, unless traveling
	Means of Travel	If activity is travel, what mode(s) was used (including specifying if a car passenger or driver)
	Mode Sequence	Unless collected as fully segmented data
	Group Size	Number of persons traveling with respondent as a group
	Group Membership	Number of persons in the group who live in respondent's household
	Costs	Total amount spent on tolls, fares and respondent's share
	Parking	Amount spent to park

[a] Minimum Question Specification, Section 2.1.1.

[b] All surveys shall use the U.S. Census Bureau definition of Race.

[c] Only start time needs to be ascertained in a time-use or activity survey because, by definition, the start time of an activity is the end time of the previous activity. Only the last activity should need an end time. In a trip-based survey, start and end time should be included.

The Contractor shall include a question to verify reported non-mobility to be asked of all persons who report they did not travel (stayed in one place/did not leave home) during the entire travel period.[5] It is strongly preferred that the Contractor also include questions that gently challenge persons who report non-mobility by asking for the reason(s) why no travel was made during that day.

Survey Instruments The Contractor will provide a schedule of contacts and reminders for the data collection process, specifying the type of contact to be used in each step. Contractors shall include as a minimum Steps 1 through 6 from Table 4, although it is desired that Contractors employ all 11 steps,[6] unless it can be shown that later steps are no longer cost-effective.

For mailed materials, the Contractor shall use the following with regard to the format and appearance of the materials:[7]

- For any materials to be returned via mail, the respondent must be provided with a stamped return envelope, preferably with instructions as to which materials should be mailed back (if any);

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[5] Incorrect Reporting of Non-Mobility, Section 2.4.6

[6] Number and Type of Contacts, Section 2.2.1

[7] Mailing Materials, Section 2.4.2

Table 2.   Response categories.[a]

Variable	Primary Category	Code	Secondary Category	Code
Type of Dwelling *(H2)*	Single-family house detached	1	Single-family house detached	10
	Single-family house attached	2	Townhouse	21
			Row house	22
			Duplex	23
			Triplex/fourplex	24
			Apartment/mother-in-law suite	25
	Apartment/condominium	3	Condominium	31
			Rented apartment	32
	Mobile home/trailer	4	Mobile home	41
			Trailer/camper	42
	Dorm/group quarters	5	Dormitory	51
			Hostel	52
			Nursing home	53
			Military barracks	54
	Hotel/motel	6	Hotel/motel	60
	Other	9	Other	90
Relationship (H4)	Self	1	Self	10
	Spouse/partner	2	Husband/wife	21
			De facto husband/de facto wife	22
	Son/daughter	3	Natural son/daughter	31
			Adopted son/daughter	32
			Stepson/stepdaughter	33
			Son-in-law/daughter-in-law	34
	Father/mother	4	Natural father/mother	41
			Adopted father/mother	42
			Stepfather/stepmother	43
			Father-in-law/mother-in-law	44
	Brother/sister	5	Natural brother/sister	51
			Adopted brother/sister	52
			Stepbrother/stepsister	53
			Brother-in-law/sister-in-law	54
	Grandfather/grandmother	6	Paternal grandfather/grandmother	61
			Maternal grandfather/grandmother	62
	Grandchild	7	Grandson	71
			Granddaughter	72
	Other relative	8	Male	81
			Female	82
	Not related	9	Boarder	91
			Housemate/ room mate	92
			Other non-relative	93
Housing Tenure *(H7)*	Own	1	Owned with mortgage	11
			Owned without mortgage	12
	Rent	2	Rent paid	21
			Occupied without rent	22
	Provided by job/military	3	Provided by job	31
			Provided by military	32
Education Level *(P10)*	No school completed	1	No school completed	10
	Elementary school	2	Preschool/nursery	21
			Kindergarten–4th grade	22
	High school	3	5th–8th grade (junior high)	31
			9th–12th grade (no diploma)	32
			High school diploma	33
	College/university	4	Some college but no degree	41
			Associate degree in college	42
			Bachelor's degree	43
	Post-graduate studies	5	Some graduate school, no degree	51
			Master's degree	52
			Professional school degree	53
			Doctorate degree	54
Disability (P11)	Difficulty standing	1	Difficulty standing	10
	Difficulty climbing	2	Difficulty climbing	20
	Visually impaired/blind	3	Visually impaired/blind	30
	Hearing impaired/deaf	4	Hearing impaired/deaf	40
	Require wheelchair	5	Require wheelchair	50
	Require cane/walker	6	Require cane/walker	60
	Other (specify)	9	Other (specify)	90

(continued on next page)

Table 2.   (Continued).

Variable	Primary Category	Code	Secondary Category	Code
Race (P12)	White (alone)	1	White (alone)	10
	Black/African American (alone)	2	Black/African American (alone)	20
	American Indian/Alaskan Native (alone)	3	American Indian	31
			Alaskan Native	32
	Asian (alone)	4	Asian Indian	41
			Chinese	42
			Filipino	43
			Japanese	44
			Korean	45
			Vietnamese	46
			Other Asian	47
	Native Hawaiian or Pacific Islander (alone)	5	Native Hawaiian	51
			Guamanian or Chamorro	52
			Samoan	53
			Other Pacific Islander	54
	Some other race (alone)	6	Some other race (alone)	60
	Two or more races	7	Two or more races	70
Vehicle Body Type (V1)	Auto	1	Auto	10
	Van	2	Van	20
	Recreational vehicle (RV)	3	Recreational vehicle (RV)	30
	Utility vehicle	4	Utility vehicle	40
	Pick-up truck	5	Pick-up truck	50
	Other truck	6	Other truck	60
	Motorcycle	7	Motorcycle	70
	Other (specify)	9	Other (specify)	90
Vehicle Ownership (V5)	Household member owned or leased	1	Household member owned or leased	10
	Employer owned or leased	2	Employer owned or leased	20
	Other (specify)	3	Other (specify)	30
Trip Purpose (A2)	Home	1	Home – domestic activity	10
			Home – paid work	11
	Work and work-related	2	Main job	21
			Other job	22
			Volunteer work and community services	23
			Looking for work	24
	Education/childcare	3	Attendance at childcare	31
			Attendance at school	32
			Attendance at college	33
	Eating out	4	Restaurant/café	41
			Fast food	42
			At friends' home	43
	Personal business/medical	5	Availing of/shopping for administrative services	51
			Availing of/shopping for professional services	52
			Availing of/shopping for government/public services	53
			Availing of/shopping for personal services	54
			Availing of/shopping for medical and health care services	55
	Shopping	6	Purchasing food and household supplies (groceries)	61
			Purchasing clothes, shoes, personal items	62
			Purchasing household appliances, articles, equipment	63
			Purchasing capital goods (cars, houses, etc.)	64
			Comparison shopping	65
			Window shopping	66

Table 2.   (Continued).

Variable	Primary Category	Code	Secondary Category	Code
	Social/recreational	7	Communication/ correspondence	71
			Socializing activities	72
			Participating in religious/community/ cultural events/activities	73
			Visiting entertainment and cultural venues	74
			Indoor and outdoor sporting activities	75
			Games/hobbies/arts/ crafts	76
			Print/audio/visual media	77
	Accompanying others/travel related	8	Accompanying children to places	81
			Accompanying adults to places	82
			Pick up or drop off other people/get picked up or dropped off (private car, car/van pool, shuttle/limousine)	83
			Activities related to bus, public transit and group rides (except car/van pool and shuttle/limousine)	84
			Change travel mode	85
	Other (specify)	9	Not further defined (n.f.d.)	90
Means of Travel (A4)	Car/van/truck driver	1	Car driver	11
			Van driver	12
			Truck driver	13
	Car/van/truck passenger	2	Car passenger	21
			Van passenger	22
			Truck passenger	23
	Motorcycle/moped	3	Motorcycle	31
			Moped	32
			Scooter	33
	Bicycle	4	Bicycle	40
	Walk/wheelchair	5	Walk	51
			Skate/roller skate/ roller board	52
			Motorized wheelchair	53
			Non-motorized wheelchair	54
	Bus/school bus	6	Regular bus	61
			Intercity bus	62
			Express bus	63
			School bus	64
	Train	7	Train	71
			Trolley/streetcar	72
	Taxi/shuttle	8	Taxi	81
			Shared-ride taxi/jitney	82
			Commuter van/shuttle bus: employer paid	83
			Commuter van/shuttle bus: pay fare	84
			Dial-a-Ride	85
			Shuttle/limousine	86
	Other (specify)	9	Other (specify)	90
Fuel Type	Gasoline	1	Gasoline	10
	Diesel	2	Diesel	20
	LPG/LNG	3	LPG/LNG	30
	Dual Fuel	4	Dual fuel	40
	Other (specify)	9	Other (specify)	90
Employment Status	Full-time	1	35–45 hours	11
			46–55 hours	12
			Greater than 56 hours	13
	Part-time	2	Less than 20 hours per week	21
			Greater than 20 hours per week	22
	Retired	3	Retired	31
			Semi-retired	32
	Full-time homemaker	4	Full-time homemaker	40
	Unemployed seeking employment	5	Unemployed seeking employment	50
	Unemployed not seeking employment	6	Unemployed not seeking employment	60
	Full-time student	7	Full-time student	70
	Child not in school/infant*to be specified if skip mechanism not in place	8	Child not in school/infant*to be specified if skip mechanism not in place	80
	Volunteer work (unpaid)	9	Volunteer work (unpaid)	90

[a] Categories for Minimum and other Questions, Section 2.1.2

Table 3. Required question wording.[a]

Question	Recommended Standard for Question Wording
Household Size (H3)	"Including yourself, how many people live at this address? Please do not include anyone who usually lives somewhere else or is just visiting, such as a college student away at school. (If further clarification is needed, include infants and children, live-in domestic help, housemates, roomers.)"
Number of Vehicles (H6)	"How many vehicles are owned, leased, or available for **regular use** by the people who currently live at this address? Please be sure to include motorcycles, mopeds and RVs." (As clarification, regular use means "are in working order.") "How many bicycles in working condition are available to members of your household for use in their daily travel?"
Owner or Renter Status (H7)	"Do you own or rent your home? • Own/buying (e.g. paying off a mortgage); • Rent/lease; or • Provided by job or military."
Gender (P1)	"Are you (is this person) male or female?"
Disability (P11)	"Do you have a disability or condition that has lasted 6 or more months and that makes it difficult to go outside the home alone, for example, to shop or visit a doctor's office?"
Activity or Trip Purpose (A2)	For work or work-related activities: • Volunteer work should be specifically excluded from the definition; • The clarification should be added that work means work for pay or profit; and • Questions should be asked about a second job. When asking for activities, include a category "Other at-home activities."
Number in Traveling Party (A6)	"Including yourself, how many people were traveling with you? How many of these were household members?" If CATI is used, it is suggested that the follow-up question regarding number of household members only be asked when the household size is greater than one. At a minimum, the number in the traveling party should be asked whenever a private car, van, or truck is the mode of travel.
Income	"Please stop me when I get to the category that best describes the total combined income for everyone living at this address for last year:" Income response categories should match the start and end points used by the U.S. Census, although collapsing across income categories is acceptable.

[a] Standard Question Wordings, Section 2.1.3.

Table 4. Schedule of contacts and reminders.

Steps	Day	Contact Type	Content	Received by Household
1	Advance letter	Mail (R-7)	Advance letter	A week before recruitment is scheduled to commence
2	Recruitment (R)	Telephone	Recruitment interview	Recruitment day
3	R+1	Mail	Survey package sent out	R+3 to R+5
4	Diary Day (D)-1	Telephone	Pre-Diary Day reminder (motivation call)	D-1
5	D+1	Telephone	Reminder to return completed survey (motivation call)	D+1
6	D+2	Mail	Postcard reminder/reset of Diary Day to D+7	D+4 to D+6
7	D+6	Telephone	Reminder and check on second opportunity for Diary Day	D+6
8	D+9	Mail	Postcard reminder and reset of Diary Day to D+14	D+11 to D+13
9	D+13	Telephone	Reminder and check on third opportunity for Diary Day	D+13
10	D+15	Mail	Re-mailing of survey package and reset of Diary Day to D+21	D+17 to D+19
11	D+20	Telephone	Reminder and check on fourth opportunity for Diary Day	D+20

- The envelopes must be large, white envelopes (4″ × 9.5″ or larger), with the address printed directly onto the envelope, rather than using address labels;
- The envelope shall be printed with a recognizable return address on the envelope and an indication of the contents of the envelope (at least the survey name); and
- Postage stamps shall be affixed to the envelope, especially commemorative stamps, rather than using a franking machine or pre-printed bulk mail.

To encourage higher response, the Contractor shall also

- Mail out a pre-notification letter that has been carefully formulated so that it is simple in language, appealing to a wide range of people, and clearly sets forth the importance of responding;[8] and
- Provide detailed instructions in the form of an informational brochure or fact sheet.[9] Care should be taken to ensure that the information is presented in an easy to read manner, with appropriate use of graphics where possible.

Contractor will describe in the proposal recommendations for providing survey materials in languages other than English, and procedures for handling households that do not speak or write in English.

Data-Collection Procedures   Contractor will specify the data-collection procedures to be used (e.g., telephone recruitment with telephone or mailback retrieval, etc.). If using telephone retrieval, call-back attempts to any household must be limited to five or six attempts, and these attempts must be made at different times on different days.[10]

To ensure that later calculations of response rate are standardized, the Contractor must use at least the following four final disposition codes for households:

1. Complete interviews;
2. Eligible cases that were not interviewed (non-respondents);
3. Case of unknown eligibility; and
4. Ineligible cases.[11]

Table 5 presents a complete definition of households that are to be categorized in each disposition code.

The following protocol must be used for proxy reporting:[12]

1. For all persons, a code must be included in the database indicating whether the activity/travel report was provided directly by the individual conducting the activities or travel or by a proxy;
2. For persons aged 14 or less, activities/travel must be reported by a parent or other adult;
3. For persons aged 15–17, proxy reporting is permitted, but direct reporting with parental permission is preferred;
4. All persons aged 18 or older must be asked directly for their activities or travel; and
5. The survey methods report must include the percent of adult respondents (persons aged 18 or older) whose activities or travel were reported by proxies (regardless of whether a completed diary was available), excluding from the denominator persons who were physically or mentally unable to provide direct reporting at the time of retrieval (illness, incapacitation, etc.).

It is desired that the Contractor's calling protocol include at least one call-back attempt to obtain a direct report from each adult household member aged 18 or older before accepting a proxy report.

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[8] Unit Non-Response, Section 2.2.6
[9] Respondent Questions, Section 2.4.3
[10] Number and Type of Contacts, Section 2.2.1
[11] Computing Response Rates, Section 2.7.1
[12] Proxy Reporting, Section 2.2.2

Table 5.   Final disposition codes for RDD telephone surveys.

Eligibility	Disposition	Recommended Code
Eligible Interview		1.0
	Complete	1.1
	Partial	1.2
Eligible Non-Interview		2.0
	Refusal and termination	2.10
	Refusal	2.11
	Household-level refusal	2.111
	Termination	2.12
	Respondent never available after call-back request	2.21
	Telephone answering device (message confirms residential household)	2.22
	Miscellaneous	2.35
Unknown Eligibility, Non-Interview		3.0
	Unknown if housing unit	3.10
	Not attempted or worked	3.11
	Always busy	3.12
	No answer	3.13
	Telephone answering device (don't know if housing unit)	3.14
	Telecommunication technological barriers, e.g., call blocking	3.15
	Technical phone problems	3.16
	Housing unit, unknown if eligible respondent	3.20
	No screener completed	3.21
	Other	3.90
Not Eligible		4.0
	Out of sample	4.10
	Fax/data line	4.20
	Non-working number	4.31
	Disconnected number	4.32
	Temporarily out of service	4.33
	Special technological circumstances	4.40
	Number changed	4.41
	Cell phone	4.42
	Cell forwarding	4.43
	Business, government office, other organization	4.51
	Institution	4.52
	Group quarters[a]	4.53
	No eligible respondent	4.70
	Quota filled	4.80

[a] If specified as ineligible in the survey design.

To encourage a higher response rate, the Contractor shall provide incentives to households unless the pretest demonstrates that a response rate in excess of 70% may be achieved without an incentive.[13] The incentives should

- Be offered only as pre-completion incentives, that is, be offered to all recruited households in the sample and not offered conditional on respondents returning a completed survey;
- Be monetary in form and be small, on the order of $1–$2 per person, except where local laws or ordinances prohibit offering money. In such cases, a small gift should be offered; and
- Be offered to each individual and not to the household as an entity.

For a household to be deemed acceptable or "complete," the Contractor must provide the following data from that household:

1. Responses to all of the Minimum Questions listed in Table 1.[14]

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[13] Incentives, Section 2.2.8
[14] Complete Household Definition, Section 2.2.3

2. Responses from at least one person from each of the following age groups represented in the household:
   - 15–17;
   - 18–64;
   - 65–74; and
   - 75 and over.[15]
3. Sufficient information to geocode to latitude and longitude[16]:
   - No less than 99% of household addresses,
   - At least 95% of school and workplace addresses, and
   - At least 90% of other locations.

To encourage a higher response rate, the Contractor must provide a toll-free telephone number for respondents to call to verify the survey's legitimacy and to ask questions.[17] The Agency will also provide a telephone contact for respondent inquiries. For the same reasons, it is desired that the Contractor provide an Internet website with information about the survey, links to sponsoring agencies, answers to frequently asked questions, email and telephone contact for assistance or further information, and the ability to download survey materials. It is also desirable for the Contractor to provide respondents with online response capabilities.

With regard to survey procedures, the Contractor shall adhere to the following standards, unless specifically exempted in the proposal:

- Contractor must provide a caller ID.[18]
- When an answering machine is reached, Contractor shall leave messages according to the following protocol[19]:
  - When an answering machine is reached on the initial recruitment/screening call, a message will be left at least once in the call rotation before classifying the number as non-responding;
  - When an answering machine is reached on a reminder telephone call, a message will be left; and
  - When an answering machine is reached during telephone retrieval of travel information, a message will be left.
- Contractor's telephone survey protocols must include a process for complying with call back requests, whether they occur in the recruitment or retrieval portion of a telephone survey.[20]
- After the sixth request for a call back from the same household, the household may be categorized as a "soft" refusal and therefore eligible for Contractor's "soft refusal" conversion techniques.[21]

The Contractor shall exert extra effort to contact households that are difficult to contact. This may be done by increasing the number of calls for non-contacted units, designating specific times to call non-contacted units, expanding the data collection, and/or conducting face-to-face interviews.[22] It is desired that the Contractor include in the proposal the costs (separately) of, and an approach for, conducting a non-response survey.

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[15] Complete Household Definition, Section 2.2.3
[16] Level of Geocoding to be Performed, Section 2.5.2
[17] Respondent Questions, Section 2.4.3
[18] Caller ID, Section 2.4.4
[19] Answering Machines and Repeated Call-Back Requests, Section 2.4.5
[20] Answering Machines and Repeated Call-Back Requests, Section 2.4.5
[21] Answering Machines and Repeated Call-Back Requests, Section 2.4.5
[22] Unit Non-Response, Section 2.2.6

Task 4: Interviewer Training and Quality Assurance

In conducting the survey, the Contractor must ensure that the survey execution observes basic practice standards regarding ethics, which include[23]

- The anonymity of the persons surveyed, and the confidentiality of the information they provide, must be protected at all times.
- A survey respondent may not be sold anything or asked for money as part of the survey.
- Persons must be contacted at reasonable times to participate in the survey and must be allowed to reschedule participation in the survey to a different time if that is more convenient for them.
- Survey personnel must be prepared to divulge their own name, the identity of the Contractor, the identity of the Agency, and the nature of the survey being conducted if requested by a respondent.
- Children under the age of 15 may not be interviewed without the consent of a parent or responsible adult.
- A respondent's decision to refuse participation in a survey, not to answer specific questions in the survey, or to terminate an interview while in progress must be respected if that is the respondents' firm decision.
- Respondents may not be surveyed or observed without their knowledge. Methods of data collection such as the use of hidden tape recorders, cameras, one-way mirrors, or invisible identifiers on mail questionnaires may only be used in a survey if the method has been fully disclosed to the respondent and the respondent agrees to its use.
- Contractor may not release research findings prior to the public release of the findings by Agency, unless the Agency has provided approval to do so.
- Contractor must ensure the reasonable safety of its fieldworkers during the execution of a survey.

Contractor shall discuss its training program for interviewers, where interviewers are used, as Agency expects that all interviewers shall receive thorough and complete training.[24]

Validation Survey The Contractor shall conduct a validation survey that uses (at a minimum) the following three questions[25]:

1. Did you complete the initial survey? (yes or no). If "yes," go to Question 3 below. If "no," go to Question 2 below.
2. Did someone else in your household complete the survey? (yes or no). If "yes," go to Question 3 below. If "no," terminate the validation survey.
3. Question 3: Select a trip that the respondent is likely to remember from among the trips reported in the initial survey and note the time spent at the destination. Ask the respondent to recall the trip in question and to report the approximate time spent at the destination.

The Contractor shall report a statistic indicating the percent of validated surveys that provided a negative answer to each of the first two questions or a mismatch on the third question.[26] Agency has established as a "tolerable" level of failure on validation the following:

- 1% level of failure on the first two questions and
- 5% level of failure on the third question.

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[23]Ethics, Section 2.4.1
[24]Unit Non-Response, Section 2.2.6
[25]Validation Statistics, Section 2.7.5
[26]Validation Statistics, Section 2.7.5

Task 5: Conduct and Analyze Pilot Survey

The Contractor shall pretest the survey instruments as necessary and must conduct a full pilot survey testing the entire survey process, including drawing the sample, conducting the survey, coding the data and performing basic analyses of the data.[27] It is desirable that the pilot survey include

- Monitoring interviewers to determine how they interact with potential respondents, how well they keep to the script of the survey, and whether the script causes difficulties in conversational style; and
- Conducting a debriefing with the interviewers used in the pilot survey or pretest to determine whether difficulties were experienced in handling survey procedures, questionnaires or other materials, scripts, etc.

The pilot survey must test

- The expected response rate.[28]
- The success of geocoding using one or all of the following methods[29]:
  - Aggregation checks on the location of geocodes,
  - Checking addresses against other information such as telephone exchanges,
  - Verifying that one trip starts where the other finishes, and
  - Cross-checking reported distances and times with those calculated from geocoded points.

It is desirable that the pilot survey also test alternative incentives, if incentives are used, to establish whether a particular population will be responsive to specific incentives.[30]

In drawing the pretest or pilot survey sample, the Contractor shall use the following approach[31]:

- The main sample must be drawn first, and the pilot survey or pretest sample shall be drawn only from those households or persons who were not drawn for the main sample. When the pilot survey or pretest is being conducted to determine the sample size required for the main survey, two options are possible.
  - The first option is that a main sample can be drawn that is expected to be more than sufficient in size. The pilot survey or pretest sample can then still be drawn subsequently from those households or persons who will not be included in the main sample under any likely circumstances.
  - The second alternative is to draw the pilot survey or pretest sample at random from the total population and then be sure to exclude all such drawings from the population for drawing the main sample. The former of these two is the preferred method.
- The minimum number of completed households for a pretest or pilot survey must be 30.
- The minimum sample size for pilot surveys shall be determined using Table 6.

Task 6: Finalize Survey Design and Procedures

The purpose of this task is to finalize all changes recommended from the pilot survey that have been approved by the Agency. The deliverables are the final versions of all survey instruments and materials (diaries, forms, scripts, letters, and other relevant materials).

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[27] Requirements for Pretests or Pilot Surveys, Section 2.3.1
[28] Sample Replacement, Section 2.2.4
[29] Geocoding Standards, Section 2.5.1
[30] Incentives, Section 2.2.8
[31] Sample Sizes for Pretests and Pilot Surveys, Section 2.3.2

Table 6.   Sample sizes required for specified levels of accuracy.

Measure	Assumed Value	Desired Accuracy	Sample Size	Measure	Assumed Value	Desired Accuracy	Assumed Variance	Sample Size
Response Rate	50%	±5%	384	*Household or Person Trip Rate*	10	±1	100	384
	50%	±10%	96		10	±2	100	96
	50%	±15%	43		10	±3	100	43
	50%	±20%	24		10	±4	100	24
	60% or 40%	±5%	369		10	±1	50	192
	60% or 40%	±10%	92		10	±2	50	48
	60% or 40%	±15%	41		10	±3	50	21
	60% or 40%	±20%	23		10	±4	50	12
	75% or 25%	±5%	288		7	±0.5	70	1076
	75% or 25%	±10%	72		7	±1	70	269
	75% or 25%	±15%	32		7	±1.5	70	120
	75% or 25%	±20%	18		7	±2	70	67
Non-Response to a Question	10%	±3%	384		7	±0.5	50	768
	10%	±5%	138		7	±1	50	192
	10%	±8%	54		7	±1.5	50	85
	10%	±10%	35		7	±2	50	48
	20%	±3%	683		4	±0.4	40	960
	20%	±5%	246		4	±0.8	40	240
	20%	±8%	96		4	±1	40	154
	20%	±10%	61		4	±1.5	40	68
	30%	±3%	896		4	±0.4	16	384
	30%	±5%	323		4	±0.8	16	96
	30%	±8%	126		4	±1	16	61
	30%	±10%	81		4	±1.5	16	27

Task 7: Conduct Survey

Geocoding   During the data collection process, the Contractor shall[32]

- Collect and geocode information about frequently visited locations during the recruitment stages of the survey to maximize the opportunity to re-contact households later on to check addresses that cannot be matched.
- Perform the geocoding for non-household and non-habitually visited locations within a few days of data retrieval, also to allow households to be re-contacted if necessary.
- Ask respondents for the names of cross streets and/or landmarks during data retrieval.
- Use interviewers with a good knowledge of the survey area or provide interviewers with access to gazetteers containing accurate addresses for shopping centers and schools. Online address directories should be used to locate addresses in situations where supplementary information is not available.

Any locations that cannot be geocoded to latitude/longitude must be referenced at least to a traffic analysis zone (TAZ) to avoid systematic bias.[33] Where it is not possible to match out-of-region locations with a TAZ, such locations shall be assigned to a representative point outside the study area.[34] Mail-back surveys must be edited immediately upon receipt so that respondents can be re-contacted to query missing or incorrect data times while the survey is still fresh in their memory.[35]

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[32] Geocoding Standards, Section 2.5.1
[33] Level of Geocoding to be Performed, Section 2.5.2
[34] Level of Geocoding to be Performed, Section 2.5.2
[35] Item Non-Response, Section 2.2.5

Task 8a: Data Coding

The data set as delivered by the Contractor shall be coded as follows[36]:

- All data fields must be filled with alphanumeric data (that is, blanks are not acceptable as a legitimate code).
- Missing data—whether as the result of a respondent refusal, an indication that the respondent does not know the answer, or a legitimate skip of the question—must receive a coded numeric value. These values shall be negative values and shall be −99 for a refusal. For "don't know" responses, it shall be −98. For legitimate skips or non-applicability of a question, the code shall be −97.
- In any question where a legitimate response could be zero, the code for that response must be the number zero (0). This will normally apply to any question requesting a count of elements. In like manner, the count that is the response will be the coded value in all cases.
- The person record must contain a count of the number of trips reported by the individual. In this variable, a count of 0 is to be used only to indicate the response that the person did not travel on the diary day. If no travel information was provided, then the value coded shall be −99.
- For questions to which the response is either "yes" or "no," the response of "yes" shall be coded as 1 and the response of "no" coded as 2. For response to the gender question, "male" shall be coded as 1 and "female" as 2.

It is required that all variables be coded using multidigit, nested codes. For example, income shall be coded at least to the minimum coding levels and categories shown in Table 7.[37]

- It is desired that trip purpose/activities be coded using the either the primary, secondary, or tertiary coding categories shown in Table 8.[38] Contractor should specify the anticipated level in the proposal; however, the final level of coding will be determined jointly by the Contractor and Agency.

Table 2 in this RFP section contains desired primary and secondary coding categories for the following complex variables[39]:

- Type of Dwelling (H2),
- Relationship (H4),
- Housing Tenure (H7),
- Education Level Attained (P10),
- Disability (P11),
- Race (P12),
- Vehicle Body Type (V1),
- Vehicle Ownership (V5),
- Trip Purpose (A2),
- Means of Travel (A4),
- Fuel Type, and
- Employment Status.

Should Contractor propose a different coding approach for any of the above variables, one of the project deliverables will be a crosswalk to the desired coding categories in Tables 2, 7, and 8. In addition, data codes must be provided in the data set as follows:

- Time of day for data entry and storage shall be coded using two fields: one for the day number and one for the time in military time (00:00–23:59).[40]

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[36] Missing Values, Use of Zero, etc., Section 2.5.3
[37] Coding Complex Variables, Section 2.5.4
[38] Coding Complex Variables, Section 8.4
[39] Coding Complex Variables, Section 2.5.4
[40] Recording Time of Day, Section 2.4.7

Table 7. Coding for income categories.

Minimum Detail Categories	Minimum Coding	More Detailed Categories	More Detailed Coding
Under $10,000	00	Under $5,000	000
		$5,000–$9,999	005
$10,000–$19,999	01	$10,000 –$14,999	010
		$15,000–$19,999	015
$20,000–$29,999	02	$20,000–$24,999	020
		$25,000–$29,999	025
$30,000–$39,999	03	$30,000–$34,999	030
		$35,000–$39,999	035
$40,000–$49,999	04	$40,000–$44,999	040
		$45,000–$49,999	045
$50,000–$59,999	05	$50,000–$54,999	050
		$55,000–$59,999	055
$60,000–$69,999	06	$60,000–$64,999	060
		$65,000–$69,999	065
$70,000–$79,999	07	$70,000–$74,999	070
		$75,000–$79,999	075
$80,000–$89,999	08	$80,000–$84,999	080
		$85,000–$89,999	085
$90,000–$99,999	09	$90,000–$94,999	090
		$95,000–$99,999	095
$100,000–$109,999	10	$100,000–$104,999	100
		$105,000–$109,999	105
$110,000–$119,999	11	$110,000–$114,999	110
		$115,000–$119,999	115
$120,000–$129,999	12	$120,000–$124,999	120
		$125,000–$129,999	125
$130,000–$139,999	13	$130,000–$134,999	130
		$135,000–$139,999	135
$140,000–$149,999	14	$140,000–$144,999	140
		$145,000–$149,999	145
$150,000 and over	15	$150,000 and over	150
Legitimate skip	–97	Legitimate skip	–97
Don't know	–98	Don't Know	–98
Refused	–99	Refused	–99

- Start and end times for 24-hour diaries shall be 03:00 A.M. to 02:59A.M.[41] (In the case of diaries that cover more than 1 day, end times are extended by 24 hours for each additional day.)
- An ID number shall be assigned to each eligible address or telephone number, and this number will remain attached to the person or household for the duration of the survey.[42]
- If a stratified sample is used, it is desired that the ID number be stratification-based; date-based numbering is desirable for simple random or systemic samples.[43]
- Should imputation be used in the final data set to substitute for missing data items or for values of data items that are known to be faulty, every inferred or imputed value shall be flagged.[44] Contractors should note that any imputation procedure with the exception of overall mean imputation may be used. If hot-deck imputation is employed, it should be conducted without replacement.

Task 8b: Interim Delivery of Data

Agency requests interim delivery of data to permit periodic review and acceptance of the completed households provided by the Contractor. This review is to be ongoing throughout the

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[41] Time of Day to Begin and End Reporting, Section 2.4.8
[42] Creation of ID Numbers, Section 2.4.9
[43] Creation of ID Numbers, Section 2.4.9
[44] Missing Data Imputation, Section 2.6.3

Table 8.   Trip purpose/activity categories.

Primary Category	Code	*Secondary Categories*	Code	*Tertiary Categories*	Code
Home	01	Sleeping/napping	011	Sleeping	0110
		Preparing/eating meals/snack/drinks	012	Preparing a meal/snack	0121
				Eating a meal/snack	0122
				Other specified food-related activities	0129
		Home maintenance/cleaning	013	Indoor cleaning	0131
				Outdoor cleaning	0132
				Gardening/ tending plants	0134
				Care of textiles and footwear	0138
				Other specified home maintenance and cleaning	0139
		Household management	014	Paying household bills	0141
				Budgeting, organizing, planning	0142
				Selling, disposing of household assets	0143
				Other specified household management	0149
		Personal-care activities	015	Showering, bathing, personal grooming	0151
				Health/medical care to oneself	0152
				Receiving personal care from others	0153
				Other specified personal-care activities	0159
		Using computer/telephone	016	Using telephone (fixed line) (not including telephone shopping)	0161
				Using cell phone (not including telephone shopping)	0162
				Sending/reading/receiving email	0163
				Internet browsing (not including online shopping)	0164
				Shopping for goods and services using telephone (fixed line)	0165
				Shopping for goods and services using cell phone	0166
				Shopping for goods and services using Internet	0167
				Other specified use of computer/telephone	0169
		Caring for others	017	Caring for children	0171
				Teaching, training, helping children	0172
				Caring for adults	0173
				Other specified caring for others	0179
		Paid work	018	Paid work – main job	0181
				Paid work – other job	0182
				Other specified at home paid work	0189
		Other specified at home activities	019	n.f.d.	0190
Work	02	Main job	021	Regular hours	0211
				Overtime hours	0212
				Extra hours (not paid as overtime)	0213
				Other specified main job activities	0219
		Other job	022	Regular hours	0221
				Overtime hours	0222
				Extra hours (not paid as overtime)	0223
				Other specified job activities	0229
		Work in internship, apprenticeship, etc.	023	Regular hours	0231
				Overtime hours	0232
				Extra hours (not paid as overtime)	0233
				Other specified internship/apprenticeship activities	0239
		Unpaid work in family business	024	n.f.d.	0240
		Breaks and interruptions from work	025	n.f.d.	0250
		Training and studies in relation to work	026	n.f.d.	0260
		Volunteer work and community services	027	n.f.d.	0270
		Looking for work/setting up business	028	Looking for work	0281
				Looking for/setting up business	0282
		Other specified work related activities	029	n.f.d.	0290
Education/ Childcare Activities	03	Attendance at childcare	031	n.f.d.	0310
		Attendance at school	032	n.f.d.	0320
		Attendance at college	033	n.f.d.	0330
		Breaks/waiting at place of general education	034	n.f.d.	0340
		Self study for distance education course work	035	n.f.d.	0350

(continued on next page)

Table 8.   (Continued).

Primary Category	Code	Secondary Categories	Code	Tertiary Categories	Code
		Homework, study, research	036	n.f.d.	0360
		Career/professional development training and studies	037	n.f.d.	0370
		Other specified activities relating to education/childcare	039	n.f.d.	0390
Eating Out	04	Restaurant/café	041	Restaurant	0411
				Café/snack bar/cafeteria	0412
		Fast food	042	Take out	0421
				Eat in	0422
		At friends' home	043	n.f.d.	0430
		Picnicking	044	n.f.d.	0440
		Other specified eating out	049	n.f.d.	0490
Personal Business	05	Availing of/shopping for administrative services	051	Post Office	0511
				Other specified administrative service	0519
		Availing of/shopping for educational services	052	n.f.d.	0520
		Availing of/shopping for professional services	053	Banking/credit union	0531
				Insurance	0532
				Real estate	0533
				Tax or accountant	0534
				Legal services	0535
				Other specified professional services	0539
		Availing of/shopping for government/public services	054	n.f.d.	0540
		Availing of/shopping for personal services	055	Hairdresser/barber/beautician	0551
				Other specified personal service	0559
		Availing of/shopping for medical and healthcare services	056	Medical	0561
				Dental	0562
				Eye care	0563
				Physiotherapy	0564
				Other specified healthcare service	0569
		Availing of/shopping for rental services	057	n.f.d.	0570
		Availing of/shopping for repair and maintenance services	058	n.f.d.	0580
		Other specified activities relating to personal business	059	n.f.d.	0590
Shopping	06	Purchasing food and household supplies (groceries)	061	n.f.d.	0610
		Purchasing clothes, shoes, personal items	062	n.f.d.	0620
		Purchasing school supplies	063	n.f.d.	0630
		Purchasing medical supplies	064	n.f.d.	0640
		Purchasing household appliances, articles, equipment	065	n.f.d.	0650
		Purchasing capital goods (cars, houses, etc.)	066	n.f.d.	0660
		Comparison shopping	067	n.f.d.	0670
		Window shopping	068	n.f.d.	0680
		Purchasing other specified goods.	069	n.f.d.	0690
Social and Recreational Activities	07	Communication/ correspondence	071	n.f.d.	0710
		Socializing activities	072	Doing activities/going to places and events together	0721
				Receiving visitors	0722
				Visiting friends and relatives	0723
				Other specified socializing activities	0729

Table 8.   (Continued).

Primary Category	Code	Secondary Categories	Code	Tertiary Categories	Code
		Participating in religious/community/ cultural events/activities	073	Participating in community celebration of historical/cultural events	0731
				Participation in non-religious community rites of weddings, funerals, births, etc.	0732
				Participating in community social functions	0733
				Participating in religious activities	0734
				Participating in other specified religious/community/cultural activities	0739
		Visiting entertainment and cultural venues	074	Attendance at movies/cinema	0741
				Attendance at concerts	0742
				Attendance at sporting events	0743
				Attendance at library	0744
				Attendance at amusement park	0745
				Attendance at museum/exhibition/art gallery	0746
				Attendance at zoo/animal park	0747
				Attendance at other specified entertainment and cultural venues	0749
		Indoor and outdoor sporting activities	075	Organized sport	0751
				Informal sport	0752
				Exercise (excludes walking)	0753
				Walking, hiking, bushwalking	0754
				Fishing, hunting	0755
				Driving for pleasure	0756
				Participation in other specified indoor and outdoor sporting activities	0759
		Games/hobbies/arts/ crafts	076	Card, paper, board games, crosswords	0761
				Gambling	0762
				Arcade games	0763
				Home computer games	0764
				Hobbies, handwork, crafts	0765
				Other specified activities relating to games/hobbies/arts/crafts	0769
		Print/audio/visual media	077	Reading	0771
				Watching/listening to television/video programs/radio	0774
				Other specified activities using print, audio or visual media	0779
		Other specified social and recreational activities	079	n.f.d.	0790
Accompanying/helping others and travel-related	08	Accompanying children to places	081	Accompanying children to receive personal services	0811
				Accompanying children to receive medical/health services	0812
				Accompanying children to school, daycare centers	0813
				Accompanying children to sports lessons, etc.	0814
				Accompanying children to other specified places	0819
		Accompanying adults to places	082	Accompanying adults to receive personal services	0821
				Accompanying adults to receive medical/health services	0822
				Accompanying adults for shopping	0823
				Accompanying adults for social activities	0824
				Accompanying adults to cultural, sports, and entertainment venues	0825
				Accompanying adults to other specified places	0829
		Pick up or drop off other people/get picked up or dropped off (private car, car/van pool, shuttle/limousine)	083	Pick up someone or get picked up	0831
				Drop off someone or get dropped off	0832
		Activities related to bus, public transit, and group rides (except car/van pool and shuttle/limousine)	084	Wait for/get on vehicle	0841
				Leave/get off vehicle	0842
		Change travel mode	085	n.f.d.	0850
		Other specified activity related to accompanying others or travel-related	089	n.f.d.	0890
No activity	09	No activity	091	n.f.d.	0910
		No recorded activity	092	n.f.d.	0920
		No further activity recorded	093	n.f.d.	0930
Other	99	n.f.d.	990	n.f.d.	9900

data-collection period. Ongoing review provides both Agency and the Contractor the opportunity to make mid-course corrections and manage expectations.

Task 9: Delivery of Final Data Set

Interim and final datasets shall be delivered in ASCII format, as portable SAS or SPSS files.[45] If the travel data base contains two or more related files, the variables that link the files together must be in each file. The Contractor must provide the following data files at the conclusion of the survey for archival purposes:

1. The raw data files,[46]
2. The call-history files describing call dispositions during the recruitment process (if telephone recruitment was used),[47] and
3. Partial data from incomplete households.[48]

Task 10: Analysis of Results

The Contractor shall report response rates using the formula developed by the American Association of Public Opinion Research (AAPOR), RR3A, as shown in Equation 1.[49] The estimation of eligibility rate will be determined jointly by the Contractor and Agency.

$$RR3A = \frac{SR}{(SR+PI)+(RB+O)+e_{\mathrm{A}}(UH+UO+NC)} \tag{1}$$

where

SR = number of complete interviews/questionnaires,
PI = number of partial interviews/questionnaires,
RB = number of refusals and terminations,
O = other,
NC = number of non-contacts,
UH = unknown if household occupied,
UO = unknown other, and
e_A = estimated proportion of cases of unknown eligibility that are eligible (AAPOR eligibility rate: the same formula for calculating the eligibility rate is used).

The Contractor will conduct a weighting and expansion exercise and shall include the weights in the data set along with a description of the weighting process in the metadata.[50] The weights must include expansion factors so that the sum of the weights matches population estimates. The weighting and expansion process must follow the two-stage procedure described below.

Stage 1   To establish household weights, Stage 1 of the weighting and expansion process should include the following steps:

1. Estimate an initial weight equal to the inverse of the design sampling rate. If disproportional sampling is used, weights should be estimated for each stratum separately. The initial weight of household i in stratum h is

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[45] Data Archiving, Section 2.6.4
[46] Data Archiving, Section 2.6.4
[47] Data Archiving, Section 2.6.4
[48] Complete Household Definition, Section 2.2.3
[49] Computing Response Rates, Section 2.7.1
[50] Weighting and Expansion of Data, Section 9.2

$$w_{i,exp} = \frac{1}{s_{h,i\in h}}$$

where

$w_{i,\text{exp}}$ = initial weight (or expansion factor) for household i, and

$s_{h,i\in h}$ = design sampling rate in stratum h of which i is an element.

2. If knowledge is available on levels of non-response in the survey at geographic or demographic subdivision level, establish a weight to account for differential non-response. If non-response is not known at a level that subdivides the sample, assume the weight for this step is 1 and proceed to the next step. If the response rate is known at a level that subdivides the sample, the response weight for household i in subdivision j is

$$w_{i,resp} = \frac{1}{r_{j,i\in j}}$$

where

$w_{i,resp}$ = response weight for household i, and

$r_{j,i\in j}$ = response rate in subdivision j of which i is an element.

3. Weight for difference in selection probabilities. This is necessary when the sample frame and the sampling unit do not coincide as, for example, when the sample frame is residential telephone numbers and the sampling unit is households. Households with more telephone lines are more likely to be selected under this system than households with fewer lines. The same applies if the sample frame is dwelling units and multiple households occupy some dwelling units. To account for these differential selection probabilities, the following weight should be applied to the households, where a one-to-one relationship between the sample frame and the households does not exist:

$$w_{i,sel} = \frac{1}{u_i}$$

where

$w_{i,sel}$ = selection weight for observation i, and

u_i = number of times household i is represented in the sample frame.[51]

4. Obtain a composite weight for each household by multiplying the weights from the equations in Steps 1, 2, and 3 together:

$$w_i = w_{i,exp} \times w_{i,resp} \times w_{i,sel}$$

The weights identified for households in Stage 1 are also assigned to the persons and trips in the household.

Stage 2   Separate weighting is conducted for households and persons. While the procedure used is similar, different variables are used in each weighting process. Final weights for households are identified by conducting the following steps:

1. *Identify household variables for which population values are available (from external sources) and which also occur within the sample.* The choice of variables should be dictated

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[51] Note that u_i can range from a fraction for those households who share a dwelling or telephone line (or are episodic telephone owners) to values in excess of 1 when a household owns multiple telephone lines or inhabits more than one dwelling in the study area.

by the purpose of the survey, where bias is most expected, and the reliability of population values.

2. *Break each variable into a manageable number of categories.* The categories must be selected so as to ensure that the multidimensional "cells" that are produced by simultaneously cross-classifying all variables, all contain at least some sample values, because empty cells cannot be adjusted by weights and are, therefore, redundant. Individual cells can be collapsed into single larger cells to eliminate empty cells.

3. *Sum household weights, established in Stage 1, in each cell.*

4. *Apply iterative proportional fitting to the cell weights identified above.* The order in which the variables are considered in each iterative cycle is irrelevant since a unique solution is guaranteed irrespective of the order of the variables. A closing error of no more than 1% on any marginal value is recommended.

5. *Identify final weights by dividing the final cell weights above by the sum of the households in each cell.* This is effectively dividing the weighted sum of households in each cell by the unweighted sum to produce a common weight for all households that belong in each cell. Note that while individual households had different weights at the end of Stage 1, households in the same cell now have the same weight. However, the effect of those individual weights did have an impact in structuring the seed *n*-dimensional matrix used in the iterative proportional fitting process employed here. The adjustments in Stage 2 represent a further improvement in Stage 1 weights, but, because cell totals are used in the process, individual weights are lost.

6. *Transfer the final household weights to the data and include a description of the expansion and weighting process in the metadata.*

7. *Establish person weights in the same manner as was accomplished with household weights* with the exception that person variables are used in the process and person weights from Stage 1 are used in the initial (seed) *n*-dimensional matrix. Final person weights are established by dividing the final cell values by the number of persons in each cell.

8. *Establish trip weights by applying person weights to each trip.* The sum of all trip weights in the sample will then represent the total number of trips made in the study area during the survey period although trip under-reporting will tend to result in this estimate being lower than the true number of trips conducted. Separate trip weights cannot be established because the true number of trips made in an area is unknown.

Task 11: Final Report

In addition to other data tables and information required by Agency, the final documentation must include the following information:[52]

- *Identification*—clear identification of the sponsoring Agency(ies), the Contractor, and the name(s) of the Contractor's subcontractors and/or fieldwork agency(ies), if any.

- *Survey purpose and objectives*—description of why the survey is being conducted, what it hopes to achieve, and the expected results.

- *Copies of the questionnaire and other survey documents*—this includes the wording of all questions including specific interviewer and respondent instructions and aids such as recruitment scripts, interview script (telephone and personal interview), maps, travel diaries, memory joggers, etc. These should be provided in an appendix.

- *Other useful survey materials*—interviewer instruction manuals, validation of results (techniques employed), codebooks, and incentive descriptions (monetary levels offered).

- *Population and sampling frame*—a description of the population that the survey is intended to represent as well as why this population was selected and a description of the sampling frame used to identify this population.

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[52] Documentation, Section 2.6.5

- *Sample design*—a complete description of the sample design: sample size, sampling frame, information on eligibility criteria, and screening procedures.
- *Sample selection procedures*—methods by which respondents were selected by the Contractor, details of how the sample was drawn, the levels of proxy reporting, what constituted a complete household, and the sample size.
- *Sample disposition*—refusals, terminations, ineligibles, completed interviews, and non-contacts. Also a description of the level of item non-response accepted for key variables and why.
- *Response rates*—how the eligibility rate for the unknown sample units was determined, a description of the AAPOR response rate formula used, as well as the calculation of the overall response rate.
- *Processing description*—editing, data adjustment, and imputation procedures used.
- *Precision of estimates*—sampling error and include other possible sources of error to inform user of accuracy or precision and a description of weighting or estimating procedures.
- *Basic statistics*—a description of all base percentages or estimates on which conclusions are made.
- *Data collection methods*—survey mode and procedures.
- *Survey period*—dates of interviews of fieldwork or data collection and reference dates for reporting—that is, time, day, and date when calls or other forms of contact were made.
- *Interviewer characteristics*—number and background of fieldwork staff.
- *Quality indicators*—results of internal validity checks and any other relevant information such as external research.
- *Contextual information*—any other information required to make a reasonable assessment of the findings and data.
- *Geocoding description*—including how geocoding was conducted, the level of data imputation and inference, and how these values are flagged, etc.

The Contractor will assist the Agency in collecting the necessary organizational documentation: the RFPs, proposal submission, contract and modifications, progress reports, key meeting results, key personnel costs, and information about situations that occurred during the survey period.

The final report shall include the following as quality indicators:

- An overall estimate of item non-response that shall be calculated as the average item-non-response and expressed as a percentage to the following key questions[53]:
  - Means of travel,
  - Licensed driver status,
  - Start time and end time of trip *or* travel time of trip, and
  - Vehicle occupancy.
- Note that item non-response includes those items where values are missing, where the respondent has indicated that they "don't know" and where the respondent has refused to answer.
- The percent of non-mobile days.[54] If questions are asked regarding the reasons why no travel occurred, as an advanced standard, the report must include analyses of these reasons and the characteristics of persons who reported no travel.
- An estimate of coverage error, calculated as the percentage deviation of the population of the study area estimated using the planned sample from that of the population of the same area

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[53]Item Non-Response, Section 5.5
[54]Incorrect Reporting of Non-Mobility, Section 7.6

using a reliable external source. Coverage error must be estimated using the definition of coverage error in Equation 2 below[55]:

$$CE = \left(1 - \frac{F_x}{\tilde{X}}\right)100 \tag{2}$$

where

CE = coverage error in percent,
F_x = sample population multiplied by the inverse of the sampling rate, and
$\tilde{X}$ = population from an external source.

- An assessment of sample bias, using the following procedure.[56]
- The following variables should be used to test for bias:
  - household size;
  - vehicle availability;
  - household income (if collected);
  - race of each person in the household;
  - age of each person in the household; and
  - gender of each person in the household.
- The variables should be measured as follows:
  - household size: mean value;
  - vehicle availability: categories of 0, 1, 2, and 3+;
  - household income: categories corresponding to those in Table 7;
  - race: categories of white, black/African American, American Indian/Alaska native, Asian, Native Hawaiian/Pacific Islander, other single race, and two or more races;
  - age: categories of 0–5, 6–10, 11–14, 15–17, 18–64, 65–74, 75 and over;
  - gender: male and female.
- Total error should be measured using the percentage RMSE statistic defined in Equation 3:

$$Percent\ RMSE = \sqrt{\frac{1}{n_i}\sum_i^{n_i}\frac{1}{n_{ji}}\sum_j^{n_{ji}}\left(\frac{r_{ij} - s_{ij}}{r_{ij}}\right)^2} \times 100 \tag{3}$$

where

n_i = number of variables i;
n_{ji} = number of categories j in variable i;
r_{ij} = reference value of variable i in Category j;
s_{ij} = sample value of variable i in Category j.

- A data cleaning statistic (DCS), calculated using the following procedure[57]:

$$DCS = \frac{\sum_n^N \sum_i^I count(x_{i,n})}{N \times I}$$

where

$x_{i,n}$ = i*th* data item of respondent n,
$count(x_{i,n}) = \begin{cases} 1 \text{ if i}^{th}\text{data item of respondent n was cleaned} \\ 0 \text{ otherwise} \end{cases}$

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[55] Coverage Error, Section 10.3
[56] Assessing Sample Bias, Section 9.1
[57] Data Cleaning Statistics, Section 2.7.6

N = number of respondents in survey, and
I = number of minimum (core) questions.

- A Missing Values Index, calculated as shown below:[58]

$$MVI = \frac{\sum\limits_{n=1}^{N}\sum\limits_{i=1}^{I} x_{i,n}^{*}}{\sum\limits_{n=1}^{N}\sum\limits_{i=1}^{I} x_{i,n}}$$

where

MVI = Missing Value Index,

$$x_{i,n}^{*} = \begin{cases} 1 \text{ if data item i of respondent n is missing} \\ 0 \text{ otherwise,} \end{cases}$$

$$x_{i,n} = \begin{cases} 1 \text{ if a response to variable i is applicable to respondent n} \\ 0 \text{ if a response is not applicable,} \end{cases}$$

I = number of variables, and
N = number of respondents in data set.

- An estimate of respondent burden in terms of either actual or estimated time in minutes for[59]
  - Review of printed materials, including instructions:
  - Recordkeeping (as applicable);
  - Use of "memory jogger" to record trips or activities;
  - Recording odometer readings from household vehicles;
  - Actual average call time for (as applicable) recruitment, reminder calls, retrieval, and any other calls (verification, re-contact for incomplete data, etc.);
  - Completing diaries and other requested data;
  - Gathering the completed surveys from responding household members, and
  - Mailing the surveys back to the Contractor/client agency (if applicable).

Contractor should note that Agency will review the above quality indicators, including the household trip rates[60], as indicators of the data quality.

Contractor is to provide a summary of the survey results, using the weighted data. The Contractor should specify in its proposal whether the results will be included in the Methods Reports or will be presented in a separate volume.

5.2.2 Schedule of Work

The anticipated project schedule is as follows:

- Month, Day, Year: Anticipated Date of Contract Execution
- Month, Day, Year: Start of the Pretest
- Month, Day, Year: Start Date of the Main Survey Data Collection
- Month, Day, Year: Completion of Field Portion of Main Survey Data Collection
- Month, Day, Year: Draft Survey Results
- Month, Day, Year: Final Survey Report

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[58] Number of Missing Values, Section 2.7.7
[59] Respondent Burden, Section 2.2.9
[60] Transportation Measures of Quality, Section 2.7.2

There are certain dates during which data collection must be suspended. These are as follows:

- Year-End Holiday Period: Month, Day, Year–Month, Day, Year
- Other National Holidays: Month, Day, Year
- Regional Holidays: Month, Day, Year

The selected Contractor may recommend alternative or additional dates for suspension of travel data collection. The Contractor will present a complete schedule of task and survey activities in its proposal.

Glossary

We have developed a standard glossary of terms and their definitions, the use of which will make comparisons among surveys easier if adopted by the transportation planning profession. The purpose of a glossary is to promote understanding and establish common terminology within the subject area.

Some of the terms used in travel surveys present no problem in understanding or interpretation among users (e.g., terms such as "gender" and "age"). Others require definition within a particular study because while there is generally no difficulty in understanding the general meaning, the specific meaning must be defined to ensure a common use of the term. Examples of these terms are words such as "trip," "employment status," or "occupation." These types of terms are appropriately defined in each study although there is definitely merit in establishing uniformity in these definitions among studies. However, there is a third group of terms which are in common use but whose meaning may vary among persons in the field. Examples of such terms are expressions such as "pretest," "activity," and "sojourn." It is this type of term that is most appropriately described in a glossary. In the section below, definitions of terms commonly used in personal travel surveys are suggested.

It is recommended that the terms described below be accepted as a glossary for personal travel surveys. The terms are presented in alphabetical order with the source of the definition, where appropriate, in parentheses after each term. To be effective, a glossary must be updated from time to time in order to amend any errors and add new terms.

Activity: The main business or undertaking engaged in by an individual, alone or with others (Zimowski et al., 1997a). Note, travel qualifies as an activity. Also, an individual can conceivably be engaged in more than one activity at a time (e.g., eating while watching television).

Advance Letter (or Announcement Letter): A letter sent to a sample member (household or person) via mail in advance of an attempt to contact the member (Zimowski et al., 1997a). It can be used to provide contact telephone numbers and a website address for obtaining more information about the survey (NHTS, 2001a).

Calibration Experiment: When old and new versions of a survey instrument are administered to different portions of the sample to assess the impact of changes in the questions on responses (Zimowski et al., 1997b).

Call Back (Disposition Code): This is a disposition code in a call-history file that shows that the household has requested to be called back. Contact was, therefore, made with the household, but a complete recruitment or retrieval interview was not obtained.

Call-History File: A call-history file is the file that houses disposition codes (labels) for each call made, on each call attempt, during the recruitment phase of the survey process. This file lists all households contacted, the disposition code showing whether the household was recruited

successfully, and the number of call attempts required for this to eventuate and shows the number of households that declined to participate in the survey. It also contains other information, such as the type of recruitment—e.g., whether a cold call is made or the intercept recruitment method is adopted—and records the time, day, and date when each call was made and, importantly, the telephone number. It may also include some demographic information about the recruited household (see also *Recruitment Interview*).

Calling Protocol: A procedure followed while contacting sample members. Most calling protocols take into account the outcomes and times of previous calls in an attempt to improve the chances of reaching sample members (adapted from Zimowski et al., 1997a).

Cluster Sampling: In cluster sampling the total population is divided into clusters of sampling units, usually on a geographic basis, and clusters sampled randomly with the units within the selected clusters either being selected in total or else selected randomly, usually at a very high rate (Richardson et al., 1995, p. 92).

Codebook: The collection of all coding frames for a survey is referred to as a codebook (adapted from Richardson et al., 1995, p. 269).

Coding: Coding is the translation of respondent answers into machine-readable data.

Coding Frame: A coding frame describes the set of codes to which answers to codes are allocated (adapted from Richardson et al., 1995, p. 269).

Cognitive Interview: A technique for developing survey questionnaires that focuses on the thought processes respondents go through as they arrive at answers to survey questions. In a cognitive interview, respondents are asked to think out loud as they answer draft survey questions. They may also be asked to respond to a number of follow-up probes to reveal how they arrived at their answers and whether the content or wording of the items should be improved (Zimowski et al., 1997a).

Cognitive Laboratory: An experimental setting for piloting the framing, order, and wording of survey items.

Cohort: A group of individuals within a population who have experienced the same life event during some specified period in time. A cohort is usually defined by year or period of birth, but it may also be used to refer to the timing of any number of other life events such as year of retirement or year of marriage (Zimowski et al., 1997b).

Cold-Deck Imputation: A statistical procedure that replaces missing or incorrect data items in one data set with values taken from a similar case in a different data set.

Computer-Assisted Personal Interviewing (CAPI): Face-to-face interviewing performed with the assistance of a computer. In a CAPI interview, the interviewer reads the questionnaire items from a computer screen and records the respondent's answers by entering them into the computer (Zimowski et al., 1997a).

Computer-Assisted Self-Administered Interviewing (CASI) or Computer-Assisted Self-Administered Questionnaire (CASAQ): A computer-based instrument that is completed by a respondent without the assistance of an interviewer. This may involve the loan of a computer, the installation of the instrument on a computer chosen by the respondent, the use of a public computer terminal (e.g., in an airport waiting area), or access via the Internet. The functions possible are similar to those of CAPI, but greater attention may be given to interactive graphics, etc., to make the survey easy to use and enjoyable.

Computer-Assisted Telephone Interviewing (CATI): Telephone interviewing performed with the assistance of a computer. CATI systems are similar to CAPI systems in that the question-

naire items are displayed online and the interviewer enters the respondent's answers with the keyboard or mouse (Zimowski et al., 1997a).

Consolidated Metropolitan Statistical Area (CMSA): A metropolitan complex of 1 million or more population, containing two or more component parts designated as Primary Metropolitan Statistical Areas (PMSAs) (NPTS, 1990).

Converting: Recontacting initial refusals one or more times in an attempt to persuade them to participate in the survey (Zimowski et al., 1997a).

CPS: Current population survey (Zimowski et al., 1997b).

CPS Supplements: Supplements have the same data as the Basic Monthly Files plus supplemental information on topics such as schooling, fertility, immigration, income, and technology use (NBER, 2002).

Critical (Key) Items: A set of questions that *must* be completed by the sample member to classify the case as a respondent. The set typically includes all items that are essential to accomplishing the major goals of the survey (Zimowski et al., 1997a).

Cross-Sectional Survey: The collection of data at one point in time from a fraction of the total population (Richardson et al., 1995, p. 34).

Disposition Code: A code assigned to each case (member) in the sample that records the most recent or final outcome of the data collection effort (e.g., ring-no-answer, non-working number, respondent refusal). Disposition codes are used to track the status of each sample member, to monitor and manage the field effort, and to compute response rates (Zimowski et al., 1997a).

Disproportionate Sampling or Stratified Sampling with Variable Sampling Fraction: A sampling method in which the population is divided into strata, and different sampling rates are used for each stratum. This method of sampling, while random within strata, does not produce a total sample that is representative of the population without weighting. It is also a method of sampling that produces the optimal sample for given cost and accuracy.

Driver: A person who operates a motorized vehicle. If more than one person drives on a single trip, the person who drives most of the distance on the trip is classified as the principal driver (NHTS, 2001b).

Eligible Units (Eligibles): Sample units who are eligible to participate in the survey because they are part of the target population (Zimowski et al., 1997a).

Expansion Factor: The inverse of the achieved sampling rate. It is the factor required to multiply each observation by to expand the sample to the total population.

Field Period: The time period during which survey data are collected from the respondents (Zimowski et al., 1997b).

Hard Refusal: A sample member who has objected strongly to taking part in the survey (outright refuser).

Hot-Deck Imputation: A statistical procedure that replaces missing or incorrect data items with values from a similar case in the same data set.

Household: All persons who occupy the same housing unit and share responsibilities and resources. A household may consist of a family, one person living alone, two or more families living together, or any other group of related or unrelated persons who make joint decisions and share resources (adapted from Zimowski et al., 1997a).

Household Income: The total household income before taxes in the past 12 months. Includes income from sources such as wages and salaries, income from a business or a farm, Social Security, pensions, dividends, interest, rent, and any other income received (NHTS, 2001b).

Household Members: Includes people who live in the household but excludes anyone who usually lives somewhere else or is just visiting, such as a college student away at school (NHTS, 2001c).

Household Vehicle: A motorized vehicle that is owned, leased, rented or company-owned and available to be used regularly by household members during the travel period. Includes vehicles used solely for business purposes or business-owned vehicles if kept at home and used for the home to work trip (e.g., taxicabs, police cars) that may be owned by, or assigned to, household members for their regular use. Includes all vehicles that were owned or available for use by members of the household during the travel period even though a vehicle may have been sold before the interview. Excludes vehicles that were not working and not expected to be working within 60 days and vehicles that were purchased or received after the designated travel day (NPTS, 1990).

Housing Unit: A house, apartment, mobile home, group of rooms, or single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. To qualify as a housing unit, the occupants must live and eat separately from other persons in the building and have direct access to their unit from the outside of the building or through a common hall (Zimowski et al., 1997a).

Imputation: A statistical or logical technique by which missing or incorrect data are estimated from other information provided by the respondent and/or other respondents. Imputed values are probabilistic estimates and therefore there is no expectation that individual imputed values are necessarily correct (Zimowski et al., 1997a).

Incentive: A gift or payment offered to sample members in an effort to gain their cooperation (Zimowski et al., 1997b).

Ineligible Units (Ineligibles): Sample units who are not qualified to participate in a survey because they do not belong to the target population (Zimowski et al., 1997a).

Inference (Logical Imputation/Editing): Where values of missing or incorrect data items are logically deduced from information furnished by the respondent and/or other respondents. In inference, values are deduced with a high degree of certainty.

Item Non-Response: The failure to obtain a specific piece of data from a responding member of the sample (Zimowski et al., 1997a).

Journey: A journey is a tour starting and ending at home (adapted from Axhausen, 2003). Home may include a temporary home such as a hotel room, provided the individual slept at the location for at least one night.

Locating Letter: A letter sent by mail to the respondents in advance of the next data collection period in an effort to obtain updated addresses and telephone numbers before the next round of data collection (Zimowski et al., 1997b).

Longitudinal Data: Data collected on multiple variables at intervals over time.

Longitudinal Panel Designs: Designs that collect information on the same set of variables from the same sample members at two or more points in time (Zimowski et al., 1997b).

Longitudinal Weights: Weights designed to be used in longitudinal analyses of data from a panel survey (Zimowski et al., 1997b).

Means of Transportation (Mode): A mode of travel used for going from one place (origin) to another (destination). Includes private and public modes, as well as walking.

Missing Data: See *Item Non-Response* (Zimowski et al., 1997a).

Module: An independent part of a questionnaire that covers a single subject or topic of interest or one instrument in a multi-instrument design (adapted from Zimowski et al., 1997b).

Multistage Sampling: A sampling technique in which the sample is selected in two or more successive stages (Richardson et al., 1995, p. 89).

Non-Response: Failure of the survey to obtain the desired information from eligible sample members (Zimowski et al., 1997b).

Non-Response Bias: Non-response bias is a function of the non-response rate and the difference between respondents and non-respondents on the statistic of interest (Keeter et al., 2000).

Non-Response Weighting: Post-sampling statistical adjustment to compensate partially for possible non-response error. Statistical weighting to compensate for non-response is different from the post-sampling weighting that is routinely performed to adjust for unequal probabilities of selection (Zimowski et al., 1997b).

Non-Working Number: A telephone number that has not been assigned to a unit by the telephone company (Zimowski et al., 1997a).

Occupancy: The number of persons, including driver and passenger(s) in a vehicle (NPTS, 1990).

One-Time Cross-Sectional Designs: Designs in which sample members are asked to complete a survey once (Zimowski et al., 1997b).

Open-Ended Question: A survey question that asks the respondent to phrase the answer in his or her own words (Zimowski et al., 1997a).

Panel Attrition: Failure of first-wave respondents to complete the survey in subsequent rounds of a panel survey (Zimowski et al., 1997b).

Paper-and-Pencil Interviewing (PAPI): An interview in which the interviewer reads the questions from a printed questionnaire and records the answers directly onto the questionnaire using a pen or pencil (Zimowski et al., 1997a).

Person Miles (Kilometers) of Travel (PMT or PKT): A measure of person travel. When a person travels 1 mile (kilometer), 1 person mile (kilometer) of travel results. Where two or more persons travel together in the same vehicle, each person makes the same number of person miles (kilometers) as the vehicle miles (kilometers) (NPTS, 1990).

Person Trip: A person-trip is a trip by one or more persons in any mode of transportation. Each person is considered as making one person-trip (NPTS, 1990).

Pilot Survey: A pilot survey is a test of all aspects of the survey process (Richardson et al., 1995, p. 214).

Population: The universe of elements from which a sample is to be drawn. The population is defined in terms of the nature of the elements (e.g., people, households, vehicles); time; location; and any other appropriate descriptor (e.g., all persons living within the metropolitan region of Atlanta in April 1993).

Post-Stratification: The process of weighting stratified data to compensate for different sampling rates in the strata.

Pretest: A relatively small number of practice interviews used to test and refine individual components of the survey material and/or field procedures before the main survey is executed (Zimowski et al., 1997a).

Primary Sampling Unit (PSU): Units included in the sampling frame of a first level of a multi-stage sampling procedure, such as all PMSAs in the United States.

Proportionate Sampling or Stratified Sampling with Uniform Sampling Fraction: Sampling from strata, using the same sampling rate in each stratum. Thus, each stratum will occur in the sample at the same proportionate rate as in the population.

Proxy: A proxy report results when someone other than the selected sample member answers survey questions on behalf of that member (Zimowski et al., 1997a).

Quota Sampling: Sampling in which a specified number of responses are required from selected groups within the population (Richardson et al., 1995, p. 95).

Random Digit Dialing (RDD): Techniques that form samples by adding random digits to the telephone prefixes that fall within the sampling area so as to include both listed (published) and unlisted numbers in the sample (Zimowski et al., 1997b).

Random Sampling: A process in which each unit in the population is sampled independently so that each unit in the population has an equal probability of being selected (Richardson et al., 1995, p. 81).

Random Seed: A randomly selected starting point for a systematic sample.

Recall Attempts (Follow Up): Re-approach of a sample member after previous contact attempts have been unsuccessful in obtaining a complete response or a response (Zimowski et al., 1997a). Recall attempts include contact attempts by telephone, personal visit, mail, or possibly email.

Recruitment Interview: The interviewer seeks to obtain consent and cooperation for the survey during the recruitment interview. Household demographic information may be obtained during this interview, regardless of whether consent and cooperation for the survey are obtained.

Refusals: Sample members who refuse to participate in the screening or main data-collection phase of a survey (Zimowski et al., 1997a). There are three main categories of refusals: hard refusals, soft refusals, and terminations.

Reminder Call: Recontact of a recruited sample member to remind them of an upcoming event or their required response to a past event.

Repeated Cross-Sectional Design: Designs that collect measurements on a population over time by repeating the same survey on two or more occasions. During each time period, a separate and independent but comparable sample of units is drawn from the population (Zimowski et al., 1997b).

Reporting Period: A reporting period is the time interval for which a respondent is asked to describe the events or episodes which are within the scope of the survey (Axhausen, 2003).

Respondent Rules (Respondent Selection): Rules that are used by the interviewers to choose a respondent from all eligible members within a sampling unit (Zimowski et al., 1997a).

Response Rates: The ratio of the number of completed interviews divided by the number of eligible units in the sample (CASRO, 1982).

Retention Rates: The proportion of respondents from the first wave that complete later waves of data collection in a panel survey (Zimowski et al., 1997b).

Retrieval Interview: This is an interview whereby household travel responses are obtained over the telephone (CATI retrieval of data).

Rotate-Outs: Respondents who are dropped from a panel survey at a pre-specified stage in the survey.

Rotating Panel Designs (Revolving): A panel design that collects measurements on a sample for some specified number of periods (waves) after which some or all of the sample is dropped from the survey and replaced with a new but comparable sample of units drawn from the current population (Zimowski et al., 1997b).

Rotation Group: A sample of units drawn from the population at the same time and following the same schedule of data collection in a rotating panel design (Zimowski et al., 1997b).

Sampling Frame: A base list or reference that properly identifies every sampling unit in the survey population (Richardson et al., 1995, p. 77).

Sampling Unit: An element in a sampling frame (Zimowski et al., 1997b).

Screening Interview: A preliminary interview used to determine the eligibility of sample members. Sample members who meet the eligibility requirements are often recruited for more detailed data collection during the interview (Zimowski et al., 1997a).

Self-Administered Questionnaire (SAQ): A questionnaire that is completed by the sample member without the assistance of an interviewer (Zimowski et al., 1997b). With this type of survey, respondents are required to perform the three tasks on their own—to read and understand the questions, to mentally formulate an answer, and to transcribe the answer onto the questionnaire form. Self-completion questionnaires can be distributed and collected in the following ways:

- Mail out/mail back surveys;
- E-mailed to respondents and e-mailed back by respondents (or URL address provided to respondents—automatic data retrieval);
- Delivered to respondents/mailed back;
- Mailed to respondent/collected from respondent; and
- Delivered to respondent/collected from respondent.

Soft Refusal: This is a respondent who has not objected strongly to participating in the survey. Refusal conversions (Conversions q.v.) are only conducted on those who provide soft refusals to participation.

Sojourn: A stop on a journey.

Split Panel: In a split panel, the split is between a cross-sectional survey and a panel (Kish, 1985; Raimond and Hensher, 1997). At each wave of measurement of the panel, which may be either a subsample panel or a refreshed panel, a separate, non-overlapping cross-sectional sample is also drawn and surveyed.

Stratification: Process in which units with similar characteristics are divided into groups called "strata" before the sampling process begins. Each unit is assigned to one and only one stratum based on prior knowledge about the unit (Zimowski et al., 1997a).

Stratified Random Sampling: Random sampling within individual strata. Strata may be sampled at the same sampling rate (proportionate sampling or sampling with a uniform rate) or at different sampling rates (disproportionate sampling or sampling with a variable sampling rate).

Stratum: A sub-grouping of the population according to some criterion—e.g., households by household income.

Survey Period: The survey period is the time interval over which information is collected from respondents. It is the period covered by all the individual reporting periods in the survey (adapted from Axhausen, 2003).

Systematic Sampling: Sampling by taking every *nth* unit from the sampling frame list, usually starting from a random seed.

Target Population: The complete group about which one would like to collect information (Richardson et al., 1995, p. 75).

Terminations/Break Offs: Sample members who begin but terminate an interview before they provide enough information to be classified as respondents (Zimowski et al., 1997a).

Time-in-Sample Effects: Effects of prior reporting on reporting in subsequent waves of data collection. These include conditioning and fatigue (adapted from Zimowski et al., 1997b).

Time Series Design: A design that collects a series of repeated measurements on one, or a limited number, of variables over a relatively large number of points in time (adapted from Zimowski et al., 1997b).

Tour: A tour is a sequence of trips starting and ending at the same location (Axhausen, 2003).

Trip: A *linked trip* is the movement from one location to another for a single purpose by one or more modes of transportation. An *unlinked trip* (also referred to as a "stage" or "leg") is that portion of a linked trip conducted on a single mode of transportation. When a trip is not qualified as being either linked or unlinked, it is usually assumed to be a linked trip.

Trip Chain: A sequence of trips starting and ending at home or work in which one or more intermediate stops are made. The stops may be made to change mode or to serve an intermediate trip purpose.

Trip Purpose: The reason the trip was made. If there is more than one reason for the trip and the reasons do not involve different destinations, then the reasons must be ranked to identify the main purpose of the trip if a single trip purpose is required.

Unit Non-Response: The failure to obtain useful information on critical data items from an eligible sample member resulting in exclusion of this sample member from the sample (adapted from Zimowski et al., 1997a). Unit non-response may result from eligible sample members that refuse to participate in the survey and also from eligible sample members who could not be contacted by telephone, mail, email, or personal visit.

Validation Interview: Interview of a selection of responding households to check on the quality and completeness of the data provided in the previous survey process (adapted from Richardson et al., 1995, p. 247).

Variable Fraction Stratified Random Sampling: Random sampling at different sampling rates in each stratum (see *Disproportionate Sampling*).

Vehicle Occupancy: The number of persons, including driver and passenger(s), in a vehicle; also includes persons who did not complete a whole trip (NPTS, 1990).

Vehicle Trip: A trip by a single vehicle regardless of the number of persons in the vehicle (NPTS, 1990).

Wave: A distinct occasion when data are collected in a panel survey. Also referred to as a "round" of data collection (Zimowski et al., 1997b).

Weight: The factor by which an observation or a group of observations must be multiplied to correct their representation in the sample for biases in the sample, usually as a result of non-response and other factors.

Weighted Response: A response rate that is calculated using the inverse of the selection probabilities as the weights. If different selection probabilities exist within different strata or different stages of complex sampling designs, the weighted response rate is a weighted aggregation of the response rates in the strata and stages (adapted from Zimowski et al., 1997b).

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Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation