CAMBRIDGE SYSTEMATICS

Metropolitan Council Travel Behavior Inventory

Household Travel Survey

final

report

prepared for

Metropolitan Council

prepared by

Cambridge Systematics, Inc.

with

Abt SRBI
PlanTrans

December 2014

www.camsys.com

draft report

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1.0 Introduction

This report summarizes the household survey conducted in the Twin Cities region for the Metropolitan Council (Council) as part of the **2010 Travel Behavior Inventory**. The household survey provides modelers and planners a snapshot of travel behavior in the region. The travel and socioeconomic data collected as part of this study were analyzed and can be used for several purposes including:

- The development of a regional activity-based model;
- A snapshot of travel in the metropolitan region highlighting:
  - Travel patterns by different times of day,
  - Geographic distribution of travel among area residents, and
  - Preferences towards different modes for different travel purposes; and
- Comparisons and trend analyses to assess how travel patterns have changed over the years by contrasting the 2010 surveys with the 1990 and 2000 Travel Behavior Inventory surveys.

1.1 SURVEY OVERVIEW

A regionwide household survey was administered over a multi-month period starting on the last week of November 2011 and ending in early 2013. The survey team consisted of Abt SRBI and PlanTrans and was supervised and coordinated by Cambridge Systematics. The roles of each individual firm can be summarized as follows:

- **Cambridge Systematics** was responsible for:
  - Oversight of the process,
  - Development of a sampling plan,
  - Refinement of the questionnaire,
  - Quality assurance/quality control of the resulting dataset,
  - Expansion and weighting of the final survey sample, and
  - Analysis of the survey results to support modeling.
- **Abt SRBI** was responsible for the survey field implementation:
  - Conducting a pretest,
  - Implementing the sampling plan,
  - Recruitment of households for survey participation,

  - Finalizing the survey instrument,
  - Printing and mailing of the questionnaires,
  - Collecting the survey data using a multimodal approach,
  - Geocoding of all location information collected,
  - Distribution and retrieval of GPS units for the GPS subsample survey,
  - Data entry, cleaning and producing master data files, and
  - Ensuring quality control for the collected data.
- **PlanTrans** was responsible for the GPS survey and PlanTrans staff:
  - Programmed the GPS units,
  - Coordinated the implementation of the GPS survey with Abt SRBI,
  - Processed the GPS subsample into a machine readable data file, and
  - Compared the travel behavior of participants in both the GPS sample and the household diary survey.

Since these survey data will influence public policy in the Twin Cities through their use in the new activity-based model over the next decade, the survey development and data collection effort focused on these key aspects:

- A sampling plan that produced a representative and unbiased sample in terms of **geography** and in terms of **socioeconomic** characteristics;
- **Continuous feedback** with Metropolitan Council to ensure that the data being collected meet the original sampling requirements;
- **Adjustments** to the approach to focus resources and sample household types where sampling rates were lower than original estimates;
- **Extensive quality assurance** of the geocoded data to confirm that the final dataset has complete information that is useful for model estimation; and
- **Innovative procedures** in sampling, data analysis and survey expansion to further the state of the practice in travel demand surveys.

1.2 STUDY AREA

The objective of the household survey was to obtain an inventory of representative travel behavior in the Twin Cities metropolitan area. The sample was distributed to a total of 19 counties including 16 counties in Minnesota and three in Wisconsin.

- The seven **Core counties** include the counties of Ramsey, Hennepin, Carver, Scott, Dakota, Washington and Anoka. These more urbanized areas account for 81.5 percent of the households in the 19-county region.

- The remaining 12 **Ring counties** include nine counties in Minnesota (Chisago, Isanti, Sherburne, Wright, McLeod, Sibley, Le Sueur, Rice, and Goodhue) and three counties in Wisconsin (Pierce, St. Croix and Polk). These counties have much lower densities and account for 18.5 percent of the households in the 19-county region.

The data collection and modeling effort was supported by the Metropolitan Council, the Minnesota Department of Transportation (MnDOT) and the Wisconsin Department of Transportation (WisDOT). Surveys distributed in Minnesota and Wisconsin were customized to mention as sponsors the Metropolitan Council and the state Department of Transportation.

The household survey data collection lasted over a year starting in late November 2011 and ending in early 2013. In total, over 14,000 households were interviewed and over 12,000 households provided valid and detailed 24-hour travel behavior information. A variety of methods to recruit respondents and to collect the survey data were used resulting in a **multimodal approach** that included recruit and retrieval surveys conducted via phone, web, and mail.

In addition, a subsample of 258[1] households participated in a supplementary data collection effort using advanced Global Positioning System (GPS) units that recorded a participant's travel in great detail. Each household member over 12 years old carried a personal GPS unit for seven days to record their travel. The objective was to collect detailed travel behavior that includes all stops and activities during the day that are sometimes overlooked by respondents in a typical household diary survey.

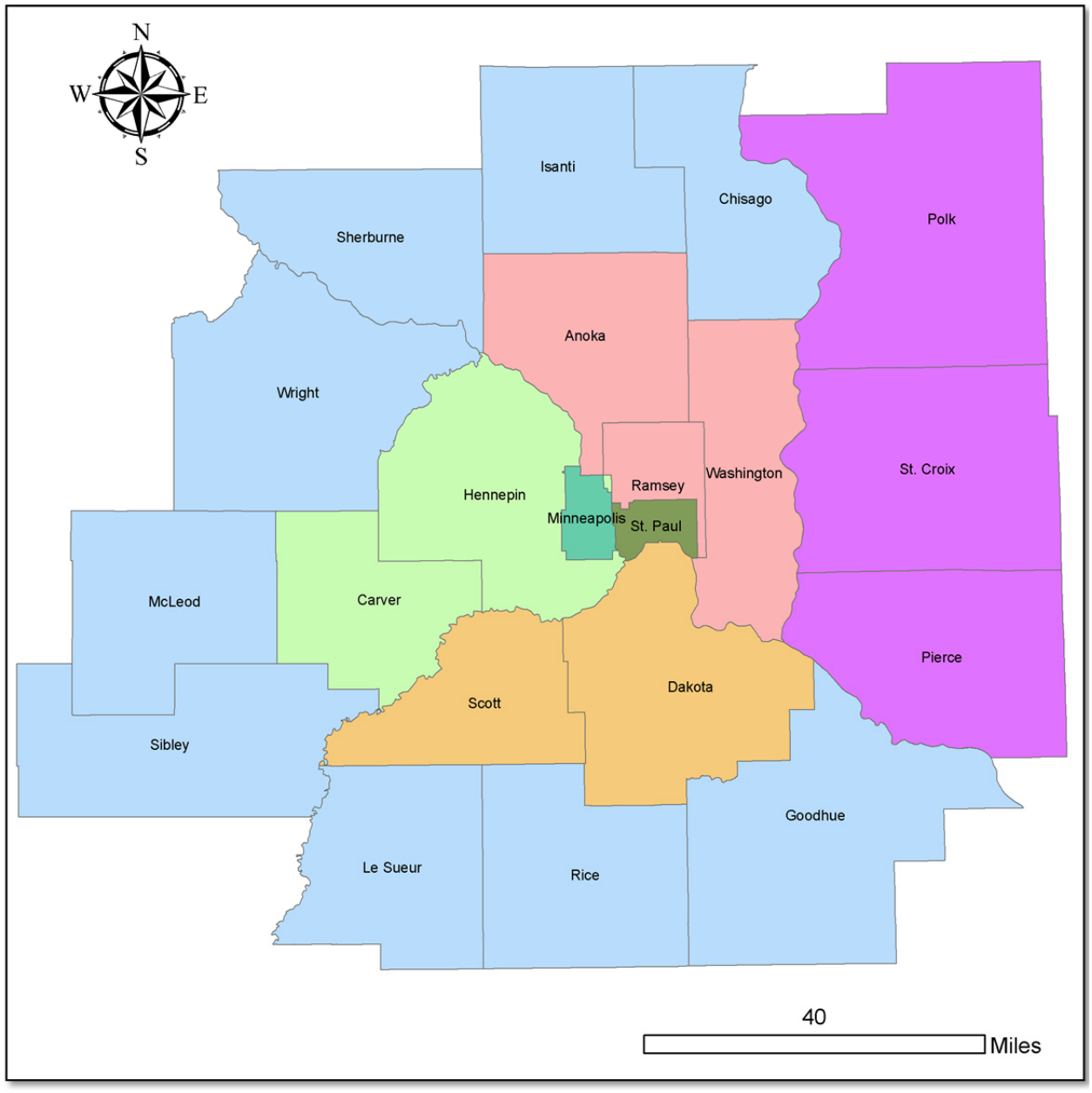
Figure 1.1 shows the study area geography for the project. For purposes of sampling, the 19 counties were grouped into the seven subregions that are shown in different colors. Differential sampling rates were used for the seven "Core" counties compared to the 12 "Ring" counties. The objective was to obtain a representative sample for the region and to focus more on the travel behavior of travelers in the seven more densely populated Core MPO counties.

The 19 counties were grouped into seven subregions for purposes of the sampling plan that are shown in **Figure 1.1** including:

1. The City of Minneapolis (green),
2. The City of St. Paul (dark green),
3. Hennepin and Carver counties (light green),
4. Ramsey, Washington and Anoka counties (light red),
5. The remainder of the Core counties of Dakota and Scott (yellow).
6. Nine Ring Counties in Minnesota (blue), and
7. Three Ring Counties Wisconsin (purple).

[1] GPS subsample figure includes n=32 pilot completes and n=226 main study completes.

Figure 1.1 Study Area, Counties, and Sampling Subregions



Source: Metropolitan Council and Cambridge Systematics, 2011.

A sampling rate of one percent of households was used in the Core MPO region that includes the Cities of Minneapolis and St. Paul, the remainder of Hennepin and Ramsey Counties, and the five adjoining core counties. A sampling rate of one half percent of households was used for the 12 lower density ring counties in both Minnesota and Wisconsin.

1.3 SOCIOECONOMIC PROFILE

In addition to a balanced sample by geography, the sampling plan also focused on obtaining a representative sample of the 1.35 million households as reflected in key socioeconomic characteristics across the region. The three-year American Community Survey 2006-2008 was analyzed to provide the patterns of household size and automobile ownership for each of the seven subregions.

Tables 1.1 and **1.2** show the household size patterns for the 1.35 million households for each of the seven subregions. The distribution of household size is rather uniform with each group accounting from a low of 15 to a high of 33 percent of the region's households. The incidence also varies by geography:

- Typical nuclear family households with three or more family members are concentrated in Scott, Dakota, and the ring counties with over 40 percent of the households in these areas; and
- One person households make up around 40 percent of the households in each of the two major urban areas in the region.

Tables 1.3 and **1.4** show the more dispersed patterns of automobile ownership. Zero vehicle households represent less than seven percent of the total and households with four or more vehicles account for six percent. Two-vehicle households are the majority in the region with over 40 percent of the total.

- The low incidence of zero-vehicle ownership underscores the need to focus the sampling effort on those households to better understand the modes available and their daily travel behavior. These are households that predominantly live in the two large cities in the region and whose travel behavior is equally important to understand.
- Households with high levels of vehicle ownership also become the focus on the sampling effort especially in areas with a lower incidence. Households with three or more vehicles represent less than 10 percent of Minneapolis and St. Paul residents, less than 20 percent of the seven core counties and around 30 percent of the 12 ring counties.

Table 1.1 Distribution of Household Size by Subregion

	One-Person Household	Two-Person Household	Three-Person Household	Four+ Household	Total Households	Percent of Households
Minneapolis	67,264	46,985	19,163	24,977	**158,389**	**11.7%**
Hennepin, Carver	91,397	103,669	46,425	71,618	**313,109**	**23.1%**
St. Paul	42,228	31,522	13,888	21,070	**108,708**	**8.0%**
Ramsey, Washington, Anoka	29,685	33,084	12,491	18,915	**94,175**	**7.0%**
Scott, Dakota	94,575	143,606	72,656	118,693	**429,530**	**31.7%**
Ring Counties, MN*	41,419	66,173	27,767	51,087	**186,446**	**13.8%**
Ring Counties, WI	14,338	24,152	10,100	15,387	**63,977**	**4.7%**
Region Total	**380,906**	**449,191**	**202,490**	**321,747**	**1,354,334**	

Source: 2006-2008 American Community Survey Three Year Estimates and Cambridge Systematics, 2011.

* Estimates for Sibley County are drawn from 2000 Census – CTPP Part I Table 1-063 since it was not covered by the ACS sample.

Table 1.2 Household Size Share for each Subregion

	One-Person Household	Two-Person Household	Three-Person Household	Four+ Person Household
Minneapolis	42%	30%	12%	16%
Hennepin, Carver	29%	33%	15%	23%
St. Paul	39%	29%	13%	19%
Ramsey, Washington, Anoka	32%	35%	13%	20%
Scott, Dakota	22%	33%	17%	28%
Ring Counties, MN*	22%	35%	15%	27%
Ring Counties, WI	22%	38%	16%	24%
Region Percent	**28%**	**33%**	**15%**	**24%**

Source: 2006-2008 American Community Survey Three Year Estimates and Cambridge Systematics, 2011.

* Estimates for Sibley County are drawn from 2000 Census – CTPP Part I Table 1-063 since it was not covered by the ACS sample.

Table 1.3 Distribution of Vehicle Ownership by Subregion

	Zero Vehicles	One Vehicle	Two Vehicles	Three Vehicles	Four+ Vehicles	Total Households
Minneapolis	29,194	69,301	47,480	9,123	3,291	**158,389**
Hennepin, Carver	17,558	101,886	135,121	43,459	15,085	**313,109**
St. Paul	16,078	44,860	36,114	8,511	3,145	**108,708**
Ramsey, Washington, Anoka	5,663	32,877	39,110	11,485	5,040	**94,175**
Scott, Dakota	14,333	108,714	200,452	75,113	30,918	**429,530**
Ring Counties, MN*	7,491	42,728	78,722	40,003	17,502	**186,446**
Ring Counties, WI	1,950	15,721	27,257	12,902	6,147	**63,977**
Region Total	**92,267**	**416,087**	**564,256**	**200,596**	**81,128**	**1,354,334**
Region Percent	**6.8%**	**30.7%**	**41.7%**	**14.8%**	**6.0%**	

Source: 2006-2008 American Community Survey Three Year Estimates and Cambridge Systematics, 2011.

* Estimates for Sibley County are drawn from 2000 Census – CTPP Part I Table 1-063 since it was not covered by the ACS sample.

Table 1.4 Vehicle Ownership Share for each Subregion

	Zero Vehicles	One Vehicle	Two Vehicles	Three Vehicles	Four+ Vehicles
Minneapolis	18%	44%	30%	6%	2%
Hennepin, Carver	6%	33%	43%	14%	5%
St. Paul	15%	41%	33%	8%	3%
Ramsey, Washington, Anoka	6%	35%	42%	12%	5%
Scott, Dakota	3%	25%	47%	17%	7%
Ring Counties, MN*	4%	23%	42%	21%	9%
Ring Counties, WI	3%	25%	43%	20%	10%
Region Total	**7%**	**31%**	**42%**	**15%**	**6%**

Source: 2006-2008 American Community Survey Three Year Estimates and Cambridge Systematics, 2011.

* Estimates for Sibley County are drawn from 2000 Census – CTPP Part I Table 1-063 since it was not covered by the ACS sample.

1.4 STRUCTURE OF THE REPORT

Section 2.0 discusses how the sampling plan was developed and implemented, how the survey returns were monitored, and how the sampling approach was adjusted to meet the sampling targets.

Section 3.0 outlines the details of the survey field implementation. It discusses the pretest, the definition of a "complete household survey," and the multimodal approach to data collection.

Section 4.0 describes the quality assurance/quality control process that was implemented for this survey effort. We outline the different tests that were used to develop a robust and detailed survey database.

Section 5.0 discusses the survey weighting process. A step-by-step approach is provided to highlight the expansion methodology and the sources of data used to arrive at a representative person sample for analysis and estimation.

2.0 Sampling Plan

The objective of the sampling plan was to obtain a representative sample of travelers in the region to get as accurate as possible a snapshot of typical daily travel in the Twin Cities metropolitan region.

In section 2.1 we describe in detail the development of the sampling plan. We outline the three key variables and discuss how we combined sampling targets across geography, household size, and vehicle ownership.

Section 2.2 describes the address based sample, an approach that was used instead of random digit dialing. The objective was to overcome the ever increasing number of households that rely exclusively on cell phones instead of (or in addition to) land line phone service. According to current estimates collected between July and December 2013, 41 percent of American households are "wireless only." This represents a 2.8 percentage point increase since the second half of 2012, which is smaller than increases noted in previous years.[2]

In Section 2.3 we outline the multimodal approach that was used to recruit the households for the survey and discuss the advance letters that were sent and the recruit interview that was conducted.

Section 2.4 summarizes the diary survey that was developed for the 2010 Travel Behavior Inventory and provides a copy of the actual survey instrument that is shown in an appendix of this report.

2.1 Development of the Sampling Plan

The guiding principle of the sampling plan was the joint, three dimensional distribution of household size, level of automobile ownership and geography. These three key variables form the backbone of the sampling approach to provide a representative sample for the Twin Cities region. **Table 2.1** shows the cross-tabulated joint distribution that resulted from the analysis of the 2006-2008 American Community Survey for the 1.35 million households across the 19 counties and the seven subregions in the Twin Cities metropolitan area.

The three sampling dimensions of geography, household size, and automobile ownership result in a total of 140 distinct individual cells. The sampling targets for each cell were identified in an iterative process using as a basis the patterns already shown in **Tables 1.1** to **1.4** and the corresponding summaries in **Table 2.1.**

[2] Blumberg, Stephen J. and Julian V. Luke. Wireless substitution: Early release of estimates from the National Health Interview Survey, July-December 2013. National Center for Health Statistics. July 2014. Available from: http://www.cdc.gov/nchs/nhis.htm.

A cursory examination of these tables demonstrates the practical problems often associated with the development of a sampling plan. There are a number of individual cells with a very low incidence in the population. In these cases, a very large random sample would be required to collect enough data that would result in a significant sample for each one of the individual cells.

One example includes households with four or more vehicles. These households were few and hard to reach especially among households who live in urban areas. Another example is households with no vehicles available to them. These households are also very few and hard to reach especially among larger households and among those living in rural areas. The development of realistic targets for individual cells is key for developing an optimal allocation of resources and for collecting sufficient information for each market segment to allow for desired analysis of key cells with ±10% at the 90 percent confidence level.

A three step approach was used to develop a sampling plan that results in a representative sample with all market segments represented.

First, a proportional allocation was made to each cell using the one percent sampling rate requirement provided by the Metropolitan Council for the "core MPO" and the one half percent sampling rate for the "ring county" subregions.

- The proportional allocation resulted in 18 instances of an expected cell sample size of less than 5 observations and 33 instances of an expected cell sample size of less than 10 observations.
- For example, there are very few households without a vehicle in the MN and WI ring counties. This pattern is especially pronounced in households with two or more persons.
- The reverse pattern is true in the cities of Minneapolis and St. Paul. There is a large sample of zero-car households, but a very low incidence of smaller size households with a high level of automobile ownership.
- The use of this method and the adherence to cell specific targets without any additional adjustments would result in cell sample sizes that would be too small to assess travel behavior characteristics at this level of detail.

As a second step, cell sample sizes were readjusted by reducing the sample size in well populated cells and increasing the sample size in poorly populated cells. This method allows us to target a minimum sample size even for those cells where the incidence of the market segment in the population is very low. Although this method "corrects" for the issues arising from a purely proportional allocation, it also places considerable burden on the sampling plan since it generates targets that are much harder to meet given the distribution of socioeconomic characteristics in the sample.

Table 2.1 Distribution of Household Size and Automobile Ownership by Subregion

Sampling Areas	One-Person Household					Two-Person Household				
	Zero Vehicles	One Vehicle	Two Vehicles	Three Vehicles	Four+ Vehicles	Zero Vehicles	One Vehicle	Two Vehicles	Three Vehicles	Four+ Vehicles
Minneapolis	19,743	42,207	4,315	491	508	4,849	15,299	24,230	2,083	524
Hennepin, Carver	11,783	69,023	8,513	1,390	688	3,138	19,088	68,014	11,002	2,427
St. Paul	10,488	27,543	3,625	361	211	3,005	8,805	17,214	2,048	450
Ramsey, Washington, Anoka	4,346	21,942	2,826	321	250	616	6,795	21,805	3,271	597
Scott, Dakota	9,427	68,663	13,181	2,472	832	2,542	23,548	92,142	20,205	5,169
Ring Counties, MN	5,464	26,392	7,192	1,518	853	970	10,332	37,276	13,556	4,039
Ring Counties, WI	1,454	9,461	2,658	485	280	365	3,977	13,860	4,637	1,313
	Three-Person Household					**Four or more Person Household**				
Sampling Areas	**Zero Vehicles**	**One Vehicle**	**Two Vehicles**	**Three Vehicles**	**Four+ Vehicles**	**Zero Vehicles**	**One Vehicle**	**Two Vehicles**	**Three Vehicles**	**Four+ Vehicles**
Minneapolis	1,965	5,539	7,635	3,461	563	2,637	6,256	11,300	3,088	1,696
Hennepin, Carver	862	7,729	21,205	13,927	2,702	1,775	6,046	37,389	17,140	9,268
St. Paul	1,038	4,233	5,292	2,767	558	1,547	4,279	9,983	3,335	1,926
Ramsey, Washington, Anoka	443	2,441	5,188	3,543	876	258	1,699	9,291	4,350	3,317
Scott, Dakota	1,245	9,418	32,780	22,959	6,254	1,119	7,085	62,349	29,477	18,663
Ring Counties, MN	385	3,487	10,950	9,266	3,679	672	2,517	23,304	15,663	8,931
Ring Counties, WI	59	1,404	3,891	3,251	1,495	72	879	6,848	4,529	3,059

Source: Cambridge Systematics and Metropolitan Council, 2011.

As the third step of this iterative process, different sampling cells were "combined" to provide a balance between the proportional allocation approach and an ad-hoc approach based on a minimum number of observations per cell. This method reconciles the objective of reflecting the true incidence in the population for each market segment and the objective of having an adequate sample size to capture the behavior of different market segments.

Instead of developing targets for individual cells, some of the targets were restated to refer to groupings of cells across household sizes, across subregions, or across vehicle ownership categories. Furthermore, combinations of cells in two of three dimensions were made to develop targets for large households with no automobiles regardless of geography or to group together market segments with high automobile ownership in urban areas and surrounding suburbs.

Table 2.2 displays the final sample cell targets with color coding where adjustments were made across regions, vehicle ownership levels, and household size groupings as follows:

- Four or more person households with four or more vehicles were rare in Minneapolis and Hennepin/Carver counties and were combined (light blue).
- Four or more person households with four or more vehicles were rare in St. Paul and in Ramsey/Washington/Anoka counties and were grouped together (dark blue).
- Two-person households with three or more vehicles were rare in the major urban areas and surrounding areas and were grouped together as follows:
  - Two-person households in Minneapolis with three or more vehicles were combined with Hennepin/Carver households to improve statistical power (light red in **Table 2.2**).
  - The same grouping was made for two-person households who had three of more vehicles in St. Paul and in the Ramsey/Washington/Anoka counties (dark red).
- Zero-vehicle households were also combined across geographies to arrive at meaningful targets for this important market segment (**Table 2.2**):
  - Three and four or more person households that did not own a car were grouped together in Minneapolis and St. Paul (yellow).
  - Similarly, three and four or more person households that did not own a car were even less frequent outside the two large urban areas. They were grouped together across the remaining five regions (green).

Table 2.2 Sampling Plan for the 2010 Travel Behavior Inventory Household Survey

Sampling Targets		Minneapolis	St. Paul	Hennepin Carver	Ramsey Washington Anoka	Scott Dakota	Ring Counties, MN	Ring Counties, WI
One-Person Household	Zero-Vehicles	189	100	116	90	76		
	One-Vehicles	410	269	720	515	321	174	
	Two-Vehicles	95		111	116	72	72	
	Three-Vehicles							
	Four+ Vehicles							
Two-Person Household	Zero-Vehicles	76		76				
	One-Vehicles	147	95	200	188	94	74	
	Two-Vehicles	237	168	715	632	400	184	74
	Three-Vehicles			174	190	105	116	
	Four+ Vehicles							
Three-Person Household	Zero-Vehicles							
	One-Vehicles	95		84	72	72		
	Two-Vehicles	126		225	195	147	74	
	Three-Vehicles	72		153	137	105	84	
	Four+ Vehicles			95				
Four+ Person Household	Zero-Vehicles	72		72				
	One-Vehicles	105		158				
	Two-Vehicles	105	100	410	358	278	147	
	Three-Vehicles	74		195	174	121	95	
	Four+ Vehicles			116	147	74	72	

Source: Cambridge Systematics and Metropolitan Council, 2011.

2.2 ADDRESS-BASED SAMPLE

A key consideration in the design of the household travel survey sampling was the representativeness of the sample upon which all subsequent data analysis and modeling efforts were based. To meet this goal, the Council household survey sample was developed using the following elements:

- An address-based sample frame was used within the entire 19-county greater Minneapolis/St. Paul region;
- The sample was randomly selected according to household density from the most current U.S. Postal Delivery Sequencing File (DSF)[3] and was sorted by Census block groups;
- Advance letters were mailed to all sampled households to alert residents to the study;
- Recruiting was conducted using the Internet, via a URL to the web survey provided in the advance letter, and by contacting households by phone;
- The requirement for the household survey was that travel was recorded for every member of the household over 5 years of age;
- Participants could complete the activity diary reporting their personal travel by phone, on the web, or by mailing back a filled out diary;
- A subsample of 234 households carried GPS loggers and recorded detailed travel for all members of the household who were at least 13 years old and who concurrently filled out a traditional survey.

The objective of a sampling plan was to produce a geographically balanced sample. However, the increasing percentage[4] of cell-phone only households is an issue in most metropolitan regions. The sources of under coverage in Random-Digit-Dial (RDD) frames drawn from household land phones include:

- Households with no telephones and,
- Cell-phone-only households without a land-line phone service.

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[3] The USPS Delivery Sequence File (DSF) includes all addresses, including individual apartments, where the post office delivers mail. Feedback from USPS letter carriers keeps the DSF database updated. The DSF is an effective sampling frame because it provides coverage to all residential delivery-point addresses, eliminates the need for a costly cell phone-only sample, and allows for tighter geographic distinctions to be made for geographic factors.

[4] Blumberg, Stephen J. and Julian V. Luke. Wireless substitution: Early release of estimates from the National Health Interview Survey, July-December 2013. National Center for Health Statistics. July 2014. Available from: http://www.cdc.gov/nchs/nhis.htm.

When taken together, the percentage of U.S. households that are not covered by random digit dial frames (RDD) is estimated to be 41%[5]. Thus, the traditional RDD sample would no longer be representative of all households in the Twin Cities metropolitan area. In addition, cell phone numbers cannot be reliably assigned to geographic areas such as county or Census block group further undermining the effort for a geographically balanced sample. Further, when cell phone numbers share the same area codes as the study area, the specific study region is still unknown.

Address-based sampling can improve the representativeness of a household survey by including households that cannot be captured by land-line phones. This approach also improves the ability to define specific geographic strata based on the address information[6]. We applied an address-based sampling approach for the Twin Cities, one of the first metropolitan regions in the country to use this sampling approach. **Figure 2.1** shows the TBI survey plan that was based on an address-based sampling approach.

A key consideration in survey design and sample design is **respondent burden**. Self-reporting of full household travel diary information, whether retrieved by mail, telephone or on the web, may result in considerable respondent burden because the amount of information is substantial and often repetitive. A retrieval phone call, for example, might take as much as 45 minutes for a household with 3 people assuming an interview length of 15 minutes. At the same time, requirements for more detailed travel demand models have increased the need for additional information about activities. These trends have changed the traditional travel inventory self-report diary from a simple location-to-location travel log to an extensive diary requiring not only locations traveled to, but details about the activities at each stop and destination. To address respondent burden and privacy concerns, Metropolitan Council excluded reporting for children 5 years old and younger.

In addition to using the address-based sampling frame for the household survey, a GPS subsample drawn among respondents who had participated in the diary survey was also collected.

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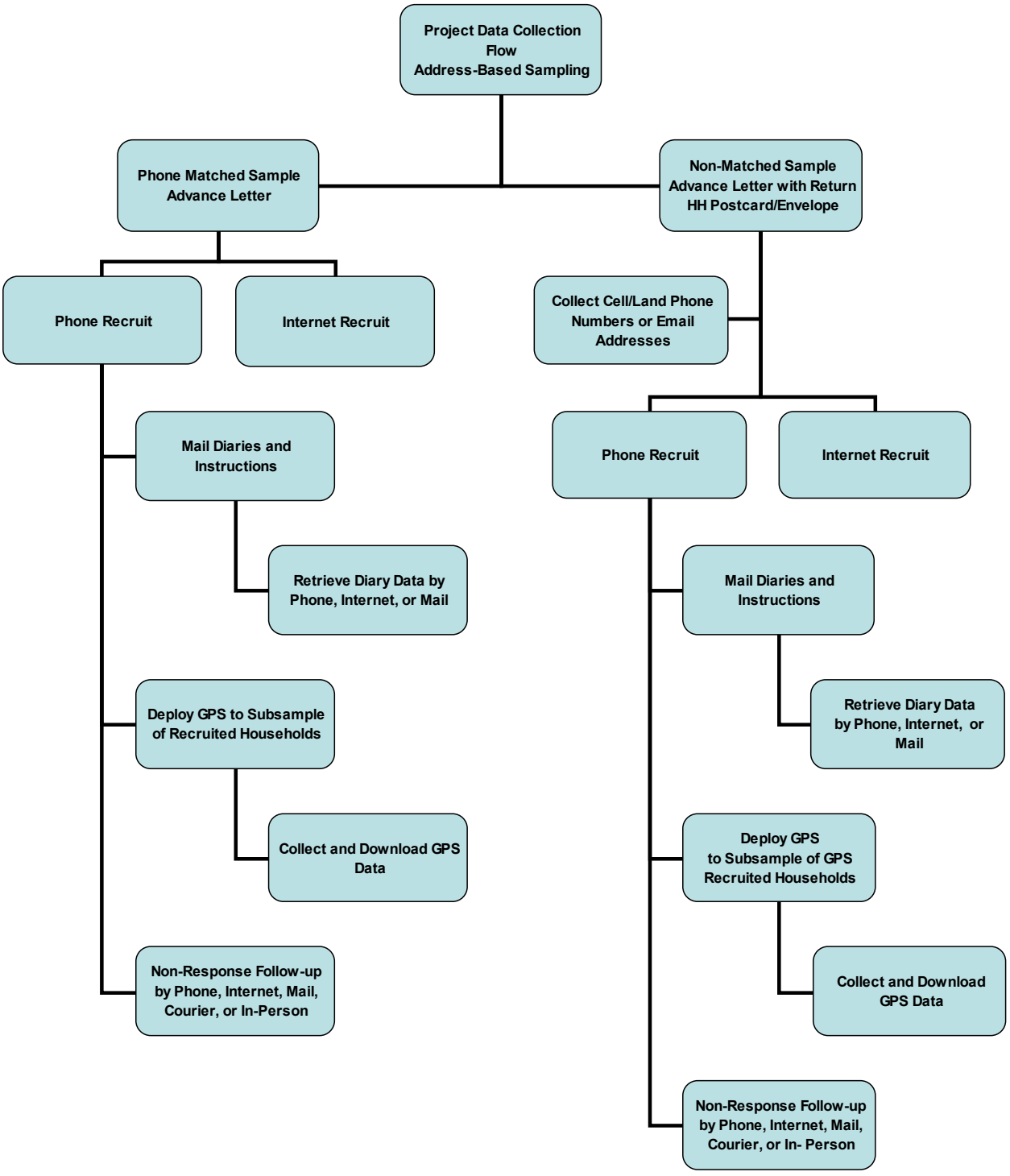
[5] Blumberg, Stephen J. and Julian V. Luke. Wireless substitution: Early release of estimates from the National Health Interview Survey, July-December 2013. National Center for Health Statistics. July 2014. Available from: http://www.cdc.gov/nchs/nhis.htm.

[6] Link, M. W., Battaglia, M.P., Frankel, M. R., Osborn, L. and Mokdad, A.H. A Comparison of Address-Based Sampling (ABS) Versus Random-Digit Dialing (RDD) for General Population Surveys. Public Opinion Quarterly, Vol. 72, No. 1, 2008, pp. 6-27.

Figure 2.1 Survey Plan with an Address-Based Sampling Approach



2.3 RECRUITMENT OF HOUSEHOLDS

The reliance on an address-based sampling frame requires additional mailing of study materials to maximize response and participation in the survey. We discuss the recruitment methods for "matched" and "unmatched" households, present the advance letters sent to "unmatched" households, and summarize the attributes of the recruit phone interview.

Address-Based Sampling Recruitment

Once the sample was designed and the random address-based sample was selected, matching of addresses with land-line based phones was conducted. A two-track recruitment approach was used to maximize the representativeness of the sample and control costs:

- **Matched households.** Approximately 55 percent of the sample included households for which there was a match between addresses and land-based phone lines. Using local white page listings, phone number matching was performed by the sample provider, MSG. Households with a matched phone number were recruited by phone. The respondents were provided with a brief description of the project and its importance and were invited to participate in the survey via mail, phone, or on the web.
- **Unmatched households.** Approximately 45 percent of households were not matched to a land-line based phone. These households were sent advance letters in "sampling replicates" over the roughly one-year long data collection period. The advance letters described the project and its importance and also provided different ways to participate in the survey via mail, phone, or on the web.

  Households were provided a URL and a unique password and were encouraged to participate via a **web-based survey**. For households with limited or no Internet access, a toll-free number was provided so that households could be re-contacted to complete the recruitment survey.

Advance Letters

To improve the response rates to the survey and enhance the legitimacy of the project in the different parts of the region, advance letters were tailored to include sponsoring agency logos and signatures from appropriate Metropolitan Council, MnDOT, and WisDOT representatives (**Figure 2.2**).

- Advance letters sent in the immediate Twin-Cities region included the Metropolitan Council logo and were signed by Council staff.
- Advance letters sent to Wisconsin households included logos and signatures from Metropolitan Council and WisDOT.
- Advance letters sent to households in other MN counties included logos and signatures from Metropolitan Council and MnDOT

Figure 2.2 Example of Advance Letter Sent to Households

Metropolitan Council

Dear Twin Cities Resident:

Traveling is part of everyday life. Whether you travel by car, truck, bus, bike or walk, local planners need to make sure the transportation system meets your needs. To better understand those needs, the Metropolitan Council and the Minnesota Department of Transportation are conducting the **2010 Travel Behavior Inventory (TBI).** This study will look at daily travel characteristics of residents and the changes in household travel that may have occurred since 2000. Minnesota's transportation planners will use the results of your participation to evaluate and develop a transportation system that improves and increases mobility for residents in your area.

Your household has been randomly selected to help us by participating in a household travel survey. The more people who complete the survey, the more accurate our results will be. To participate, you will need to register by using one of the following two options:

Internet: You can complete the initial survey online by logging on to: **www.opinionport.com/metrocounciltravelsurvey** and entering your password.

Your password is: **<<INSERT PASSWORD>>**

Phone: If you are not able to complete by Internet, please call our toll-free line at 1-877-699-4344 to participate. You will need to provide your name, home address, and telephone number when you call. Please indicate if the telephone number you provide is a landline or a cell phone. We would prefer to contact you on a local landline instead of a cell phone. A trained telephone interviewer from Abt SRBI, a national research organization, will call your household back within the following couple of weeks to register your household for the travel survey.

If you have any questions about the household travel survey, please contact *Abt SRBI* at 1-877-699-4344 or email us at MCtravelsurveyhelp@srbi.com. Thank you in advance for helping us to better understand the transportation needs of your community.

Sincerely,

Jonathan Ehrlich
Project Manager, Metropolitan Council

James Henrickson
Minnesota Department of Transportation

Recruit Phone Interview

Households with matched phone numbers were recruited by telephone and were encouraged to participate in the survey on the web. Participants were also provided the option of filling out and mailing back a print diary or filling out a diary and providing their travel information over the phone.

The recruit instrument was designed to capture household, person and home-related information. The recruit interview consisted of assigning a random travel day for diary recording on a concurrent weekday for each member of the household five years or older and collecting household and person demographic data. The recruit phone interview was on average of 10 minutes in length (**Appendix C)**.

The recruitment interview was the respondents' first contact with Abt SRBI survey staff. The respondent was asked about household demographic characteristics, available vehicle information, and the age and basic employment information about persons in the household. The contact person was then asked if the household would like to participate in the Travel Behavior Inventory.

A travel day was randomly generated and assigned to all households during the recruit interview.[7] The travel day assignments were closely monitored to keep travel days evenly spread out over the interviewing period. Home mailing address, email, and phone contact information were obtained, and brief instructions were given on how to receive the diaries or access the activity travel diaries on the web. In cases where an answering machine or voicemail was reached, a message was left identifying the Council household survey and providing the 1-800 number to call.

As a part of the household recruit interview, a subsample of households and persons were also randomly recruited to participate in the GPS tracking portion of the study.

[7] During the travel day assignment portion of the recruit interview, five possible travel days were generated beginning at the earliest possible date considering mailing schedules and extending four business days in to the future. Interviewers were instructed to read the first randomly generated day to the respondent as their assigned travel day. If a respondent suggested that the first assigned travel day is not a day he/she typically travels, interviewers were instructed to inform recruits that, for the purposes of this survey, travel data is needed for specific days regardless of whether it is typical or not. In the case that a household member was not able to participate on the assigned travel day (e.g., out of town on business, on vacation, being physically unable to participate that day for undergoing medical procedures), then the next randomly generated travel day was offered as an option.

2.4 SURVEY INSTRUMENT

The **survey instrument** design process was extensive and required adequate management to ensure that all data elements and variables were reviewed. Survey instruments were developed with the full input of the Council project management team and Cambridge Systematics. A complete data matrix and fully defined data dictionary was submitted after finalization of materials, and kept up-to-date as the project proceeded.

Retrieval materials and components of the mailed retrieval materials are described below.

- **Diary instruction cover letter was** provided to instruct households as to how to proceed on their specific travel day (**Figure 2.3**).
- A brief section was asked about the respondent's **personal information** about their workplace location, work hours, arrival time flexibility and type of industry (**Figure 2.4**).
- **Reminder call script:** Interviewing staff contacted households on the evening before their travel day to remind them of their travel day obligations. Where no phone number was available, an email was sent.
- **24-Hour diary:** A personalized diary was designed specifically to capture all trips made, places visited and activities in which respondents participated (**Appendix E**).
- **Instructions:** Included with the diary were instructions shown in **Figure 2.5.** In addition, respondents were provided with examples on how to use the diary properly (**Figure 2.6**).
- **Travel retrieval instruments (Phone, Web, and Mailback):** Phone and web retrieval instruments were programmed versions of the diary, designed with internal checks and instructions to ensure accurate data collection. These three methods mirrored each other in terms of question content and collection protocol with minor wording revisions depending on the method.

Figure 2.3 Diary Instruction Cover Letter

Metropolitan Council

Dear «MAILATTN»:

Many thanks to you and your household for agreeing to participate in this very important travel study. Whether you travel by car, bus, bike, or on foot, our daily commutes to work, errands around town, personal business, and everything in between is so important. You should have received a travel diary for each person in your household **over the age of five** to participate in the study. Participation is as easy as 1, 2, 3.

1. **Please make sure to read the instructions and go over the example provided in the diary before your scheduled travel date.**

2. **At 3 a.m. on <<INSERT TRAVEL DAY>> begin recording every trip made, whether it is typical or not; continuing until you have finished traveling for the day.**

3. **Log on to www.opinionport.com/metrocounciltraveldiary using your unique household password and enter the data you recorded in your travel diary. Your password is <<PASSWORD>>.**

If you don't have access to the Internet, don't worry, someone will call your home in the days following your travel date to collect the information over the phone. Or, if you prefer, you can mail the diary back using the return envelope we provided in this packet.

Remember, the information you provide will be kept **confidential** and **secure**.

If you have questions about filling out the travel diaries, contact *Abt SRBI* at 1-877-699-4344 or email us at MCtravelsurveyhelp@srbi.com.

Thank you for your household's participation in improving transportation in your community!

Sincerely,

Jonathan Ehrlich
Project Manager,
Metropolitan Council

James Henrickson
Minnesota Department of Transportation

James Koenig
Minnesota Department of Transportation

www.metrocouncil.org

390 Robert Street North • St. Paul, MN 55101-2229 • (651) 602-1005 • Fax (651) 602-1138 • TTY (651) 291-0904

An Equal Opportunity Employer

Figure 2.4 Introductory Person-Level Employment Information

Person Information

School Information ☐ Not a student – Skip to Work Information

☐ In pre-school/nursery school ☐ K-12 student ☐ Vocational/Technical

☐ Full-time college/graduate student ☐ Part-time college/graduate student

School/College Name: _____

Location: _____ _____

Street Address or Closest Intersection *City, State, Zip*

Work Information ☐ Not currently employed – Skip to Page 2

If you have more than one job, please reference the job where you spend the most hours

Where do you work? _____

Name of Employer

_____

Type of Business

_____

Street Address or Closest Intersection

_____

City, State, Zip

Does your job involve…? ☐ Evenings (6 PM to 12 AM) ☐ Overnight shifts (12 AM to 5 AM)

Does your job usually require you to make 5 or more work-related trips during the course of an average workday?

☐ No ☐ Yes --→ If yes, how many trips on average? _____ Trips

Average hours worked per week? _____ Hours

Which of the following best describes your work schedule?

- ☐ "I have no flexibility in my work schedule."
- ☐ "I have some flexibility in my work schedule."
- ☐ "I'm pretty much free to adjust my schedule as I like."

Does your employer offer compressed workweek options? (e.g. 40 hrs in less than 5 days)

☐ Yes ☐ No ☐ Don't know

What is your employer's industry?

- ☐ Agriculture, Forestry, Fishing and Hunting
- ☐ Mining
- ☐ Utilities
- ☐ Construction
- ☐ Manufacturing
- ☐ Wholesale Trade
- ☐ Retail Trade
- ☐ Transportation and Warehousing
- ☐ Information
- ☐ Finance and Insurance
- ☐ Real Estate, Rental/Leasing
- ☐ Professional, Scientific and Technical Services
- ☐ Management of Companies and Enterprises
- ☐ Administrative and Support, Waste Management, Remediation Services
- ☐ Educational Services
- ☐ Health Care and Social Services
- ☐ Arts, Entertainment and Recreation
- ☐ Accommodation and Food Services
- ☐ Public Administration/ Government
- ☐ Other Services
- ☐ Military
- ☐ Other _____

Figure 2.5 Instructions for Filling out the Trip Diary

- Use this diary on your assigned travel day, shown on your cover letter. Begin at 3:00 AM on your assigned travel day and continue until you go to sleep that night.
- For each stop, even quick stops for coffee or gas, dropping off or picking up someone, or at a drive-thru window, fill out one page for each location. If uncertain whether to include a stop as a location, go ahead and include it.
- Record the EXACT time that you arrive and leave each location.
- Provide as much address information as you can. Include:
  - street address
  - type of place or business
  - nearest cross streets
- Record your primary activity (what you did) at each location.
  (*Refer to Activity Choices on Page 4.)*
- If you take a round-trip without stopping at a location (walk the dog or ride around in the car), record the furthest point of the trip as the location and what you do there as TURN AROUND.
  (*Refer to Activity Choice 21 on Page 4.)*
- If you park your car and walk AT LEAST five minutes to your destination, record your type of transportation as car first, then walk. If you walk AT LEAST five minutes from a bus to your destination, record your transportation as bus first, then walk.
- If your work involves frequent travel - truck driver, sales person, taxi driver, etc. - record where and when you start work and where and when you end work. Do not include work-related stops. If you make non-work related stops between work stops, record those locations.
- If children under the age of 6 accompany you on any trip, please include them when reporting on question 4 of each travel section. We want to know about all individuals who travel with you.
- If you make more than 12 trips on your travel day please report all 12 trips in the diary format. For trips 13 and above, please turn to the very last page of the diary and report the additional trips.
- An example of a travel day begins on page 3.

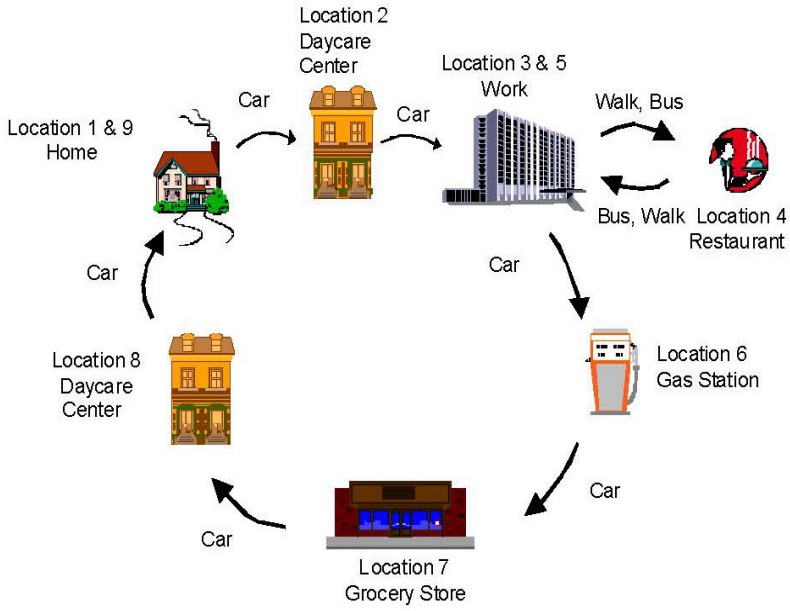
Figure 2.6 Example of a Travel Day

Chris has a busy day.

In addition to having to work a full day, he needs to drop off and pick up his 3 year old son Michael at daycare, have lunch with his mother-in-law, make sure to get gas, stop at the grocery store, and make it home by 7 pm for his favorite television show.

Despite the busy day, Chris diligently records all his trips, activities, and modes of transportation. This is what it looks like.

Chris' Day of Travel

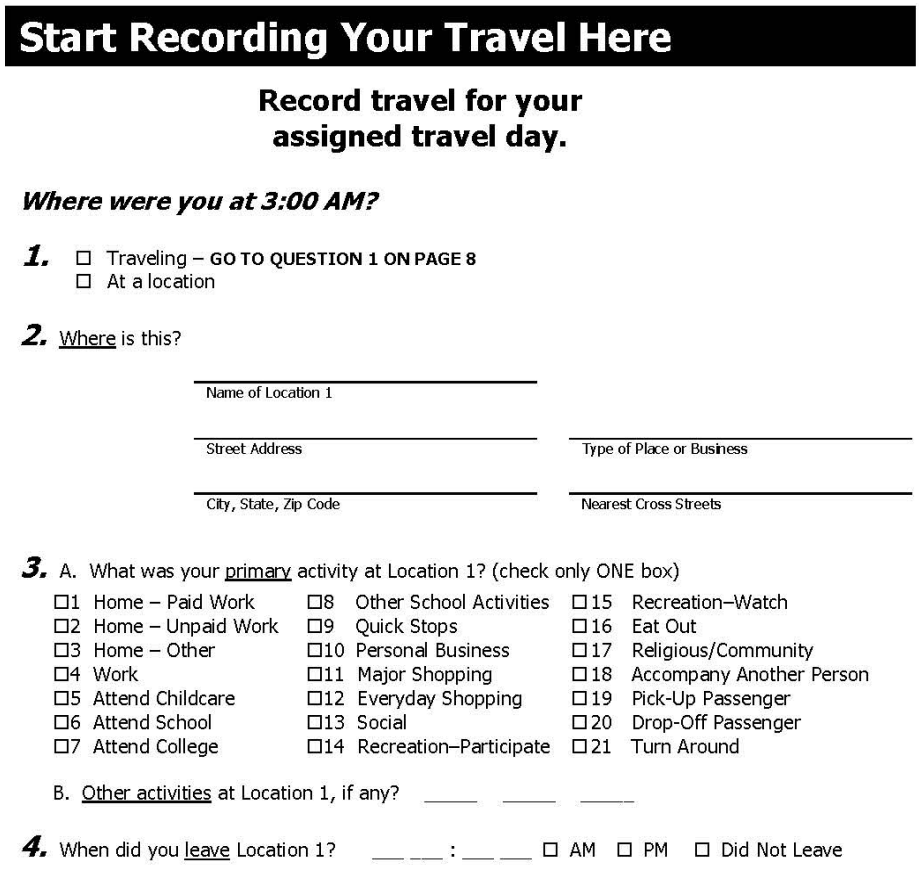


- **Figure 2.7** shows the questions that were used to establish the starting point for the respondent's travel day. This series of questions established whether the starting point for the day was home or another location.
- **Figure 2.8** shows a typical location described by the respondent. Typically, up to 12 such locations could be recorded by travelers although respondents had the option of recording additional locations on the diary and during the retrieval. For each reported location, respondents were prompted to provide information about:
  - Mode used,

- Party size,
- Presence of other household members in the traveling party,
- Cost of travel,
- Arrival time at the location,
- Nature / purpose of the activities,
- Location, and
- Departure time from that location.

Abt SRBI customized its web-based survey capabilities and integrated them with CATI-based features to provide a call-in number, mail-back and data entry, and web-based data capture. A full suite of state-of-art technologies and protocols and leveraged database technologies were used.

Figure 2.7 Recording the Starting Point of Today's Travel



Start Recording Your Travel Here

Record travel for your assigned travel day.

Where were you at 3:00 AM?

1. ☐ Traveling – **GO TO QUESTION 1 ON PAGE 8**
☐ At a location

2. Where is this?

Name of Location 1

Street Address | Type of Place or Business

City, State, Zip Code | Nearest Cross Streets

3. A. What was your primary activity at Location 1? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 1, if any? _____ _____ _____

4. When did you leave Location 1? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Figure 2.8 Recording the Travel Details for Today's Second Location

Travel: How did you get to Location 2? **DIARY EXAMPLE**

1. What type(s) of transportation did you use to go to Location 2?

1st	→	2nd (if needed)	→	3rd (if needed)
1				

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --> How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☒ Driver ☐ Passenger

B. Was this vehicle from your household? ☒ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☒ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . 2 5 Was the rate...? ☒ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

Michael , _____ , _____ , _____

Location 2 **DIARY EXAMPLE**

5. When did you arrive at Location 2? 7 : 4 2 ☒ AM ☐ PM

6. Where is this? Anytown Daycare
Name of Location 2

If address already reported, provide location name and *GO TO QUESTION 7*

123 Main St
Street Address

Daycare
Type of Place or Business

Anytown, MN 55401
City, State, Zip Code

Main St & Elm Rd
Nearest Cross Streets

7. A. What was your primary activity at Location 2? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☒20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 2, if any? _____ _____ _____

8. When did you leave Location 2? 7 : 4 5 ☒ AM ☐ PM ☐ Did Not Leave

3.0 Field Implementation

The field implementation followed the development o the sampling plan and the survey design. The objective was to implement the sample design to achieve the primary objective of the plan and obtain a representative sample of travelers in the Twin Cities metropolitan region.

Section 3.1 outlines the implementation program. We discuss how the recruitment process was monitored to meet the specific sampling targets and produce a balanced sample. We also outline how the retrieved datasets were geocoded and examined to meet quality standards before a database was developed.

Section 3.2 describes the number of surveys that were retrieved by web, phone and by mail and the response rates that were realized.

In section 3.3 discusses the incentives that were provided to different market segments that filled out the survey.

Section 3.4 focuses on the quality control procedures that were implemented during the collection process and section 3.5 summarizes how different survey quality issues were addressed.

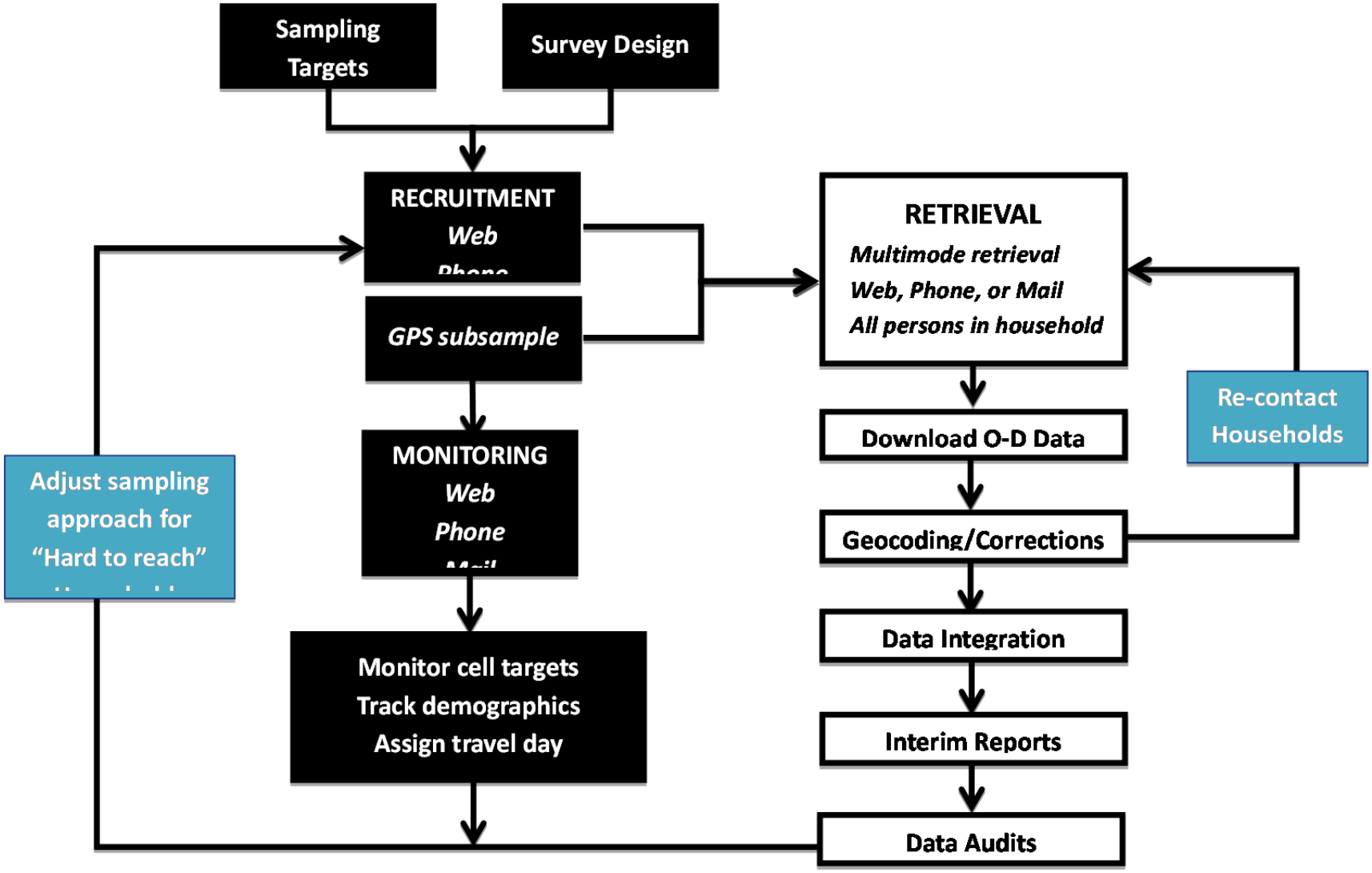
Section 3.6 describes the GPS subsample while section 3.7 summarizes the collection of diary surveys among the MnPass user and Student market segments.

3.1 SURVEY IMPLEMENTATION PROGRAM

Figure 3.1 demonstrates the full scope of that data collection effort and the protocols that were established to collect, manage, and edit data to guarantee reasonableness and quality in the final household survey dataset. First, respondents were **recruited via the web and by phone** to participate in the survey. A random subsample of respondents who agreed to participate in the survey were also asked to participate in the GPS data collation effort.

- The traditional household survey sample and the GPS subsample were monitored to ensure that the survey returns were within the specified geography and were apportioned appropriately to meet geographic and socioeconomic cell targets specified in the sampling plan.

Figure 3.1 Outline of the 2010 TBI Household Survey Fielding, Monitoring, and Database Development Process



- The sample was also described in terms of other socioeconomic variables that were not included in the sampling plan. These comparisons ensured that the respondents in the sample provided a balanced picture of area incomes, type of employment, household lifecycle, and age profile.
- The sample was closely monitored during recruitment using a customized telephone-calling algorithm to ensure that each non-responding sample record received multiple attempts and that these attempts were strategically made at different times of day and days of the week.
- A minimum of three attempts were made to contact each household in the sample over the following calling sessions:
  - Early evening (Saturday-Thursday, 5:00 p.m. to 7:00 p.m. CST),
  - Late evening (Saturday-Thursday, 7:00 p.m. to 9:00 p.m. CST), and
  - Saturday and Sunday (10:00 am to 5:00 p.m. CST).
- If contact was made with a household at any point during these three attempts, the respondent had the option of scheduling a time for a follow up survey callback. The computer aided telephone interview (CATI) sample control system recorded the specific ways and the specific times that a household or person wanted to be re-contacted and automatically rescheduled callbacks.
- As the data collection progressed, adjustments were made to the sampling approach to improve response rates among market segments that were lagging behind target. Examples of such segments were the "hard to reach" households with low incomes and zero vehicles.

Second, a **multimode retrieval process** was used in this study. The objective was to facilitate survey respondents and increase the response rate across all market segments. This approach allowed respondents to provide their responses on the web, by phone, or by mailing back the filled out diary survey.

- Data checks were put in place to manage final data files and interim monitoring reports. Data were geocoded and checked for reasonableness and accuracy. All data were stored in a central database and were managed by a dedicated SQL programmer. Centrally stored data allowed for automated daily reports for the mailing of survey material, programming and phone interviewing staff.
- Automatic tracking of web-based collection activities and timing of responses was coupled with weekly automated reports and summary statistics on data collection status, quota cells fulfillment and sampling plan adherence.
- Travel data retrieved by phone, web, and mail were linked to household and person-level data gathered during the recruitment using unique identification numbers for all households and its members.

- The full and strictest confidentiality of respondent level data was maintained. Data were stored on servers which adhere to the latest Federal government standards of data security. Only immediate identified project staff had access to the personal identifying information.

3.2 RESPONSE RATES

The objective of the multi-mode sample process was to increase the response rate by providng the respondent with the option to complete the survey on the web, by phone or return it by mail. Following up on an invitation letter that provided a web address and a 1-800 number, the recruitment process focused on the web and on the phone options. The retrieval process was flexible providing three options that included web, phone, and mail back (**Figure 3.2**).

Two post cards were sent to encourage response to the survey via the web and via phone. Those who did not respond and belonged to "hard to reach" marekts segments were oversampled using the matched address-based sample. Those were recruited on the web or by phone, were sent full survey diaries and were given the multimode option of completing the survey on the web, by phone, and by mailing back the diaries.

For the Council travel inventory retrieval, a total of 14,055 households were retrieved. Out of those, a total of 12,103 households were successfully completed with all data reviewed and accepted by Cambridge Systematics and the Metropolitan Council. An additional 1,952 households were partially completed.

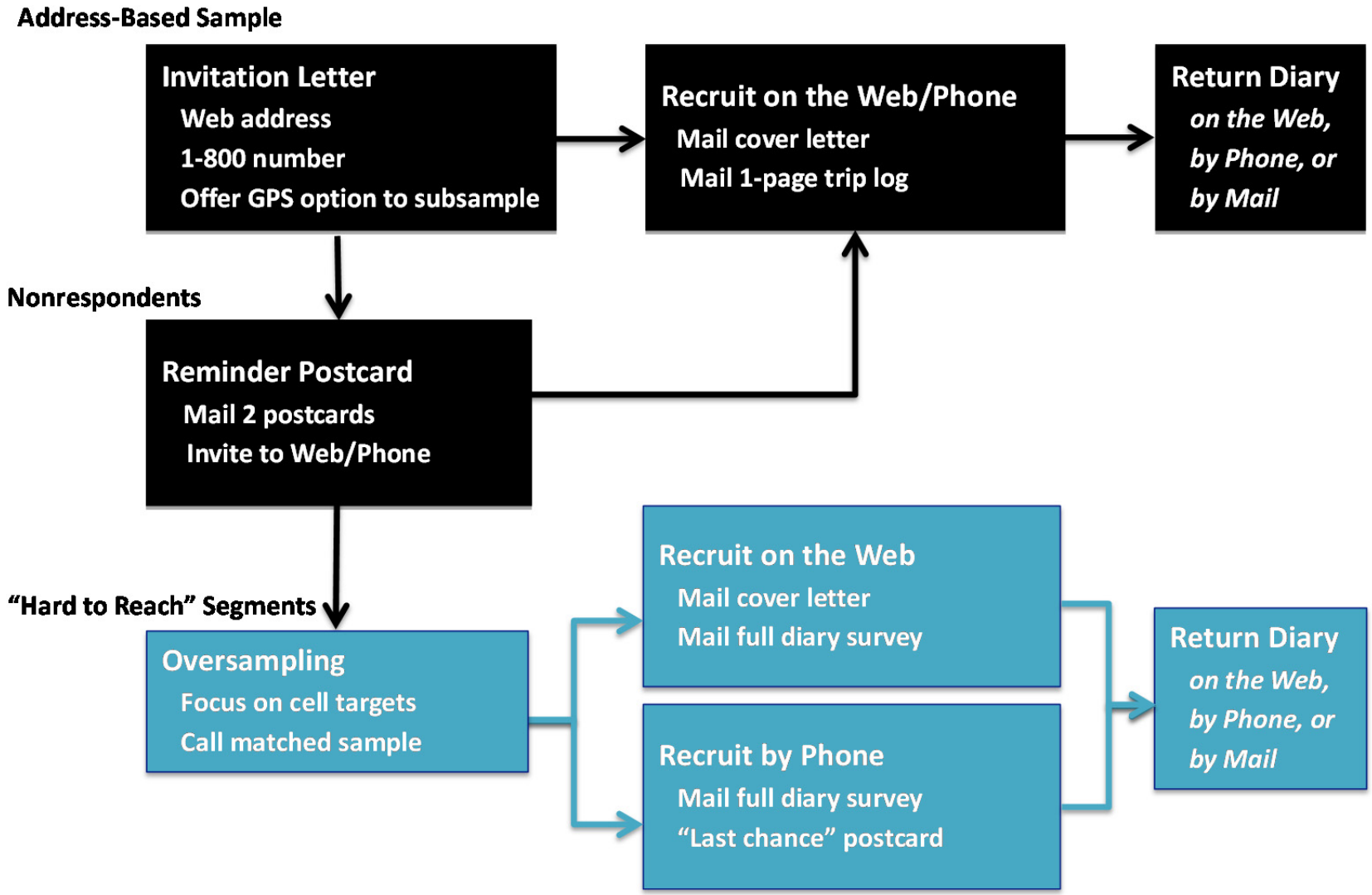
This resulted in a final retrieval to recruitment ratio of 53.3 percent. The final completion rate for fully completed households was 45.9 percent. For purposes of this report, we will focus exclusively on the 12,103 households that were fully completed. **Table 3.1** details the recruitment mode and retrieval mode of the fully completed households.

Table 3.1 Recruited Households and Complete Household Surveys

	Total Households	Response Rate
Contacted Households	235,520	N/A
Recruited Households	26,342	11.2%
Surveyed Households	14,055	53.36%
Partially Compete Households	1,952	7.41%
Complete Households	12,103	45.95%

Source: Abt SRBI and Cambridge Systematics, 2013.

Figure 3.2 Implementing the Address-Based Sample and Reaching Non-respondents and "Hard to Reach" Segments



A total of 12,103 households were successfully retrieved and met data quality standards. In terms of recruitment, 87 percent of these households were recruited by phone (10,324 households) while 13 percent (1,779 households) were recruited on the web (**Table 3.2**).

The retrieval methods were different than the recruitment patterns and highlighted the increasing importance of web surveys but also the critical role of traditional mailback surveys for a large portion of the population. Among the 12,103 households, 13.3 percent of the surveys were completed by phone, 45.5 percent by web, and 41.2 percent by mailback or by using more than one response methods within a household.

Table 3.2 Survey Completes by Recruitment and Retrieval Method

	RECRUITMENT Method					
	Phone		Web		Total	
RETRIEVAL Method	N	Percent	N	Percent	N	Percent
Phone	1,563	15.2%	46	2.6%	1,609	13.3%
Web	4,292	41.5%	1,211	68.1%	5,503	45.5%
Mail-back/Multiple methods	4,469	43.4%	522	29.3%	4,991	41.2%
Total Completes	**10,324**	**100%**	**1,779**	**100%**	**12,103**	**100%**

Source: Abt SRBI and Cambridge Systematics, 2013.

Our analyses suggested that telephone-based reporting was preferred by smaller households and seniors, while mailback of diaries was the preferred method for more than 40 percent of participants spanning a range of characteristics. This may be explained by one or more of the following factors:

- Advanced modeling requirements have increased respondent burden and made telephone and web-based reporting cumbersome and less palatable;
- A lot of thought has been given over the past five years to the development and design of more appealing paper diaries; and/or
- The web is not accessible by certain market segments or household members may be unwilling or not have the skills to use web-based methods.

3.3 INCENTIVES

Established literature in survey research and the social sciences documents the merits of offering monetary incentives to survey participants[8]. Monetary incentives have been found to improve response rates, reduce non-response bias, and encourage participation among "hard to reach" to reach populations. However, nearly all of this literature concentrates on mail and telephone surveys and often focuses exclusively on one-stage survey efforts.

There is little research that addresses the use of incentives in two-stage survey settings that involve respondent recruitment and diary retrieval. Notably, the significant respondent burden associated with two-stage household surveys forces the researcher to strategically use incentives to improve response rates in at least the final travel inventory phase. Moreover, recent GPS surveys, while very valuable from a data collection standpoint, introduce yet a third element of respondent burden.

As part of the Council household survey, an incentive of $20 was gradually introduced to encourage non-GPS "hard to reach" households to complete the second phase of the survey. Incentives were focused on low-income households, zero-vehicle households, and four+ person households that did not participate in the GPS survey.

Recognizing the challenges with compliance with the additional GPS recording element of the survey, Abt SRBI engaged in incentive scenario testing for the GPS component to determine the optimal use of incentives. Abt SRBI staff presented a report at the Transportation Research Board 91st annual meeting on incentive experiments in regard to GPS compliance for the Council HTS title: *"***Early Reports on Incentive Effectiveness on Household Cooperation in GPS Validation Study."**

This presentation detailed the pilot incentive experiment conducted to determine the optimal incentive amount for the GPS subsample. The three scenarios that were tested included no incentives, an incentive of $25, and an incentive of $50. Our findings suggested that a $25 incentive per household was the most effective and that amount was offered to households for full study compliance. The per-household incentive structure and the higher non-compliance among larger households for the GPS survey suggested the need for further investigation.

3.4 REPORTING

Rigorous tracking systems, data auditing, and reporting procedures were key elements to ensure quality survey results for the Travel Behavior Inventory. In

[8] Singer, E., J. Van Hoewyk, and M. P. Maher, Experiments with Incentives in Telephone Surveys, *Public Opinion Quarterly*, Volume 64, 2000, pages 171-188.

addition to the carefuly designed sampling plan, survey instrument and supporting materials it was critical to carefully execute the data collection operations. The elements of the project management plan that were key to quality assurance included the following:

- The early involvement of all project members and the Metropolitan Council to ensure that the sample and survey met modeling and analysis needs.
- Monitoring the sample design and survey design elements of the design to avoid biases and errors.
- Establishing and maintaining a detailed project work schedule.
- Developing and maintaining detailed data collection protocols.
- Conducting a full in-house pilot to confirm that survey design and data collection procedures were adequate for producing quality survey data.
- Monitoring survey labor and cost expenditures so that any overruns in one area of the survey did not affect efforts and outcomes in other areas.
- Effective selection, training, and debriefing of interviewers and fieldworkers. The effort and their responsibilities were explained and also included local geography training.
- Periodic monitoring of recruitment interviews by project management staff, in addition to continuous phone room supervisor monitoring. Feedback was provided in the form of supplemental training.
- Electronic tracking of interviewers' performance included dialing statistics, completed interviews, refusals, non-contacts, and average survey recruitment and retrieval lengths by interviewer.
- Establishing measures to protect respondents' privacy rights to ensure the confidentially of survey data.
- Secure storage and disposal of survey data, equipment, and materials.

3.5 SURVEY QUALITY CONTROL PLAN

Beyond these design and management elements, the project quality control plan for the 2010 household survey specifically addressed and corrected for the most common errors and biases found in recent travel surveys. These potential biases and errors included the following:

1. **Non-response bias** often takes the form of underrepresentation of certain low participation population groups such as four+ person households, lower income and zero vehicle households, transit users, and ethnic populations.
2. **Overrepresentation** of certain population groups that more readily cooperate with surveys such as retired households.

3. **Item non-response** bias such as refusal to answer questions related to household income, employment, and other demographic information.
4. **Underreporting** of trips or not complying with GPS use procedures.
5. **Missing trip segments** and links and inconsistent reporting of trips resulting in sequencing of activities and trips that does not make sense.
6. **Inappropriate imputation** of data.
7. **Inconsistencies** among the person, household, and trip file data records.
8. Failure to meet established monthly **data collection targets**.

Five well developed work programs were necessary to address these quality control issues and make adjustments to the data collection process:

1. A Continuous Data Flow Tracking System,
2. Automated Data Processing and Data Checking Systems,
3. Interim Reporting and Review System,
4. Corrective Actions Using Non-Response Design Interview Techniques, and
5. Definition of a Completed Household.

Each one of these five systems was used by Abt SRBI during the Travel Behavior Inventory project are briefly described in the remainder of this section.

3.5.1 Continuous Data Flow Tracking System

This sample monitoring plan delineates monthly or weekly quotas for the recruitment of households, travel day assignments for the diary, and the household mailouts and retrievals of GPS units.

Quality control requires that each household is individually tracked through this process to completion or to final disposition of their status. This required Abt SRBI's electronic Continuous Data Flow Tracking System to be customized to the needs of the Metropolitan Council project. This sample management system provided the up-to-date status of each household sample element through approximately 15 steps of the survey process.

Household Monitoring. Particularly important was tracking and reporting of the progress of households that were assigned the same travel days. The system generated continuous information to ensure that each household received appropriate attention so that remedial action could be taken as needed. Timely contact was needed to increase response rates. Abt SRBI developed customized sample tracking systems as the study progressed, so that continuously accessible and summary status reports by household and person could be generated.

Sample Monitoring. Throughout the data collection process, weekly status tallies were provided to Metropolitan Council and Cambridge Systematics project managers. These tallies tracked the number and percent of recruited and

completed households by geography and by key sampling demographic variables including household size and number of vehicles per household.

Figure 3.3 shows a summary status of recruited households and the number of retrieved housesholds by web, phone, and mailback. In addition, a detaiiled week by week log shows the detail on the recruitment and retrieval fronts with estimates of cumulative number of surveys in each cateory byh method of recruit adn retrieval. Finally, there is an entry for comments that provides qualitative background to the survey process highlighting important milestones in th survey process.

Sample Profile. A range of household and person characteristics were reported on a weekly basis to monitor for the representativeness of the sample. The sample demographic percentages were continually compared with the latest available American Community Survey data breakdowns as data collection progressed.

GPS Unit Managment. The Continuous Data Flow Tracking System also included the tracking of each GPS unit so that its status and whereabouts were known and linked with the appropriate household at all times.

3.5.2 Automated Data Checking and Data Processing Systems

Abt SRBI's Computer-Assisted-Telephone-Interviewing (CATI) program and Web-based interviewing program for recruitment interviews have extensive in-system and out-system data checking capabilities to ensure the internal consistency fo the collected data – for example the number of total household members matched the person information reported in the survey diaries. In-system and out-system checks kept ranges and responses consistent and non-repetitive. Automated Data developed for household travel surveys by Abt SRBI for Household, Person, and Trip files were customized for the Metropolitan Council household survey.

Figure 3.3 Recruit and Retrieval Patterns by Method and Over Time

SUMMARY		
		HTS
Total Recruit		13925
Total Retrieved		7574
PHONE	14%	1088
WEB	38%	2879
MAIL	48%	3607

RETRIEVAL BY RECRUITMENT METHOD	Phone	Web
Not Ret.	10805	1340
PHONE	1715	51
WEB	5159	1403
MAIL/Multi	4655	556
Total	22334	3350

TIME PERIODS				RECRUITMENT						RETRIEVAL *(Subject to Change)*						
# OF WEEKS	Recruit Week	Travel Week	GPS RWeek	ESTIMATED RECRUIT	ESTIMATED RETRIEVED	WEEKLY RECRUIT	PHONE RECRUITED	WEB RECRUITED	Cum. RECRUITED	PHONE RETRIEVAL	WEB RETRIEVAL	MAIL/MULTI_MODES RETRIEVAL	# of Retrieved from Recruit	% of Retrieved from Recruit	Cum. RETRIEVED	COMMENTS
1	11/28/10	12/5/10		300	180	300	300	0	300	37	15	114	166	55.3%	166	Recruit begins
2	12/5/10	12/12/10		300	180	307	301	6	607	25	13	121	159	51.8%	325	Advanced letters are sent out.
3	12/12/10	12/19/10		300	180	292	260	32	899	26	36	91	153	52.4%	478	
4	12/19/10	12/26/10		0	0	8	0	8	907	0	3	1	4	50.0%	482	Phone recruit discontinued; retrieval continues
5	12/26/10	1/2/11		0	0	3	1	2	910	0	0	0	0	0.0%	482	Phone recruit discontinued; retrieval continues; Inclement weather closed our Boston office. Mail retrieve not available at time of reporting.
6	1/2/11	1/9/11		300	180	308	304	4	1218	20	64	99	183	59.4%	665	Recruit restarted as of 1/3/11
7	1/9/11	1/16/11		300	180	302	302	0	1520	38	68	92	198	65.6%	863	Phone Retrieval resumes tonight with yesterday's travel date. Lag in retrieval due to limited recruit over the holiday break.
8	1/16/11	1/23/11		300	180	306	305	1	1826	18	81	86	185	60.5%	1048	
9	1/23/11	1/30/11		550	330	548	547	1	2374	38	138	140	316	57.7%	1364	
10	1/30/11	2/6/11		550	330	554	554	0	2928	23	116	162	301	54.3%	1665	
11	2/6/11	2/13/11		550	330	552	551	1	3480	33	118	138	289	52.4%	1954	
12	2/13/11	2/20/11		550	330	608	556	52	4088	47	101	140	288	47.4%	2242	MAILWAVE=2--Advanced letters sent out (N=15,794)
13	2/20/11	2/27/11	X	550	330	791	553	238	4879	34	166	241	441	55.8%	2683	GPS Pretest to begin. 15 households were recruited (13 by phone and 2 by Web)
14	2/27/11	3/6/11		810	486	864	777	87	5743	62	199	215	476	55.1%	3159	2 GPS households both by web. **Scheduled conversation about hard-to-reach groups and geographic distribution**

Figure 3.3 Recruit and Retrieval Patterns by Method and Over Time (continued)

TIME PERIODS				RECRUITMENT						RETRIEVAL *(Subject to Change)*						COMMENTS
# OF WEEKS	Recruit Week	Travel Week	GPS RWeek	ESTIMATED RECRUIT	ESTIMATED RETRIEVED	WEEKLY RECRUIT	PHONE RECRUITED	WEB RECRUITED	Cum. RECRUITED	PHONE RETRIEVAL	WEB RETRIEVAL	MAIL/MULTI_MODES RETRIEVAL	# of Retrieved from Recruit	% of Retrieved from Recruit	Cum. RETRIEVED	
15	3/6/11	3/13/11		**810**	**486**	**855**	**817**	**38**	**6598**	**85**	**162**	**223**	**470**	**55.0%**	**3629**	0 GPS households were recruited this week. GPS data should be returning this week. I will report on GPS data developments once travel packets are returned.
16	3/13/11	3/20/11	X	**810**	**486**	**610**	**595**	**15**	**7208**	**66**	**108**	**143**	**317**	**52.0%**	**3946**	29 GPS households recruited.
17	3/20/11	3/27/11		**810**	**486**	**821**	**812**	**9**	**8029**	**66**	**179**	**178**	**423**	**51.5%**	**4369**	11 GPS households recruited.
18	3/27/11	4/3/11		**810**	**486**	**822**	**812**	**10**	**8851**	**90**	**185**	**170**	**445**	**54.1%**	**4814**	Advanced letters scheduled to be sent (MAILWAVE=3) have been sent. No GPS households were recruited this week.
19	4/3/11	4/10/11	X	**810**	**486**	**960**	**650**	**310**	**9811**	**59**	**262**	**240**	**561**	**58.4%**	**5375**	18 GPS households were recruited (14 by phone; 4 by web)
20	4/10/11	4/17/11		**810**	**486**	**867**	**695**	**172**	**10678**	**80**	**223**	**180**	**483**	**55.7%**	**5858**	87 households were recruited from the University sample
21	4/17/11	4/24/11		**810**	**486**	**814**	**700**	**114**	**11492**	**73**	**177**	**183**	**433**	**53.2%**	**6291**	46 households were recruited from the University sample. Rounding us out at 133 total University samples recruited.
22	4/24/11	5/1/11	X	**810**	**486**	**759**	**720**	**39**	**12251**	**60**	**133**	**196**	**389**	**51.3%**	**6680**	15 households were recruited from the University sample. Rounding us out at 148 total University samples recruited. 7 GPS households were recruited.
23	5/1/11	5/8/11		**810**	**486**	**895**	**701**	**194**	**13146**	**52**	**164**	**255**	**471**	**52.6%**	**7151**	Advanced letters scheduled to be sent (MAILWAVE=4). Two households were recruited for GPS
24	5/8/11	5/15/11		**810**	**486**	**779**	**601**	**178**	**13925**	**56**	**168**	**199**	**423**	**54.3%**	**7574**	Reminder letters sent to University students. Autodialer time increased from 30 seconds to 40 seconds. University households (161 recruited; 45 Completed)

3.5.3 Interim Reporting and Review

An in-house pretest and evaluation was conducted prior to the fielding of the survey. Weekly sample monitoring tallies documented progress in meeting sampling goals and data requirements. Interim datasets were provided to Cambridge Systematics for auditing of the survey content and the sample distribution. This process allowed for consideration of corrective measures including incentives and more focused targeting of the sample as the data collection progressed.

3.5.4 Nonresponse Design Interviewing Techniques

To address nonresponse among "hard to reach" populations (e.g., four+ person households and zero auto households), Abt SRBI employed a responsive design[9] approach. Broadly, this approach is based on five components:

1. Preidentification of design elements affecting costs and error;
2. Selection of indicators related to design elements preidentified;
3. Monitoring of those indicators during data collection;
4. Modification of survey features (e.g., recruitment targets, incentives) in a subsequent phase; and
5. Merging of data from separate design phases.

Modified approaches such as the use of *differential incentives* and *oversampling* of targeted low-income households(based on address-based sampling and Census block data) were introduced as the data collection proceeded. This adjustment aimed at improving the representation of "hard to reach" segments resulted in a sample that more closely matched Census American Community Survey data on key variables of interest for modeling.

Throughout data collection, real-time sample monitoring tracked the filling of data cells according to Census data. When disproportionate recruiting or participation (retrieval) was identified within any of the targeted sampling data cells (documented by the weekly sampling status tallies), the following responsive interviewing techniques were initiated with Metroplitan Council and Cambridge Systematics approval:

- Adjusting recruitment sample targets based on the varying actual retrieval rates for different data cells;

[9] Groves, R. M., and S. G. Heeringa, 2006, Responsive design for household surveys: tools for actively controlling survey errors and costs, *Journal of the Royal Statistical Society: Series A (Statistics in Society), 169*(3), 439-457.

- Targeted sampling of Census tracts for zero-vehicle and four+ person households by augmenting existing address-based sample with American Community Survey data;
- Conducting full non-response, refusal conversion-attempting re-interviewing with re-assigned travel days for all households recruited in rare population data cells; and
- Introducing differential incentives for low participation segments if all members of the underrepresented households completed the travel surveys.

3.5.5 Definition of a Completed Household

A key element to the final quality control is that the Project Team agrees on the definition of a "completed household." This is necessary so that households with significant missing or inconsistent data, or households not meeting sampling goals, can be corrected or replaced as data collection proceeds. This avoids discovering at the end, when there are few alternatives, that the data collection effort has not met sampling and/or modeling goals.

The Metropolitan Council and Cambridge Systematics agreed with Abt SRBI upon a series of data completion rules for the household travel survey. Strict requirements were imposed on home street address, for which 100 percent of the sample needed to be collected. Section 4.3 describes the inclusion requirements for households and persons. From the over 14,000 households for which travel diaries were collected and entered, a total of 12,103 passed the final test and were accepted as "complete" meeting these criteria.

3.6 GPS SUBSAMPLE

Data previously collected by Abt SRBI as well as the published literature on the subject show that respondents using traditional diaries tend to consistently underreport trip data either due to respondent burden of diary reporting, respondent misunderstanding of what a "trip" is, and ignoring shorter trips or travel that does not involve a vehicle.

The goal of the GPS data collection for the Travel Behavior Inventory was to serve as a "proof of concept" for future survey efforts and as a "validation tool" for the 2010 travel diary survey. The use of GPS allows for passive precise data collection and provided data that would be comparable to traditional survey diary data. A subset of the individuals who participated in the traditional survey were asked to also carry a GPS unit to passively record their travel.

The comparisons between the traditional diary and GPS surveys could help us examine the following questions:

- Do respondents underreport travel in the traditional diary survey?
- If so, are there certain trip types that are more likely to be underreported?
- Can an adjustment factor be developed to adjust for underreporting?

Our approach to GPS data collection for the Metropolitan Council household survey was to replicate the non-GPS travel diary components. Additional products from the GPS data collection included the following:

- Precise travel routes for all GPS trips with exact calculation of distances;
- Start and stop of GPS trips to the nearest second for exact travel speeds;
- Capture of all modes of both vehicle and non-vehicle trips via GPS; and
- Travel modeling factors such as trip rates and short trips.

Plan Trans GPS units were deployed for the GPS household survey. The device is a durable and simple GPS data logger that is customized to record participants' GPS positions, even in a building or on a bus. This highly detailed data collection method allows for accurate identification of routing information, the specific time stamp of trip start and end points, travel speed, travel direction, and geographic location of origins and destinations.

The device is a passive GPS unit and requires no input from the user over the course of the survey. The unit is automatically activated by a movement sensor, eliminating the need to be turned on and off to record trip data. This movement sensor function is also an important power-saving feature, as the device goes into sleep mode after 15 minutes without movement. Participants kept this device with them during the designated travel days as the device records all travel data without any required input from participants. Respondents were required to carry the device with them for seven days including weekdays and weekends.

A full pilot of the GPS study was conducted with 32 households fully completing both diary and GPS recordings for all household members 13 years and older. For the main study, a total of 226 households were finally accepted as totally reviewed and meeting GPS completion criteria. About 35 percent of those recruited households completed the GPS component only, while only two percent completed the diaries without any GPS recordings. GPS recordings were not considered an undue privacy burden by respondents, and were considered less burdensome than reporting travel by diary.

Tables 3.3 and **3.4** show the GPS data collection outcomes and results for both the pilot and the main GPS Metropolitan Council Survey. A total of

258 households completed their GPS surveys and 234 of these households provided complete GPS data for comparison with the traditional diary surveys[10].

Table 3.3 Recruited GPS Households and Complete Surveys

	Total Households	Response Rate
Recruited GPS Households	693	N/A
Surveyed GPS Households	258	37.2%
Partially GPS Compete Households	24	3.5%
Complete GPS Households	234	33.7%

Source: Abt SRBI and Cambridge Systematics, 2013.

Table 3.4 Recruitment Methods for GPS Households

	Recruitment Method					
	Phone		Web		Total	
RETRIEVAL Method	N	Percent	N	Percent	N	Percent
Phone	7	3.2%	0	–	7	2.7%
Web	144	66.7%	33	78.6%	177	68.6%
Mail-back/Multiple methods	65	30.1%	9	21.4%	74	28.7%
Total Completes	216	100%	42	100%	258	100%

Source: Abt SRBI and Cambridge Systematics, 2013.

The majority of the GPS households were recruited by phone (90 percent) with 10 percent of recruited by web. The majority of the GPS household respondents reported their diary information on the web (67 percent) and another 29 percent mailed back the filled out diaries along with the GPS units. Participating in both the diary and the GPS survey effort provided useful data for one-on-one comparisons but imposed a considerable burden on respondents.

The findings of the GPS data collection survey were summarized in the PlanTrans report *"Revised Final Report on GPS Validation Survey"* as follows:

1. Trips were under-reported in the diaries by around 18 percent, when comparing GPS and diary data for the GPS validation sample.
2. Travel times were over-reported in the diaries by around 10 percent, when comparing GPS and diary data for the GPS validation sample.

[10] GPS report by Plan Trans *"Revised Final Report on GPS Validation Survey,"* April 2013.

3. There was no clear evidence of regional differences in reporting accuracy in travel diaries.
4. The trips that were recorded by GPS that were missing from the travel diaries tended to be shorter in duration and distance than all trips, but only by about 25 percent. Missed trips included both long and short trips and were not restricted predominantly to short trips.
5. Trip rates were substantially higher from GPS than from diary and this was more marked when comparing GPS and non-GPS households. In the case of the latter, the under-reporting appears to be on the order of 28 percent, rather than the 18 percent found by comparing within the validation sample.
6. While there were socio-demographic differences between the GPS and non-GPS households, these differences would generally be expected to be associated with higher, not lower, trip rates. In general, however, the differences were not large and only the difference in average age appeared to be statistically significant, among those that can be tested for significance.

Cambridge Systematics undertook additional analyses of the GPS and diary surveys focusing on a subsample of individual travelers. To support one-on-one comparative analyses, we retained only those individuals for which we had both travel diary and GPS data. In total, 187 individuals who belonged to 125 households were preserved in this version of the dataset. This comparative analysis confirmed some of the PlanTrans findings but also provided some additional insights as follows:

- There was underreporting in the travel diary survey but in the matched GPS/diary subsample the difference was about 8 percent.
- Short trips of less than 5 minutes were underrepresented in the traditional travel diary survey and may reflect rounding errors that may also have overstated the average duration of short trips.
- The duration patterns for all other trips were more comparable between the GPS and the diary survey.
- GPS trip rates may have been affected both positively and negatively:
  - GPS trip rates could decrease by respondents who did not carry their GPS units at all times.
  - GPS trip rates could increase due to very short activities. The data need to be further examined carefully since they may include artificial intermediate stops that inflate trip rates.
- The algorithm of assigning trip ends at bus stops may inadvertently also increase GPS trip rates.

In summary, we obtained useful "proof of concept" insights by designing, collecting and analyzing the GPS sample. As new cell phone and GPS data

collection options are emerging, agencies can benefit from lessons learned and from an in-depth analysis of these datasets.

3.7 MnPass and University Student Segments

As part of the recruitment survey respondents were asked about ownership of a MnPass transponder. The purpose of monitoring MnPass users was to provide a sample basis for analyzing the demographic characteristics and travel patterns of MnPass users vis-à-vis non-users in the I-394 corridor where existing road pricing is in effect, and also possibly to measure MnPass usage in the I-35W corridor where HOT Lanes were in effect during the survey period.

A total of 556 households recruited to participate in the household survey indicated that the household was enrolled in MnPass program. Of the 556 households enrolled in the program and recruited to participate, 39 percent (216 households) fully completed the survey.

As part of the larger Travel Behavior Inventory and follow-up analysis, these 216 MnPass households can be compared to non-MnPass households with similar origin-destination points to identify demographic and travel patterns difference.

In an effort to increase the number of participating University students, Abt SRBI explored several opportunities to improve coverage of local universities in a cost effective manner. A sample of 1,137 known University students was drawn for five local universities and most of them (82 percent) were students at the University of Minnesota, the largest university in the study region.

Advance letters were sent to each student's parents or to a guardian's address since the sample addresses were for actual home addresses and not university addresses. Parents/guardians were asked to notify their student of the invitation and encourage them to go online to complete the recruitment survey. A reminder letter was sent one month after the initial invitation. Each student household was offered $10 upon completion of the study.

A total of 177 university student households were recruited to participate and 60 households fully completed both the recruit and travel portions of the survey. Overall, a total of 1,095 persons in the survey indicated they were currently enrolled in a University-level program corresponding to approximately four percent of the persons submitting fully complete surveys. For comparisons purposes, the American Community Survey data indicate that seven percent of the region's population is currently enrolled in a University-level program.

4.0 Quality Assurance

In this section we discuss the different elements of quality assurance and quality control (QA/QC) for the household survey. We discuss the quality of the observed survey sample and then shift gears to talk about operations-related QA/QC tests. We conclude by focusing on the QA/QC checks that were used to audit the collected household travel survey prior to analysis and modeling.

Section 4.1 focuses on the sample distribution in the final complete household survey travel diary dataset for the Travel Behavior Inventory. We discuss how the data matched, exceeded or lagged the cell specific targets set at the outset.

Section 4.2 explores the representativeness of the sample. Although adherence to targets is important for a balanced sample, these comparisons show how closely the survey data matched the latest American Community Survey.

Section 4.3 discusses in detail the quality assurance/quality control tests that Abt SRBI had built into the data collection process. We also focus on the detailed checks introduced by Cambridge Systematics to provide an independent audit of the dataset prior to any analysis.

In Section 4.4, we conclude by discussing how the individual trip records were compared across individuals and how the origin-destination information for all trips were parsed to come up with tour level data.

4.1 ADHERENCE TO GEOGRAPHIC TARGETS

Abt SRBI's automated, customized interim reports included the recruitment and retrieval status and summarized how well the fieldwork was filling data cell targets along with the corresponding survey response and participation rates. In addition, a template of key household and person characteristics was developed by Cambridge Systematics and was compared with corresponding Census data. We also summarized travel and trip characteristics including number of trips, length of trips per person and by purpose, trip mode and activity (purpose), detailed geocoding status information, and a report on households with no reported travel during the assigned travel day.

4.1.1 Monitoring and Adjustments

The weekly status reports continually monitored recruitment and retrieval results for overall household and person characteristics for the region based on the 2008 American Community Survey data. These comparisons ensured not only the completion of target cells consistent with the sampling plan, but the overall representativeness of the sample that was collected.

After every interim data audit by the Cambridge Systematics team, a "Progress Table by Sampling Data Cell" was updated with counts per cell for completed, accepted, and not accepted households. Households that were not accepted were flagged in the database. Abt SRBI continued to work on correcting the "unacceptable" household responses. If these corrections did not solve the problem, additional households were recruited to replace households that were deemed unacceptable.

Abt SRBI had planned to complete a minimum of 105 percent of the sample target households as an allowance for replacement households. During this project, the total number of households collected were 16 percent higher than planned. The Progress Table served as a guide as to which data cells needed replacement households. The Progress Table on Sampling Data Cells was provided as an addendum to the interim reports.

Full interim datasets were delivered to the Metropolitan Council and Cambridge Systematics with missing and inconsistent data. Together, the project team identified households that should be flagged as "not complete" and designated the number of households that needed to be replaced to reach the household survey target.

Weekly status reports developed by Abt SRBI monitored data collection by all of the sampling targets as well as by household and person data compared to the latest American Community Survey Census data.

4.1.2 Regional Comparisons

We first focused our comparisons of our sample versus the target values summarizing the survey returns at the seven sampling region level that was defined as a key sampling dimension by the Metropolitan Council.

Table 4.1 suggests that a regional level the sample was very close to the sampling targets and also reflected reasonably well the 2006-2008 American Community Survey. It should be noted that the differential sampling targets of one percent for the more urbanized areas and one half percent for the rest of the region account for some of the observed differences.

The household survey is very representative of the seven defined sampling subregions except Core East which is slightly overrepresented and Core South which is slightly underrepresented. However, completed totals for these regions are more than sufficient for independent statistical analysis. Overall, these comparisons suggest that the sample reflects the regional target counts and is consistent with the original sampling plan.

Table 4.1 Survey and ACS Comparisons at the Sampling Region Level

	Recruited		Completed		ACS 2006-2008 Number of Households	
Quota Regions	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Minneapolis	3,645	13.8%	1,789	14.8%	158,389	11.8%
St. Paul	2,471	9.4%	1,122	9.3%	108,708	8.1%
Hennepin Carver	7,145	27.1%	3,313	27.4%	345,262	25.7%
Ramsey Washington Anoka	6,540	24.8%	2,922	24.1%	213,200	15.9%
Scott Dakota	3,587	13.6%	1,638	13.5%	278,352	20.7%
Ring Counties, MN	1,894	7.2%	841	6.9%	176,191	13.1%
Ring Counties, WI	1,060	4.0%	478	3.9%	63,977	4.8%
Total	**26,342**	**100.0%**	**12,103**	**100.0%**	**1,344,079**	**100.0%**

Source: Cambridge Systematics and Abt SRBI, 2013.

Table 4.2 repeats these comparisons using a more detailed geographic definition with each of the 19 counties in the study area. It further differentiates between Minneapolis and the rest of Hennepin County and between St. Paul and the rest of Ramsey County resulting in 21 geographic entities.

Noting the effect of the differential sampling rates used for urbanized parts of the region versus the remainder of the study area, these comparisons again suggest that the sample is well balanced at a geographic level with enough observations at most of the individual counties.

4.2 REPRESENTATIVENESS OF THE FINAL SAMPLE

In addition to the geographic dimension, comparisons were made by contrasting the household and personal profiles for fully completed surveys against the American Community Survey. All data in this section are unweighted and are compared to the Census to assess the degree of representativeness of the drawn household and person sample before any weighting is applied to the dataset.

The final household-level results are presented in **Tables 4.3** through **4.5** and the final person-level results are presented in **Tables 4.6** and **4.7**. It should be noted that the data are presented for recruited households and persons and for the fully completed surveys.

Table 4.2 City and County-Level Comparisons of Survey and ACS Data

	Recruited		Completed		ACS 2006-2008 Number of Households	
County	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
St. Paul, MN	2,195	8.3%	1,003	8.3%	108,708	8.1%
Minneapolis, MN	2,959	11.2%	1,447	12.0%	158,389	11.8%
Anoka, MN	2,650	10.1%	1,121	9.3%	119,025	8.9%
Carver, MN	703	2.7%	317	2.6%	32,153	2.4%
Dakota, MN	2,779	10.5%	1,276	10.5%	149,118	11.1%
Suburban Hennepin, MN	7,053	26.8%	3,307	27.3%	313,109	23.3%
Scott, MN	859	3.3%	376	3.1%	43,730	3.3%
Suburban Ramsey, MN	2,232	8.5%	1,074	8.9%	94,175	7.0%
Washington, MN	1,951	7.4%	866	7.2%	85,504	6.4%
Chisago, MN	162	0.6%	75	0.6%	18,133	1.3%
Goodhue, MN	180	0.7%	76	0.6%	18,659	1.4%
Isanti, MN	126	0.5%	52	0.4%	14,415	1.1%
Le Sueur, MN	107	0.4%	45	0.4%	10,647	0.8%
McLeod, MN	151	0.6%	77	0.6%	14,206	1.1%
Rice, MN	264	1.0%	129	1.1%	21,823	1.6%
Sherburne, MN	466	1.8%	198	1.6%	28,653	2.1%
Sibley, MN	54	0.2%	21	0.2%	5,805	0.4%
Wright, MN	388	1.5%	166	1.4%	43,850	3.3%
Pierce, WI	220	0.8%	107	0.9%	14,892	1.1%
Polk, WI	265	1.0%	115	1.0%	17,819	1.3%
St. Croix, WI	578	2.2%	255	2.1%	31,266	2.3%
Total	**26,342**	**100.0%**	**12,103**	**100.0%**	**1,344,079**	**100.0%**

Source: Cambridge Systematics and Abt SRBI, 2013.

4.2.1 Household Characteristics

The household survey completes was fully representative of Minneapolis, St. Paul, and the surrounding counties. We should note that the GPS component was intentionally targeted to Minneapolis, St. Paul and the remainder of Hennepin and Ramsey Counties where complex trip data were most likely given a higher incidence of multimodal nonmotorized travel—transit, walk, and bike.

Vehicle ownership. The distribution of the completed sample by vehicle ownership was closely representative of the region's population as shown in **Table 4.3**. These patterns are very important especially for "hard to reach" zero

car households that account for four percent of our sample compared to 6.8 percent in the region's population.

Table 4.3 Vehicle Ownership Comparisons

	Recruited		Completed		ACS 2006-2008 Households by Vehicle Ownership	
Total Vehicles	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
0 vehicles	1,282	4.9%	483	4.0%	91,586	6.8%
1 vehicle	7,220	27.4%	3,806	31.4%	413,357	30.8%
2 vehicles	11,358	43.1%	5,223	43.2%	560,487	41.7%
3 vehicles	4,257	16.2%	1,758	14.5%	198,375	14.8%
4+ vehicles	2,225	8.4%	833	6.9%	80,274	6.0%
Total	**26,342**	**100.0%**	**12,103**	**100.0%**	**1,344,079**	**100.0%**

Source: Cambridge Systematics and Abt SRBI, 2013.

Household lifecycle. The lifecycle comparisons between the recruited and the completed sample are shown in **Table 4.4**. Retirees were slightly overrepresented in the final complete version of the household survey. Sample sizes for all other lifecycle groups were sufficient for independent analysis and there was no major drop in any group between the recruitment phase and the final phase of the survey.

Table 4.4 Household Lifecycle Comparisons

	Recruited		Completed	
Household Type	**Frequency**	**Percent**	**Frequency**	**Percent**
Adult Household	12,801	48.6%	6,135	50.7%
Adult Student Household	573	2.2%	200	1.7%
Household with Children	8,118	30.8%	3,024	25.0%
Retiree Household	4,850	18.4%	2,744	22.7%
Total	**26,342**	**100.0%**	**12,103**	**100.0%**

Source: Cambridge Systematics and Abt SRBI, 2013.

Income effects. The completed household sample is very close to target when the cutoff point of $50,000 is considered. With the exception of the four lowest income categories, the survey incomes match the Census data very well. Even in the case of household incomes less than $20,000 the underrepresentation is modest with sample sizes sufficient for independent analysis at each level.

Table 4.5 Income Distribution Comparisons

	Recruited		Completed		ACS 2006-2008 Households by Income Level	
Household Income	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Less than $5,000	272	1.3%	110	1.1%		
$5,000 but less than $10,000	350	1.7%	128	1.3%	63,884	4.8%
$10,000 but less than $15,000	571	2.7%	261	2.6%	49,074	3,7%
$15,000 but less than $20,000	646	3.1%	303	3.0%	49,751	3.7%
$20,000 but less than $25,000	739	3.5%	374	3.7%	48,756	3.6%
$25,000 but less than $30,000	804	3.8%	393	3.9%	53,740	4.0%
$30,000 but less than $35,000	723	3.4%	378	3.8%	56,475	4.2%
$35,000 but less than $40,000	737	3.5%	347	3.5%	56,927	4.3%
$40,000 but less than $45,000	716	3.4%	350	3.5%	61,924	4.6%
$45,000 but less than $50,000	1,004	4.7%	489	4.9%	54,620	4.1%
$50,000 but less than $60,000	1,872	8.8%	894	9.0%	113,695	8.5%
$60,000 but less than $75,000	2,599	12.3%	1,276	12.8%	154,056	11.5%
$75,000 but less than $100,000	3,796	17.9%	1,831	18.4%	207,389	15.5%
$100,000 but less than $125,000	2,657	12.5%	1,188	11.9%	140,762	10.5%
$125,000 but less than $150,000	1,402	6.6%	639	6.4%	79,828	6.0%
$150,000 but less than $200,000	1,206	5.7%	555	5.6%	76,838	5.7%
$200,000 but less than $250,000	521	2.5%	226	2.3%	70,555	5.3%
$250,000 or more	568	2.7%	228	2.3%		
Total	**21,183**	**100.0%**	**9,970**	**100.0%**	**1,338,274**	**100.0%**
Less Detailed Responses						
Below $50,000	745	2.8%	326	2.7%		
$50,000 or above	1,963	7.5%	847	7.0%		
Aggregated Responses						
Below $50,000 Total	7,307	30.6%	3,459	31.0%	495,151	37.0%
$50,000 or above Total	16,584	69.4%	7,684	69.0%	843,123	63.0%
	23,891	**100.0%**	**11,143**	**100.0%**	**1,338,274**	**100.0%**
Don't Know/Refused	2,451	9.3%	960	7.9%		
Total	**26,342**	**100.0%**	**12,103**	**100.0%**		

Source: Cambridge Systematics and Abt SRBI, 2013.

4.2.2 Person Characteristics

The 12,103 households for which fully completed surveys were available yielded a total of 25,843 total persons over five years of age.

Age Profile. Table 4.6 displays the age distribution for the fully complete survey sample. While 18 to 34 year olds are underrepresented in the final sample and seniors are overrepresented, sample sizes are sufficient among young adults and each age group for statistical analysis purposes. Seniors are always more likely to be home for recruitment calls, more likely to not be cell-phone-only households, and are also more likely to cooperate with the burden of completing household travel surveys. Overall, only a modest weighting of the observed distribution will be needed to reflect a representative sample of the region's population.

Table 4.6 Age Comparisons – Survey versus ACS Data

	Recruited		Completed		ACS 2006-2008	
Person Age	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Less than 18 years of age	15,498	23.7%	4,187	16.2%	860,729	25.2%
18 to 24 years old	3,881	5.9%	1,199	4.6%	312,797	9.2%
25 to 34 years old	4,927	7.5%	1,913	7.4%	462,619	13.6%
35 to 44 years old	8,451	12.9%	3,278	12.7%	529,018	15.5%
45 to 54 years old	11,812	18.0%	4,813	18.7%	538,822	15.8%
55 to 64 years old	10,902	16.6%	5,241	20.3%	361,089	10.6%
65 to 74 years old	6,028	9.2%	3,234	12.5%	183,993	5.4%
75 to 84 years old	3,116	4.8%	1,572	6.1%	113,373	3.3%
85 years and over	817	1.2%	354	1.4%	51,431	1.5%
Total	**65,432**	**99.8%**	**25,791**	**100.0%**	**3,413,871**	**100.0%**
Less Detailed Responses						
18 years of age or older	115	0.2%	47	0.2%		
Under 18 years of age	30	0.0%	3	0.0%		
Don't Know/Refused	8	0.0%	2	0.0%		
Total	**65,585**	**100.0%**	**25,843**	**100.0%**		

Source: Cambridge Systematics and Abt SRBI, 2013.

Employment Profile. It should be noted that the comparison of the household survey patterns with the 2006-2008 American Community Survey data is not considered totally valid given the ways in which respondents report employment, the economic crisis effects, and the small impact of excluding Sibley County from the American Community Survey data. In addition, the definition of "unemployed" in this analysis includes seniors who are traditionally overrepresented.

Overall, the household survey sample reflects the regional employment profile and the sample sizes in each category meet and exceed the standard for statistical analysis and modeling. A comparison with the weighted sample will be required to assess whether the weights account for the observed differences.

Table 4.7 Employment Comparisons – Survey versus ACS Data

	Recruited		Completed		ACS 2006-2008	
Employment Status[a]	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Armed Forces	–	–	–	–	2,079	0.1%
Employed	32,219	49.1%	12,784	49.5%	1,854,481	69.9%
Unemployed	3,391	5.2%	1,835	7.1%	103,233	3.9%
Not in labor force	29,515	45.0%	11,058	42.8%	693,573	26.1%
Other	395	0.6%	145	0.6%	–	–
Don't know/Refused	65	0.1%	21	0.1%	–	–
Total	**65,585**	**100.0%**	**25,843**	**100.0%**	**2,653,366**	**100.0%**

Source: Cambridge Systematics and Abt SRBI, 2013.

[a] Excludes Sibley County due to data suppression by Census Bureau to avoid disclosure.

4.3 QUALITY ASSURANCE/QUALITY CONTROL

The household survey was processed by Abt SRBI in two steps for separate purposes. First, the data received were cleaned to most accurately reflect the information given by respondents. This process cleaned and codified the responses in the trip diary as well as the demographic information at the household and person levels. The second step focused on preparing the dataset by creating "tour" level data from the information reported in the travel diary.

Besides the quality assurance checks built in by Abt SRBI for the telephone survey, the web-based version, and the mailback diary survey, Cambridge Systematics conducted extensive quality assurance/quality control on the coded Travel Behavior Inventory household survey data. These data auditing checks can be grouped into six broad areas:

- Geocoding checks,
- Household file checks,
- Structural checks,
- Person file checks,
- Trip file checks, and
- Logical checks.

Household and person-level records that did not meet one or more of these quality assurance tests were flagged. The analysis of the households that did not meet a pre-specified set of criteria resulted in "incomplete" household records. In total, about 2,000 of the over 14,000 households that were surveyed were deemed incomplete as part of this quality control assessment. These households were dropped from the statistical analysis and modeling activities that relied on the 12,103 complete household diaries.

4.3.1 Geocoding Checks

Geocoding checks were conducted and reported separately for the origins and the destinations of places of residence, workplaces, and schools. The following general criteria were used:

- Level of accuracy: none of the geocodes were rounded and eight decimals were used to code the values.
- Missing geocodes.
- Sign consistency in geocodes: All latitudes had a positive value and all longitudes had a negative value.
- "Out of the region" observations: All longitudes and all latitudes were within a specified range within the 19-county region.

When address information provided by respondents could not be geocoded to an exact street address with a 25 feet offset, a rigorous hierarchical geocoding methodology was used by Abt SRBI including the steps below:

- Origins and destinations were geocoded to the most specific address-based location possible using:
  - ArcView 9.3 and TeleAtlas (GDT) Multinet files
  - Transit network and station GIS databases as appropriate
- Where an address could not be provided by the respondent, the Internet was used to look up the address based on available information such as name of place, type of business, nearest intersection, landmark, city, or zip code. The data file provided both the location information variables provided by the respondent and the corrected street address provided by Abt SRBI.
- For those places where an address could not be obtained from available information, the location was looked up and geocoded to the nearest street intersection.
- Each non-geocodable record was reviewed to extract spatial information contained in the open-ended responses.
- Utilizing available correspondence tables, zonal information was assigned to the records geocoded using the methods above.

The following geocoding targets were used in developing the Travel Behavior Inventory dataset:

- 99 percent or more of home addresses were geocoded to longitude and latitude.
- 95 percent or more of all school and work locations were geocoded to longitude and latitude.
- 90 percent or more of other stops/locations were geocoded to longitude and latitude.
- Locations that could not be geocoded to physical street address or intersection were geocoded to the appropriate traffic analysis zone (TAZ). Points geocoded to TAZs were identified in the data set.
- Geocoding to block group midpoints or other Census polygons was not allowed.
- Offsets were set at 25 feet.
- For locations that were not automatically geocoded, Abt SRBI used on-line and map checks to manually geocode those locations.
- After the manual geocoding options were exhausted, the location was deemed ungeocodable.

A household was considered incomplete in cases where 25 percent or more of its locations were nongeocodable either directly or after Abt SRBI's efforts to impute and manually geocode the travel information.

4.3.2 Household File Checks

The household file was audited by Cambridge Systematics to ensure the unique identification of each household and relevant location and household size information. The following criteria were used:

1. Each case had a household record type indicator;
2. All household IDs were unique;
3. The number of workers in the household did not exceed the number of people 16 or older in the household;
4. All home addresses and home zip codes were located in the 19-county study area; and
5. All household fields had information.

4.3.3 Structural Checks

The household, person, and trip files were compared to one another to ensure the internal consistency between these three data sources. The criteria that were used in comparisons by Cambridge Systematics included the following:

1. Each person's household was included in the Household file;
2. All households in the household file were represented in the Person file;
3. The number of persons in each household as reflected in the Person file was equal to the number of household members older than five years as reflected in the Household file;
4. The number of households in the Trip file was equal to the total number of households in the Household file;
5. All households in the Household file were represented in the Trip file;
6. The number of trips by household in the Trip file was equal to the household trips (*hhtrips* field) in the Household file;
7. The number of trips per person reported in the Person file was equal to the number of trip records for that person in the travel day Trip file;
8. All persons in the person file were represented in the Trip file; and
9. The number of persons by household in the Trip file was equal to the household size for persons older than five years in the Household file.

4.3.4 Person File Checks

The person file was checked for complete information collected in the recruit survey and also included checks against household related information. Most of the criteria used by Cambridge Systematics focused on the individual's socioeconomics and their work and school locations:

1. Each case had a person record type indicator.
2. Person numbers in the Person file were consistent with the number of people in the household from the Household file.
3. The contact person (code 0) was coded as person number 1.
4. The number of spouses was equal to or less than one.
5. Age values for spouses, children, and parents were internally consistent.
6. Only respondents who said "other" for relationship should have an answer for "other relationship" to the contact person.
7. All cases had a value for licensed driver and all values were age appropriate.
8. Age of students were appropriate.
9. School attendance and educational attainment were consistent.

10. If respondent was a student, school type was reported.
11. No valid school type responses were accepted from non-students.
12. If respondent was a student, school name was coded.
13. State codes and zip codes for school address were consistent with the area, unless the student is above the K-12 level.
14. All cases had a value for work status and all values were age appropriate.
15. Worker questions were asked of respondents who reported to be workers.
16. Respondents who had a fixed workplace provided answers to work address fields.
17. Zip codes for work addresses were consistent with the region.
18. Only respondents who indicated "other" industry have an answer for other industry.
19. Only respondents who had a fixed workplace provided a work address.
20. State codes and zip codes for work address were consistent with the area.
21. No information was missing for the following variables: RECRUITMODE, RETRIEVEMODE, Diary, Gender, Age, Age2, Relation, License, Student, Education, Disable, School type.

4.3.5 Trip File Checks

The trip file was audited in even greater detail by Cambridge Systematics given its importance to the Travel Behavior Inventory project. In addition to the proper identification of trip records within a household, checks focused on proper recording of origins and destinations, travel times, departure and arrival times, modes used, party size and composition, and the consistency between origins and destinations of each consecutive trip:

1. Each case had a trip record indicator.
2. Persons who did not take any trips had origin information only – where they started and ended during the travel period.
3. No trip records were duplicated.
4. For trip number equal to 1, the time of departure and type of transportation used should be answered, unless the respondent began his/her travel period traveling.
5. For trip numbers greater than 1, time of departure and type of transportation used should be answered.
6. For the final trip record for each person, the value of *DNTLV* (a variable to denote whether there is a next trip in the diary) must be 1.
7. All trips had a valid origin and destination name.

8. Trips should start from home, a place that offers accommodation, or work.
9. Trips should end at home, a place that offers accommodation, or work.
10. There was a linkage between the diary entries for origins and destinations.
11. Consecutive trip records with the same location as origins or destinations were flagged.
12. Trip records where origin and destination locations were the same and the purpose at the destination was not a "turn around" were flagged.
13. Only respondents who indicated "other" for type of origin, destination, and type of transportation had an answer in the "other" category.
14. If a trip involved a car, van, truck, or motorcycle then the driver/passenger variable should not be missing. Children under 14 years of age were not asked the question and should be post coded as passengers.
15. If a trip involved a car, van, truck, or motorcycle, the number of additional people in the vehicle was asked.
16. If the respondent took a trip with other people in a car, van, truck, or motorcycle, the number of household members in the vehicle was asked unless the respondent lives alone. If the respondent was in a one-member household, the variable was post-coded as "none."
17. In cases where a trip involved a car, van, truck, or motorcycle the respondent was asked if a household vehicle was used for the trip.
18. The number of persons traveling with the respondent was valid.
19. The number of household members traveling with the respondent must be different than zero.
20. All accompanying household members were included.
21. The number of accompanying household members did not exceed the household size.
22. The number of accompanying household members did not exceed the total number of travelers in the vehicle.
23. Each person accompanying a household member was recorded once.
24. All travel observations recorded arrival time and destination information.
25. Departure and arrival times were provided in military time.
26. Arrival time at each activity/destination was later than the departure time for that activity/destination.
27. Departure time was greater than the preceding trip's arrival time within each person's trip diary.
28. Unusual activity durations were examined and flagged.

29. Total time spent for travel and activities was equal to 24 hours
30. Location types and activities were checked to be consistent.
31. The sequencing of travel modes was checked.
32. The reasonableness of walk, nonmotorized, transit, and auto modes was checked using travel time, distance and speed checks.
33. In the case of transit trips, method and amount of payment was checked.

4.3.6 Logical Checks

The logical checks by Cambridge Systematics included both internal consistency checks within each household and comparisons to ensure that the travel times, distances, and speeds for each trip were reasonable:

1. The number of household members in a vehicle was less than the number of people in the vehicle.
2. Zero vehicle households did not report a trip with a household vehicle.
3. Number of workers who did not make a work trip.
4. Number of non-workers who made a work trip.
5. Number of school trips made by non-students.
6. Number of auto trips made by unlicensed drivers.
7. Number of work trips made by zero-worker households.
8. Substantial differences between reported and estimated travel times.
9. Unusually long intracity trips.
10. Very slow trips.
11. Trips with very high implied speed.
12. Short and slow trips.

4.3.7 Quality Assurance / Quality Control Summary

The set of QA/QC checks ensured that critical information was coded and compiled adequately and the datasets were free of critical errors. In addition to these checks, CS developed an independent sample adherence summary for each interim dataset and identified the number of households with critical QA/QC violations.

The results were summarized in a spreadsheet showing the total counts of violations for each check. The households, persons, or trips were flagged and stored for further analysis or revision. The spreadsheet also include a fact sheet detailing key characteristics of the sample in terms of:

- Number of households,
- Nontraveling households,
- Number of zero-vehicle households,
- Number of persons,
- Number of transit users,
- Non-traveling persons,
- Number of persons 16 or older,
- Number of workers,
- Number of students,
- Number of trips,
- Number of trips by purpose, and
- Number of trips by transit.

4.4 PREPARING SURVEY DATA FOR TOUR CREATION

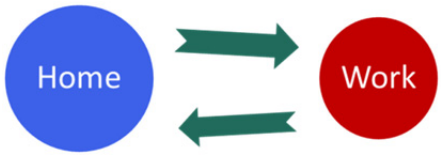
One of the key steps after the quality controls tests was to collapse the trips to identify tours and to check for tours that "do not close." A four-step process was employed to identify and develop tour hierarchies.

Step 1. Identifying Tours

A tour consists of a closed loop of trips starting from a primary origin (home) with intermediate stops and ending at the same primary origin (home). =

- The simplest tour has a base as home with a single stop that also serves as the main stop/primary destination of the tour. In this simple case, the tour consists of two trips between the primary origin and the primary destination as shown in **Figure 4.1**.
- Prior to identifying tours, several checks need to be made including:
  - Making sure that the trips are lined sequentially;
  - Ensuring that the destination of trip "n-1" is the same as the origin of trip "n"; and
  - Confirming that the origin and destination purposes are clearly defined and line up well within the activity-based structure outlined in the model design plan.

Figure 4.1 Simple Home-Based Tour

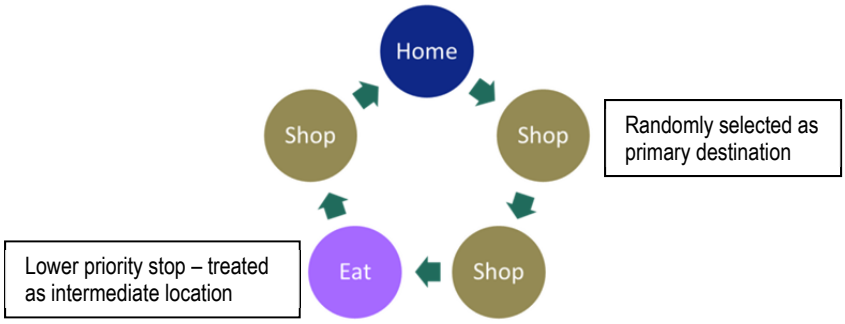


Step 2. Establishing Tour Hierarchy

An individual's daily travel can involve more than one tour. Furthermore, each tour can have more than one destination, known as stops.

- If there are different types of destinations, then the primary destination is determined by the hierarchy outlined in the model design plan. The agreed upon hierarchy considered **work** as the highest priority followed by **shopping, recreational,** and **personal purposes**. Joint tours, that involve travel with other members of the household, were also given high priority.
- In other cases, there may be multiple stops for the same purpose on a single tour. For instance, it is not uncommon to have several shopping stops on a single tour. Similarly, people may work at multiple locations in a single day. In such cases, one of the stops was randomly chosen as the main stop.
- **Figure 4.2** shows a travel diary with a home based shopping tour with multiple stops.

Figure 4.2 Shop Tour with Multiple Stops



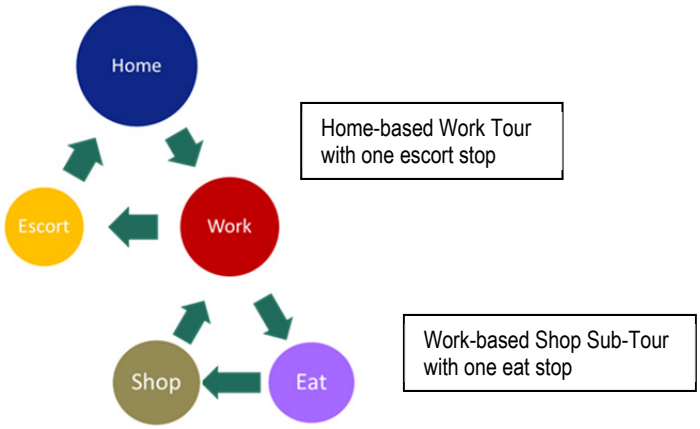
Step 3. Identifying Subtours

Subtours were allowed from the primary workplace, as shown in **Figure 4.3**. In this case, the individual participated in two tours:

- The first tour is a closed loop between home and work with an intermediate escorting stop.

- While at work, the worker went on a closed loop shopping tour with an eating stop that ended at work. This second tour was treated as a work-based subtour and the stops in the work-based subtour were not considered to be part of the main tour.

Figure 4.3 Primary Tour and Subtours

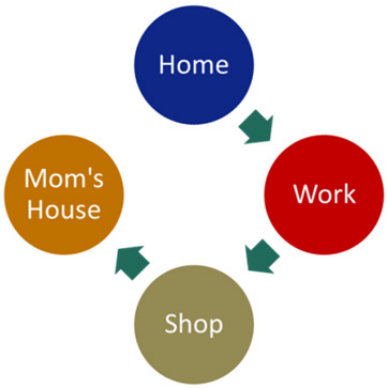


Step 3. Closing Incomplete Tours

It was observed that some tours do not close either because of misreported trips or because respondents do not return home by the end of the day. The QA/QC checks flagged and rejected many of these diaries as unusable. However, certain travel and activity patterns were deemed valid and were not marked as a violation of data quality assumptions.

- One possible configuration is shown in **Figure 4.4**, where the respondent started from home, traveled to work, then went shopping and traveled to his mother's house and did not make any trips afterwards before the travel day ended at 3 AM the following day. While the travel diary is free of any errors, the tour was never closed. For such cases, travel patterns of other household members (if any) were analyzed to impute the time and location for the end of the tour.

Figure 4.4 Incomplete Tours



- In other cases, intermediate trips were missing. In such cases, it was not possible to develop a sequence of continuous trips that make up a tour (origin for trip "n" was not the same as the destination for trip "n-1"). Again, if possible, this information was imputed using the travel patterns of other household members that the individual may have traveled with. If such imputation was not possible, then the respondent diaries were dropped from further analysis.
- Open tours were found to occur both on regular tours as well as subtours. Therefore, the checking procedures were applied to both types of tours.

4.4.1 Overview of Tours

The expansion of the survey discussed later in Section 5 was based on a total of 1.36 million households and 3.15 million persons in the region (Table 5.3 and Table 5.7).

The tour creation process created almost 4.19 million tours that correspond to over 11.7 million weighted survey trips (**Table 4.8**). This corresponds to an average of 2.80 trips for every tour that was created.

When contrasting the trip and tour making patterns by households and persons on a typical day, an average of 3.07 tours are made by each household and an average of 1.33 tours by each person in the region.

Table 4.8 shows the tour activity profile in more detail by breaking down the tours by the type of the activity and stop making.

- Work tours account for 41 percent of all tours followed by social/ recreational tours and school tours, with 17 percent and 11 percent respectively.
- When examining the overall stop patterns, more than half of all tours are simple tours that serve the main destination and without any additional stops to engage in other activities. The more common type of tour is a work tour with no additional stops.
- Tours that show a greater degree of complexity and are more likely to have stops where travelers engage in other activities include tours on personal business, shopping, and work.

Table 4.9 provides additional detail in the distribution of stops by tour type.

- The top three tour types in terms of stop making also have the highest incidence of tours with more stops and more complex trip making. Tours with two or more stops account for 33 percent of personal business, 29 percent of shopping and 26 percent of work tours.
- The simplest types of tours with a very high percentage of zero stops include the escorting, social/recreational and University/school tours.
- Although work tours represent a high share of total travel compared to the home based work trip share in traditional trip-based models, roughly half of work tours have a stop and a quarter have two or more stops.

Finally, **Table 4.10** provides a profile of mode use for the overall tour sample. Driving either alone or by carpooling is the dominant mode with 84 percent of all tours. We should note the important role of ride sharing that is further highlighted in the analysis and modeling of tour mode choice.

Transit accounts for four percent while nonmotorized travel accounts for six percent with a four percent walk and a two percent bike share. School bus is treated as a separate mode that is used for six percent and is concentrated in serving the school tours that account for 11 percent of all tours.

Table 4.8 Tours by Activity and Type

Activity	Tours by Number of Stops			Total	Share of Activity	Tours with Stops
	0	1	2+			
Work	877,962	376,424	448,569	**1,702,956**	**41%**	**48%**
School	323,939	64,971	66,390	**455,299**	**11%**	**29%**
University	35,772	7,018	11,244	**54,033**	**1%**	**34%**
Personal Business	132,008	90,245	107,428	**329,681**	**8%**	**60%**
Shop	189,191	118,366	130,070	**437,627**	**10%**	**57%**
Meal	145,558	55,745	37,392	**238,695**	**6%**	**39%**
Social/Recreational	551,667	102,388	50,420	**704,475**	**17%**	**22%**
Escort	212,660	34,925	17,064	**264,649**	**6%**	**20%**
Total	**2,468,758**	**850,081**	**868,576**	**4,187,415**	**100%**	**41%**
Percent of Stops	**59%**	**20%**	**21%**	**100%**		

Source: Cambridge Systematics, 2014.

Table 4.9 Distribution of Tours by Number of Stops

Activity	Tours by Number of Stops		
	0	1	2+
Work	52%	22%	26%
School	71%	14%	15%
University	66%	13%	21%
Personal Business	40%	27%	33%
Shop	43%	27%	30%
Meal	61%	23%	16%
Social/Recreational	78%	15%	7%
Escort	80%	13%	6%

Source: Cambridge Systematics, 2014.

Table 4.10 Tours by Mode

Mode	Total Tours	Mode Share
Drive alone	1,805,750	43%
Shared ride 2	607,716	14%
Shared ride 3	1,138,462	27%
Walk to transit	136,346	3%
Drive to transit	23,557	1%
School bus	234,381	6%
Bike	66,754	2%
Walk	174,449	4%
Total	**4,187,415**	**100%**

Source: Cambridge Systematics, 2014.

5.0 Survey Weighting

The survey team worked to meet or come close to the target sample size across all individual target cells. However, some cells were underrepresented to some extent due to the low incidence of the segment in the general population, low response rates among targeted respondents in the segment, and random variation. As a result, there is a need for a detailed expansion process that can address the underrepresentation and over-representation of certain geographic and household characteristics.

One of the key objectives of survey expansion is to ensure that the expanded household travel survey database is truly representative of travel by the region's households. Therefore, variables included in expansion include determinants of travel behavior from a household context such as household size, vehicle ownership, number of household workers, household residential location (to capture travel by geographic subsegments), household lifecycle; and personal characteristics such as age and employment status.

This last section outlines all the key aspects of survey expansion. We start the discussion in Section 5.1 by contrasting the sampling plan with the final distribution of cell values in our sample

We then discuss the geographic, household level and person level variables that were used in sample weighting and expansion in Section 5.2.

We briefly outline the national level datasets that were used as control totals in our survey expansion in Section 5.3.

We conclude the section and the report by discussing the methodological approach employed to support expansion and weighting in Section 5.4.

5.1 Sampling Plan and Cell Target Adherence

In this section we focus on the comparison between the original sampling plan targets or each geographic/socioeconomic cell shown in **Table 2.2** and the completed observations in each cell shown in **Table 5.1**. The discussion draws comparisons between these two tables to demonstrate the degree of sampling cell adherence for fully completed households across different geographic and socioeconomic groups.

Table 5.2 combines the values in these two tables by presenting the degree of cell target adherence in the household survey sample. Values of around 100 percent suggest that the survey observations in these cells were very comparable to the original sampling targets. Values of 60 percent or lower suggest that the sample was under-represented in specific cells while values much higher than 100 percent suggest an over-representation of certain groups in the sample.

In Section 4 we discussed the distribution of the sample across geography and across socioeconomic groups. These comparisons suggested a geographically balanced sample that is to some extent influenced by the differential sampling rates that were used. The comparisons also suggested a balanced sample in terms of automobile ownership with a modest underrepresentation of zero-car households. Finally, we observed the overrepresentation of older households in our survey sample.

Tables 5.1 and **5.2** confirm these patterns but also examine in greater depth the three-dimensional comparisons across combinations of geography, household size, and automobile ownership. The following general observations can be made based on these comparisons:

- The survey sample targets were easily met or were exceeded for those geographic and socioeconomic groups that have a high incidence in each subregion.
  - Targets for households whose size is equal to cars available are met across geographies – for example, one person households with one car and two person households with two cars.
  - Targets for households with more members than cars are also met across certain geographies – for example, singles without a car in urban areas or couples with one car in most regions,
- Survey returns for larger households with three or four+ members generally lagged behind their sample targets regardless of geography or car ownership. This pattern reflects to some extent the lower response rates by these households coupled with the strict completion criteria.
- Categories of households where the survey returns lagged considerably behind the sample targets include "hard to reach" cases with a lower incidence of the segment in the region's population. For example,
  - Single respondents without a car in suburban or rural locations lagged significantly behind their sample targets.
  - Couples without a car available failed to meet their targets regardless of geography.
  - Larger households with three or more people and with one or no cars available had a very low incidence regardless of geography and their presence in the sample lagged the original targets.

Table 5.1 Completed Household Surveys by Sample Cell

Retrieved Sample Cell Counts		Minneapolis	St. Paul	Hennepin Carver	Ramsey Washington Anoka	Scott Dakota	Ring Counties, MN	Ring Counties, WI
One-Person Household	Zero-Vehicles	189	97	61	43	33		
	One-Vehicles	565	335	798	586	310	197	
	Two-Vehicles	115		136	114	63	75	
	Three-Vehicles							
	Four+ Vehicles							
Two-Person Household	Zero-Vehicles	33		15				
	One-Vehicles	197	108	178	176	83	75	
	Two-Vehicles	318	225	920	762	417	196	123
	Three-Vehicles	73	37	252	278	159	179	
	Four+ Vehicles							
Three-Person Household	Zero-Vehicles	6		3				
	One-Vehicles	51		26	16	24		
	Two-Vehicles	151		165	141	81	56	
	Three-Vehicles	59		113	138	65	90	
	Four+ Vehicles			116				
Four+ Person Household	Zero-Vehicles	2		1				
	One-Vehicles	41		40				
	Two-Vehicles	134	91	363	346	226	122	
	Three-Vehicles	66		158	154	97	94	
	Four+ Vehicles	11	7	78	97	71	82	

Source: Cambridge Systematics and Abt SRBI, 2013.

Table 5.2 Adherence to Sample Cell Targets

Percent Retrieved Sample Cell Targets		Minneapolis	St. Paul	Hennepin Carver	Ramsey Washington Anoka	Scott Dakota	Ring Counties, MN	Ring Counties, WI
One-Person Household	Zero-Vehicles	100%	97%	53%	48%	43%		
	One-Vehicles	137%	125%	111%	114%	97%	113%	
	Two-Vehicles	121%		123%	98%	88%	104%	
	Three-Vehicles							
	Four+ Vehicles							
Two-Person Household	Zero-Vehicles	43%		20%				
	One-Vehicles	134%	114%	89%	93%	88%	101%	
	Two-Vehicles	134%	134%	128%	121%	104%	107%	166%
	Three-Vehicles			145%	146%	151%	154%	
	Four+ Vehicles							
Three-Person Household	Zero-Vehicles							
	One-Vehicles	54%		31%	22%	33%		
	Two-Vehicles	120%		73%	72%	55%	76%	
	Three-Vehicles	82%		74%	101%	62%	107%	
	Four+ Vehicles			122%				
Four+ Person Household	Zero-Vehicles	3%		1%				
	One-Vehicles	39%		25%				
	Two-Vehicles	128%	91%	88%	97%	81%	83%	
	Three-Vehicles	89%		81%	89%	80%	99%	
	Four+ Vehicles			67%	66%	96%	114%	

Source: Cambridge Systematics and Abt SRBI, 2013.

5.2 SURVEY VARIABLES FOR EXPANSION

The first step during survey expansion is to identify key socio-demographic variables that determine travel behavior characteristics and use these variables during expansion. In addition to expansion by ***geography***, the study team identified both ***household-level*** and ***person-level*** variables to ensure that the expanded survey database matched both household and person-level distributions.

Unlike traditional four-step models that relied on survey expansion based on household level weights, the development of detailed activity-based models would benefit from an expansion procedure that takes into account both household and personal attributes. The use of person-level weights that vary within a household allows for a weighted survey sample that is more balanced along employment status and age attributes of the population. This Section identifies all the variables selected for expansion.

Geography

The 19-county study area was divided into seven regions of interest: Minneapolis, St. Paul, Hennepin-Carver, Ramsey-Washington-Anoka, Dakota-Scott, Wisconsin collar counties and Minnesota collar counties. Geographic areas in the Core counties were sampled at 1 percent while the Ring counties were sampled at a rate of 0.5 percent to provide sufficient detail for the models. Owing to differences in sampling rates, it was deemed critical to use the residential choice geography as a variable in expansion. Section 5.4 provides a summary of the survey expansion results at the geographical level.

Household-level Variables

In addition to geographic-level expansion, four distinct household attributes were identified as key determinants of travel behavior and were included in the expansion procedures. In Section 5.4 we provide summaries of each of the household expansion variables. We contrast the unweighted survey results with the weighted survey estimates and the control totals from the American Community Survey. The household level variables that were used in the sample expansion include the following:

- **Household lifecycle**. Lifecycle stages have an impact on travel patterns and activity durations. Four distinct household lifecycle variables were identified in the household survey. These include:
  - Households with children which have more chauffeur-driven trips and whose activity patterns are impacted by the demands to provide mobility to the children;

  - Adult-only student households that have fixed constraints for both work and education activities, thereby limiting the time available for non-mandatory travel;
  - Adult-only non-student working households that only have work constraints and therefore have greater amount of time available for discretionary travel; and
  - Adult-only non-student non-working households which have the least constraints on available travel time and budget and perform discretionary travel and activities exclusively.

- **Household size**. The number of members in a household impacts several elements of travel including – a) total number of trips, b) number of joint trips, and c) vehicle allotment. Four distinct household size classes were developed from the household survey – one person, two persons, three persons, and four or more persons. The larger households were collapsed into one category to ensure that enough records existed in the segment to support expansion.
- **Number of workers**. The number of workers in a household has an impact on commute patterns, activity duration, and amount of time budget available for discretionary travel. Therefore, it is critical to expand the household survey to reflect the overall travel patterns of workers. Three distinct categories were created for the expansion – zero workers, one worker, and two or more workers in a household.
- **Number of vehicles**. Vehicle ownership impacts household mobility (and mode choice) as well as the range of destinations available to the household. Three categories – zero, one, and two or more autos were created from the household survey and used during expansion.

Person-level Variables

Two person-level attributes were identified as key determinants of travel behavior and were included in the expansion procedures – age and employment status. Both of these personal attributes have an impact on personal mobility, available travel budgets, and travel behavior at an individual level while also affecting travel interactions and decisions within the household. In addition to using the traditional household-level variables for survey expansion the study team decided to utilize these two person-level variables during expansion.

Employment was treated as a binary variable for expansion using the worker and nonworker categories.

Age was broken down into six categories as follows:

- Children aged 6 to 15;
- Children aged 16 to 17 (of driving age);
- Adults aged 18 to 24 (young adults);

- Adults aged 25 to 44;
- Adults aged 45 to 64; and
- Adults over 65 (less mobile individuals).

5.3 NATIONAL DATABASES FOR EXPANSION

The next step in the implementation of the expansion procedure was to identify a national database that could provide good representation of the household characteristics in the study region. For this expansion, the 2006-2010 American Community Survey Public Use Microdata Sample (5-year ACS PUMS data) was selected as the primary data source for expansion since it provided a comprehensive database with all the relevant variables and is a widely used source for demographic information.

Key features of this database include:

- It includes one percent sample of households for each of the five years;
- It consists of microdata with sampling weights that enables custom tabulation of household characteristics; and
- Only nonvacant housing unit records were retained for survey expansion (no group quarters records).

Public Use Microdata Sample (PUMS) Data Analysis

The PUMS data are available at the Public Use Microdata Areas (PUMA) geographies. To support expansion, study area PUMAs were identified, and PUMS population and household data records were downloaded for these PUMAs.

- Some PUMA geographies extended beyond the study region. For these geographies, PUMS household weights were adjusted based on the percentage of the PUMA that fell within the study region. This allowed the weighted PUMS records to properly reflect the study area population.
- PUMS household variables were summarized using consistent definitions with the household survey for each of the key dimensions – household lifecycle, geographic region, household size, number of workers and number of autos. Person-level attributes such as age and employment status were also retained.

5.4 SURVEY EXPANSION METHODOLOGY

Iterative proportional fitting (IPF) techniques are used to match survey responses against the general population especially in cases where multiple dimensions must be monitored during expansion. Given the number of household-level and person-level variables selected to support expansion for the TBI household

survey, a multi-stage IPF framework was deemed to be the most appropriate methodology for expansion.

Preparation of the Household Survey for Expansion

A two-step process was undertaken to prepare the household survey for survey expansion.

- First, checks were performed across multiple variables such as household size, number of workers and number of adults to ensure consistency in the household survey database (for e.g., number of household workers must always be less than or equal to the number of adults living in the household).
- Second, a final household survey dataset which could be used in the expansion process was developed after assessing every individual household record for completeness. Some of the checks performed include:
  - Geocoding households and summarizing their household location to one of the 7 geographic regions;
  - Retaining only those households that provide complete demographic information;
  - Developing lifecycle variables consistent with the four categories discussed in Section 5.1; and
  - Adjusting the status for all respondents 16 or younger to non-worker and student.

IPF Framework

During expansion, all the households that belong to a specific demographic segment in the household survey must be expanded to match the number of households with the same demographic segment in the ACS dataset. In an ideal scenario, household would be assigned to a demographic market by considering all the variables of interest and expanding to the appropriate control total. However, when multiple demographic segments are considered, this procedure becomes complex because of three reasons:

- First, there may be very few records in the household survey for a particular segment resulting in a large number of missing cells for the different categories in the segment; and/or
- Second, there may be very few households in the overall population that belong to a certain demographic subsegment. In such cases, developing expansion weights for a small segment may not be statistically valid; and/or

Therefore, a step-wise IPF procedure that matches the distribution of two variables at every step was chosen as the preferred approach to develop the expansion factors.

Collapsing Categories for IPF

As an additional check, the study team analyzed both the survey dataset as well as the ACS data to identify demographic segments where there are one or more records in the survey data with a particular control variable category, but no records in the corresponding ACS estimates (PUMS data also represent a sample; it is possible that households with certain characteristics are present in the population but not in the PUMS data).

Three control variable categories were unrepresented in the ACS data set. These include:

- Three or 4+ person adult-only non-working non-student households with one auto;
- Three or 4+ person adult-only non-working non-student households with two or more autos; and
- Four+ person adult-only student households with workers and without an auto.

In order to support an effective IPF framework, the three cross-classification categories unrepresented (missing) in the ACS, were combined with other similar demographic categories in the household survey. Using this approach, a one-to-one correspondence was achieved between the household survey and ACS demographic segments.

Design of Multi-Step IPF

As discussed above, household size, number of workers, vehicle ownership, lifecycle, residential location, age, and employment status were used as the dimensions for the IPF process. The expansion was carried out in two distinct stages: household-level IPF and person-level IPF.

Household-level IPF

A four-step IPF process was designed to expand the survey data to match the ACS distribution. The variables used in each step are as follows:

- IPF 1: Geography and lifecycle;
- IPF 2: IPF1 results and household size;
- IPF 3: IPF2 results and auto ownership; and
- IPF4: IPF3 results and number of workers.

At every step, ACS data were used to establish row and column marginal totals for control variable categories. The household survey data were then tabulated by the control variable categories to provide an initial estimate of the joint distribution. The joint distribution cells were factored to match row marginal totals first and then the resulting matrix was adjusted to match column marginal

totals. Row and column factoring continued until the joint distribution of row and column sums matched the marginal estimates.

IPF 1 – Geography and lifecycle. In the first round of the household-level IPF, the distribution of households by geography from the PUMS data were used as row totals and the distribution by lifecycle from the PUMS data were used as column totals. Multiple iterations were performed until both row and control totals match perfectly.

IPF 2 – IPF 1 results and household size. In the second step of the household-level IPF, the distribution of households by number of members (household size) from the PUMS data was used as column totals. The row totals utilized the distribution of households by geographic region and lifecycle from the first stage of the IPF.

IPF 3 – IPF 2 results and auto ownership. In the third step of the household-level IPF, the distribution of households by number of vehicles from PUMS were used as the column totals, while the row control totals included the combination of geographic region, lifecycle and household size from the previous step in the IPF. Because of small sample sizes either in the survey, the ACS, or both datasets, a few cells were combined into broader categories during expansion.

IPF 4 – IPF 3 results and workers. In the final step of the household-level IPF, the distribution of households by number of workers from PUMS were used as the column totals, while the row control totals were a combination of geographic region, lifecycle, household size and auto ownership from the third step of the household-level IPF. Again, a few cells were combined due to small sample sizes.

Person-Level IPF

The final dataset developed at the end of the household-level IPF served as the input for the person-level IPF. The person-level IPF was carried out using the following steps.

- Household-level adjustment weights developed at the end of the household-level IPF were assigned to each member of the household.
- The PUMS data were summarized for age and worker status. Similar summaries were developed for the weighted person-level responses from the survey as well.
- A standard IPF was applied to adjust row and column totals sequentially until both age and worker status distributions in the survey match the ACS distributions.
- The adjusted weights from the person-level IPF were averaged to develop a household-level weight and assigned back to the household file.
- The adjusted household weights were compared against the totals developed after the household-level IPF (which serves as the control total for this round of household-level adjustments) and adjustment factors were developed so

that the totals within each market segment (unique combination of household size, number of workers, number of vehicles, residential geography, and lifecycle) matched the results from the household-level IPF.

- These adjusted weights were then imported back to the person-level file and a second round of IPF were conducted at the person-level. This process was continued until the adjustment factors at both the household level and person-level remained unchanged between consecutive rounds of the IPF.

5.5 SURVEY EXPANSION RESULTS

The outcome of the geographic, household-level, and person-level survey expansion is presented in this section. We present the unweighted survey results for each variable of interest along with the weighted survey estimates. We contrast the weighted survey against the American Community Survey data across all geographic, household, and person level variables.

Table 5.3 shows the comparison across the seven ***geographic*** areas. In every case the difference between the weighted survey share and the ACS percentage is less than half a percentage point. The largest difference is observed when comparing the total weighted records from the survey and from ACS in the smallest geographic category that includes the Wisconsin collar counties.

Table 5.4 highlights the patterns of households with a different ***lifecycle***. The differences between the weighted survey share and the ACS percentage are low although a little higher than the geographic comparisons. The largest difference is observed when comparing the total weighted records from the survey and from ACS in households with adult students that are slightly under-represented and households with children that are slightly overrepresented.

Table 5.5 examines the expansion along households with different ***household sizes***. The differences between the weighted survey share and the ACS percentage are lower than one percent in all cases. The largest difference is observed when comparing the total weighted records from the survey and from ACS in larger households. Households with four or more members are slightly overrepresented while households with three members are underrepresented to the same extent.

Table 5.6 compares the distribution of ***vehicle ownership*** in the weighted sample and ACS. The differences between the weighted survey share and the ACS percentage are lower than 0.6 percent in all cases. Households with one vehicle are slightly overrepresented in the weighted survey sample.

Finally, **Table 5.7** contrasts the results for the ***number of workers***. The differences between the weighted survey share and the ACS percentage are lower than one percent in all cases. The largest difference is observed when comparing the total weighted records from the survey and from ACS in zero-worker and one-worker households.

Three additional tables show the distribution of person-level attributes in the weighted sample versus the American Community Survey data.

Table 5.8 shows the comparison between individuals in different ***age groups*** across each of the seven ***geographic*** areas. The total estimates for each age group match very closely with ACS with differences being less than 1.3 percent. The distributions by geography in both the weighted survey and the ACS dataset are also similar highlighting the correspondence between the two data sources.

Table 5.9 shows the comparison between ***workers and nonworkers*** across each of the seven ***geographic*** areas. The totals number of workers and nonworkers match very closely with differences less than 0.3 percent. Workers are slightly overrepresented in the urban areas of Minneapolis and St. Paul compared to the Wisconsin collar counties where workers are underrepresented.

Finally, **Table 5.10** shows the comparison between ***male and female*** respondents across ***geography***. Although gender was not a variable used in the survey expansion, the total estimates for men and women in the weighted sample match very closely with ACS with percentage differences less than 0.2 percent. The distributions of gender by geography are also similar highlighting the correspondence between the two data sources.

Table 5.3 Weighted Household Survey Compared to the ACS Data by Geography

Region	Unweighted HH Survey Records	Unweighted HH Survey Percentage	Weighted HH Survey Records	Weighted HH Survey Percentage	Weighted ACS Records	Weighted ACS Percentage
Minneapolis	1,525	14.7%	166,372	12.2%	167,141	12.4%
St. Paul	971	9.4%	106,863	7.8%	111,534	8.3%
Hennepin-Carver	2,857	27.6%	342,432	25.1%	345,102	25.7%
Ramsey-Washington-Anoka	2,517	24.3%	304,914	22.4%	298,188	22.2%
Dakota-Scott	1,368	13.2%	197,168	14.5%	188,750	14.0%
MN Collar	708	6.8%	180,603	13.2%	175,955	13.1%
WI Collar	416	4.0%	64,805	4.8%	58,434	4.3%
Total	**10,362**	**100.0%**	**1,363,157**	**100.0%**	**1,345,104**	**100.0%**

Source: Cambridge Systematics, 2014.

Table 5.4 Weighted Household Survey Compared to the ACS Data by Lifecycle of Household

Household Type	Unweighted HH Survey Records	Unweighted HH Survey Percentage	Weighted HH Survey Records	Weighted HH Survey Percentage	Weighted ACS Records	Weighted ACS Percentage
Adult Non-Student Non-Working HH	3,213	31.0%	145,945	10.7%	146,518	10.9%
Adult Non-Student Working HH	4,142	40.0%	609,640	44.7%	618,114	46.0%
Adult Student HH	627	6.1%	110,625	8.1%	120,213	8.9%
HH with Children	2,380	23.0%	496,947	36.5%	460,257	34.2%
Total	**10,362**	**100.0%**	**1,363,157**	**100.0%**	**1,345,103**	**100.0%**

Source: Cambridge Systematics, 2014.

Table 5.5 Weighted Household Survey Compared to the ACS Data by Size of Household

Household Type	Unweighted HH Survey Records	Unweighted HH Survey Percentage	Weighted HH Survey Records	Weighted HH Survey Percentage	Weighted ACS Records	Weighted ACS Percentage
One Member	3,462	33.4%	380,422	27.9%	375,364	27.9%
Two Member	4,091	39.5%	453,197	33.2%	449,561	33.4%
Three Member	1,054	10.2%	191,517	14.0%	200,304	14.9%
Four or More Member	1,755	16.9%	338,022	24.8%	319,875	23.8%
Total	**10,362**	**100.0%**	**1,363,157**	**100.0%**	**1,345,104**	**100.0%**

Source: Cambridge Systematics, 2014.

Table 5.6 Weighted Household Survey Compared to the ACS Data by Auto Ownership of Household

Household Type	Unweighted HH Survey Records	Unweighted HH Survey Percentage	Weighted HH Survey Records	Weighted HH Survey Percentage	Weighted ACS Records	Weighted ACS Percentage
Zero Vehicle	444	4.3%	98,032	7.2%	97,537	7.3%
One Vehicle	3,475	33.5%	431,180	31.6%	417,838	31.1%
Two or More Vehicle	6,443	62.2%	833,945	61.2%	829,729	61.7%
Total	**10,362**	**100.0%**	**1,363,157**	**100.0%**	**1,345,103**	**100.0%**

Source: Cambridge Systematics, 2014.

Table 5.7 Weighted Household Survey Compared to the ACS Data by Number of Workers of Household

Household Type	Unweighted HH Survey Records	Unweighted HH Survey Percentage	Weighted HH Survey Records	Weighted HH Survey Percentage	Weighted ACS Records	Weighted ACS Percentage
No Worker	3,481	33.6%	159,794	11.7%	154,143	11.5%
One Worker	3,634	35.1%	459,825	33.7%	444,387	33.0%
Two or More Worker	3,247	31.3%	743,538	54.5%	746,573	55.5%
Total	**10,362**	**100.0%**	**1,363,157**	**100.0%**	**1,345,103**	**100.0%**

Source: Cambridge Systematics, 2014.

Table 5.8 Weighted Household Survey by Age of Person

Region	2	3	4	5	6	7	Grand Total
Minneapolis	35,324	7,576	51,333	121,871	78,478	28,451	323,033
St. Paul	33,211	8,193	34,894	76,769	57,903	22,801	233,770
Hennepin-Carver	126,313	24,557	64,703	236,977	234,363	103,997	790,911
Ramsey-Washington-Anoka	112,748	25,202	67,031	214,614	221,734	88,439	729,769
Dakota-Scott	78,546	15,968	38,628	158,871	139,662	46,414	478,089
MN Collar	70,028	15,586	42,024	128,826	123,899	55,447	435,811
WI Collar	21,760	4,766	16,230	40,683	44,517	23,690	151,645
Grand Total	**477,930**	**101,849**	**314,843**	**978,613**	**900,557**	**369,237**	**3,143,028**

Source: Cambridge Systematics, 2014.

Table 5.9 Weighted Household Survey Compared to the ACS Data by Worker Status of Person

	Weighted Household Survey			ACS		
Region	**Non-Worker**	**Worker**	**Grand Total**	**Non-Worker**	**Worker**	**Grand Total**
Minneapolis	80,345	242,696	323,040	86,713	262,062	348,775
St. Paul	74,384	159,432	233,815	80,693	175,281	255,974
Hennepin-Carver	244,212	549,884	794,096	234,487	531,824	766,310
Ramsey-Washington-Anoka	222,913	508,321	731,235	219,374	500,662	720,036
Dakota-Scott	134,124	344,701	478,825	136,408	349,161	485,570
MN Collar	131,659	304,927	436,585	132,189	302,746	434,935
WI Collar	47,435	104,356	151,791	42,684	94,191	136,876
Grand Total	**935,071**	**2,214,317**	**3,149,388**	**932,549**	**2,215,927**	**3,148,476**

Source: Cambridge Systematics, 2014.

Table 5.10 Weighted Household Survey Compared to the ACS Data by Gender of Person

	Weighted Household Survey			ACS		
Region	**Male**	**Female**	**Grand Total**	**Male**	**Female**	**Grand Total**
Minneapolis	161,279	161,582	322,861	174,228	174,547	348,775
St. Paul	111,537	122,278	233,815	122,594	133,380	255,974
Hennepin-Carver	388,850	402,946	791,796	376,410	389,900	766,310
Ramsey-Washington-Anoka	360,275	370,790	731,065	355,100	364,936	720,036
Dakota-Scott	230,664	247,870	478,533	234,267	251,303	485,570
MN Collar	220,017	216,568	436,585	219,807	215,128	434,935
WI Collar	75,432	76,359	151,791	68,493	68,383	136,876
Grand Total	**1,548,054**	**1,598,393**	**3,146,447**	**1,550,899**	**1,597,577**	**3,148,476**

Source: Cambridge Systematics, 2014.

A. Summary of Resident Travel in the Twin Cities

Source: Metropolitan Council Analysis of the Household Survey, 2013.

TRAVEL BEHAVIOR

THE 2010 MSP REGION TRAVEL BEHAVIOR INVENTORY (TBI) REPORT
HOME INTERVIEW SURVEY

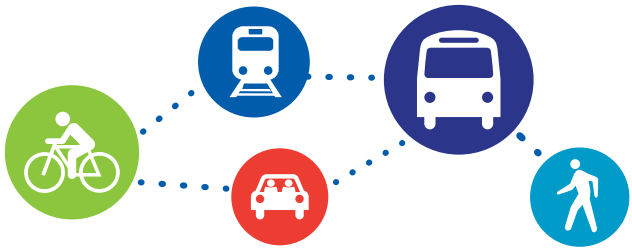
A Summary of Resident Travel in the Twin Cities Region

October 2013

METROPOLITAN COUNCIL

WHAT IS THE TBI?

The Travel Behavior Inventory (TBI) is a comprehensive survey conducted every 10 years by the Metropolitan Council (Council) to assess how and how much people in the Minneapolis-St. Paul (MSP) region and surrounding counties travel, including what mode of transportation they use, where they go, and when.



KEY FINDINGS FROM THE 2010 SURVEY

- Driving remains the dominant mode of transportation in the Twin Cities metropolitan area, but it is down slightly from 2000. The number of vehicle miles traveled and trips per person was also down.
- Transit mode share has increased in the last decade.
- Commuting to work accounts for a significant amount of all travel in the region, 18 percent, but it's not the primary reason for traveling. Forty percent of all trips in the region are for social and recreational purposes.

WHY IS THIS STUDY IMPORTANT?

Studying the way people travel in the region helps the Council plan transportation service and infrastructure for the future. The TBI, along with other data — such as the census and regional development trends — help to paint a picture about how travel trends have changed and evolved. It is a tool used by the Council to help plan and fund future transportation projects and develop the region's travel forecast models.

Thrive MSP 2040 will be the metropolitan development guide for the Twin Cities region, including land use and transportation, affordable housing, water resources, parks, and regionally significant economic places. The Transportation Policy Plan 2040 (TPP) will flow out of the Thrive MSP 2040 plan and be consistent with the broad goals set forth in it. The TPP will lay out goals and sets objectives and strategies to meet goals. The TPP will include summary information from this report.

ABOUT THE DATA

More than 30,000 people in 14,000 households from the seven-county metro area and 19 surrounding counties participated in the most recent regional travel survey, which was conducted from 2010-12. This report contains information from the household travel survey component of the TBI. It concentrates on the seven-county region that makes up the Metropolitan Council's planning area, as well as impacts on the seven-county area from surrounding counties. The TBI report summarizes the findings, compares past travel behavior with today's, and makes some guesses about future trends.

How Were the Data Collected?*

Household survey

- Each member of more than 14,000 households kept a travel diary for a single day
- 285 of those households agreed to have each member of their household carry a GPS unit on their person for one week

Other focused surveys

- Transit riders
- Mall of America and Minneapolis-St. Paul International Airport visitors
- Those outside the region who travel into the region

Speed and traffic data

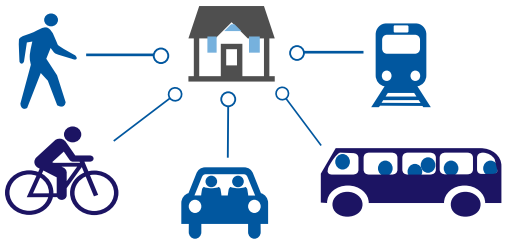
- To gain specific information about highway and transit system performance and for travel modeling

*This report focuses only on the Household Survey data

WHAT DO WE MEAN BY…

Trip: one leg of a journey; for example, going from home to the supermarket, bank, dry cleaner, and back home counts as four trips.

Mode: the way a trip is made; for example, walking, biking, driving, or public transit.



WHAT DID WE MEASURE?*

4 Types of Travel Based on Purpose:

Work Commute: travel from home to work and back.

School and Within Work: travel from home to school and back; and travel during the workday, for example, going to a meeting in another location.

Shopping/Errand: travel for shopping, banking, doctor visits and other personal business; and dropping off and picking up others for the same types of trips.

Social/Recreational: travel for social, recreational, entertainment, community, and religious destinations.

5 Major Modes of Travel:

- Walking
- Biking
- Taking public transit
- Riding a school bus
- Driving: driving alone, driving with passengers, riding as a passenger

Type of Household:

- Adult/non-student/non-worker
- Adult/non-student/worker
- Adult student
- Adults with children

Age Groups:

- under 18
- 18 - 64 / non-working
- 18 - 64 / working
- 65 - 84
- 85 and over

Origins and Destinations of Travelers:

- Central City — includes Minneapolis and St. Paul
- Developed (first ring) suburb — includes communities such as Columbia Heights, Golden Valley, Richfield, and Roseville
- Developing (second ring) suburb — includes communities such as Blaine, Plymouth, Savage and Woodbury
- Rural includes townships and communities with low development density.

Household Incomes (annual):

- $30,000 and under
- $30,000 to $60,000
- $60,000 to $125,000
- $125,000 to $250,000
- $250,000 and over

Other Things Considered:

- Gender
- Time of travel (helps in planning for greatest travel demand on the transportation system)
- Travel distance (to document influences on time spent traveling, and effects on emissions and resulting air quality)

*Note: The survey collected all of this information in much greater detail than is presented in this report. The categories described above have been simplified for clarity.

NATIONAL TRENDS: COULD THE DRIVING BOOM BE OVER?

(Public Interest Research Group Report, A New Direction, Spring 2013)

The driving boom in the United States — from the end of WWII to the late 1990s — was fueled by a rise in income, the building of the highway system, the affordability of cars, the development of low-density suburbs, and more women entering the workforce. Gas tax revenues and relatively cheap gas continued a cycle of building more roads to accommodate more cars. This trend is slowing down and even reversing for a number of reasons.

A Shrinking Workforce

Workers drive more than non-workers. The population of workers has a significant effect on the number of cars on the road. From 1970 to 2000, the portion of Americans in the workforce increased from 60 percent to more than 67 percent. Even before the recession the American labor force began declining, largely due to baby boomers retiring. The Congressional Budget Office has estimated that by 2021, the workforce will drop to 63 percent of the population.

Car Ownership and Number of Licenses

In 2006 the total number of vehicles in the US was greater than the number of licensed drivers, with a peak of 1.24 vehicles per licensed driver. Since then, vehicle ownership per licensed driver has declined by 4 percent.

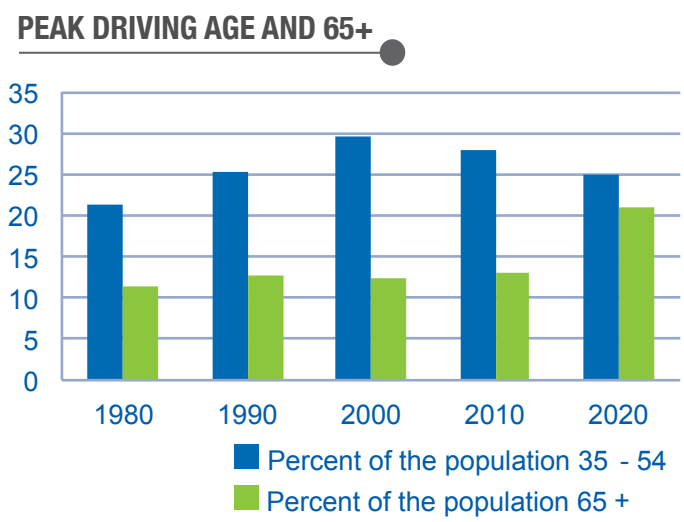
Also decreasing is the percentage of the population holding a driver's license. From 1992 to 2011 there was a 4 percent decline in the number of people holding a driver's license, from 90 percent to 86 percent of those within the driving age (16 and older). Many young people are postponing getting their licenses for a variety of reasons, including, decreased disposable income largely due to the recession, and a desire to live in denser communities with access to transit and the options of walking and biking.

An Aging Population

The peak driving age — between 35 and 54 — coincides with the average peak-earning and child-rearing years. This population hit a peak in 2000, reaching 29.5 percent of the population, then began declining. By 2010 this population had decreased by 1.6 percent, and it is expected to decrease again to 24.8 percent by 2020, reaching numbers that have not been seen since the late 1980s.

At the same time, the percent of the population 65 years of age and older—those likely to drive less because of retirement, health, and other life changes—has been growing and is projected to keep growing. This group went from 11 percent of the total population in 1980 to 13 percent in 2010, and is expected to jump to 21 percent in 2020. In other words, this population increased by 20 percent over three decades, but will grow by a staggering 62 percent in just one decade, from 2010 to 2020.

Looking ahead, if the millennial generation—those born between 1983 and 2000—continue their trend of driving less throughout their peak-earning, child-rearing years and into their golden years, there will be fewer drivers, fewer cars on the road, fewer trips taken, and fewer miles driven than we see today.



From 2005 - 2011
telecommuting rose by

73%

Technological Advances Equal Fewer Trips

More people are accomplishing their professional, social and shopping needs online than ever before and that number is expected to increase.

Telecommuting nationwide

Telecommuting — whether a few days a week or working from home exclusively — is on the rise. Telecommuting rose by 73 percent from 2005 to 2011, with 2.5 percent of the American workforce considering their home their primary place of work.

Telecommuting in the Twin Cities region

Workers in the Twin Cities region have a much higher telecommuting rate than the national average. Thirty-three percent of workers in the region report telecommuting at least monthly. This can perhaps be attributed to a workforce that has a higher education rate than the national average. Workers in the region with a bachelor's degree are 70 percent more likely to telecommute, and those with a post-bachelor degree are 90 percent more likely to telecommute. Also, workers with children are 25 percent more likely to telecommute than workers without children.

Of telecommuters in the region, 15 percent (or 5 percent of the workforce) telecommute four to five times a week; 31 percent (or 10 percent of the workforce) telecommute one to three times a week; and 36 percent (or 12 percent of the workforce) telecommute less frequently but at least a few times a month.

Online commerce

Shopping online has been steadily increasing. The U.S. Department of Commerce has been tracking retail e-commerce sales since 2004. From 2004 to 2013, online retail sales rose steadily from 2 percent to 5.5 percent of all retail sales, or $61.2 billion (adjusted for seasonal variation). The result of more goods and services being acquired online instead of making physical trips has been fewer cars on the road.

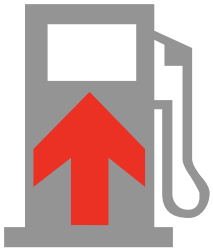
Social media and online entertainment

Americans are not just buying more products online, they are also socializing more on their computers and hand-held devices, and downloading entertainment media. Today, people are more likely to walk to their mailboxes to catch a movie than go to a movie theater.

A 2012 survey by the computer-networking company Cisco found that two-thirds of college students and young professionals spend at least as much time with friends online as they do in person.

Higher Gas Prices

Between 2002 and 2011 gas prices doubled. This has implications for both short- and long-term driving habits and decisions. In the short term, people may choose to reduce discretionary trips, such as for leisure or social purposes, and take care of some of their shopping and errand trips online. Long-term, people may make bigger life decisions such as moving closer to work, moving closer to a transit line, or buying a fuel-efficient vehicle.



Gas Prices

2002 - 2011 gas prices doubled

Rise of the 'Millennials'

The millennial generation, or Generation Y — those born between 1983 and 2000 — is the largest generation the US has ever seen, more than 77 million strong. This generation surpasses baby boomers, those born between 1946 and 1964, by about 1 million.

But even with millennials entering the workforce, driving and car ownership is likely to continue to decline. Millennials are driving less for several reasons:

- They have less income as a result of the economic downturn starting with the 2008 recession.
- They are more environmentally conscious, and more willing to lead a lifestyle that doesn't require owning a car.
- They are postponing getting their driver's licenses.
- They want to live in walkable, transit-oriented urban centers, near the amenities they seek, and also near the workplace.
- They are choosing to live in closer-knit communities.

Cities Are Making a Comeback

Cities are growing again. Many young families are not following in their parents' footsteps and moving to the suburbs to raise their kids; they are choosing denser urban centers for easier access to schools, shopping, and a greater sense of community. Middle age and older people are downsizing and choosing smaller, more affordable homes in cities. Twenty-three percent of the population growth in the region occurred in Minneapolis and Saint Paul between 2010 and 2012, compared to just 5 percent between 1990 and 2010. Generally, with urban living comes a reduction in the number of cars per household, and less overall driving.

A BRIEF LOOK BACK

TBI reports have been conducted every 10 years starting in 1949. The Twin Cities region has been mirroring trends of metropolitan areas of the same size around the country.

In this region, as well as nationally, the number of households has increased at a greater rate than the population, with the average household size decreasing. From 1970 to 2010, the average household size in the region has decreased from 3.27 to 2.47 people, a decrease of almost 25 percent. These changes have affected travel habits and trends, and could have implications for how transportation projects are funded and prioritized in the future.

What Has Decreased

- The number of licensed drivers per household has decreased from an average of 1.97 in 1970 to 1.73 in 2010.
- The average number of vehicles per household was on a steady rise from 1.25 in 1970 to 1.80 in 2000, but between 2000 and 2010, there has been a slight decrease to 1.78 vehicles per household.
- The average motorized trips per household has also decreased, this time to 1970 levels. In 1970, there were 8.02 motorized trips per household, rising steadily to a high of 10.3 trips in 2000; by 2010 this number was back down to 8.05.
- The average trips per household for all modes (including biking and walking) decreased from 11.1 to 8.8 trips from 2000 to 2010.
- The number of motorized (including transit) trips per person in 2010 has gone back down almost to 1980 levels, 3.3 trips per person. In 1970 there was an average of 2.7 motorized trips per person, reaching a high of 4.2 trips in 2000.
- The total number of car trips decreased from 7.7 million trips to 6.3 million trips from 2000 to 2010.
- Total number of trips by all modes (including walking and biking) has decreased from 2000 to 2010 from 11.6 million trips to 9.8 million trips per day.
  - Driving alone decreased by 9 percent as a percentage of all trips.
  - Riding as a passenger decreased by almost 30 percent.

What Has Increased

- The average trip length (calculated for all modes) has increased steadily from 6.5 miles in 2000 to 6.9 miles in 2010.
- The average trip time (calculated for all modes) has also increased, from 17 minutes in 2000 to 22 minutes in 2010.
- While the number of trips decreased for many modes, leading to an overall decrease in trips taken from 2000 to 2010, some mode trips increased:
  - Transit trips increased by 25 percent as a percentage of all trips.
  - Driving with a passenger increased by 4 percent as a percentage of all trips.
  - Riding a bicycle increased by 13 percent as a percentage of all trips.
  - Walking increased by 16 percent as a percentage of all trips.

TRAVEL IN THE TWIN CITIES REGION TODAY

Where Is this Region Going?

Of all the trips taken in the region, the largest group, 40 percent, were for social and recreational purposes. Work, school, and errands all tied for second place, at about 20 percent each.

Who Is Traveling the Most?

Household type

By far, households with children are making the most trips per day, almost 14, with adult student households coming in second at about 8, then working adult households not in school at 6 trips a day. Households composed of adults who are neither in school or working are making about 4 trips a day, the least of any group.

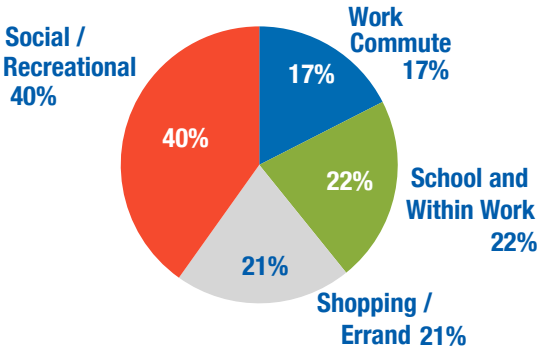
Adult non-students drive alone the most at 62 percent. Adult students and adults who neither work nor go to school drive alone 50 percent and 46 percent, respectively. Not surprisingly, households with children take the most car trips with passengers and as passengers, 23 percent and 27 percent, respectively. Working adults not attending school drove with passengers the least, and rode as passengers the least, as well — 14 percent and 11 percent, respectively.

Adult students and adults who neither work nor go to school walk the most, 9 percent and 9 percent, respectively. Adult students also take transit the most at 7 percent. Households with children tend to walk the least at just 5 percent of their trips.

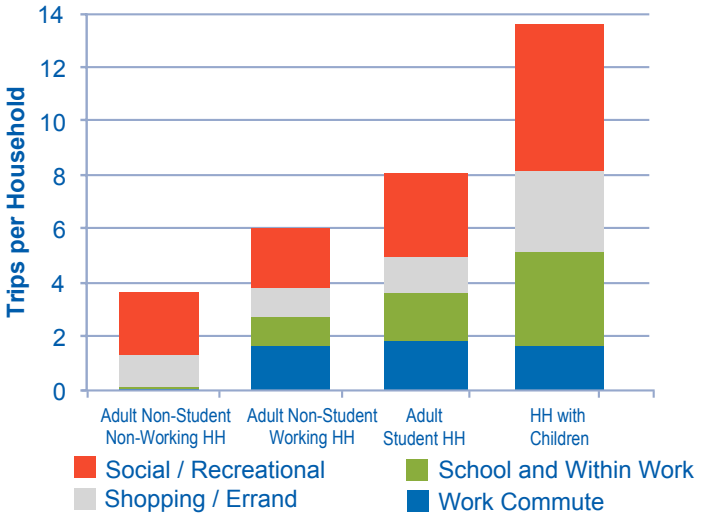
Working adults

Workers between the ages of 18 and 65 make the most trips, averaging slightly more than four per day; seniors, non-workers, and those age 18 and younger make about three trips a day; and seniors 85 and older make the fewest trips per day, about 1.5.

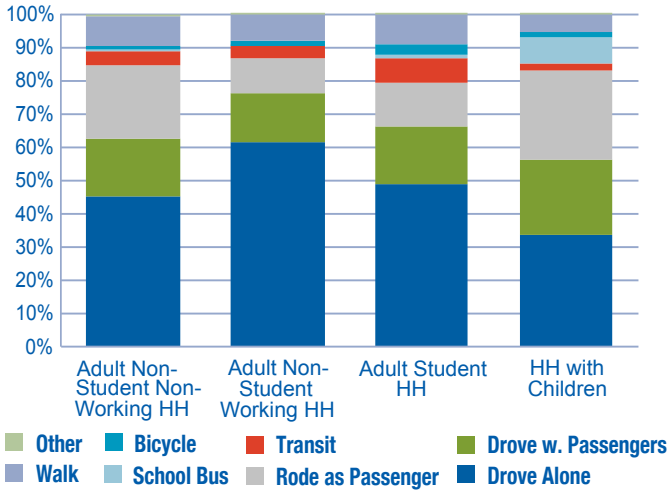
WHY DO WE TRAVEL?



WHO IS TRAVELING? WHY? BY HOW MUCH?



MODE BY HOUSEHOLD TYPE



Earn more, drive more

Households earning between $125,000 and $250,000 annually make an average of 12 trips a day, the most of any income group. Households earning the least, $30,000 and under, make five trips a day, the least of any income group.

Conversely, those who earn the most ride transit the least, and those who earn the least, ride transit the most, .3 percent versus 13 percent, respectively.

How Do We Get There?

Cars and buses and bikes, oh my!

Driving is still the way most trips are made in the region. Whether driving alone, with a passenger, or riding as a passenger—driving accounted for 84 percent of the way trips are made. Taking transit and riding a school bus account for 3 percent and 5 percent, respectively. Of all trips made in the region, 6 percent are made by walking, and 2 percent by biking.

Commuting to work

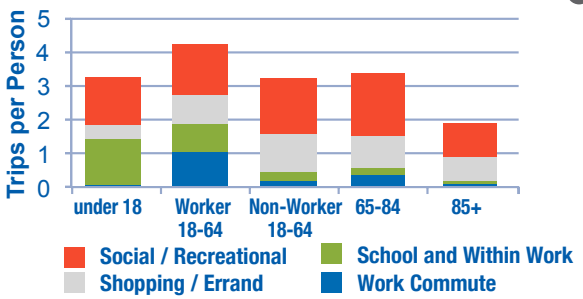
Almost 90 percent of commutes to work are made by car, with 75 percent driving alone. Transit accounts for 6 percent of commute trips, with biking and walking both coming in at 3 percent each.

Shopping, errands, social, and recreational trips

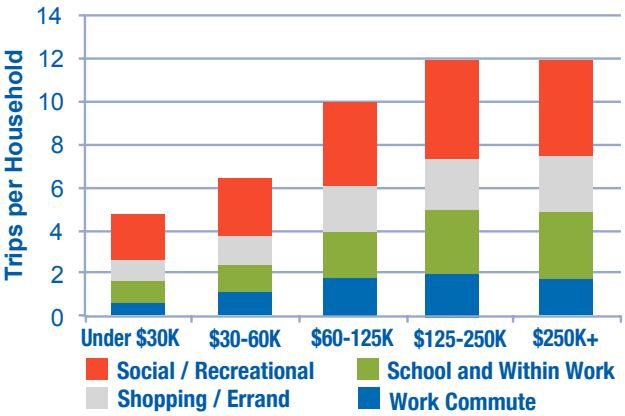
Residents in the region ride more often with passengers and as passengers for non-commute trips such as shopping, errands, and for social and recreational reasons; and they take transit less for these purposes, as well.

Fifty-four percent of shopping and errand trips, and 52 percent of social and recreational trips are made with passengers or by those riding as a passenger.

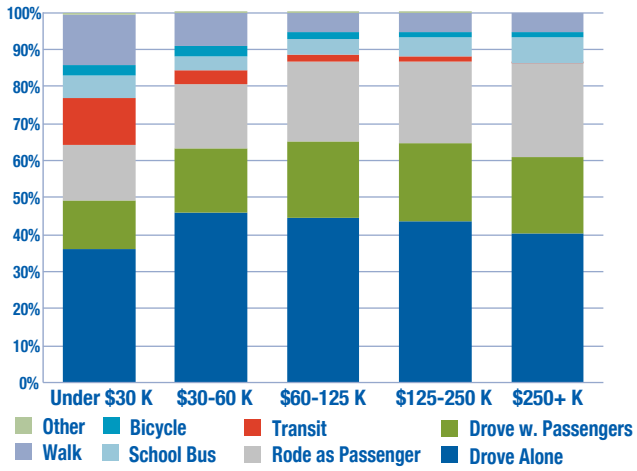
TRAVEL BY AGE AND EMPLOYMENT STATUS



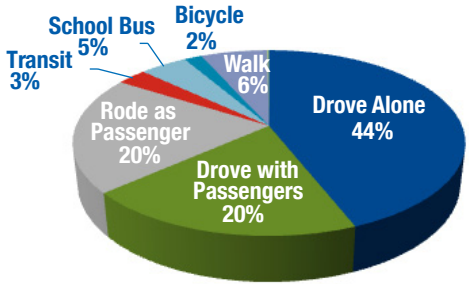
TRAVEL BY INCOME



MODE BY INCOME



HOW DO WE TRAVEL?



Walking

Walking is used as often to get to school and for within work trips, as well as for social and recreational trips, with each purpose coming in at about 8 percent. Walking is only used 3 percent of the time when going to work or for shopping and errands.

Transit trips rise

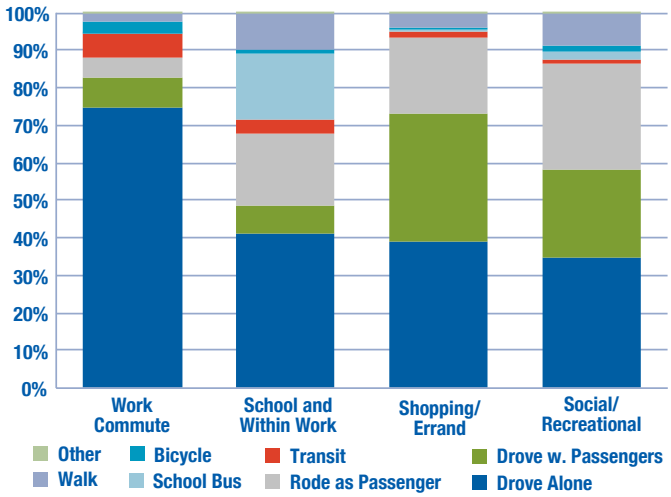
Transit is growing in the region. Transit use increased to 3.2 percent of all motorized trips in 2010, up from 2.5 percent in 2000.

Of those who ride transit, more than half live in urban centers, about 31 percent live in developed suburbs, 15 percent in developing suburbs, and just slightly more than 1 percent are in rural areas.

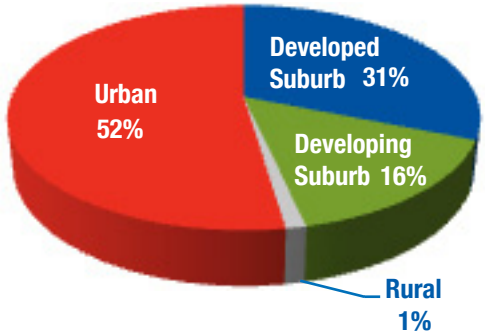
Transit riders in the region are predominantly workers between 18 and 64 years of age. at more than 75 percent. The second highest group riding transit are non-workers between 18 and 64 years of age, at 13 percent. Seniors between 65 and 84 years of age make up 7.5 percent of transit riders; children under 18 are 3.1 percent of riders, and seniors 85 and older are .5 percent of all transit riders.

Transit riders in the Twin Cities region have a wide range of incomes. Those who earn between $60,000 and $125,000 make up the most riders at 36 percent; those earning $30,000 and less make up 32 percent of riders; between $30,000 and $60,000 are almost 19 percent of riders; and almost 13 percent of riders earn $125,000 to $250,000 a year.

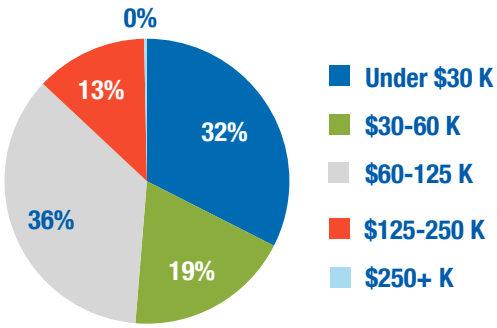
MODE BY PURPOSE



TRANSIT BY GEOGRAPHIC AREA



TRANSIT RIDERSHIP BY INCOME



From where do you hail?

Mode of travel is influenced by where someone lives. Those living in more urban areas are less likely to drive, and more likely to take transit, walk, and bike. Living in a rural area means the predominant way to reach destinations is by car. Urban dwellers use transit 7 percent of the time while rural dwellers ride transit only .5 percent of the time. Suburban and rural dwellers travel by car 88 percent and 89 percent of the time respectively, while urban dwellers travel by car 71 percent of the time.

Urban dwellers make the most trips by walking, while rural dwellers use this mode the least to reach their destinations, 15 percent versus 3 percent, respectively. Rural dwellers make the smallest share of trips by bicycle, only 1 percent, while urbanites will use a bicycle 4 percent of the time.

Age matters

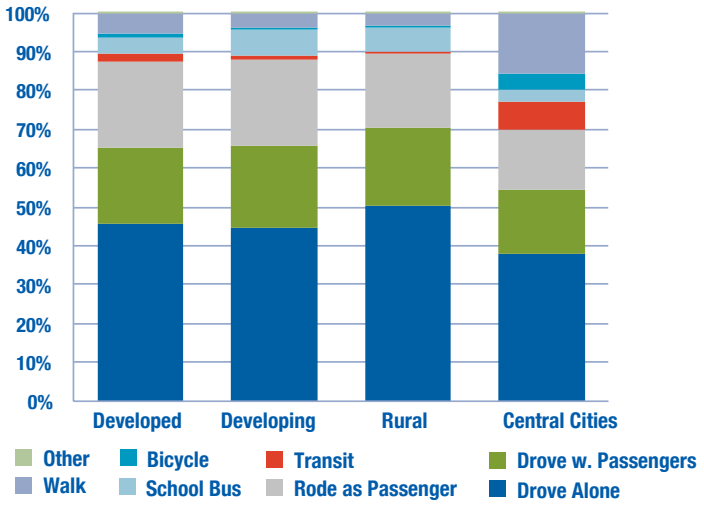
Age plays an important role in transportation choice. The young and the elderly ride as passengers in a car predominantly, 61 and 41 percent, respectively. Adults between 18 and 64 who do not work ride transit the most, 5 percent, compared to children younger than age 18 who ride transit the least at less than .5 percent.

Adults 85 and older walk 11 percent of the time, as much as they drive with passengers. Non-working adults between 18 and 64 years of age walk at the second highest rate, 10 percent of the time.

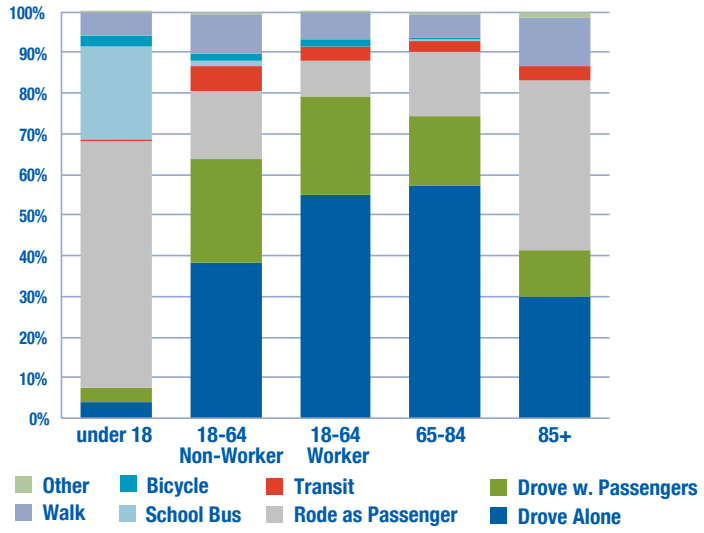
Non-student adults between 35 and 64 make the most trips alone by car. Younger non-student adults, those between 18 and 34, take transit the most. Younger adults between 25 and 34 walk the most of any other age group at 12 percent of the time.

In households with children, adults 35 to 44 years old use transit the least at just 1 percent of the time, while younger adults between 18 and 24 use transit the most at 4 percent. These younger adults also

MODE BY GEOGRAPHIC AREA



MODE BY AGE AND EMPLOYMENT STATUS



walk the most — 9 percent of their trips are made on foot. Of all households with children, adults 55 to 64 made the most trips alone by car, 59 percent. Adults between 35 and 44 with children drove with passengers 37 percent of the time, the most of any other age group in this category.

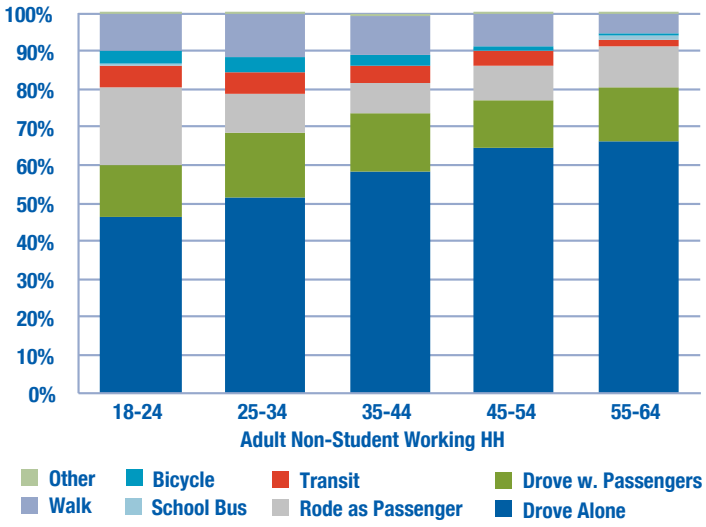
When Do We Get There?

Time of travel

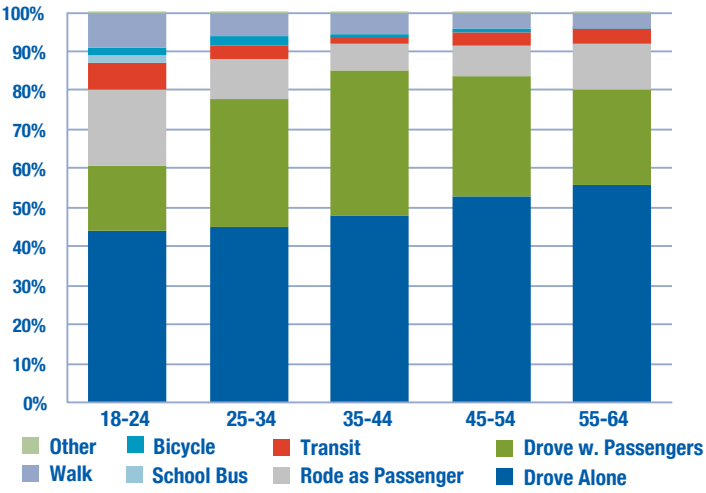
For all types of trips, two peaks emerge: 7 a.m. to 8 a.m. and 4 p.m. to 6 p.m. These peaks are partially the result of the work commute. Children have similar peak travel times as working adults, with their afternoon peak occurring a little earlier, between 3 p.m. and 4 p.m. Seniors do most of their traveling midday, between 11 a.m. and 3 p.m.

The work commute, and shopping and errands, tend to follow the two dominant peak times mentioned above. Social and recreational trips peak at about 7 p.m., with a secondary peak occurring around noon.

MODE BY AGE: WORKING ADULTS



MODE BY AGE: HH WITH CHILDREN



Footnotes

[i] GlobalWorkplaceAnalytics.com/telecommuting-statistics

[ii] U.S. Census Bureau News, U.S. Department of Commerce, May 15, 2013. http://www.census.gov/retail/mrts/www/data/pdf/ec_current.pdf

[iii] http://uspirg.org/reports/usp/new-direction. A New Direction, Our Changing Relationship with Driving and the Implications for America's Future, page 25. U.S. Public Interest Research Group, Spring 2013.

[iv] http://www1.eere.energy.gov/vehiclesandfuels/facts/m/2012_fotw741.html

[v] http://uspirg.org/reports/usp/new-direction, page 15.

ABOUT THE METROPOLITAN COUNCIL

The Metropolitan Council is the regional planning agency serving the Twin Cities seven-county metropolitan area and providing essential services to the region. The Council works with local communities to provide these critical services:

- operates the region's largest bus system
- collects and treats wastewater
- engages communities and the public in planning for future growth
- provides forecasts of the region's population and household growth
- provides affordable housing opportunities for low- and moderate-income individuals and families
- provides planning, acquisitions and funding for a regional system of parks and trails
- provides a framework for decisions and implementation for regional systems including aviation, transportation, parks and open space, water quality and water management

The Council is committed to environmental stewardship, sustainable solutions, and reduced energy use.

The 17-member Metropolitan Council has 16 members who each represent a geographic district and one chair who serves at large. They are all appointed by and serve at the pleasure of the governor. The State Senate confirms Council member appointments.

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B. Advance Letter

Metropolitan Council

Dear Twin Cities Resident:

Traveling is part of everyday life. Whether you travel by car, truck, bus, bike or walk, local planners need to make sure the transportation system meets your needs. To better understand those needs, the Metropolitan Council and the Minnesota Department of Transportation are conducting the **2010 Travel Behavior Inventory (TBI).** This study will look at daily travel characteristics of residents and the changes in household travel that may have occurred since 2000. Minnesota's transportation planners will use the results of your participation to evaluate and develop a transportation system that improves and increases mobility for residents in your area.

Your household has been randomly selected to help us by participating in a household travel survey. The more people who complete the survey, the more accurate our results will be. To participate, you will need to register by using one of the following two options:

Internet: You can complete the initial survey online by logging on to: **www.opinionport.com/metrocounciltravelsurvey** and entering your password.

Your password is: **<<INSERT PASSWORD>>**

Phone: If you are not able to complete by Internet, please call our toll-free line at 1-877-699-4344 to participate. You will need to provide your name, home address, and telephone number when you call. Please indicate if the telephone number you provide is a landline or a cell phone. We would prefer to contact you on a local landline instead of a cell phone. A trained telephone interviewer from Abt SRBI, a national research organization, will call your household back within the following couple of weeks to register your household for the travel survey.

If you have any questions about the household travel survey, please contact *Abt SRBI* at 1-877-699-4344 or email us at MCtravelsurveyhelp@srbi.com. Thank you in advance for helping us to better understand the transportation needs of your community.

Sincerely,

Jonathan Ehrlich
Project Manager, Metropolitan Council

James Henrickson
Minnesota Department of Transportation

www.metrocouncil.org

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An Equal Opportunity Employer

Source: Abt SRBI and Metropolitan Council, 2011.

C. Recruitment Interview

Source: Abt SRBI and Metropolitan Council, 2011.

Minnesota Metropolitan Council
"Household Interview Survey"
Recruit Interview

DISPO_INT. Hello, my name is **<INSERT INTERVIEWER'S FIRST NAME>** from Abt SRBI calling on behalf of
(IF MARKET=1,2,3 SHOW "the Metropolitan Council and the Minnesota Department of Transportation". The Metropolitan Council is conducting a transportation study to better understand the daily travel characteristics of residents in the metro area).
(IF MARKET=4 SHOW "the Minnesota Department of Transportation and the Metropolitan Council. The Metropolitan Council is conducting a transportation study to better understand the daily travel characteristics of residents in the greater Twin Cities region.")
(IF MARKET=5 SHOW "the Wisconsin Department of Transportation and the Metropolitan Council. The Metropolitan Council is conducting a transportation study to better understand the daily travel characteristics of residents in the greater Twin Cities region.")

Are you a member of this household and at least 18 years old?

(INTERVIEWER: If necessary, say: "I'm allowed to only interview individuals that are at least 18 years of age. Are you at least 18?")

INT: IF NEW RESPONDENT COMES TO PHONE RE-READ INTRO

(INTERVIEWER: IF UNWILLING TO CONFIRM ELIGIBILITY, READ: "Thank you for your time." Then enter "SCREEN-OUT NO ONE IN HH 18", which will terminate the interview.)

(PROGRAMMER: INSERT DISPOSITION SCREEN)

INTRO. (CONTINUE WITH HOUSEHOLD MEMBER AT LEAST 18 YEARS OF AGE)
This is an official Metropolitan Council study and the information collected is confidential and secure. This is not a sales call and no sales calls will result from this interview. For quality control purposes, this call may be monitored.

1	Continue with interview	**(GO TO AREA)**
2	Not a good time callback	**(GO TO CALLBACK SCREEN)**
3	Refused	**(GO TO TERM_INT)**

TERM_INT. I understand your reluctance but the Metropolitan Council would like to hear from as many people in the area as possible. Your participation will help the Metropolitan Council understand your traveling needs and how to better improve roads, reduce congestion, improve walking and bike paths and improve public transportation.

1	Continue with interview	**(CONTINUE)**
3	Refused	**(TERMINATE)**

ASK ALL

AREA. I first need to confirm that you live in the study area.
(IF MARKET=1 SHOW "Do you live in St. Paul?")
(IF MARKET=2 SHOW "Do you live in Minneapolis?")
(IF MARKET=3,4,5 SHOW "What county do you live in?)
[INTERVIEWER NOTE: IF DO NOT LIVE IN ST. PAUL OR MINNEAPOLIS PROBE WITH "What county do you live in?"]

01	ST. PAUL, MN
02	MINNEAPOLIS, MN
03	ANOKA, MN [ah-NO'-kuh]
04	CARVER, MN
05	DAKOTA, MN
06	HENNEPIN, MN
07	SCOTT, MN
08	RAMSEY, MN
09	WASHINGTON, MN
10	CHISAGO, MN [shih SAH' go]
11	GOODHUE, MN
12	ISANTI, MN [eye SAN' tee]
13	LE SUEUR, MN [le SEWER']
14	MCLEOD, MN
15	RICE, MN
16	SHERBURNE, MN
17	SIBLEY, MN
18	WRIGHT, MN
19	PIERCE, WI
20	POLK, WI
21	ST. CROIX, WI
96	OTHER (SPECIFY) **(GO TO AREA_TM)**
98	DON'T KNOW **(GO TO AREA_TM)**
99	REFUSED **(GO TO AREA_TM)**

AREA_TM. Unfortunately, your household is not eligible for this project. Thank you for your time. **(TERMINATE)**

[IF STUDYTYPE=1 SHOW HIS_INFO; IF STUDYTYPE=0 SHOW GPS_INFO

HIS_INFO. Periodically, Minnesota's transportation planners will recruit residents in different communities to participate in a study to evaluate transportation needs. Your household was randomly selected to participate in such a study.

For this study, each member of your household over the age of 5 will receive a diary to easily record travel information for a 24-hour period. The diary will ask you what locations you visit and how you travel from one location to the next. After the one-day travel period, we will recontact your household to collect the information.

To participate, we need ALL members of your household, regardless of age, to take part in the study for your household to count. Can we rely on your support for this important study?

01	Yes – Continue	**(GO TO BEGIN)**
02	No – Will Not Participate	**(GO TO END2)**
98	Don't Know	**(GO TO RESTATE)**
99	Refused	**(GO TO END2)**

GPS_INFO Periodically, Minnesota's transportation planners will recruit residents in different communities to participate in a study to evaluate transportation needs. Your household was randomly selected to participate in such a study.

For this study, each member of your household over the age of 12 will receive a diary and a GPS device. Each individual will easily record travel information for a 24-hour period and carry with them a personal GPS device. These GPS devices will ONLY record travel for this project and are not useful for anything else. For household members between the ages of 6 and 12, we will ask you to fill out a travel diary for the same 24 period. You will not be required to provide record any travel information for children under the age of 6.

To participate, we need ALL members of your household, regardless of age, to take part in the study for your household to count. Can we rely on your support for this important study?

(INTERVIEWER: GPS stands for Global Positioning System)

1	Yes – Continue	**(GO TO BEGIN)**
2	No – Will Not Participate	**(GO TO END2)**
98	Don't know	**(GO TO RESTATE)**
99	Refused	**(GO TO END2)**

RESTATE I understand your reluctance but the Metropolitan Council would like to hear from as many people in the area as possible. Your participation will help the Metropolitan Council

understand your traveling needs and how to better improve roads, reduce congestion, improve walking and bike paths and improve public transportation.

1 Continue with interview **(CONTINUE)**
3 Refused **(TERMINATE)**

END2. This concludes our survey. Thank you for your participation. Your time and opinions are valued.

ASK ALL

BEGIN **Thank you for your willingness to participate in this valuable transportation study. Next, I need to collect some information about your household and members of your household.**

TOTVEH I first need to ask about the vehicles available to your household. Please count all working owned and leased cars, vans, trucks, and motorcycles, as well as vehicles available for REGULAR USE to your household, such as company vehicles. Include RVs and mopeds if they are used for local trips. Do NOT include bicycles, golf carts, boats or snowmobiles.

How many working vehicles are available to your household?

(INTERVIEWER: Verify if more than 6 vehicles.)
(INTERVIEWER: If respondent says don't know/refused say, "This information is very important to our study. In order to continue we need to know how many vehicles are available to your household.")
(RECORD NUMBER OF HOUSEHOLD VEHICLES)

__ __ (PROGRAMMER: Allow 0 to 10 vehicles.) (If 0 GO TO BICYC)

98 Don't Know **(TERMINATE)**
99 Refused **(TERMINATE)**

OWNVEH# [IF TOTVEH EQ 1] Is this vehicle owned or leased by your household or is it employer-provided?
[IF TOTVEH GT 1] Now for each vehicle could you tell me if it is owned or leased by your household or if it is employer-provided. How about the first vehicle?

[PROGRAMMER NOTE: COLLECT OWNERSHIP INFORMATION FOR ALL VEHICLES STATED IN TOTVEH, UP TO 10]

01 HOUSEHOLD OWNED
02 HOUSEHOLD LEASED
03 EMPLOYER PROVIDED
97 OTHER,SPECIFY

98 Don't Know
99 Refused

MNPASS Minnesota currently offers a program known as MnPASS that allows drivers to use carpool lanes on I-394 and I-35W by paying an electronic toll.

Is your household currently enrolled in this program?

01 YES (GO TO MNPASSPAY)
02 NO (GO TO BICYC)
98 DON'T KNOW (GO TO BICYC)
99 REFUSED (GO TO BICYC)

MNPASSPAY Is your MnPASS provided or subsidized by a household member's employer?

01 Yes
02 No

98 Don't Know
99 Refused

BICYC How many working bicycles are available to your household?

_ _ (Allow 0 to 10 bicycles) (10=10 or more bicycles)

98 Don't know
99 Refused

HHSIZE. INCLUDING yourself, all other adults, and children of all ages, how many people currently live in your household?
(IF NEEDED: We need to know how many people are in your household to make sure we send enough materials for each household member.)
(INTERVIEWER: Include roommates and housemates. Do NOT include children living away from home.)
(INTERVIEWER: If respondent says don't know/refused say, "This information is very important to our study. In order to continue we need to know how many people live in your household.")
(RECORD TOTAL NUMBER OF HOUSEHOLD MEMBERS)

__ __ (PROGRAMMER: Allow 1 to 10; 10 EQ 10 or more)
98 Don't Know **(TERMINATE)**
99 Refused **(TERMINATE)**

(ASK IF HHSIZE>9)
GROUPCK. Are any of these people related?

01 Yes
02 No **(TERMINATE)**

98 Don't Know **(TERMINATE)**
99 Refused **(TERMINATE)**

WRKRS. **(ASK IF HHSIZE=1)** Are you employed?
(ASK IF HHSIZE>1) Including yourself, how many of the people, 16 years of age or older, living in your household are employed?

(INTERVIEWER: If respondent says don't know/refused say, "This information is very important to our study. In order to continue we need to know how many people in your household are employed.")
(INTERVIEWER: IF ONE PERSON IN HOUSEHOLD AND WORKS CODE 1)
__ __ (PROGRAMMER: Allow 0 to HHSIZE; CODE 0 IF A HOUSEHOLD WITH ONE PERSON IS UNEMPLOYED)

[IF WRKRS GT HHSIZE RESTATE QUESTION)

98 Don't Know **(TERMINATE)**
99 Refused **(TERMINATE)**

(ASK IF HHSIZE>1)
PERS_INT. Now I'd like to ask a few questions about each household member. This will help us prepare the study materials. Again, I want to assure you that this information is for research purposes only. Let's start with you.

[INTERVIEWER NOTE: IF ASKED WHY NEED INFORMATION ABOUT HOUSEHOLD MEMBERS UNDER THE AGE OF 5 SAY "For statistical purposes we need to collect information about every member of the household whether they are included in the diary study or not]

NAME_1. Please tell me your first name.
NAME_#. Now please tell me the next person's first name.
(INTERVIEWER: If respondent refuses, ask for initials or other identifying information.)
(RECORD FIRST NAME)

_____

SEX_1. (RECORD GENDER - BY OBSERVATION)
SEX_#. Is **<INSERT NAME_#>** male or female?

01 Male
02 Female

99 Refused

SAGE_1. What is your age?
SAGE_#. What is **<INSERT NAME_#>**'s age?
(RECORD AGE)

__ __ __ (PROGRAMMER: Allow 18 to 97 for SAGE_1.)
(PROGRAMMER: Allow 0 to 97 for SAGE_2:15.)
97 97 or older
98 Don't Know
99 Refused

[IF WRKRS EQ HHSIZE2 AND SAGE_# LT 16 LOOP BACK TO WRKRS TO RESTATE QUESTION]

(ASK IF SAGE_#=98 OR 99)
AGE_1. Which of the following categories best describes your age?
AGE_#. Which of the following categories best describes **<INSERT NAME_#>**'s age?

01	5 or younger	**(DO NOT SHOW FOR PERSON 1)**
02	6 to 12	**(DO NOT SHOW FOR PERSON 1)**
03	13 to 15	**(DO NOT SHOW FOR PERSON 1)**
04	16 to 17	**(DO NOT SHOW FOR PERSON 1)**
05	18 to 24	
06	25 to 34	
07	35 to 44	
08	45 to 54	
09	55 to 64	
10	65 to 74	
11	75 to 84	
12	85 and over	
98	Don't know	
99	Refused	

(ASK IF AGE_#=98 or 99)
AGE18_#. Is **<INSERT NAME_#>** 18 years of age or older?

01	Yes (18 or older)
02	No (under 18)
98	Don't Know
99	Refused

[PROGRAMMER NOTE: IF SAGE# EQ 98/99 AND AGE# EQ 98/99 AND AGE18# EQ 98/99
TERMINATE THE CALL.]

(ASK IF NOT FIRST PERSON)
RELAT_#. What is **<INSERT NAME_#>**'s relationship to you?
(DO NOT READ LIST. PROMPT, IF NEEDED.)

1 Husband/Wife/Unmarried Partner
2 Son/Daughter/In-Law
3 Brother/Sister/In-Law
4 Mother/Father/In-Law
5 Other Relative
6 Roommate/Friend
7 Household Help
8 Foster Home Resident
9 Grandchild
10 Child of Boyfriend/Girlfriend/Spouse
11 Boyfriend/Girlfriend/Spouse of Son/Daughter
12 Tenant
13 Cousin
14 Exchange Student
15 Foster Child/Daughter/Son

16 Grandmother/Grandfather/In Law
17 Great Grandchild
18 Legal Guardian
19 Step Granddaughter/Grandson
20 Caregiver/Care Worker
21 Dependent
22 Niece/Nephew
23 Aunt/Uncle
24 Grandparent
25 Employers Child
96 Other (SPECIFY: _____)
98 Don't Know
99 Refused

[PROGRAMMER NOTE: IF SAGE_# LE 5 SKIP TO SCH_#]

LDRV_1. Are you a licensed driver?
(ASK IF (SAGE_#>15 AND SAGE_#<97) OR (AGE_#>2 AND AGE_#≤11) OR AGE18_# <>2)
LDRV_#. Is **<INSERT NAME_#>** a licensed driver?

01 Yes
02 No

98 Don't Know
99 Refused

TPASS_1. If you travel using a public bus, light rail or commuter rail, how do you usually pay for your trips?

TPASS_#. If **<INSERT NAME_#>** travels using a public bus, light rail or commuter rail, how do he/she usually pay for his/her trips? (DO NOT READ OPTIONS)

(INTERVIEWER NOTE: IF USE ALL THREE TRANSPORTATION OPTIONS ASK THEM TO GIVE THE PASS INFORMATION FOR THE MOST FREQUENTLY USED TYPE OF TRANSPORTATION)

(INTERVIEWER NOTE: If needed, A transit pass is a pre-purchased card that allows you to use a bus, a train or any oth28er kind of public transportation).

(INTERVIEWER NOTE: IF NEEDED, LIGHT RAIL REFERS TO THE HIWATHA LINE AND COMMUTER RAIL REFERS TO NORTH STAR)

01 CASH (NO SPECIFICATION PROVIDED)
02 BUS/LIGHT RAIL CASH FARE
03 EXPRESS BUS CASH FARE
04 REDUCED BUS/LIGHT RAIL CASH FARE (applies to seniors, youths, Medicare holders, persons with disabilities)
05 REDUCED EXPRESS BUS CASH FARE (applies to seniors, youths, Medicare holders, persons with disabilities)
06 DOWNTOWN ZONE FARE (applies to the downtown area only)
07 NORTHSTAR LINE CASH FARE

08 DAY PASS (e.g. unlimited rides for 24 hour period, $6.00)
09 METROPASS (e.g. unlimited rides automatically refilled each month, $76.00 per month or less)
10 EVENT PASS (e.g., unlimted rides for 6 hour period, $3.50 to $4.00 depending on weekday)
11 NORTHSTAR ROUNDTRIP FAMILY PASS (e.g., round trip rides on Northstar commuter rail for two adults and up to three children, purchased from Northstar ticket machine)
12 U-PASS (e.g., unlimited rides valid for one semester, $97.00 per semester, for University of Minnesota students ONLY)
13 COLLEGE PASS (e.g. unlimited rides for one semester, pricing varies by college and for select schools)
14 STUDENT PASS (e.g. unlimited rides for one semester for select high schools)
15 SUPERSAVERS (e.g., stored value card and 31-day passes available at select retailers, values start at $10 up to $113.50)

16 DIAL-A-RIDE FARE

94 DON'T USE A TRANSIT PASS [INTERVIEWER NOTE: CLARIFY IF THEY USE CASH OR DO NOT USUALLY USE TRANSIT AND THEN CODE APPROPRIATELY]
95 DO NOT USUALLY USE TRANSIT/DON'T USE TRANSIT
96 OTHER: (SPECIFY:_____)
98 Don't Know
99 Refused

[ASK ONLY IF TPASS_# GE 8 OR TPASS_# LE 15]

PASSPAY Is this transit pass provided or subsidized by a household member's employer, University or school?

01 Yes
02 No

98 Don't Know
99 Refused

WRKR_1. Are you a…?

(ASK IF (SAGE_#>15 AND SAGE_#<97) OR (AGE_#>3 AND AGE_#≤12) OR AGE18_# <>2)

WRKR_#. Is **<INSERT NAME_#>** a…?
(INTERVIEWER NOTE: Answers 1 and 2 refer to PAID work. Answer 3 can be full-time OR part-time.
(READ LIST)
[INTERVIEWER NOTE: If respondent has more than one job, specify their primary employer, where they work the most hours each week)
[INTERVIEWER NOTE: If respondent reports they work and go to school, code as either full-time or part-time worker]

1 A PAID full-time worker **(GO TO ADDJOB)**
2 A PAID part-time worker **(GO TO ADDJOB)**
3 AN UNPAID worker or volunteer
4 A homemaker
5 Retired
6 Unemployed **(GO TO NOWK_#)**
7 A disabled non-worker
8 Student **(GO TO SCH_#)**

96 Other
98 Don't know
99 Refused

(ASK IF WRKR_#=6)

NOWK_1. Are you looking for PAID work?
NOWK_#. Is **<INSERT NAME_#>** looking for PAID work?

01 Yes (GO TO SCH_#)
02 No (GO TO SCH_#)

98 Don't Know (GO TO SCH_#)
99 Refused (GO TO SCH_#)

(ASK IF WRKR_1 OR WRKR_# EQ 1 OR 2)

ADDJOB (Do you/Does NAME) have more than one job?
01 Yes
02 No

98 Don't Know
99 Refused

[ASK ONLY IF ADDJOB=1]
SECJOB Is this second job, paid full-time work, paid part-time work, or does it vary?

[INTERVIEWER NOTE: If more than two jobs clarify that the second job is the one they spend the most time at other than their primary job]

01 Full-time
02 Part-time
03 Varies

98 Don't Know
99 Refused

[ASK OF EVERYONE]
SCH_1 Are you a full or part-time student?
SCH_# Is <INSERT NAME> <INSERT if SAGE>12 OR AGE>2 'a full or part time student?'> <INSERT if SAGE<13 or AGE<3 'in school or daycare full-time or part-time?'>

1 Yes, full-time
2 Yes, part-time
3 No
8 Don't know
9 Refused

[ASK OF EVERYONE]
EDU_1. What is the highest level of school you have completed?
EDU_#. What is the highest level of school <INSERT NAME_#> has completed?
(DO NOT READ LIST. PROMPT, IF NEEDED.)

01 Daycare / Pre-school
02 Less than high school
03 High school graduate
04 Some college
05 Vocational/Technical training
06 Associates degree
07 Bachelors degree
08 Graduate/Post-graduate degree

98 Don't Know
99 Refused

[IF SAGE LT 16 GO TO DISABLE]
[IF WRKR EQ 3 GO TO DISABLE]
[IF WRKR EQ 1,2 GO TO TELECOM]
[IF WRKR NE 1,2 GO TO DISABLE]

(ASK IF WRKR_# EQ 1 OR 2)

TELCOM <"Do YOU" OR "Does INSERT NAME" >ever work from home instead of traveling to<YOUR /HIS/HER>usual workplace? This is sometimes called telecommuting or telework.

01 Yes
02 No
03 Works from home only (SKIP TO DISABLE)
98 DK
99 Refused

(ASK IF TELCOM EQ 1)

TELFREQ About how often <do YOU or does INSERT NAME >work from home instead of traveling to<YOUR/HIS/HER>usual workplace?

01 Almost every day (4 or 5 days per week)
02 Once a week or more
03 Once a month or more
04 A few times a year, or more
05 Once a year

98 DK
99 RF

(ASK IF WRKR_# EQ 1 OR 2)

TELPOLICY Does<YOUR /INSERT NAME's>employer have a formal policy for working from home?

01 Yes
02 No

98 Don't know
99 Refused

(ASK IF WRKR_# EQ 1 OR 2 and TELCOM NE 3)

USUALMODE How <do YOU or does INSERT NAME>usually get to<YOUR/HIS/HER >main job?
[INTERVIEWER NOTE: If respondent says they usually get to work by transit probe with "Do you usually walk or drive to get to transit?']
01 Drive alone
02 Shared ride - 2 person (carpool)
03 Shared ride - 3+ persons (carpool)
04 VanPool
05 Transit - walk access
06 Transit - auto access
07 Walk
08 Bike
09 Work at home
96 OTHER (SPECIFY)
99 Refused

(ASK IF TELCOM_# EQ 1 OR 2)

TELWORK On days when you/INSERT NAME **travel/travels to work**, <<do/does you/INSERT NAME ever do paid work before or after you/he/she have/has traveled to or after you/he/she return/s from your/his/her place of employment?

01 Yes
02 No
98 DK
99 Refused

(ASK IF WRKR_# NE 7)

DISABLE Are/Is <YOU/INSERT NAME> limited in any way to go outside the home alone by an impairment or health problem?

[INTERIEWEVER NOTE: "GO OUTSIDE THE HOME ALONE" means any activity outside of the home, such as shopping or visiting the doctor]
01 Yes
02 No

98 Don't Know
99 Refused

(ASK IF DISABLE EQ 1 AND WRKR_# EQ 7)

TYPDISABLE Which of the following best describes your/INSERT NAME impairment or health problem?

[INTERVIEWER NOTE: Read response categories. If respondent provides answer before you finish reading the list stop and code answer given.]
01 Eye or vision,
02 Hearing,
03 Walking (requiring wheelchair or cane),
04 General health (Heart, breathing, arthritis), OR
05 Some other impairment (DO NOT SPECIFY)
98 Don't know
99 REFUSED

PROGRAMMER: COMPARE WRKRS ANSWER TO TOTAL OF WRKR_#=1 OR 2

IF EQUAL, CONTINUE WITH INTERVIEW BY PROCEEDING TO DATE.
IF NOT EQUAL, GO TO WRKVER.

(ASK IF WRKRS<>TOTAL OF WRKR_#=1 OR 2)

WRKVER. In the beginning of the interview, you indicated that **<INSERT WRKRS>** member(s) of your household work(s). However, when we asked about the individual members of your household, it appears that **<TOTAL OF WRKR_#=1 OR 2>** work(s). Which number is correct?

01 Beginning of the interview was incorrect
Need to change the beginning number
02 Beginning of the interview was correct
Need to change an individual's employment answer

(ASK IF WRKVER=1)

WRKCH1. So, to confirm, there is/are **<TOTAL OF WRKR_#=1 OR 2>** worker(s) in your household.
(IF RESPONDENT AGREES, ENTER ABOVE NUMBER)
(IF NOT, BACKUP AND CHANGE PREVIOUS ANSWER)

__ __ (PROGRAMMER: Allow TOTAL OF WRKR_#1 OR 2 ONLY!!)

98 Don't Know **(TERMINATE)**
99 Refused **(TERMINATE)**

(ASK IF WRKVER=2)

WRKCH2. Let's now review which household members are employed.

(PROGRAMMER: Cycle back through all WRKR_# questions.)

[IF STUDYTYPE=1 ASK HIS_DATE; IF STUDYTYPE=0 ASK GPS_DATE]

HIS_DATE. As I mentioned earlier, we'd like to send [PROGRAMMER: If HHSIZE=1 SHOW: "you", ELSE SHOW: "each member of your household over the age of 5"] a diary to keep track of travel for a 24-hour period. Your household's assigned travel date is <<MM/DD/YYYY>>

<INSERT DAY OF WEEK AND DATE OF TRAVEL DAY>
<INSERT DAY OF WEEK AND DATE OF TRAVEL DAY>
<INSERT DAY OF WEEK AND DATE OF TRAVEL DAY>
<INSERT DAY OF WEEK AND DATE OF TRAVEL DAY>
<INSERT DAY OF WEEK AND DATE OF TRAVEL DAY>

98	Don't know	**(GO TO ASSURE)**
99	Refused	**(GO TO END3)**

[SKIP TO MAILADD]

GPS_DATE As I mentioned earlier, we'd like to send [PROGRAMMER: If HHSIZE=1 SHOW: "you", ELSE SHOW: "each member of your household 13 years and up"] a travel diary to easily record their travel information and a GPS device(s) with simple instructions for you to carry the device with you on the same day you record your travel information. Your household is assigned to travel on <MM/DD/YYYY>. Is this date good for you and your household?

What about . . . ?

<INSERT DAYS OF WEEK AND DATE OF TRAVEL DAYS>
<INSERT DAYS OF WEEK AND DATE OF TRAVEL DAYS>
<INSERT DAYS OF WEEK AND DATE OF TRAVEL DAYS>
<INSERT DAYS OF WEEK AND DATE OF TRAVEL DAYS>

998	Don't know	**(GO TO ASSURE)**
999	Refused	**(GO TO END3)**

ASSURE. Your household will represent many others in the region, and no one else can be substituted for you. Your input will help the Met Council better understand how and why people travel in the region. Will you help us out with this important project?

01	Yes – willing to participate	**(GO BACK TO HIS/GPSDATE)**
02	No – not willing to participate	**(TERMINATE)**
98	Don't Know	**(TERMINATE)**
99	Refused	**(TERMINATE)**

ASK ALL

MAILADD. In order to mail the project materials to you, I need to verify that your MAILING address is USE SAMPLE MAILING ADDRESS…?
(VERIFY/EDIT ADDRESS OR RECORD NEW STREET ADDRESS)
(BE SURE TO INCLUDE APARTMENT NUMBER, IF APPLICABLE)

ASK ALL

MAILCITY. City?

(RECORD NUMBER FOR APPROPRIATE CITY FROM CITY LIST)
(RECORD 9996 FOR OTHER SPECIFY)

ASK ALL
MAILSTAT. State?

001 Minnesota
002 Wisconsin
996 Other (Specify _____)

ASK ALL
MAILZIP. Zip code?
(VERIFY/EDIT ZIP CODE OR RECORD NEW ZIP CODE)

__ __ __ __ __
<INSERT ZIP>

ASK ALL
MAILTYPE. INTERVIEWER: RECORD IF THE ADDRESS IS …

01 Normal street address
02 P O Box

ASK ALL
MAILATTN. To whom should we address the envelope?
[INTERVIEWER NOTE: RECORD FULL NAME. DO NOT enter same or same as above. We must retype first and last name and verify spelling]
[INTERVIEWER NOTE: If refused or don't know insert "Current Resident".]

_____

(ASK IF MAILTYPE=1)
MAILHOME. Is this your home address?

01 Yes (GO TO HOMETYP)
02 No (GO TO HOMEADD)

(ASK IF MAILTYPE=2 OR MAILHOME=2)
HOMEADD. So we know where most of your trips will begin, I need to know the location of your home. What is your home address?
(INTERVIEWER: Do NOT record a P O Box. Record the PHYSICAL ADDRESS of the household, even if mail cannot be received at this address.)
(RECORD HOME STREET NAME AND NUMBER)

(ASK IF MAILTYPE=2 OR MAILHOME=2)
HOMECITY. City?

(RECORD NUMBER FOR APPROPRIATE CITY FROM CITY LIST)
(RECORD 9996 FOR OTHER SPECIFY)

(ASK IF MAILTYPE=2 OR MAILHOME=2)
HOMESTAT. INTERVIEWER: HIT "1" TO CONTINUE

01 Minnesota
02 Wisconsin

(ASK IF MAILTYPE=2 OR MAILHOME=2)
HOMEZIP. Zip code?
(RECORD ZIP CODE)

— — — — —

Now just a few final questions . . .

HOMETYP What type of housing do you live in?
01 Single family home
02 Mobile home / Manufactured home
03 Townhome,[GO TO UNITS]
04 Duplex, triplex or fourplex [GO TO UNITS]
05 Apartment [GO TO UNITS]
06 Condominium or cooperative [GO TO UNITS]
07 Group housing, assisted living, or other institutional housing [GO TO TENURE]

96 Other: [SPECIFY]
98 Don't Know
99 Refused

UNITS If you live in a condo or apartment building or other attached housing, how many housing units are in your specific building (or townhouse block)?

_ _ (Allow 2 to 100 units) (100=100 units or more)

998 Don't Know
999 Refused

OWNRENT Do you own or rent this home?
01 Own / buying
02 Rent
07 OTHER, SPECIFY
08 Don't know
09 Refused

TENURE How long have you lived at this address?
01 Less than 2 years
02 2-5 years
03 6-10 years
04 More than 10 years

98 Don't know
99 Refused

RENT What is the amount of your regular required payments for your home?
(ENTER VERBATIM—FOR EXAMPLE, IF $500 IT SHOULD BE ENTERED 500)
(INTERVIEWER NOTE: This refers to your rent payment or mortgage payment, including maintenance and assessment fees.)
(IF MORE THAN ONE MORTAGE PAYMENT OR RENT PAYMENT ASK FOR THE REGULAR AMOUNT FOR THE ADDRESS THEY LIVE IN)

99997 HOME IS PAID FOR **(GO TO HHINC)**
99998 Don't know
99999 Refused

PAYMNT Do you make these payments . . .
01 monthly,
02 biweekly (every 2 weeks),
03 quarterly, or
07 Some other way – Specify

98 Don't know
99 Refused

HHINC. In order to be sure that the project accurately represents all residents, could you tell me if the total 2009 combined annual income for your HOUSEHOLD is …?
(IF NEEDED: "I understand your reluctance to divulge your household income. However, I can assure you that this information is used for classification purposes only. We must be sure that our project accurately represents residents, and income is an important factor in projecting transportation needs.")
(READ LIST)

01	Below $50,000	**(GO TO INC_U50)**
02	$50,000 or above	**(GO TO INC_O50)**

98 Don't Know
99 Refused

(ASK IF HHINC=1)

INC_U50. Please stop me when I get to the category that best describes the total 2009 combined income for everyone living in your household. Was it …?
(IF NEEDED: "I understand your reluctance to divulge your household income. However, I can assure you that this information is used for classification purposes only. We must be sure that our project accurately represents residents, and income is an important factor in projecting transportation needs.")

01 less than $5,000
02 $5,000 but less than $10,000
03 $10,000 but less than $15,000
04 $15,000 but less than $20,000
05 $20,000 but less than $25,000
06 $25,000 but less than $30,000
07 $30,000 but less than $35,000

08 $35,000 but less than $40,000
09 $40,000 but less than $45,000
10 $45,000 but less than $50,000
98 Don't know
99 Refused

[SKIP TO OTHPHONE]

(ASK IF HHINC=2)

INC_O50. Please stop me when I get to the category that best describes the total 2009 combined income for everyone living in your household. Was it …?
(IF NEEDED: "I understand your reluctance to divulge your household income. However, I can assure you that this information is used for classification purposes only. We must be sure that our project accurately represents Minnesota residents, and income is an important factor in projecting transportation needs.")

01 $50,000 but less than $60,000
02 $60,000 but less than $75,000
03 $75,000 but less than $100,000
04 $100,000 but less than $125,000
05 $125,000 but less than $150,000
06 $150,000 but less than $200,000
07 $200,000 but less than $250,000
08 $250,000 or more
98 Don't know
99 Refused

OTHPHONE. For future contact, where is the best place to reach you in the evenings?
(DO NOT READ LIST. PROMPT, IF NEEDED.)

01 Home
02 Work **(GO TO O_NUM)**
03 Cell phone **(GO TO O_NUM)**
04 Other **(GO TO O_NUM)**

98 Don't Know
99 Refused

(ASK IF OTHER>1 AND OTHER<98)

OTHNUM. Can I have that number please?
(RECORD PHONE NUMBER TO REACH RESPONDENT AT)

(__ __ __) __ __ __ - __ __ __ __

Ask All

EMAIL We may need to contact you to verify some of your travel information. Can we have your email address for this follow-up?

_____ @ _____ Email Address (Confirm spelling and punctuation)
7 Don't have one
8 Preferred to be contacted by phone
9 Refused to give address

[IF STUDYTYPE=1 READ HISEND; IF STUDYTYPE=0 RESEND GPSEND

HISEND. That completes this portion of the project. The travel diaries will be sent to you via standard postal service and need to be completed on **<INSERT TRAVEL DATE**>. An Abt SRBI interviewer will call to collect your household's travel information over the phone the day after your assigned travel day or within a few days if we have trouble reaching you. If you prefer you may also enter your information online (information provided in travel packet) or mail your diaries back using the postage-paid return envelope provided in your travel packet.

If you have any questions, a toll-free number will be provided with your travel packet.

Your household's participation in this project is greatly appreciated. Thank you for your time.

(ONLY PROVIDE IF REQUESTED: 1-877-699-4344)

GPSEND That completes this portion of the project. The GPS devices and travel diaries will be sent to you via **<INSERT 'FedEx' IF MAILTYP=1 OR INSERT 'mail' IF MAILTYP=2> before your assigned travel day. Your assigned travel day is <INSERT TRAVEL DATE>.** Our staff will call to remind you when to start recording information in your travel diary and using the GPS devices. An Abt SRBI interviewer will call to collect your household's travel information over the phone the day after your assigned travel day or within a few days if we have trouble reaching you. You also have the option of going online or mailing the diaries back with the GPS devices.

If you have any questions, a toll-free number will be provided in your travel packet, along with instructions for your travel day.

Your household's participation in this project is greatly appreciated. Thank you for your time.

END3. I am sorry, <those are/that is> the only travel date(s) available at this time. We will have someone contact you at a later date if additional travel dates become available.

This concludes our survey. Thank you for your participation. Your time and opinions are valued.

D. Diary Survey Instrument

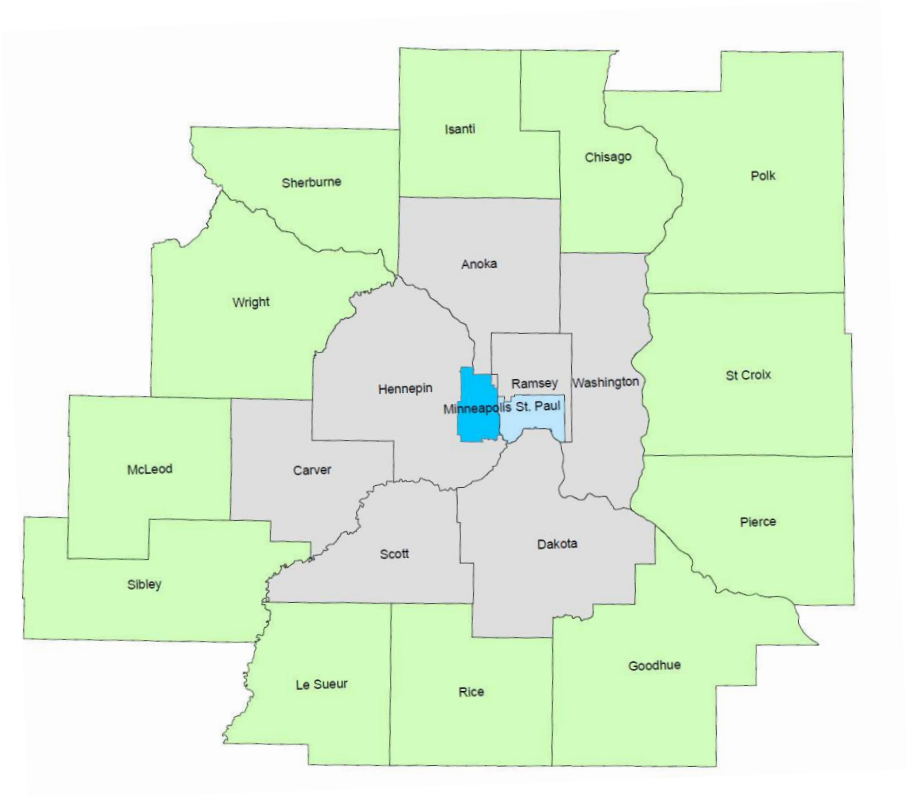
Source: Abt SRBI, Cambridge Systematics, and Metropolitan Council, 2011.

Notes/Additional Locations & Travel

Thank you for your participation in this important study. Enter your travel information by logging on to:

www.opinionport.com/metrocounciltraveldiary

If you don't have access to the Internet, don't worry, someone will call your home in the days following your travel date to collect the information over the phone. Or, if you prefer, you can mail the diary back using the return envelope we provided in the travel packet.



One-Day Travel Diary

Metropolitan Council

MINNESOTA DEPARTMENT OF TRANSPORTATION

WISCONSIN DEPARTMENT OF TRANSPORTATION

Person Information

School Information ☐ Not a student – Skip to Work Information

☐ In pre-school/nursery school ☐ K-12 student ☐ Vocational/Technical

☐ Full-time college/graduate student ☐ Part-time college/graduate student

School/College Name: _____

Location: _____ _____

Street Address or Closest Intersection *City, State, Zip*

Work Information ☐ Not currently employed – Skip to Page 2

If you have more than one job, please reference the job where you spend the most hours

Where do you work? _____

Name of Employer

_____

Type of Business

_____

Street Address or Closest Intersection

_____

City, State, Zip

Does your job involve…? ☐ Evenings (6 PM to 12 AM) ☐ Overnight shifts (12 AM to 5 AM)

Does your job usually require you to make 5 or more work-related trips during the course of an average workday?

☐ No ☐ Yes --→ If yes, how many trips on average? _____ Trips

Average hours worked per week? _____ Hours

Which of the following best describes your work schedule?

☐ "I have no flexibility in my work schedule."
☐ "I have some flexibility in my work schedule."
☐ "I'm pretty much free to adjust my schedule as I like."

Does your employer offer compressed workweek options? (e.g. 40 hrs in less than 5 days)

☐ Yes ☐ No ☐ Don't know

What is your employer's industry?

☐ Agriculture, Forestry, Fishing and Hunting
☐ Mining
☐ Utilities
☐ Construction
☐ Manufacturing
☐ Wholesale Trade
☐ Retail Trade
☐ Transportation and Warehousing
☐ Information
☐ Finance and Insurance
☐ Real Estate, Rental/Leasing
☐ Professional, Scientific and Technical Services
☐ Management of Companies and Enterprises
☐ Administrative and Support, Waste Management, Remediation Services
☐ Educational Services
☐ Health Care and Social Services
☐ Arts, Entertainment and Recreation
☐ Accommodation and Food Services
☐ Public Administration/ Government
☐ Other Services
☐ Military
☐ Other _____

Travel: How did you get to Location 12?

1. What type(s) of transportation did you use to go to Location 12?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 12

5. When did you arrive at Location 12? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____
Name of Location 12

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ _____
Street Address Type of Place or Business

_____ _____
City, State, Zip Code Nearest Cross Streets

7. A. What was your primary activity at Location 12? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 12, if any? _____ _____ _____

8. When did you leave Location 12? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 11?

1. What type(s) of transportation did you use to go to Location 11?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 11

5. When did you arrive at Location 11? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this?

_____
Name of Location 11

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ _____
Street Address Type of Place or Business

_____ _____
City, State, Zip Code Nearest Cross Streets

7. A. What was your primary activity at Location 11? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 11, if any? _____ _____ _____

8. When did you leave Location 11? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Instructions for One-Day Travel Diary

- Use this diary on your assigned travel day, shown on your cover letter. Begin at 3:00 AM on your assigned travel day and continue until you go to sleep that night.
- For each stop, even quick stops for coffee or gas, dropping off or picking up someone, or at a drive-thru window, fill out one page for each location. If uncertain whether to include a stop as a location, go ahead and include it.
- Record the EXACT time that you arrive and leave each location.
- Provide as much address information as you can. Include:
  - street address
  - type of place or business
  - nearest cross streets
- Record your primary activity (what you did) at each location. (*Refer to Activity Choices on Page 4.)*
- If you take a round-trip without stopping at a location (walk the dog or ride around in the car), record the furthest point of the trip as the location and what you do there as TURN AROUND. (*Refer to Activity Choice 21 on Page 4.)*
- If you park your car and walk AT LEAST five minutes to your destination, record your type of transportation as car first, then walk. If you walk AT LEAST five minutes from a bus to your destination, record your transportation as bus first, then walk.
- If your work involves frequent travel - truck driver, sales person, taxi driver, etc. - record where and when you start work and where and when you end work. Do not include work-related stops. If you make non-work related stops between work stops, record those locations.
- If children under the age of 6 accompany you on any trip, please include them when reporting on question 4 of each travel section. We want to know about all individuals who travel with you.
- If you make more than 12 trips on your travel day please report all 12 trips in the diary format. For trips 13 and above, please turn to the very last page of the diary and report the additional trips.
- An example of a travel day begins on page 3.

If you have any questions, please call or e-mail:
1-877-699-4344 or MCtravelsurveyhelp@srbi.com

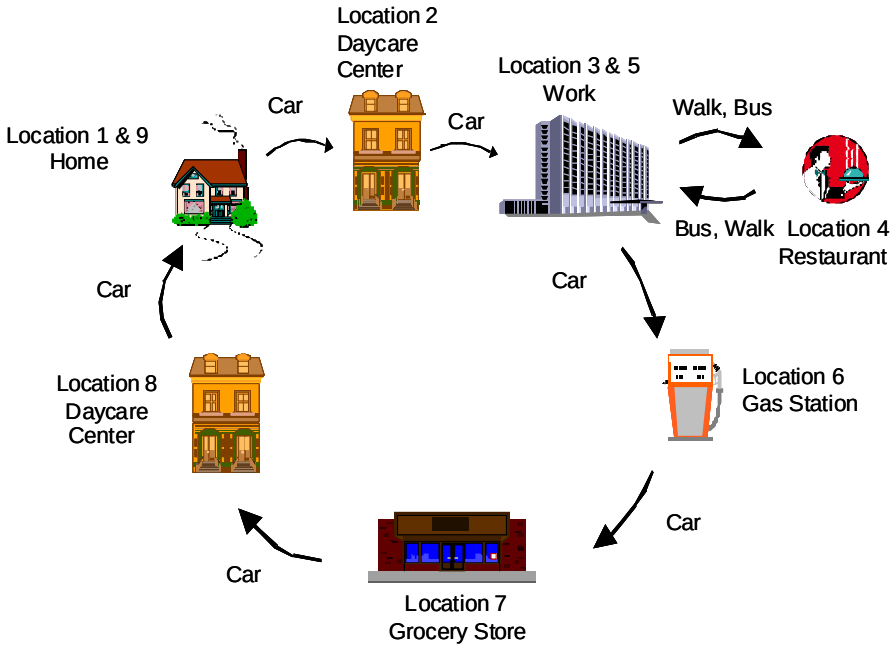
Example of a Travel Day

Chris has a busy day.

In addition to having to work a full day, he needs to drop off and pick up his 3 year old son Michael at daycare, have lunch with his mother-in-law, make sure to get gas, stop at the grocery store, and make it home by 7 pm for his favorite television show.

Despite the busy day, Chris diligently records all his trips, activities, and modes of transportation. This is what it looks like.

Chris' Day of Travel



Travel: How did you get to Location 10?

1. What type(s) of transportation did you use to go to Location 10?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 10

5. When did you arrive at Location 10? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this?

_____
Name of Location 10

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ _____
Street Address Type of Place or Business

_____ _____
City, State, Zip Code Nearest Cross Streets

7. A. What was your primary activity at Location 10? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 10, if any? _____ _____ _____

8. When did you leave Location 10? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 9?

1. What type(s) of transportation did you use to go to Location 9?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 9

5. When did you arrive at Location 9? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____
Name of Location 9

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ Street Address

_____ Type of Place or Business

_____ City, State, Zip Code

_____ Nearest Cross Streets

7. A. What was your primary activity at Location 9? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 9, if any? _____ _____ _____

8. When did you leave Location 9? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

At each location, Chris had to determine his primary activity completed and then any other activities. The list below helped him in making the determination.

Activity Choices: What you do at locations

1. HOME – PAID WORK
2. HOME – UNPAID WORK (general maintenance, car repair, housekeeping)
3. HOME – OTHER (sleeping, eating, watching TV, etc.)
4. WORK (employment and job-related activities)
5. ATTEND CHILDCARE (daycare, pre-school, etc.)
6. ATTEND SCHOOL (K-12)
7. ATTEND COLLEGE (college or university, graduate or professional school)
8. OTHER SCHOOL ACTIVITIES (performances, meetings)
9. QUICK STOPS (ATM, a cup of coffee)
10. PERSONAL BUSINESS (banking, medical, salon, etc.)
11. MAJOR SHOPPING (appliances, cars, home furnishings, clothes, etc.)
12. EVERYDAY SHOPPING (grocery, drug store, gas, etc.)
13. SOCIAL (visit friends, relatives, etc.)
14. RECREATION – PARTICIPATE (sports, exercise, park, museum, etc.)
15. RECREATION – WATCH (movies, sports events, etc.)
16. EAT OUT (restaurant, drive-thru, etc.)
17. RELIGIOUS/COMMUNITY (worship, wedding, funeral, meetings, volunteer work, etc.)
18. ACCOMPANY ANOTHER PERSON (child accompanies parent to food store, etc.)
19. PICK-UP PASSENGER(S)
20. DROP-OFF PASSENGER(S)
21. TURN AROUND (to travel back from furthest point on dog walk, etc.)

Chris recorded each trip made that day: where the trip began, the primary activity, the types of transportation, the times the trip began and ended, and the friends or family that went with him. See an example of Chris' day beginning at 3:00 A.M.

DIARY EXAMPLE

Where were you at 3:00 AM?

1. ☐ Traveling – **GO TO NEXT TRAVEL**
☒ At a location

2. Where is this?

Home
Name of Location 1

715 Lovely Lane
Street Address

Anytown, MN 55401
City, State, Zip Code

Residential
Type of Place or Business

Lovely Lane & Sea Way
Nearest Cross Streets

3. A. What was your primary activity at Location 1? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☒3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 1, if any? _____ _____ _____

4. When did you leave Location 1? __7__ : __1__ __5__ ☒ AM ☐ PM ☐ Did Not Leave

EXAMPLE

Travel: How did you get to Location 8?

1. What type(s) of transportation did you use to go to Location 8?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 8

5. When did you arrive at Location 8? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this?

Name of Location 8

If address already reported, provide location name and ***GO TO QUESTION 7***

Street Address

Type of Place or Business

City, State, Zip Code

Nearest Cross Streets

7. A. What was your primary activity at Location 8? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 8, if any? _____ _____ _____

8. When did you leave Location 8? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 7?

1. What type(s) of transportation did you use to go to Location 7?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 7

5. When did you arrive at Location 7? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____ Name of Location 7

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ Street Address

_____ Type of Place or Business

_____ City, State, Zip Code

_____ Nearest Cross Streets

7. A. What was your primary activity at Location 7? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 7, if any? _____ _____ _____

8. When did you leave Location 7? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 2? DIARY EXAMPLE

1. What type(s) of transportation did you use to go to Location 2?

1st	→	2nd (if needed)	→	3rd (if needed)
1				

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☒ Driver ☐ Passenger

B. Was this vehicle from your household? ☒ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☒ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . 2 5 Was the rate…? ☒ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

Michael , _____ , _____ , _____

Location 2 DIARY EXAMPLE

5. When did you arrive at Location 2? ___ 7 : 4 2 ☒ AM ☐ PM

6. Where is this? Anytown Daycare Name of Location 2

If address already reported, provide location name and ***GO TO QUESTION 7***

123 Main St Street Address

Daycare Type of Place or Business

Anytown, MN 55401 City, State, Zip Code

Main St & Elm Rd Nearest Cross Streets

7. A. What was your primary activity at Location 2? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☒20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 2, if any? _____ _____ _____

8. When did you leave Location 2? ___ 7 : 4 5 ☒ AM ☐ PM ☐ Did Not Leave

Start Recording Your Travel Here

Record travel for your assigned travel day.

Where were you at 3:00 AM?

1. ☐ Traveling – **GO TO QUESTION 1 ON PAGE 8**
☐ At a location

2. Where is this?

Name of Location 1

Street Address | Type of Place or Business

City, State, Zip Code | Nearest Cross Streets

3. A. What was your primary activity at Location 1? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 1, if any? _____ _____ _____

4. When did you leave Location 1? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 6?

1. What type(s) of transportation did you use to go to Location 6?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 6

5. When did you arrive at Location 6? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this?

Name of Location 6

If address already reported, provide location name and ***GO TO QUESTION 7***

Street Address | Type of Place or Business

City, State, Zip Code | Nearest Cross Streets

7. A. What was your primary activity at Location 6? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 6, if any? _____ _____ _____

8. When did you leave Location 6? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 5?

1. What type(s) of transportation did you use to go to Location 5?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 5

5. When did you arrive at Location 5? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____ Name of Location 5

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ Street Address _____ Type of Place or Business

_____ City, State, Zip Code _____ Nearest Cross Streets

7. A. What was your primary activity at Location 5? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 5, if any? _____ _____ _____

8. When did you leave Location 5? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 2?

1. What type(s) of transportation did you use to go to Location 2?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 2

5. When did you arrive at Location 2? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____ Name of Location 2

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ Street Address _____ Type of Place or Business

_____ City, State, Zip Code _____ Nearest Cross Streets

7. A. What was your primary activity at Location 2? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 2, if any? _____ _____ _____

8. When did you leave Location 2? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 3?

1. What type(s) of transportation did you use to go to Location 3?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 3

5. When did you arrive at Location 3? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____ Name of Location 3

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ Street Address _____ Type of Place or Business

_____ City, State, Zip Code _____ Nearest Cross Streets

7. A. What was your primary activity at Location 3? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 3, if any? _____ _____ _____

8. When did you leave Location 3? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

Travel: How did you get to Location 4?

1. What type(s) of transportation did you use to go to Location 4?

1st	→	2nd (if needed)	→	3rd (if needed)

1 Car, van, truck	4 Public Bus	7 Amtrak	10 Taxi/Shuttle
2 Walk	5 Light Rail (Hiawatha)	8 Bicycle	11 Dial-A-Ride
3 School Bus	6 Commuter Rail (Northstar)	9 Motorcycle/Moped	12 Other (specify)_____

2. If you used a bus/train for this trip, did you use a pass? ☐ Yes ☐ No --→ How much did you pay?_____

3. If you used a car/van/truck or motorcycle/moped for this trip . . .

A. Were you the . . .? ☐ Driver ☐ Passenger

B. Was this vehicle from your household? ☐ Yes ☐ No

C. Did you pay a toll? ☐ Yes ☐ No

D. How much, in total, did you personally pay for parking? ☐ Nothing

$ ____ ____ . ____ ____ Was the rate…? ☐ Hourly ☐ Daily ☐ Monthly ☐ Other

4. A. Including yourself, how many people were with you on this trip? 1 2 3 4+

B. Including yourself, how many were household members? 1 2 3 4+

C. Which household members were with you?

_____ , _____ , _____ , _____

Location 4

5. When did you arrive at Location 4? ___ ___ : ___ ___ ☐ AM ☐ PM

6. Where is this? _____ Name of Location 4

If address already reported, provide location name and ***GO TO QUESTION 7***

_____ Street Address _____ Type of Place or Business

_____ City, State, Zip Code _____ Nearest Cross Streets

7. A. What was your primary activity at Location 4? (check only ONE box)

☐1 Home – Paid Work	☐8 Other School Activities	☐15 Recreation–Watch
☐2 Home – Unpaid Work	☐9 Quick Stops	☐16 Eat Out
☐3 Home – Other	☐10 Personal Business	☐17 Religious/Community
☐4 Work	☐11 Major Shopping	☐18 Accompany Another Person
☐5 Attend Childcare	☐12 Everyday Shopping	☐19 Pick-Up Passenger
☐6 Attend School	☐13 Social	☐20 Drop-Off Passenger
☐7 Attend College	☐14 Recreation–Participate	☐21 Turn Around

B. Other activities at Location 4, if any? _____ _____ _____

8. When did you leave Location 4? ___ ___ : ___ ___ ☐ AM ☐ PM ☐ Did Not Leave

E. Diary Survey Instructions

Metropolitan Council

Dear «MAILATTN»:

Many thanks to you and your household for agreeing to participate in this very important travel study. Whether you travel by car, bus, bike, or on foot, our daily commutes to work, errands around town, personal business, and everything in between is so important. You should have received a travel diary for each person in your household **over the age of five** to participate in the study. Participation is as easy as 1, 2, 3.

1. **Please make sure to read the instructions and go over the example provided in the diary before your scheduled travel date.**

2. **At 3 a.m. on <<INSERT TRAVEL DAY>> begin recording every trip made, whether it is typical or not; continuing until you have finished traveling for the day.**

3. **Log on to www.opinionport.com/metrocounciltraveldiary using your unique household password and enter the data you recorded in your travel diary. Your password is <<PASSWORD>>.**

If you don't have access to the Internet, don't worry, someone will call your home in the days following your travel date to collect the information over the phone. Or, if you prefer, you can mail the diary back using the return envelope we provided in this packet.

Remember, the information you provide will be kept **confidential** and **secure**.

If you have questions about filling out the travel diaries, contact *Abt SRBI* at 1-877-699-4344 or email us at MCtravelsurveyhelp@srbi.com.

Thank you for your household's participation in improving transportation in your community!

Sincerely,

Jonathan Ehrlich
Project Manager,
Metropolitan Council

James Henrickson
Minnesota Department
of Transportation

James Koenig
Minnesota Department
of Transportation

www.metrocouncil.org

390 Robert Street North • St. Paul, MN 55101-2229 • (651) 602-1005 • Fax (651) 602-1138 • TTY (651) 291-0904

An Equal Opportunity Employer

Source: Abt SRBI and Metropolitan Council, 2011.

F. Recruit Survey – Data Dictionary

Source: Abt SRBI, 2012.

Appendix F. Data Dictionary for Households in the Recruit Survey

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Compuation
PASSWORD	PASSWORD	Household Password	Alphanumeric Variable	Household Record	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly Assigned
HHID	HHID	6-DIGIT UNIQUE ID FOR EACH HH RECORD	Numeric Variable	Household Record	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly Assigned
QKEY	QKEY	Household Sample ID Number	Numeric Variable	Household Record	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly Assigned
STUDYTYPE	STUDYTYP	Participation in HIS or GPS subsample	0=GPS 1=HIS	Household Record	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly Assigned
PHONEMATCH	PHONEMAT	Sample Record Matched to Phone Number	0=Unmatched 1=Matched	Household Record	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly Assigned
MAILWAVE	MAILWAVE	Wave Assignment of HH	1=PILOT/FALL 2010 2=MARCH 2011 3=APRIL 2011 4=MAY 2011 5=JUNE THRU AUGUST 2011 6=Targeted 8=University Sample	Household Record	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly Assigned
RECRUITMODE	RECRUITM	Method of recruitment	1=Phone 2=Web	Household Record	Abt SRBI	Assigned	All participants	Recruitment	RECRUITMODE
RETRIEVEMODE	RETRIEVE	Method of Retrieval	0=Not Yet Retrieved 1=Phone 2=Web 3=Mail 4=Multiple modes	Person Record	Abt SRBI	Assigned	All participants	Retrieval	DIARY
TRVDATE	TRVDATE	Assigned Travel Date	YYYYMMDD	Household Record	Abt SRBI	Assigned	All participants	Recruitment	TDATE

TRVWEEK	TRVWEEK	Scheduled Travel Week	1=Week of 12/5 2=Week of 12/12 3=Week of 12/19 4=Week of 12/26 5=Week of 01/02 6=Week of 01/10 7=Week of 01/16 8=Week of 01/23 9=Week of 01/30 10=Week of 02/06 11=Week of 02/13 12=Week of 02/20 13=Week of 02/27 14=Week of 03/06 15=Week of 03/13 16=Week of 03/20 17=Week of 03/27 18=Week of 4/3 19=Week of 4/10 20=Week of 4/17 21=Week of 4/24 22=Week of 5/1 23=Week of 5/8 24=Week of 5/15 25=Week of 5/22 26=Week of 5/29 27=Week of 6/5 28=Week of 6/12 29=Week of 6/19 30=Week of 6/26 31=Week of 7/3 32=Week of 7/10 33=Week of 7/17 34=Week of 7/24 35=Week of 7/31 36=Week of 8/7 37=Week of 8/14 38=Week of 8/21 39=Week of 8/28	Household Record	Abt SRBI	Survey Response	Randomly generated (HTS ONLY)	Sample	Randomly Assigned
HHCOMP	HHCOMP	Completed Household	0=Not Completed 1=HIS Completed 2=GPS Completed	Household Record	Abt SRBI	Calculated	Identifies whether or not a household completed (NEED DETERMINE DEFINITION OF COMPLETED HH)	Recruitment	Based on when retrieval is completed
EXHHCOMP	EXHHCOMP	Expanded Completed Household	0=Not Completed 1=HIS Completed 2=Partial HIS Completed 3=GPS Completed 4=Partial GPS Completed 5=University HH Completed	Household Record	Abt SRBI	Calculated	Expands and identifies whether or not a household completed (for different components of the study)	Recruitment	Based on when retrieval is completed

GPSCOMPSTATUS	GPSCOMPS	GPS Household Completion Status	0=Not a GPS Household 1=Neither complete 2=Diary complete but not GPS 3=GPS complete but not Diary 4=Completed entire study 5=Some household members completed both, others did not	Household Record	Abt SRBI	Calculated	Identifies completion scenarios for households participating in the GPS component of the study	Recruitment/GPS	Based on retrieval of diaries and GPS units
GPSSTUDY	GPSSTUDY	GPS Pilot/Main Study	0=HTS ONLY 1=Pilot (Feb 21 thru May 1st) 2=Main (May 15 thru Oct 1st)	Household Record	Abt SRBI	Assigned	Identifies study phase for GPS participants.	Recruitment	Based on recruit date
COMPMONTH	COMPMONT	Month of HH Completion	0=Not Yet Completed 1=January-2011 2=February-2011 3=March-2011 4=April-2011 5=May-2011 6=June-2011 7=July-2011 8=August-2011 9=September-2011 10=October-2011 11=November-2011 12=December-2010	Household Record	Abt SRBI	Survey Response	This variable captures when a household is defined as complete	Recruitment	Based on when retrieval is completed
INCENTIVEAMNT	INCNTAMN	Incentive Amount	-1=Not eligible for incentive	Household Record	Abt SRBI	Assigned	This variable indicates how many households are to receive a certain incentive amount	Recruitment	Based on study parameters
INCENTSENT	INCNTYPE	Household Classification Receiving Incentive	0=NOT INCENTED/NOTCOMP 1=GPS HH 2=HTS HH 3=UNVRSTY HH 4=GPS HH NO INCENT	Household Record	Abt SRBI	Assigned	Identifies households who were sent an incentive.	Retrieval/GIS	Based on retrieval of diaries and/or GPS units
SUBSAMPLE	SUBSAMPL	Household Subsample Classification	1=University Household 2=MNPass Household 3=University/MNPass Household 4=No Classification	Household Record	Abt SRBI	Assigned	Identifies households within subsamples	Recruitment	SUBSAMPLE
UNIVREMIND	UNIRMNDL	University Household Received a Reminder Letter	0=Not University Household/Did not receive letter 1=Receieved a reminder letter	Household Record	Abt SRBI	Assigned	Identifies University households who received a reminder letter	Sample	UNIVREMIND
HHTRIPS	HHTRIPS	Total Trips Made by Household	-1=Not yet Retrieved	Trip Record	Abt SRBI	Calculated	All participants	Retrieval	LOC#
MARKET	MARKET	Geographic Area	1=St. Paul 2=Minnepolis 3=7-county metropolatin area 4=Minnesota collar counties 5=Wisconsin counties 9=University Sample (TBD)	Household Record	Abt SRBI	Sample	Collapsed geographic area	Sample	Based on sample address

AREA	AREA	Verified Geographic Area	1=ST. PAUL, MN 2=MINNEAPOLIS, MN 3=ANOKA, MN 4 =CARVER, MN 5=DAKOTA, MN 6=HENNEPIN, MN 7=SCOTT, MN 8=RAMSEY, MN 9=WASHINGTON, MN 10=CHISAGO, MN 11=GOODHUE, MN 12=ISANTI, MN 13=LE SUEUR, MN 14=MCLEOD, MN 15=RICE, MN 16=SHERBURNE, MN 17 =SIBLEY, MN 18 =WRIGHT, MN 19=PIERCE, WI 20=POLK, WI 21=ST. CROIX, WI	Household Record	Abt SRBI	Sample	Expanded geographic area	Recruitment	Self-reported (AREA)
FUTURE	FUTURE	Agreed to Participate in Future Research	0=Not yet Responded/Did Not Respond 1=Yes 2=No 98=Don't Know 99=Refused	Household Record	Abt SRBI	Survey Response	This will be agreed upon in the retrieval to ensure completed households	Retrieval	FUTURE
HOMEADD	HOMEADD	Home Address	Alphanumeric Variable	Household Record	Abt SRBI	Sample	All participants	Sample	Sample address/Self-Report
HOMECITY	HOMECITY	Home City	Alphanumeric Variable	Household Record	Abt SRBI	Sample	All participants	Sample	Sample address/Self-Report
HOMESTAT	HOMESTAT	Home State	Alphanumeric Variable	Household Record	Abt SRBI	Sample	All participants	Sample	Sample address/Self-Report
HOMEZIP	HOMEZIP	Home Zip Code	Numeric Variable	Household Record	Abt SRBI	Sample	All participants	Sample	Sample address/Self-Report
HOMELON	HOMELON	Home Longitude	-180.000000 to 0.00000000 ; " . "=Missing	Household Record	Abt SRBI	Generated	All participants	GIS	Sample address/Self-Report
HOMELAT	HOMELAT	Home Latitude	00.000000 to 99.999999; "."=Missing	Household Record	Abt SRBI	Generated	All participants	GIS	Sample address/Self-Report
HOMESTATUS	HOMESTA1	Status of Original Home Address	-1=Not Yet Geocoded 0=Unmatched 1=Matched	Household Record	Abt SRBI	Assigned	All participants	GIS	ArcGIS generated
HOMESCORE	HOMESCOR	ESRI Confidence Score of Home Address	-1=Not yet Geocoded	Household Record	Abt SRBI	Assigned	All participants	GIS	ArcGIS generated
HOMEMATCHTYP	HOMEMATC	Automatic or Manual Match of Home Address	-1=Not Yet Geocoded 0=Manual 1=Automatic	Household Record	Abt SRBI	Assigned	All participants	GIS	ArcGIS generated
THHSIZE	THHSIZE	Total Number of Persons in HH	10=10 or more individuals	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	THHSIZE
HHSIZE6	HHSIZE6	Total Number of Persons over the age of 5	10=10 or more individuals	Person Record	Abt SRBI	Calculated	All participants over age 5	Recruitment	HHSIZE, SAGE, AGE
LIFECYCLE	LIFECYCL	Household Type (a.k.a Household Lifecycle)	1= Adult HH 2= Adult Student HH 3= HH with children 4= Retiree	Person Record	Abt SRBI	Calculated	All participants	Recruitment	SAGE, AGE, WORKER, STUDENT

INCOME	INCOME	HH Income	1=Less than $5,000 2=$5,000 but less than $10,000 3=$10,000 but less than $15,000 4=$15,000 but less than $20,000 5=$20,000 but less than $25,000 6=$25,000 but less than $30,000 7=$30,000 but less than $35,000 8=$35,000 but less than $40,000 9=$40,000 but less than $45,000 10=$45,000 but less than $50,000 11=$50,000 but less than $60,000 12=$60,000 but less than $75,000 13=$75,000 but less than $100,000 14=$100,000 but less than $125,000 15=$125,000 but less than $150,00 16=$150,000 but less than $200,000 17=$200,000 but less than $250,000 18=$250,000 or more 96=Below $50,000 97=Above $50,000 98=Don't know 99=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	HHINC, INC_U50, INC_O50
WORKERS	WORKERS	Number of Workers in HH	Numeric Variable	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	WRKRS
STUDENTS	STUDENTS	Number of Students in HH	Numeric Variable	Person Record	Abt SRBI	Calculated	All participants	Recruitmet	total number 1 AND 2 SCH_1-SCH_10
DRIVERS	DRIVERS	Number of Drivers in HH	Numeric Variable	Person Record	Abt SRBI	Calculated	All participants	Recruitment	total number 1's LDRV_1-LDRV_10
DISABLE	DISABLE	Number of HH members with a disability or impairment	Numeric Variable	Person Record	Abt SRBI	Calculated	All participants	Recruitment	DISABLE1 to DISABLE10
TOTVEH	TOTVEH	Number of HH vehicles	10=10 or more vehicles	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	TOTVEH
quotaREGION	QUOTAREG	Quota Region Classifications	0=Out of Region 1=Minneapolis 2=St. Paul 3=CORE WEST (C/H)--Sub. Minneapolis 4=CORE EAST (A/R/W)--Sub. St. Paul 5=CORE SOUTH (D/S)--MPO Core 6=Ring Counties, MN 7=Ring Counties, WI	Household Record	Abt SRBI	Assigned	All participants	Recruitment	AREA
quotaHHSIZE	QUOTAHHS	Quota Household Size Classifications	4=4 or more	Household Record	Abt SRBI	Assigned	All participants	Recruitment	THHSIZE
quotaTOTVEH	QUOTATOT	Quota Household Vehicle Classifications	4=4 or more	Household Record	Abt SRBI	Assigned	All participants	Recruitment	TOTVEH
MNPASS	MNPASS	Presence of MNPass	-1=INAP 1=Yes 2=No 98=Don't know 99=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	MNPASS

MNPASSPAY	MNPASSPA	MNPass Subsidized	-1=INAP 1=Yes 2=No 98=Don't know 99=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	MNPASSPAY
BICYC	BICYC	No. of Bicycles in HH	10= 10 or more bicycles 98= Don't know 99= Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	BICYC
HOMETYP	HOMETYP	Type of housing	1=Single family home 2=Mobile home / Manufactured home 3=Townhome, 4=Duplex, triplex or fourplex 5=Apartment 6=Condominium or cooperative 7=Group housing, assisted living, or other institutional housing 96=Other 98=Don't Know 99=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	HOMETYP
UNITS	UNITS	Number of units in complex	-1=INAP 100= 100 units (100+ units) 998=Don't know 999=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	UNITS
OWNRENT	OWNRENT	Own or Rent home	-1=INAP 1=Own / buying 2=Rent 7=Other 8=Don't know 9=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	OWNRENT
TENURE	TENURE	Length of time at current address	1=Less than 2 years 2=2-5 years 3=6-10 years 4=More than 10 years 98=Don't know 99=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	TENURE
RENT	RENT	Amount of payment for home	99996=Flagged (TBD) 99997=Home is Paid For 99998=Don't Know 99999=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	RENT
PAYMNT	PAYMNT	Frequency of payments	0=INAP 1=Monthly 2=Biweekly (every 2 weeks) 3=Quarterly 7=Other 98=Don't know 99=Refused	Household Record	Abt SRBI	Survey Response	All participants	Recruitment	PAYMNT

G. Household Survey Persons – Data Dictionary

Source: Abt SRBI, 2012.

Appendix G. Data Dictionary for Persons in the Household Survey

Field	New Field	Description	Values / Notes	Record Type	Agency So	Type	Comment	Data Source	Variable Compuation
PASSWORD	PASSWORD	Household Password	Alphanumeric Variable	Person Record	Abt SRBI	Assigned	All participants	Sample	randomly generated
HHID	HHID	Household ID Number	Numeric Variable	Person Record	Abt SRBI	Assigned	All participants	Sample	randomly generated
PERSONID	PERSONID	Person ID	1 to 10	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	INDEX
HHPERSONID	HHPERSON	Household Person ID	Numeric Variable	Person Record	Abt SRBI	Calculated	All participants	Generated	Combined HHID+PersonID
STUDYTYPE	STUDYTYP	Participation in HIS or GPS subsample	0=GPS1=HIS	Person Record	Abt SRBI	Assigned	All participants	Sample	randomly generated
HHCOMP	HHCOMP	Completed Household	0=Not Complete1=HIS Complete2=GPS Complete	Household Record	Abt SRBI	Assigned	All participants	Retrieval	Percomp
PERCOMP	PERCOMP	Household Person Complete	0=Not Complete 1=Complete	Person Record	Abt SRBI	Calculated	All participants	Retrieval	DIARY
RECRUITMODE	RECRUITM	Method of recruitment	1=Phone 2=Web	Household Record	Abt SRBI	Assigned	All participants	Recruitment	RECRUITMODE
RETRIEVEMODE	RETRIEVE	Method of Retrieval	0=Not Yet Retrieved1=Phone 2=Web3=Mail4=Multiple modes	Person Record	Abt SRBI	Assigned	All participants	Retrieval	DIARY
DIARY	DIARY	Household Person Self-Report Complete	-1=Not yet Retrieved0=Not contacted by phone1=Complete but not retrieved	Person Record	Abt SRBI	Survey Response	All participants	Retrieval	DIARY
PROXY	PROXY	Diary Retrieval from Person or Proxy	-1=Not Yet Retrieved1=Person 2=Proxy	Person Record	Abt SRBI	Assigned	HIS participants	Retrieval	INFO
PROXYPERSON	PROXYPER	HH Person as Proxy	-1 Not Yet Retrieved0 reported personal Diary	Person Record	Abt SRBI	Assigned	HIS participants	Retrieval	INFOA#
PERTRIPS	PERTRIPS	Total Trips Made by Person	-1 Not Yet Retrieved; 0 to 11	Person Record	PlanTrans/A	Calculated	All participants	Trip	Summed variable of trips per person
GENDER	GENDER	Gender of Person	1=Male2=Female9=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	SEX1 to SEX10
AGE	AGE	Age of Person	97= 97 yrs or older98=Don't know99=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	SAGE1 to SAGE10
AGE2	AGE2	Collapsed Age of Person	0= INAP1=5 or younger2=6 to 123=13 to 154=16 to 175=18 to 246=25 to 34	Person Record	Abt SRBI	Assigned	All participants	Recruitment	AGE
AGE18	AGE18	Age of Person over and under 18 yrs	0= INAP1=Over 182=Under 18	Person Record	Abt SRBI	Assigned	All participants	Generated	AGE; AGE_18#
AGE06	AGE06	Age of Person over and under 6 yrs	1=Under 62=6 and Over	Person Record	Abt SRBI	Assigned	All participants	Generated	AGE
RELATION	RELATION	Relationship to contact person	0=Contact Person1= Husband/Wife/Unmarried Partner2 =Son/Daughter/In-L	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	RELAT1 to RELAT10
LICENSE	LICENSE	Licensed Driver	0=Ineligible to Drive1=Yes2=No8=Don't Know9=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	LDRV1 to LDRV10
TPASS	TPASS	Type of transit pass	0=INAP01=CASH (NEC)02=BUS/LIGHT RAIL CASH FARE03=EXPRESS B	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	TPASS1 to TPASS10
TPASSPAY	TPASSPAY	Transit Pass Subsidized	0=INAP1=Yes2=No98=Don't know99=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	PASSPAY1 to PASSPAY10
STUDENT	STUDENT	Student Status	1=Yes, full-time 2=\	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	SCH1 to SCH10
EDUC	EDUC	Education Level	1=Daycare / Pre-school2=Less than high school3=High school graduate4=S	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	EDU1 to EDU10

WRKR	WRKR	Employment Status	0=INAP1=A PAID full-time worker 2=A PAID part-time worker	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	WRKR1 to WRKR10; NOWK1 to NOWK10
WRKEVE	WRKEVE	Primary Work Includes Evenings	-1=Not Yet Retrieved0=Not provided/INAP1=Yes2=No98=Don't Know99=Ref	Person Record	Abt SRBI	Survey Response	HIS participants	Retrieval	WRKEVES
WRKNITE	WRKNITE	Primary Work Includes Overnights	-1=Not Yet Retrieved0=Not provided/INAP1=Yes2=No98=Don't Know99=Ref	Person Record	Abt SRBI	Survey Response	HIS participants	Retrieval	WRKNIGHT
WRKHRS	WRKHRS	Average Number of Hours Worked in a W	-1=Not Yet Retrieved0=Not provided/INAP1 to 120998=Don't Know999=Refu	Person Record	Abt SRBI	Survey Response	HIS participants	Retrieval	WRKHRS
WRKFLEX	WRKFLEX	Flexibility in Work Hours	-1=Not Yet Retrieved0=Not provided/INAP1=No flexibility2=Some flexibility3	Person Record	Abt SRBI	Survey Response	HIS participants	Retrieval	WRKFLEX
WRKCMPR	WRKCMPR	Employer Offers Compressed Work Week	-1=Not Yet Retrieved0=Not provided/INAP1=Yes2=No8=Don't Know9=Refus	Person Record	Abt SRBI	Survey Response	HIS participants	Retrieval	WRKCMPRS
MULTITRIP	MULTITRI	Job requires 5 or more trips per day	-1=Not Yet Retrieved0=Not provided/INAP1=Yes2=No8=Don't know9=Refus	Person Record	Abt SRBI	Survey Response	All participants	Retrieval	MULTITRIP
AVGTRIPS	AVGTRIPS	Average Number of Trips per Work day	-1=Not Yet Retrieved0=Not provided/INAP998=Don't Know999=Refused	Person Record	Abt SRBI	Survey Response	All participants	Retrieval	AVGTRIP
MULTIJOB	MULTIJOB	Works More Than One Job	-1=INAP1=Yes2=No8=Don't Know9=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	ADDJOB1 to ADDJOB10
SECJOB	SECJOB	Second Job Hours	-1=INAP1=Full-time2=Part-time3=Varies8=Don't know9=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	SECJOB1 to SECJOB10
TELCOM	TELCOM	Telecommuting Status	0=INAP1=Yes2=No3= Works from home only8=Don't know9=Refused	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	TELCOM1 to TELCOM10
TELFREQ	TELFREQ	Frequency of telecommuting	-1=INAP1=Almost every day (4 or 5 days per week)2=Once a week or more3	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	TELFREQ1 to TELFREQ10
TELPOLICY	TELPOLIC	Company policy on telecommuting	0=INAP1=Yes2=No98=Don't know99=Refused999=Flag (TBD)	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	TELPOLICY1 to TELPOLICY10
USUALMODE	USUALMOD	Usual mode when not telecommuting	0=INAP1=Drive alone2=Shared ride - 2 person (carpool)3=Shared ride - 3+	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	USUALMODE1 to USUALMODE10
TELWORK	TELWORK	Work at home before and after workday	0=INAP1=Yes2=No98=Don't know99=Refused999=Flag (TBD)	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	TELWORK1 to TELWORK10
DISABLE	DISABLE	Disability Status	0=INAP1=Yes2=No98=Don't know99=Refused999=Flag (TBD)	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	DISABLE1 to DISABLE10
TYPDISABLE	TYPDISAB	Type of Disability	0=INAP1=Eye or vision2=Hearing3=Walking (requires wheelchair or cane)4=	Person Record	Abt SRBI	Survey Response	All participants	Recruitment	TYPDISABLE1 to TYPDISABLE10
INDUSTRY	INDUSTRY	Employment industry of Primary Workplac	0=Not Yet Retrieved1=Agriculture, Forestry, Fishing and Hunting2=Mining3=	Person Record	Abt SRBI	Survey Response	All participants	Retrieval	WRKIND
INDUSTRY_O	INDUSTR1	Other Specify for Employment Industry of	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	All participants	Person Form	OTHINDSTRY
SCHTYPE	SCHTYPE	Type of School Enrollment	-1=Not Yet Retrieved1=Pre-School/Nursery School2=K-123=Vocational/Tech	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHTYPE
SCHNAME	SCHNAME	Name of School	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHNAME
SCHADD	SCHADD	School Address	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHADD
SCHCITY	SCHCITY	School City	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHCITY
SCHSTATE	SCHSTATE	School State	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHSTATE
SCHZIP	SCHZIP	School Zip	Numeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHZIP
SCHXSTS	SCHXSTS	School Cross Street	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	SCHXSTS

SCHLON	SCHLON	School Longitude	-180.000000 to 180.000000; " . "=Missing	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
SCHLAT	SCHLAT	School Latitude	00.000000 to 99.999999; " . "=Missing	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
SCHSTATUS	SCHSTATU	Status of Original School Address	-1=Not yet retrieved0=Unmatched1=Matched	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
SCHSCORE	SCHSCORE	ESRI Confidence Score of School Addres	ESRI 0 to 100 Geocoding Score-1=Not yet retrieved	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
SCHMATCHTYP	SCHMATCH	Automatic or Manual Match of School Add	-1=Not Yet Retrieved0=Manual1=Automatic	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
WRKNAME	WRKNAME	Name of Work	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	WRKNAME
WRKADDR	WRKADDR	Work Address	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	WRKADDR
WRKCITY	WRKCITY	Work City	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	WRKCITY
WRKSTATE	WRKSTATE	Work State	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	WRKSTATE
WRKZIP	WRKZIP	Work Zip	Numeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	WRKZIP
WRKXSTS	WRKXSTS	Work Cross Street	Alphanumeric Variable	Person Record	Abt SRBI	Survey Response	HIS Participants	Diary	WRKXSTS
WRKLON	WRKLON	Primary Employer Longitude	-180.000000 to 180.000000 ; " . "=Missing-1 indicates various location (no fi	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
WRKLAT	WRKLAT	Primary Employer Latitude	00.000000 to 99.999999; " . "=Missing-1 indicates various location (no fixed	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
WRKSTATUS	WRKSTATU	Status of Original Primary Employer Addr	-1 Not Yet Retrieved0=Unmatched1=Matched	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
WRKSCORE	WRKSCORE	ESRI Confidence Score of Primary Emplo	ESRI 0 to 100 Geocoding Score-1=Not yet retrieved	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated
WRKMATCHTYP	WRKMATCH	Automatic or Manual Match of Primary Em	-1=Not Yet Retrieved0=Manual1=Automatic	Person Record	Abt SRBI	Assigned	HIS Participants	GIS	ArcGIS generated

H. Household Survey Trips – Data Dictionary

Source: Abt SRBI, 2012.

Appendix H. Data Dictionary for Trips in the Household Survey

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
PASSWORD	PASSWORD	Household Password	Alphanumeric Variable	Person	Abt SRBI	Assigned	All participants	Sample	Randomly generated
STUDYTYPE	STUDYTYP	Participation in HIS or GPS subsample	0=GPS 1=HIS	Household	Abt SRBI	Assigned	Randomly generated in sample creation	Sample	Randomly assigned
RECRUITMODE	RECRUITM	Method of recruitment	-1=Not Yet Retrieved 0=INAP 1=Phone 2=Web	Household	Abt SRBI	Assigned	All participants	Recruitment	RECRUITMORE
RETRIEVEMODE	RETRIEVE	Method of Retrieval	-1=Not Yet Retrieved 0=INAP 1=Phone 2=Web 3=Mail 4=Multiple modes	Person	Abt SRBI	Assigned	All participants	Retrieval	DIARY
HHID	HHID	Household ID Number	Numeric variable	Household	Abt SRBI	Assigned	All participants	Assigned	Randomly generated
PERSONID	PERSONID	Person ID	1 to 10	Person	Abt SRBI	Assigned	All participants	Assigned	INDEX
HHPERSONID	HHPERSON	Household Person ID	Numeric variable	Person	Abt SRBI	Assigned	All participants	Assigned	Combined HHID+PersonID
HHCOMP	HHCOMP	Completed Household	0=Not Completed 1=HIS Completed 2=GPS Completed	Household	Abt SRBI	Assigned	All participants	Retrieval	Percomp
TRIPNUM	TRIPNUM	Number of Trip	-1=Not yet assigned 1 thru 11	Trip Record	Abt SRBI	Assigned	All participants	Assigned	Combined HHPERSONID+ TRIP
TRIPID	TRIPID	Household Person's Trip ID	0=Not yet Assigned	Trip Record	Abt SRBI	Assigned	All participants	Assigned	Combined HHPERSONID+ TRIP
STARTTRAVEL	STARTTRA	Location status at 3:00 AM	-1=Not Yet Retrieved 0=INAP 1=Traveling 2=At A Location	Person	Abt SRBI	Survey response	All participants	Retrieval	STARTTRAVEL
ONAME	ONAME	Location Name of Origin Trip	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC1ONLY; LOC#NAME
OADDR	OADDR	Origin Address	AlphaNumeric variable	Trip Record	Abt SRBI	Assigned	All participants	Retrieval	LOC#ADDR
OCITY	OCITY	Origin City	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#CITY
OSTATE	OSTATE	Origin State	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#STATE
OZIP	OZIP	Origin Zip Code	-1 Not Yet Provided 0 Missing	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ZIP
OXSTS	OXSTS	Origin Cross Streets	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#XSTS
OLAT	OLAT	Origin Latitude	-90.000000 to 90.0000000 "." MISSING -1 indicates various location (no fixed work location)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	OLAT

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
OLON	OLON	Origin Longitude	-180.000000 to 180.000000 "." MISSING -1 indicates various location (no fixed work location)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	OLONG
OSTATUS	OSTATUS	Status of Original Origin Address	-1= Not yet Retrieved/Geocoded 0=Unmatched 1=Matched	Trip Record	Abt SRBI	Assigned	All participants	GIS	GIS generated
OSCORE	OSCORE	ESRI Confidence Score of Origin Address	-1= Not yet Retrieved/Geocoded ESRI 0 to 100 Geocoding Score	Trip Record	Abt SRBI	Assigned	All participants	GIS	GIS generated
OMATCHTYP	OMATCHTY	Automatic or Manual Match of Origin Address	-1= Not yet Retrieved/Geocoded 0=Manual 1=Automatic	Trip Record	Abt SRBI	Assigned	All participants	GIS	GIS generated
OLOCTYPE	OLOCTYPE	Origin Type of Location	-1=Not Yet Retrieved 0=INAP 100=Home 200=Primary Workplace 300=Secondary workplace 400=School 501=Residential 502=Residential--OTHER 503=Automotive Dealer/Repair 504=Bank/Financial Institution 505=Barber/Beauty/Nail Salon 506=Bookstore/Library/Newsstand 507=Construction Site 508=Convenience/Drug Store 509=Daycare Facility/Preschool/Nursery School 510=Gas Station 511=Government/Municipal/City Offices 512=Grocery 513=Hotel/Motel/Other Lodging Facility 514=Indoor Recreation - gym/health club, skating rink 515=Industrial Site 516=Medical Facility/Hospital 517=Movie Theater/Theatre/Concert Venue/Sports Arena 518=Museum/Zoo/Historic Site 519=Office Building 520=Outdoor Recreation - Park, Athletic Field, Beach 521=Religious - Church/Synagogue/Houses of Worship 522=Restaurant/Fast Food/Bar & Grill 523=School - K-12 524=School - College/University/Technical/Vocational 525=Shopping Mall/Department Store 526=Transportation Terminal (airport, train, or bus) 996=Other 998=Don't Know 999=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#TYPE; LOC1ONLY
OTYPE_O	OTYPE_O	Other Type of Origin Location	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#TYPE

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
OLOCACT1	OLOCACT1	Primary Activity at Origin Location	-1=Not Yet Retrieved 0=INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97 NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT1
OLOCACT2	OLOCACT2	2nd Activity at Origin Location	-1=Not Yet Retrieved 0=INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97 NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT2

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
OLOCACT3	OLOCACT3	3rd Activity at Origin Location	-1=Not Yet Retrieved 0=INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97 NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT2
OLOCACT4	OLOCACT4	4th Activity at Origin Location	-1=Not Yet Retrieved 0=INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97 NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT2

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
LVLOCTIME	LVLOCTIM	Time of Location Departure	-1 Not Yet Retrieved 8888 INAP 0000 to 2459 9997 Did not leave location 9998 Don't know/remember 9999 Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LVLOCTIME
TRANSTYPE1	TRANSTYP	1st Type of Transportation Used	-1 Not Yet Retrieved 0 INAP 1 Car, van, truck 2 Walk 3 School bus 4 Public bus 5 Light rail (example: Hiwatha Line) 6 Commuter rail (example: Northstar) 7 Amtrak 8 Bicycle 9 Motorcycle/Moped 10 Taxi/Shuttle 11 Dial-A-Ride 12 Private Bus 13 Boat/Ferry Boat/Kayak 14 Skateboard/Scooter 15 Airplane 16 Tractor 17 Golf Cart 18 Ambulance 19 ATV 20 Funeral Home Limousine 21 Rollerblades/Rollerskates 22 Baby Stroller/Stroller 23 Wheel Chair/Power Chair 24 Snowmobile 96 Other 97 None	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#TYPE

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
TRANSTYPE2	TRANSTY1	2nd Type of Transportation Used	-1 Not Yet Retrieved 0 INAP 1 Car, van, truck 2 Walk 3 School bus 4 Public bus 5 Light rail (example: Hiwatha Line) 6 Commuter rail (example: Northstar) 7 Amtrak 8 Bicycle 9 Motorcycle/Moped 10 Taxi/Shuttle 11 Dial-A-Ride 12 Private Bus 13 Boat/Ferry Boat/Kayak 14 Skateboard/Scooter 15 Airplane 16 Tractor 17 Golf Cart 18 Ambulance 19 ATV 20 Funeral Home Limousine 21 Rollerblades/Rollerskates 22 Baby Stroller/Stroller 23 Wheel Chair/Power Chair 24 Snowmobile 96 Other 97 None	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#TYPE

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
TRANSTYPE3	TRANSTY2	3rd Type of Transportation Used	-1 Not Yet Retrieved 0 INAP 1 Car, van, truck 2 Walk 3 School bus 4 Public bus 5 Light rail (example: Hiwatha Line) 6 Commuter rail (example: Northstar) 7 Amtrak 8 Bicycle 9 Motorcycle/Moped 10 Taxi/Shuttle 11 Dial-A-Ride 12 Private Bus 13 Boat/Ferry Boat/Kayak 14 Skateboard/Scooter 15 Airplane 16 Tractor 17 Golf Cart 18 Ambulance 19 ATV 20 Funeral Home Limousine 21 Rollerblades/Rollerskates 22 Baby Stroller/Stroller 23 Wheel Chair/Power Chair 24 Snowmobile 96 Other 97 None	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#TYPE
TRANSTYPE_O	TRANSTY3	Other Type of Transportation Used	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#TYPE
USEPASS	USEPASS	Used Pass for trip	-1=NOT Yet Retrieved 0=INAP 1=Yes 2=No 98=Don't know 99=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	USEPASS#
PAYPASS	PAYPASS	Amount of money paid for transit trip	-1=Not Yet Retrieved 0=INAP 998=Don't know 999=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	PAYPASS
TRVLOCDR	TRVLOCDR	Driver or Passenger	-1=Not Yet Retrieved 0=INAP 1=Driver 2=Passenger 98=Don't Know 99=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRVLOC#DR

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
TRVVEH	TRVVEH	Household Vehicle Used for Trip	-1=Not Yet Retrieved 0=INAP 1=Yes 2=No 98=Don't Know 99=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#VEH
TOLL	TOLL	Toll Used for Trip	-1=Not Yet Retrieved 0=INAP 1=Yes 2=No 98=Don't know 99=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TOLL
PARKPAY	PARKPAY	Pay for Parking	-1=Not Yet Retrieved 0=INAP 99997 Did not pay 99998 Don't know/remember 99999 Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	PRKPAY#
PARKRATE	PARKRATE	Parking Rate	-1=Not Yet Retrieved 0=INAP 1=Hourly 2=Daily 3=Monthly 4=Annually 5=Bi-Weekly 6=Per Semester 7=One Time Rate 8=Quarterly 9=Meter 96=Other 98=Don't Know 99=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	PRK#RT
PARKRATE_O	PARKRAT1	Other Parking Rate	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	PRK#RT
TRVPS	TRVPS	Number of Additional People on Trip (including yourself)	-1=Not Yet Retrieved 0=INAP 1 thru 250 98=Don't know 99=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRVPS
TRVHHPS	TRVHHPS	Number of Household Members on Trip (including yourself)	-1=Not Yet Retrieved 0=INAP 1 thru 250 998=Don't know 999=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#HHPS
TRVHHPS_1	TRVHHPS_	1st Household Member in Vehicle	PERSONID (1 to 10)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#HHPER
TRVHHPS_2	TRVHHPS1	2nd Household Member in Vehicle	PERSONID (1 to 10)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#HHPER
TRVHHPS_3	TRVHHPS2	3rd Household Member in Vehicle	PERSONID (1 to 10)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#HHPER
TRVHHPS_4	TRVHHPS3	4th Household Member in Vehicle	PERSONID (1 to 10)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	TRV#HHPER

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
ARVTIME	ARVTIME	Time of Arrival - Hour/Minute	Military Time -1=Not Yet Retrieved 8888=INAP	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	ARVLOC#TIME
DNAME	DNAME	Location Name of Trip Destination	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#NAME
DADDR	DADDR	Destination Address	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ADDR
DCITY	DCITY	Destination City	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#CITY
DSTATE	DSTATE	Destination State	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#STATE
DZIP	DZIP	Destination Zip Code	-1 Not Yet Retrieved 0 Missing	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ZIP
DXSTS	DXSTS	Destination Cross Streets	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#XSTS
DLAT	DLAT	Destination Latitude	-90.000000 to 90.000000 0E-8 Not Yet Retrieved/Geocoded -1 indicates various location (no fixed work location)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	DLAT
DLON	DLON	Destination Longitude	-180.000000 to 180.000000 0E-8 Not Yet Retrieved/Geocoded -1 indicates various location (no fixed work location)	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	DLONG
DSTATUS	DSTATUS	Status of Original Destination Address	-1= Not yet Retrieved/Geocoded 0=Unmatched 1=Matched	Trip Record	Abt SRBI	Assigned	All participants	GIS	GIS generated
DSCORE	DSCORE	ESRI Confidence Score of Destination Address	-1= Not yet Retrieved/Geocoded ESRI 0 to 100 Geocoding Score	Trip Record	Abt SRBI	Assigned	All participants	GIS	GIS generated
DMATCHTYP	DMATCHTY	Automatic or Manual Match of Destination Address	-1= Not yet Retrieved/Geocoded 0=Manual 1=Automatic	Trip Record	Abt SRBI	Assigned	All participants	GIS	GIS generated

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
DLOCTYPE	DLOCTYPE	Destination Type of Location	-1=Not Yet Retrieved 0=INAP 100=Home 200=Primary Workplace 300=Secondary workplace 400=School 501=Residential 502=Residential--OTHER 503=Automotive Dealer/Repair 504=Bank/Financial Institution 505=Barber/Beauty/Nail Salon 506=Bookstore/Library/Newsstand 507=Construction Site 508=Convenience/Drug Store 509=Daycare Facility/Preschool/Nursery School 510=Gas Station 511=Government/Municipal/City Offices 512=Grocery 513=Hotel/Motel/Other Lodging Facility 514=Indoor Recreation - gym/health club, skating rink 515=Industrial Site 516=Medical Facility/Hospital 517=Movie Theater/Theatre/Concert Venue/Sports Arena 518=Museum/Zoo/Historic Site 519=Office Building 520=Outdoor Recreation - Park, Athletic Field, Beach 521=Religious - Church/Synagogue/Houses of Worship 522=Restaurant/Fast Food/Bar & Grill 523=School - K-12 524=School - College/University/Technical/Vocational 525=Shopping Mall/Department Store 526=Transportation Terminal (airport, train, or bus) 996=Other 998=Don't Know 999=Refused	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#TYPE; LOC1ONLY
DTYPE_O	DTYPE_O	Other-Destination Type of Location	AlphaNumeric variable	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#TYPE

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
DLOCACT1	DLOCACT1	Primary Activity at Destination	-1= Not Yet Retrieved 0= INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97=NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT1
DLOCACT2	DLOCACT2	2nd Activity at Destination	-1= Not Yet Retrieved 0= INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97=NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT2

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
DLOCACT3	DLOCACT3	3rd Activity at Destination	-1= Not Yet Retrieved 0= INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97=NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT2
DLOCACT4	DLOCACT4	4th Activity at Destination	-1= Not Yet Retrieved 0= INAP 1=HOME – PAID WORK 2=HOME – UNPAID WORK 3=HOME – OTHER 4=WORK 5=ATTEND CHILDCARE 6=ATTEND SCHOOL 7=ATTEND COLLEGE 8=OTHER SCHOOL ACTIVITIES 9=QUICK STOPS 10=PERSONAL BUSINESS 11=MAJOR SHOPPING 12=EVERYDAY SHOPPING 13=SOCIAL 14=RECREATION – PARTICIPATE 15=RECREATION – WATCH 16=EAT OUT 17=RELIGIOUS/COMMUNITY 18=ACCOMPANY ANOTHER PERSON 19=PICK-UP PASSENGER 20=DROP-OFF PASSENGER 21=TURN AROUND 96=OTHER 97=NO OTHER ACTIVITY	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	LOC#ACT2
ENDTRIP	ENDTRIP	Flag for end of person's trip	0=Not Ended/Not Travelled Yet 1=End of Trip	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	

2010 TBI Household Survey - Trip Record

Field	New Field	Description	Values / Notes	Record Type	Agency Source	Type	Comment	Data Source	Variable Computation
ADDTRIP	ADDTRIP	Additional trips	0=No Additional Trips 1= Has Additional Trips	Trip Record	Abt SRBI	Survey response	All participants	Retrieval	ADDTRIP
ADDTRIP_O	ADDTRIP_	Additional Trips Other	AlphaNumeric variable						

I. GPS Survey – Data Dictionary

Source: Abt SRBI and PlanTrans, 2013.

Appendix I. Data Dictionary for the GPS Survey

Field	Description	Values / Notes	Record Type	Agency Source	Type	Comments	Data Source
HHID	Household ID Number	Numeric Variable	Household Record	Abt SRBI	Assigned	GPS Participants ONLY	Assigned
PERSONID	Number of Household Member	Numeric Variable (Range 1-15)	Person Record	Abt SRBI	Assigned	GPS Participants ONLY	Assigned
Travel Day	1=Day, 2=Day, 3=Day	HHID * 1000 + PERSONID from HH * 100 + TRIPSEQ + Day	Trip Record	PlanTrans	Assigned	GPS Participants ONLY	Assigned
TRIPID	ID associated with each trip	HHID * 1000 + PERSONID from HH * 100 + TRIPSEQ	Trip Record	PlanTrans	Assigned	GPS Participants ONLY	Assigned
AnalysisDay	Analysis Day	1 = analysis day w/full data GPS 2 = analysis day w/partial data (under 18 only) GPS 3 = surrogate data (under 18 only) GPS (used for when the analysis day for a 13-18 y.o. is different from the analysis day of their parents) 4 = all other GPS 5 = analysis day child diary 6 = surrogate day child diary (similar conditions to #3) 7 = prompted recall	Trip Record	PlanTrans	Assigned	GPS Participants ONLY	Assigned
DEP_TDAY	Departure Travel Day	1=Day 1 2=Day 2 3=Day 3	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
DEP_DAY	Departure Day of Week	1=Monday 2=Tuesday 3=Wednesday 4=Thursday 5=Friday	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
DEP_DATE	Departure Travel Date	MM/DD/YYYY	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
DEP_TIME	Departure Time	Hour:Minutes:Seconds	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
ARV_TDAY	Arrival Travel Day	1=Day 1 2=Day 2 3=Day 3	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
ARV_DAY	Arrival Day of Week	1=Monday 2=Tuesday 3=Wednesday 4=Thursday 5=Friday	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
ARV_DATE	Arrival Travel Date	MM/DD/YYYY	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
ARV_TIME	Arrival Time	Hour:Minutes:Seconds	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based

TRIPDIST	Trip Distance	Calculated from time start and time end from GPS record	Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Caclulated
TRIPSPD	Trip Speed	Calculated from time start and time end from GPS record	Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Caclulated
TRIPDUR	Trip Duration	Calculated from time start and time end from GPS record	Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Caclulated
O_PTYPE	Place (Origin)	1=Home 2=Primary Workplace 3=Secondary Workplace 4=Volunteer Job 5=School (Daycare, K-12) 6=School (College, Vocational) 7=Retail 8=Some other habitual address / previously entered place within Study Area 9=New place within Study Area (No Match) 10=Out of Study Area	Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Imputed from HH and Person Forms, GPS, and Prompted Recall
O_ACT	Activity (Origin)	1=At home 2=Paid work 3=School 4=Volunteer Work 5=Pick-Up / Drop Off Person 6=Social, Recreational, Church 7=Catch a Bus, Train or Airplane 8=Transfer From One Bus, Train or Airplane to Another 9=Shop 10=Personal Business 11=Eat Meal 12=Go for a Drive 13=Work Related 14=School Related 15=Other 99=DK/RF	Trip Record	PlanTrans	From Prompted Recall Only	GPS Participants ONLY	From Prompted Recall Only
O_Longitude	Longitude (Origin)	Longitude of GPS Trip End	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
O_Latitude	Latitude (Origin)	Latitude of GPS Trip End	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
O_LocationID	Location ID from the Location Table		Trip Record	Abt SRBI	Assigned	GPS Participants ONLY	Assigned

MODE	Mode of Trip	1=Motor Vehicle (Auto/Van/Truck/Motorcycle/Moped) 2=Bus (school, public transit, demand response) 3=Walk 4=Bicycle 5=Driver of Auto/van/truck (prompted recall only) 6=Passenger of Auto/van/truck/motorcycle (prompted recall only) 7=Driver of Carpool (prompted recall only) 8=Passenger of Carpool (prompted recall only) 9=Driver of Vanpool (prompted recall only) 10=Passenger of Vanpool (prompted recall only) 11=Bus (Public Transport) (prompted recall only) 12=Demand Response Bus (prompted recall only) 13=School Bus (prompted recall only) 14= Taxi / paid limo (prompted recall only) 15=Motorcycle/Moped (prompted recall only) 96=Other 98=Unknown	Trip Record	PlanTrans	Imputed from GPS and From Prompted Recall	GPS Participants ONLY	Imputed from GPS and Prompted Recall
DRIV_PASS	Driver or Passenger	1=Driver 2=Passenger 3=Not Determined 4=Not Applicable 99=DK/RF	Trip Record	PlanTrans	From Prompted Recall Only	GPS Participants ONLY	From Prompted Recall Only
DRIV_HH	DRIVER HOUSEHOLD MEMBER	1= Yes 2=No 3=Not Determined 4=Not Applicable 99=DK/RF	Trip Record	PlanTrans	From Prompted Recall Only	GPS Participants ONLY	From Prompted Recall Only
PARTY	Number of people on trip		Trip Record	PlanTrans	From Prompted Recall Only	GPS Participants ONLY	From Prompted Recall Only
PER_TRP	HH Persons on trip		Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Imputed from GPS and Children's Diaries
PER_1	1st HH Person on Trip (PERSONID)		Trip Record	PlanTrans	Calculated	GPS Participants ONLY	
PER_2	2nd HH Person on Trip (PERSONID)		Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Imputed from GPS and Children's Diaries

PER_3	3rd HH Person on Trip (PERSONID)		Trip Record	PlanTrans	Calculated	GPS Participants ONLY	Imputed from GPS and Children's Diaries
PER_4	4th HH Person on Trip (PERSONID)		Trip Record	PlanTrans	Calculated	GPS Participants ONLY	
PER_5	5th HH Person on Trip (PERSONID)		Trip Record	PlanTrans	Calculated	GPS Participants ONLY	
D_PTYPE	Place (Destination)	1=Home 2=Primary Workplace 3=Secondary Workplace 4=Volunteer Job 5=School (Daycare, K-12) 6=School (College, Vocational) 7=Retail 8=Some other habitual address / previously entered place within Study Area 9=New place within Study Area (No Match) 10=Out of Study Area	Trip Record	PlanTrans	Caluculated	GPS Participants ONLY	Imputed from HH and Person Forms, GPS, and Prompted Recall
D_ACT	Activity (Destination)	1=At home 2=Paid work 3=School 4=Volunteer Work 5=Pick-Up / Drop Off Person 6=Social, Recreational, Church 7=Catch a Bus, Train or Airplane 8=Transfer From One Bus, Train or Airplane to Another 9=Shop 10=Personal Business 11=Eat Meal 12=Go for a Drive 13=Work Related 14=School Related 15=Other 99=DK/RF	Trip Record	PlanTrans	From Prompted Recall Only	GPS Participants ONLY	From Prompted Recall Only
D_Longitude	Longitude (Destination)	Longitude of GPS Trip End	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
D_Latitude	Latitude (Destination)	Latitude of GPS Trip End	Trip Record	PlanTrans	GPS Based	GPS Participants ONLY	GPS Based
D_LocationID	Location ID from the Location Table		Trip Record	Abt SRBI	Assigned	GPS Participants ONLY	Assigned
GPS_REC	Confidence in GPS Trip Recorded Record	1=GPS Trip 2=Imputed Trip, Middle of the Day 3=Imputed Trip, Last Trip of the Day	Trip Record	PlanTrans	Assigned	GPS Participants ONLY	Assigned

J. Experiments with Incentives in Telephone Surveys

EXPERIMENTS WITH INCENTIVES IN TELEPHONE SURVEYS

ELEANOR SINGER
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Abstract In an effort to counter the problem of noncooperation, survey organizations are offering incentives to respondents with increasing frequency, some at the outset of the survey, as has traditionally been done in mail surveys, and some only after the person has refused, in an attempt to convert the refusal. This article reports on a series of experiments carried out over a period of about 2 years with a monthly telephone survey, the Survey of Consumer Attitudes, in an effort to increase response rates or reduce interviewer effort. We report on experiments with prepaid versus promised incentives; advance letters; and advance letters with prepaid incentives; and we also report on the effects of incentives on response quality, sample composition, response bias, interviewer and respondent expectations, and costs.

In an effort to counter the growing problem of noncooperation (De Heer and Israëls 1992; De Leeuw and De Heer 1999; Groves and Couper 1996; Steeh et al. 1999), survey organizations are offering incentives to respondents with increasing frequency, some at the outset of the survey, as has traditionally been done in mail surveys, and some only after the person has refused, in an attempt to convert the refusal. In the case of mail surveys, the payment of incentives is one of two design factors that consistently and substantially increase the response rate, the other being the number of contacts (Heberlein and Baumgartner 1978; Yu and Cooper 1983).

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A meta-analysis by Church (1993) identified those characteristics of incentives in mail surveys that are associated with greater effects on response rates: prepayment, cash, and larger (vs. smaller) payments. A subsequent examination of the use of incentives in telephone and face-to-face surveys (Singer et al. 1999) demonstrated the utility of incentives in those surveys, as well. The effects of incentives are hypothesized by some to result from the norm of reciprocity (Cialdini 1988; Gouldner 1960) and by others as an exchange of more tangible benefits in return for cooperation (e.g., Biener and Kidd 1994; Dillman 1978). More recently, Groves, Singer, and Corning (1999) have proposed a theory of survey participation that identifies incentives as one of the factors among others that is capable of motivating respondent cooperation.

The present article builds on and extends the findings reported in Church (1993) and Singer et al. (1999). The findings are drawn from four series of experiments extending over a period of approximately 2 years which were built into the Survey of Consumer Attitudes; the timing and experimental conditions are summarized in table 1. The first set of experiments was designed to test more thoroughly, in the context of telephone surveys, the conflicting findings concerning promised and prepaid incentives that had been reported in the two meta-analyses. The second series was designed to investigate the efficacy of advance letters without incentives; the third, the effect of adding incentives; and the fourth, to determine whether the effect of prepaid incentives is mediated by interviewers' knowledge that they have been given to respondents. In addition, the experiments enabled us to investigate several other questions related to incentives: namely, the effects of incentives on response quality, sample composition, response bias, respondent expectations, and costs.

Method

The Survey of Consumer Attitudes is a monthly random digit dialed (RDD) survey designed to measure consumer expectations about the economy and their own financial situation. It is used by a variety of governmental and nongovernmental agencies for purposes of economic planning. Every month, some 500 interviews are conducted, 300 with newly selected telephone households and 200 with respondents first interviewed 6 months earlier. Two features of the survey combine to make it somewhat atypical. First, the interviewing period is short—less than a month—and second, strenuous efforts are made to achieve a 70 percent response rate.[1] For these reasons, interviewer incentives and respondent refusal conversion incentives have been increasingly used in

1. *Response rate* is defined as the number of completed interviews divided by the sum of completed interviews, respondent refusals, and noninterviews (phone never answered, language barrier, incomplete interview, permanent health condition, don't know if eligible person in household).

Table 1. Incentive Experiments with the SCA, 1996–98

Month and Year	Experimental Condition	*n*	Control Condition(s)	*n*
	Incentive Only			
July 1996	$5 promised	220	$0	219
September 1996	$5 promised	216	$0	226
November 1996	$10 promised	211	$0	216
December 1996	$20 promised	218	$10 promised	216
	Letter Only[a]			
July 1997	Advance letter	111	No advance letter	129
October 1997	Advance letter	100	No advance letter	94
November 1997	Advance letter	89	No advance letter	98
	Letter plus Incentive[a]			
January 1998	Advance letter + $5 prepaid	96	Advance letter only	91
February 1998	Advance letter + $5 prepaid	91	Advance letter only	89
March 1998	Advance letter + $5 prepaid	82	Advance letter only	84
April 1998	Advance letter + $5 prepaid	99	Advance letter only	103
	Letter plus Incentive: Interviewer Blind versus Not Blind[a]			
May 1998	Advance letter + $5, interviewer not blind	61	Advance letter + $5, interviewer blind	69
June 1998	Advance letter + $5, interviewer not blind	59	Advance letter + $5, interviewer blind	61
July 1998	Advance letter + $5, interviewer not blind	59	Advance letter + $5, interviewer blind	60
August 1998	Advance letter + $5, interviewer not blind	61	Advance letter + $5, interviewer blind	68

[a] Only those respondents for whom a valid address could be obtained in advance were randomized into the letter/no letter or letter only/letter+$5 conditions.

recent years, and the survey director as well as the field staff have been interested in finding alternative ways to increase the survey's response rate.

The Effect of Incentives on Response Rates

PROMISED INCENTIVES AT FIRST CONTACT WITH HOUSEHOLD

The first set of experiments involved the promise of a monetary incentive during the interviewer's first contact with the household to a random half of the RDD portion of the sample. If they are successful in motivating coop-

Table 2. Response and Cooperation Rates by Promised Incentives

	Response Rate[a,b]		Cooperation Rate[b,c]	
	Interviewed (%)	*n*	Interviewed (%)	*n*
July 1996:				
$0	67.6	219	74.0	200
$5	69.6	220	74.3	206
	n.s.		n.s.	
September 1996:				
$0	62.0	226	72.5	193
$5	69.4	216	74.3	202
	$\chi^2 = 2.75$, $df = 1$, $p < .10$		n.s.	
November 1996:				
$0	67.4	221	73.0	204
$10	67.8	211	74.9	191
	n.s.		n.s.	
December 1996:				
$10	66.7	216	73.9	195
$20	67.9	218	76.3	194
	n.s.		n.s.	

[a] Includes noncontacts in denominator.
[b] After refusal conversion efforts.
[c] Excludes noncontacts from denominator.

eration, promised incentives are clearly more cost effective than prepaid incentives, since only those who actually respond are paid. Church (1993), however, found no effect of promised incentives in mail surveys, and although Singer et al. (1999) found no significant differences between promised and prepaid incentives in interviewer-mediated surveys, that finding was based on very few instances of prepaid incentives. We therefore decided to experiment with varying amounts of promised incentives specifically in the context of an RDD survey.

During the first 2 months of the experiment—July and September of 1996—the amount offered was $5; in November, interviewers offered $10; and in December, half the sample was offered $10 and half, $20.

The results of these experiments are summarized in table 2. As can be seen from that table, there is no consistent effect of incentives on either the response rate or the cooperation rate;[2] only one of the eight comparisons is even marginally significant ($p < .10$). Even pooling the results over the 4 months, so that the comparison is between no (or low) incentive and some (or higher)

2. *Cooperation rate* is defined as the number of completed interviews divided by the sum of completed interviews and respondent refusals.

incentive, results in an insignificant difference of 3 percentage points in favor of the higher-incentive condition.

ADVANCE LETTERS TO RESPONDENTS FOR WHOM ADDRESSES COULD BE MATCHED

Because the results of this set of experiments were so disappointing, we undertook a second series of experiments involving the sending of advance letters to those telephone households for which we could obtain an address. As noted earlier, number of contacts is one of two variables consistently yielding gains in response rates in the mail survey literature (Heberlein and Baumgartner 1978). Whether because an advance letter increases the number of contacts with the household or because it provides advance notice and legitimacy for the interviewer's request, such letters have been found to increase response rates in both telephone and face-to-face surveys (Groves and Couper 1998, pp. 276–81). Because addresses are not available for all telephone numbers in an RDD survey, advance letters have generally not been used in such surveys. However, if they succeeded in increasing survey cooperation, they would clearly be more cost effective than prepaid incentives.

Accordingly, we designed an experiment involving advance letters to a randomly designated subset of those RDD respondents for whom addresses could be obtained. The design, and the numbers of households involved, are shown in table 1. There is some evidence that households with listed telephone numbers differ from those with unlisted numbers on demographic and attitudinal characteristics and in their response rates to telephone surveys (Traugott, Groves, and Lepkowski 1987). To avoid confounding the effects of the letter with the household's propensity to respond even without the letter, advance letters were sent to a random half of the telephone households with listed addresses. Interviewers were blind to whether or not a letter had been sent.

The results of these experiments are shown in table 3, aggregated over all 3 months; the results are entirely consistent from one month to another. As can be seen from table 3, there are virtually no differences between the letter and the no-letter conditions. We carried out these analyses in two other ways: omitting respondents who had received refusal conversion incentives, and coding such cases as refusals. Although the response and cooperation rates change as a result, the lack of significant difference between the letter and no-letter conditions remains. We do not know the reasons for this difference between our results and previous findings concerning advance letters. However, the studies summarized by Groves and Couper (1998) show considerable

Table 3. Response and Cooperation Rates by Advance Letters

	Response Rate[a,b]		Cooperation Rate[b,c]	
	Interviewed (%)	*n*	Interviewed (%)	*n*
July, October, November 1997:				
Advance letter	73.0	300	80.8	271
No letter	74.1	321	79.3	300
	n.s.		n.s.	

[a] Includes noncontacts in denominator.
[b] After refusal conversion efforts.
[c] Excludes noncontacts from denominator.

variation in the effectiveness of advance letters, and not every study shows a positive effect.[3]

PREPAID INCENTIVES ENCLOSED WITH ADVANCE LETTERS

Neither incentives promised at first contact nor advance letters without an incentive succeeded in consistently and substantially increasing the response rate to the Survey of Consumer Attitudes (SCA). Accordingly, we mounted an experiment in which a five dollar bill was enclosed in an advance letter to a random half of that portion of the sample for whom an address could be obtained (see table 1).

The results of the prepayment experiment are aggregated in table 4 over the 4 months of the experiment. Unlike the two previous series of experiments, prepayment enclosed with an advance letter shows a significant and large effect on response and cooperation rates. Only one of the 4 months, April, failed to show such an effect, but, as discussed in the next section, it was replicated in four additional months of experimentation.

EFFECTS ON RESPONDENTS OR EFFECTS ON INTERVIEWERS?

Because interviewers were not blind to the experimental condition in the previous set of experiments, we cannot tell whether the incentive was effective primarily because of its effect on the respondent or because of its effect on the interviewer. It is possible, for example, that interviewers expect respondents who have received an incentive to be more cooperative and that they

3. A review by Brick et al. (1997) of methods of increasing response rates to RDD surveys estimates that a first-class advance letter would boost the response rate for the sample as a whole by 0 to 3 percentage points. Our studies clearly fall in that range.

Table 4. Response and Cooperation Rates by Advance Letters and Letters plus Prepaid Incentive

	Response Rate[a,b]		Cooperation Rate[b,c]	
	Interviewed (%)	*n*	Interviewed (%)	*n*
January–April 1998:				
Advance letter + $5	77.7	368	82.2	348
Advance letter only	67.0	367	71.9	342
	$\chi^2 = 10.49$, $df = 1$, $p < .001$		$\chi^2 = 10.27$, $df = 1$, $p < .001$	

[a] Includes noncontacts in denominator.
[b] After refusal conversion efforts.
[c] Excludes noncontacts from denominator.

behave in such a way as to fulfill their expectations.[4] Or they may feel more confident about approaching a household that has received an incentive in the mail and, therefore, be more effective in their interaction with the potential respondent. Alternatively, respondents who have received an incentive in advance may feel obliged to reciprocate by granting an interview. Or both principles may be at work.

In order to separate the effects of incentives on interviewers from their effects on respondents, we replicated the experiment involving advance letters and incentives for an additional 4 months. The details of the design are also shown in table 1. One-third of the group for whom we could get addresses was sent an advance letter and $5; interviewers were kept blind to this condition. Another third received a letter plus $5, and still another third received the letter only. Interviewers were made aware of these latter two conditions by information presented on their Computer-Assisted Telephone Interview (CATI) screens.

The results of this experiment are aggregated in table 5 over the 4 months, and these results are consistent across the 4 months. Large differences continue to be observed between the letter-only and the letter-plus-incentive conditions, but there is no evidence that this is due to expectations on the part of interviewers. Thus, we tentatively conclude that prepayment of a $5 incentive substantially increases cooperation with an RDD survey and that the incentive exerts its effect directly on the respondent rather than being mediated through interviewer expectations. This conclusion is in accordance with research done

4. For evidence concerning interviewer expectation effects, see Hox (1999), Hyman (1954), Singer, Frankel, and Glassman (1983), Singer and Kohnke-Aguirre (1979), and Sudman et al. (1977).

Table 5. Response and Cooperation Rates by Advance Letters and Letters plus Prepaid Incentive, Controlling for Interviewer Expectations

	Response Rate[a,b]		Cooperation Rate[b,c]	
	Interviewed (%)	*n*	Interviewed (%)	*n*
May–August 1998:				
Advance letter only	61.7	230	68.3	208
Advance letter + $5, interviewers blind	76.3	257	85.2	230
Advance letter + $5, interviewers not blind	75.0	236	80.8	219
Advance letter only vs. letter + $5	$\chi^2 = 14.83$, $df = 1$, $p < .001$		$\chi^2 = 18.39$, $df = 1$, $p < .001$	
Blind vs. not blind	n.s.		n.s.	

[a] Includes noncontacts in denominator.
[b] After refusal conversion efforts.
[c] Excludes noncontacts from denominator.

by Stanley Presser and Johnny Blair, at the University of Maryland, who also found substantial increases in response rates as a result of small prepayments to respondents to which interviewers were blind (personal communication).

Incentives and Response Quality

INCENTIVES AND ITEM MISSING DATA

The merits of refusal conversion efforts have been debated among survey methodologists. On the one hand, concerns about nonresponse bias argue for strenuous attempts to encourage participation by everyone. On the other, there are concerns that "excessive" efforts at persuasion will bring into the sample respondents who are careless or indifferent in answering questions, thus ultimately damaging the quality of the information obtained.

Similar questions can be raised about advance payments to respondents. On the one hand, such payments may encourage reciprocal efforts by respondents. On the other, they may undermine intrinsic motivation and lead to a deterioration in the quality of response. Theory and research on intrinsic/extrinsic motivation suggest that the latter effect is more likely to occur if the payment is perceived as too large for the effort required.

To get some purchase on these questions, we performed two analyses on the SCA data. First, we calculated an Index of Item Nonresponse,[5] based on 17 key questions asked every month. The index is the sum of the number of times the respondent does not answer, or answers "Don't know," to these 17 items, divided by the total number of items he or she should have been asked. The log of the index was then regressed on incentives promised at the initial contact (or on prepaid incentives included with advance letters), and on any refusal conversion payments that were offered. Because respondents' demographic characteristics may affect item nonresponse tendencies, we control for these in the analyses below, which pool data for all 15 months in which we experimented with incentives.[6]

The results are shown in table 6. Model 1 includes only the incentive variables and indicates that, without controlling for demographic characteristics, both the promise or prepayment of an incentive and the payment of a refusal conversion incentive significantly reduce item nonresponse. These effects remain significant when we control for demographic characteristics in model 2, and, in addition, all the demographic characteristics except nonwhite have significant effects, as well. Model 3 introduces interaction terms between each of the demographic characteristics and the two incentives variables. None of the interactions between the demographics and the refusal conversion payments is significant, but there are significant interactions between age and nonwhite status and promised or prepaid incentives. In both cases, the effect of incentives is to *reduce* the tendency of older people and nonwhites to have more item missing data. (To save space, the nonsignificant interaction coefficients have been omitted from the table.) The remaining demographic characteristics, with the exception of Hispanic, also remain significant. Analyses which examine the effects of prepaid and promised incentives separately yield essentially the same conclusions.

Thus, there is no evidence from these analyses that the offer of an initial

5. The Index of Item Nonresponse is the percentage of "Don't knows" and no answers to 17 key questions on the Survey of Consumer Attitudes. The questions, whose tabulated responses appear in each SCA monthly report, indicate, among other things, respondents' assessment of their current and future family finances and income, the nation's business and employment conditions, and the government's role in affecting the country's economy. The index has been logarithmically transformed to correct for skew.

6. Because some 23 percent of the respondents failed to answer the question about income and 11 percent do not answer it even when they are presented with income brackets, we imputed income using a multiple regression procedure that makes use of the bracket information, and use the imputed variable in the analyses below. We used a general purpose multivariate imputation procedure that can handle relatively complex data structures. For each variable on which an individual is missing data, the imputed values are conditional on all the observed values for the individual. The imputations are created through a sequence of univariate regressions with the covariates including all other variables observed or imputed for the individual. The type of regression used (linear, logistic, Poisson, generalized logit) depends on the variable to be imputed. The sequence of imputing missing values is continued in a cyclic manner, each time overwriting the previously imputed values to build more interdependence and exploit the correlational structure of the data. A more technical description can be found in Raghunathan and Siscovick (1996).

Table 6. Log Index of Item Nonresponse Regressed on Incentives, Demographic Variables, and Interactions ($n = 4{,}305$)

	Model 1		Model 2		Model 3	
	Parameter Estimate	SE	Parameter Estimate	SE	Parameter Estimate	SE
Promised/prepaid incentives	−.231**	.039	−.232**	.038	−.011	.262
Refusal conversion payments	−.170**	.046	−.173**	.045	−.252	.305
Age			.011**	.001	.014**	.001
Nonwhite			.042	.053	.103	.072
Hispanic			.177*	.074	.170	.101
Education			−.040**	.007	−.046**	.010
Female			.226**	.036	.231**	.047
Income			−.000**	.000	−.000**	.000
Age × incentives					−.008**	.002
Nonwhite × incentives					−.287*	.119
Intercept	1.062**	.025	1.026**	.123	.976**	.165

* $p < .05$.
** $p < .01$.

incentive or a refusal conversion payment increases the response rate at the price of a reduction in data quality—if anything, such payments seem to reduce the amount of item missing data, especially among certain subgroups. However, the total amount of variance explained by incentives is small. Only 7 percent is explained by both the demographics and the incentives, and incentives alone explain less than 1 percent of the variance in item nonresponse.

INCENTIVES AND RESPONSE DISTRIBUTIONS

Even more troubling, potentially, than an effect on item missing data is the effect of incentives on the distribution of responses. The question we tried to address is whether offering or paying incentives to bring into the sample people who might otherwise refuse affects their answers to the survey questions.

For this investigation, we used the same 17 key variables already included in the Index of Item Nonresponse, and for each month we looked at whether the response distributions varied significantly by (*a*) the initial incentive and (*b*) refusal conversion payments, using the multinomial logit specification in

CATMOD[7] and again controlling for the same set of demographic characteristics as in the analysis of item nonresponse.

The offer of an initial incentive is associated with significantly different response distributions (at the .05 level) on four of the 17 variables; a refusal conversion payment, with significantly different response distributions on four of them. One variable was significantly affected by both types of incentives.[8] In five of these cases, the responses given with an incentive were more optimistic than those given without an incentive; in two cases, they were more pessimistic. In the remaining case, respondents who received an incentive were somewhat more likely to respond "good" and "bad" and somewhat less likely to give an equivocal reply. Thus, there is a suggestion that respondents who receive an incentive may give somewhat more optimistic responses than those who do not. Similar findings have been reported by Brehm (1994) and by James and Bolstein (1990). Theory and experimental findings by Schwarz and Clore (1996) suggest that this happens because the incentive puts them in a more positive mood, and this possibility clearly warrants more research.[9]

Do Incentives Create Expectation Effects?

In addition to concerns about the possible effect of incentives on data quality, there are concerns that the payment of incentives, especially prepayment, will create expectations for future payment on the part of respondents. The effect of incentives may be direct—that is, arouse expectations on the part of respondents for payment the next time they are asked to participate in a survey—or both direct and indirect, creating a climate that affects even those members of the public who have not themselves been paid before for their cooperation. In an earlier exploration of this question, Singer, Van Hoewyk, and Maher (1998) reported that although people who had received a monetary incentive in the past were significantly more likely to endorse the statement that "people should be paid for doing surveys like this" than those who had not, they were actually more likely to participate in a subsequent survey 6 months later, in spite of receiving no further payments.

We have since replicated this analysis using 15 months of data, which has enabled us not only to look separately at the effect of incentives offered at

7. The SAS CATMOD procedure allows researchers to perform modeling of data that can be represented by a contingency table. CATMOD fits linear models to functions of response frequencies and can use linear modeling, log-linear modeling, logistic regression, and repeated measurement analysis. A more complete description can be found in SAS Institute (1989).

8. These counts are based on the bivariate distributions, without controls for demographic characteristics. In the case of three additional variables, incentives have a significant effect once demographic characteristics and the interactions of demographics and incentives are also controlled.

9. An alternative interpretation, which we are unable to test, is that the incentive brought into the sample people who differed on the attitudes being measured from those not offered an incentive, even though they did not differ on characteristics such as gender, age, and race.

the outset of a survey and at refusal conversion payments but also to control for the demographic characteristics of respondents, as measured at the time of the initial survey.

The effects of initial incentives and refusal conversion payments are shown in table 7. Also included in each model are a series of demographic characteristics and interactions between them and the incentives. The effects of both kinds of incentives on response rates 6 months later are negative, but neither effect is significant. Several demographic characteristics have significant effects on response to the reinterview. Multivariate analysis indicates that education has a positive effect on cooperation, whereas nonwhite race and Hispanic ethnicity have negative effects. Age is positively related to cooperation, and, in addition, there is a significant interaction between age and refusal conversion payments.

The question remained, however, whether the absence of a significant effect of time 1 incentives on time 2 cooperation was because respondents construed the payment as covering the reinterview (by the same survey organization) as well as the initial interview, and whether the same results would be obtained if they were approached by a different survey organization.

An experiment examining this question is reported by Singer, Groves, and Corning (1999). In March 1996 two-thirds of the households in the Detroit Area Study (DAS) were sent an advance letter containing a $5 bill; one-third received the letter only. Households that received the $5 incentive were significantly more likely to respond than those who did not. The difference in completion rates was 8 percentage points; the completion rate for the study, defined as the proportion of interviews completed divided by the number of households listed less vacants and nonsample households and those ineligible because of illness or language problems, was 66 percent.

A little more than a year later, all 451 original DAS respondents for whom an address could be located were sent a mail questionnaire on the topic of assisted suicide. The return address on the letter differed from that used for the original Detroit Area Study, thus providing a test of whether the effects extended to requests from other survey organizations.[10] The questionnaires were preceded by advance letters, a random half of which included a $5 prepaid incentive. A week after the questionnaires had been mailed, everyone in the sample was sent a reminder postcard.[11]

The response rate to the self-administered survey was 41.4 percent for those who did not receive an incentive and 65.1 percent for those who did—a

10. The questionnaire and the return address identified the research organization as the Program on Public Opinion and Health Policy at the Survey Research Center, University of Michigan.
11. The number of respondents to the original Detroit Area Study was 451; the follow-up request was sent to 433 of those respondents (18 respondents were omitted because no address could be located for them). Completed questionnaires were returned by 202 respondents, 4 respondents refused to participate, and 172 respondents did not return questionnaires. Fifty-three questionnaires were undeliverable, and 2 respondents were deceased or could not be contacted for other reasons. The completion rate, as defined earlier, was 53.4 percent.

Table 7. Logistic Regression of Time 2 Participation on Time 1 Initial Incentives or Refusal Conversion Payments, Controlling for Demographic Characteristics and Interactions ($n = 4{,}055$)

	Effect of Initial Incentives				Effect of Refusal Conversion			
	Model 1		Model 2		Model 1		Model 2	
	Parameter Estimate	SE	Parameter Estimate	SE	Parameter Estimate	SE	Parameter Estimate	SE
Promised/prepaid incentives	−.073	.077	−.707	.529				
Refusal conversion payments					−.111	.089	−.668	.616
Age			.008**	.003			.005*	.003
Nonwhite			−.399**	.125			−.390**	.122
Hispanic			−.560**	.167			−.431**	.165
Education			.074**	.019			.080**	.017
Female			−.162	.092			−.094	.084
Income			−.000	.000			.000	.000
Age × incentives/refusal conversion			.001	.005			.014*	.006
Intercept	1.137**	.045	.018	.307	1.136**	.041	−.068	.281

* $p < .05$.
** $p < .01$.

statistically significant difference, and one much larger than the original effect in the face-to-face survey, which utilized many more refusal conversion attempts. However, those who received an incentive payment in 1996 and did not receive an incentive in 1998 were no less likely to respond to the new survey than those who had not received an incentive in either year: 42 percent of the latter group, and 41 percent of the former, responded to the 1998 survey. In other words, receipt of an incentive for an earlier survey had no effect on subsequent participation in a survey by an ostensibly different organization a year later; the major effect on participation in the subsequent survey was whether or not the respondent received an incentive in 1998. Given the small sample size and the specialized nature of both surveys, this finding is clearly in need of replication.

Do Monetary Incentives Produce Biased Samples?

It has been argued that monetary incentives may be differentially effective in recruiting certain demographic groups into the sample—for example, nonwhites or people with lower income or less education. Since these groups are ordinarily underrepresented in probability samples, monetary incentives might be used to correct a bias that would otherwise occur. Indeed, some studies claim to have found such effects (for reviews, see Kulka [1994] and Singer et al. [1999]).

Because we have no information on the characteristics of people in the sampling frame, the SCA is not ideal for investigating such issues. It is, however, possible to compare the demographic characteristics of the interviewed samples with and without the promise or prepayment of a monetary incentive. Since the incentives are offered at random to half the sample, there should be no significant demographic differences by incentive condition unless the incentive is more effective in recruiting some demographic categories into the sample.

We examined this possibility in a variety of ways, comparing promised incentives with no incentives, prepaid incentives with no incentives, and letters with no letters (among those for whom an address could be obtained). In each case, we examined only the randomized portion of the sample, and aggregated cases over all the months in which a particular experiment was run. We then looked at (1) differences by incentive condition on one variable at a time and (2) differences by incentive condition on all demographic variables simultaneously, in a logistic regression framework. However, with the exception of education, neither prepaid nor promised incentives, nor the sending of an advance letter, results in "biased" recruitment. Nor, for that matter, do they appear to compensate for biases that might otherwise exist. In the case of education, the data suggest that the less well educated are more likely to be

recruited into the sample with a prepaid incentive of $5, and that might be considered a compensating effect.[12] It is, of course, possible that more pronounced effects of monetary incentives would be detected with larger amounts of money and in larger samples; the effects that have been reported in the literature all satisfy these conditions.

We also examined the effects of refusal conversion payments on the demographic composition of the sample. Here, almost all comparisons involving demographics are statistically significant. But this simply reflects the fact that nonwhites, Hispanics, the less well educated, younger respondents, and those with lower incomes are more difficult to recruit into the sample in the first place and are therefore more likely to be offered refusal conversion payments (table available from the authors on request).

Are Prepaid Incentives Cost Effective?

The answer to this question has to be, compared to what? For interviewer-mediated studies, the comparison is likely to be with refusal conversion payments, and the answer is likely to depend on the nature of the study and the importance of a high response rate, on how interesting the study is to respondents (i.e., how many of them are willing to participate even without a prepaid incentive), on whether or not prepaid incentives reduce the effort required, and on a variety of other factors.

Using call record data available from the SCA, we found that a $5 incentive included with an advance letter significantly reduced the number of calls required to close out a case (8.75 calls when an incentive was sent, compared with 10.22 when it was not; $p = .05$), and significantly reduced the number of interim refusals (.282 refusals when an incentive was sent, compared with .459 when it was not; $p < .05$). There is no significant difference between the incentive and the no-incentive condition in calls to first contact. The outcome of the first call indicates that compared with the letter only, the addition of a $5 incentive results in more interviews, more appointments, and fewer contacts in which resistance is encountered. Given the size of the incentive and the average cost per call aside from the incentive, sending a prepaid incentive to respondents for whom an address can be obtained is cost effective for the SCA. However, as we have tried to indicate, this conclusion depends on the size of the incentive as well as the structure of other costs associated with a study for a given organization and should not be assumed to be invariant across organizations and incentives.[13]

12. We also performed the analysis on cases interviewed after refusal conversion efforts, including conversion payments; the results are identical to those reported above. Although the number of those receiving refusal payments is slightly larger in the group not receiving initial incentives, the differences are not dramatic.

13. This discussion is based on unpublished analyses by John Van Hoewyk, Eleanor Singer, and Mick Couper of data from the Survey of Consumer Attitudes during 8 months in 1998.

There are, in addition, some intangible benefits to prepaid incentives. Interviewers like them. Knowing the household is in receipt of an advance payment, modest though it may be, they feel entitled to ask the respondent to reciprocate with an interview. Furthermore, prepaid incentives are equitable—they reward equally everyone who happens to fall into the sample, and they reward them for the "right" behavior—that is, for cooperation, rather than refusal. Both of these advantages are likely to make modest prepaid incentives an attractive alternative to refusal conversion payments in many types of surveys.[14]

Conclusions

The experiments reported in this article have tested a number of hypotheses about monetary incentives in random-digit dialed telephone surveys. As a results of these experiments—all of them replicated over a number of months—we feel reasonably confident in reporting the following conclusions:

1. Neither promised incentives nor advance letters reliably increase response rates in RDD telephone surveys.
2. Prepaid incentives enclosed with advance letters do reliably increase response rates to such surveys, by at least 10 percentage points in these experiments. They do so by affecting respondents directly and not through their effects on interviewer expectations. In this series of experiments, prepaid incentives significantly reduced the number of calls required to close out a case as well as the number of interim refusals.
3. Prepaid incentives do not reduce the likelihood that respondents will participate in a reinterview 6 months later, even if they are not offered an incentive again. That is, they do not appear to create expectations for payment on subsequent interviews. It is possible, however, that respondents offered such additional payments would agree to be reinterviewed at a higher rate.
4. Neither prepaid incentives, nor refusal conversion incentives, increase item nonresponse. If anything, prepaid incentives interact with certain respondent characteristics to reduce item nonresponse.
5. Prepaid incentives did not appear to affect the sample composition,

14. An argument that can be raised against the use of prepaid incentives is that they may undermine more altruistic motives for participating in surveys. We have found that prepaid incentives have smaller effects on survey participation for people who score high on a measure of community activism (Groves, Singer, and Corning 1999). But we do not know whether people high on community activism who are offered a prepaid incentive respond at a lower rate than they would have had they not been offered the incentive, nor do we know whether such an effect would appear on a later survey. Although there is anecdotal evidence that some people are offended by the offer of an incentive, such negative reactions appear to be few. A recent experiment by Lynn (1999), for example, found that though interviewers at the National Center for Social Research in the United Kingdom expected negative effects on response rates as a result of offering incentives to respondents, the effects were, in fact, significantly positive.

although refusal conversion payments did. There is a suggestion that both prepaid and refusal conversion incentives affect responses to some of the key items asked on the survey; respondents receiving incentives tend to answer more positively than those who do not, even with background characteristics controlled. More research is needed on the conditions under which incentives affect sample composition and/or responses to survey questions.

Prepaid incentives are already common in mail surveys, although the amounts used are ordinarily quite modest (see Church 1993). We suspect that the use of incentives will increase in interviewer-mediated surveys as well. Although we have failed to demonstrate expectation effects on the part of respondents, we believe such expectations are likely to become more prevalent among interviewers, and, as we have already indicated, interviewers' expectations about the ease or difficulty of interviewing do indeed affect the response rates they get.

Clearly, there is still much about incentives that is unknown. In particular, we have not examined the interaction of respondent characteristics such as socioeconomic status with incentives to see whether they are particularly effective with certain demographic groups. Geocoding telephone numbers in the initial sample might permit analysis of such interaction effects (cf. King [1998], who applied a similar method to face-to-face interviews in Great Britain). And we need better information on the conditions under which incentives might affect sample composition or bias responses. Such analyses should receive high priority in future work.

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K. A Comparison of ABS vs RDD for General Population Surveys

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A COMPARISON OF ADDRESS-BASED SAMPLING (ABS) VERSUS RANDOM-DIGIT DIALING (RDD) FOR GENERAL POPULATION SURVEYS

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Abstract Valid and reliable public health data are becoming more difficult to obtain through random-digit dial (RDD) telephone surveys. As a result, researchers are evaluating different survey designs (i.e., sampling frame and survey mode combinations) as complements or alternatives to RDD. Traditionally, mail surveys of the general public have been limited due to a lack of a complete sampling frame of households. Recent advances in electronic record keeping, however, have allowed researchers to develop a sample from a frame of addresses (e.g., the U.S. Postal Service Delivery Sequence File, which appears to provide coverage which rivals or possibly exceeds that obtained through RDD sampling methods). To test the use of this frame for surveying adults aged 18 years and older across a wide geographic area, a pilot study was conducted as part of the 2005 Behavioral Risk Factor Surveillance System (BRFSS). The pilot compared use of a traditional, RDD telephone survey methodology to an approach using a mail version of the questionnaire completed by a random sample of households drawn from an address-based frame.

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The findings indicate that the mail survey approach can achieve higher response rates in low-response-rate states (<40%) than RDD (particularly when two mailings are sent). Additionally, the address frame with mail survey design provides access to cell phone only households and offers cost savings over the telephone approach. The resulting sample, however, significantly overrepresents non-Hispanic whites and people with higher levels of education.

For more than 30 years, random-digit dial (RDD) telephone surveys have been the workhorse of the survey research industry. During the past decade, however, participation in most RDD telephone surveys has declined due most likely to factors such as the growth of call-screening technologies, heightened privacy concerns in the face of increased telemarketing calls, and the proliferation of nonhousehold telephone numbers which are typically nonvoice and unassigned numbers (Steeh et al. 2001; Curtin, Presser, and Singer 2005). Additionally, coverage provided by RDD sampling frames has increasingly been called into question. RDD frames do not include households that do not have a telephone of any type (approximately 2.2 percent in 2005; Blumberg and Luke 2007). The increased use of cellular telephones has exacerbated this problem with 12.8 percent of households reported to be cell phone only during the last half of 2006 (Blumberg and Luke 2007). Because most RDD samples typically include only landline numbers, cell phone only households end up being excluded. Additionally, most survey organizations have adopted "list-assisted" RDD sampling approaches, which exclude telephone numbers (approximately 3–4 percent of all households) that are included in "zero blocks," that is, banks of 100 telephone numbers with no directory-listed households (Brick et al. 1995). When we consider all sources, undercoverage in RDD frames may be as high as 15–19 percent.

Probability sample design alternatives to RDD that are of comparable speed, efficiency, and cost are, however, scarce. Face-to-face area probability surveys tend to achieve higher response rates, but the costs associated with traditional counting and listing procedures (i.e., those based on in-person methods rather than mail lists) and conducting in-person interviews are often prohibitive. Conversely, mail surveys have tended to provide a less expensive means of collecting information, although rarely, if ever, has an address frame been available that could provide sufficient coverage of the general population. Likewise, internet penetration, while high (as of May–June 2005, an estimated 68 percent of American adults reported using the internet), does not provide sufficient coverage for conducting surveys of the general adult population (Fox 2005).

More recently, however, the growth of database technology has allowed for the development and maintenance of large, computerized address databases, which may provide survey researchers with an inexpensive address-based sampling (ABS) alternative to RDD for drawing household samples. In particular,

the Delivery Sequence File (DSF) used by the U.S. Postal Service (USPS) is a computerized file that contains all delivery-point addresses serviced by the USPS, with the exception of general delivery (USPS 2005). Each delivery point is a separate record that conforms to all USPS-addressing standards. Initial evaluations of the DSF as a means of reducing the costs associated with enumeration of primarily urban households in area probability surveys have proven to be promising (Iannacchione, Staab, and Redden 2003; O'Muircheartaigh, Eckman, and Weiss 2003; Staab and Iannacchione 2004). These initial studies have shown that for a survey of the general population, the DSF offers potential coverage of 97 percent of U.S. households thereby providing a cost-effective and timely sampling frame. The frame's standardized format also facilitates geocoding of addresses and linkage to other external data sources, such as the Census Zip Code Tabulation Areas data. These data can be used to stratify the frame for sampling target populations.

Use of the DSF does have some drawbacks. Researchers cannot obtain DSF information directly from the USPS, but rather must purchase the information through a nonexclusive license agreement with private list vendors. The quality and completeness of the address information obtained from these vendors can vary significantly based on how frequently the company updates the listings, the degree to which the listings are augmented with information from other available databases, and if the company purges records based on requests from householders to not release their information (Link et al. 2005). Moreover, vendors differ in their experience with drawing probability samples from the DSF list. This can be problematic for researchers who do not wish to draw their own samples and tend to rely upon vendor expertise for this task. The DSF coverage in rural areas also tends to be lower than that in urban areas (Link et al. 2005). Additionally, in some rural areas the DSF contains simplified (i.e., city, state, and zip code only) listings, rather than full street addresses. The percentage of these types of addresses in the database is declining, however, as local governments adopt emergency 911 protocols, which require that all households be identified with a street address. The DSF contains post office (PO) boxes and multidrop addresses (i.e., multiple persons associated with the same address), which may be problematic for in-person and telephone surveys where a street address is required to locate the household or an associated telephone number. Such addresses may be less problematic for mail surveys. Finally, households with multiple mailing addresses (e.g., a street address and a residential PO box) induce selection multiplicities in mail surveys. Iannacchione, Staab, and Redden (2003) provide some evidence that a large percentage of households with residential PO boxes in their Dallas County study also have mail delivered to their street address. In a national sample based on the DSF, however, Staab and Iannacchione (2003) were not able to develop a reliable estimate of the percent of households with a PO box that also received home mail delivery. It is likely that in some areas, households with a PO box do not receive home mail delivery. This may be more likely to occur in rural areas where a PO box is provided at

no cost and no home mail delivery is made. Thus, including PO boxes may be necessary to ensure coverage of all households. Despite these limitations, the DSF appears to be a promising source of information for developing sampling frames of residential addresses.

In this study, we extended ABS-based survey assessment by comparing its use with RDD sampling methods for conducting surveys of the general public across a wide geographic area. In particular, we sought to answer the following questions: What design factors impact case resolution and response rates in ABS-based mail surveys? How do RDD telephone surveys and ABS-based mail surveys compare in terms of response rates and resulting respondent demographics? Can ABS-based mail surveys reach households without telephones and cell phone only households, both of which are currently excluded from most RDD sampling frames? And, finally, how do these different approaches compare in terms of cost?

Methods and Design

As one of the world's largest RDD computer-assisted telephone interview health surveys, the Behavioral Risk Factor Surveillance System (BRFSS) collects uniform, state−specific data on preventive health practices and risk behaviors linked to morbidity and mortality among adults (further details on the BRFSS survey design, methodology, and questionnaire are available at http://www.cdc.gov/brfss). Six states participated in the 2005 BRFSS mail survey pilot: California, Illinois, New Jersey, North Carolina, Texas, and Washington. We selected these states because (1) five of the six (North Carolina being the exception) have response rates below 50%, based on calculations using American Association for Public Opinion (AAPOR) response rate formula #4; (2) they represent various geographic regions of the United States; and (3) when combined, they provide a good representation of the racial and ethnic mix of the U.S. population (AAPOR 2006). Data collection for five of the states was conducted from March 15 through May 15, 2005, while the field period in New Jersey was from March 30 through May 30, 2005.

ABS MAIL SURVEY SAMPLE

Households were sampled from the DSF sample frame, which is based on residential housing unit addresses. The frame includes city-style addresses and PO boxes as well as single-unit, multi-unit, and other types of housing structures. To ensure the most complete coverage possible, we also included units identified by the USPS as being seasonal or vacant units, as well as throwback units (i.e., housing units with addresses of residents who do not want mail delivered to their house, but prefer to pick it up at the local PO) and drop-point units (i.e., locations where mail is dropped off, such as a general

store in a rural area or a trailer park office, and the residents of those addresses pick up their mail at that location). For multi-unit structures, the DSF allows for the unique identification of apartments because it includes fields for the house number, street name, and apartment number. Known business addresses were excluded. A national survey sample vendor provided access to the DSF file and conducted the sampling following our specifications. For the pilot survey, the frame was first sorted by county FIPS code within each of the six participating states. Separate samples of 1,680 addresses per state were then drawn as a systematic random sample, for a total of 10,080 addresses across the six states.

SPLIT SAMPLE EXPERIMENTS TO IMPROVE PARTICIPATION

Embedded within the mail survey pilot were several experiments designed to test the effectiveness of various contacting and within-household selection procedures. Randomization of cases within each of these experiments was conducted independently across the four embedded experiments. These included the following:

- Inclusion of surname/family name on the mailing envelope. Two database vendors matched the sampled addresses with any name(s) they could associate with the address. Cases with a surname match were randomized in an equal fashion into one of two groups: (i) addressed to "The <Surname> Household or Current <State> Resident," or (ii) addressed to "<State> Resident." Cases in which a surname could not be matched were addressed to "<State> Resident."
- Postcard reminder. All cases were equally randomized to one of two groups: (i) received a postcard one week after the initial questionnaire mailing or (ii) did not receive a postcard.
- Second questionnaire mailing. All cases were equally randomized to one of two groups: (i) nonrespondents, who received a second mailing after four weeks, including cover letter and questionnaire, or (ii) nonrespondents, who did not receive a second mailing.
- Alternative within-household selection techniques. Sampled addresses were randomized equally to one of three respondent selection methods: (i) any adult in the household, with the household deciding who responds (a non-probability approach hypothesized to have the lowest associated respondent burden and potentially the lowest level of nonresponse), (ii) adult with the next birthday (based on selection procedures used widely in a number of RDD surveys), or (iii) every adult in the household.

MAIL SURVEY WEIGHTING

The ABS mail survey data were weighted to adjust for probability of selection at both the residential address and the within-household respondent

selection levels (depending on the type of within-household selection used), poststratified by sex and age of the respondents, then ratio-adjusted to equalize weighted state sample sizes. First, household base sampling weights (BSW) were calculated by state. For each state, this sum equaled the DSF population count of residential addresses divided by the sample size. Because we did not include questions on the survey about type of mail delivery, the BSW did not include an adjustment for potential multiplicity of addresses, such as where households have mail delivered to both a street address and a PO box.

Next, a design weight (BSW_2) for version 2 (respondent selection = next birthday) completed questionnaires was calculated as BSW × the number of adults in the household, where the maximum value for the number of adults in a household was capped at 5. For version 1 (respondent selection = any adult) and version 3 (respondent selection = all adults) completed questionnaires, BSW_2 = BSW. A version 3 (all adults) nonresponse adjustment was made (BSW_3) and calculated as BSW_2 times the ratio: (number of adults in the household/number of adults in household that completed a questionnaire), where the maximum value for the number of adults in a household was capped at 5. For version 1 and 2 completed questionnaires, BSW_3 = BSW_2.

For all completed questionnaires in a state combined, BSW_3 was poststratified to 2004 population control totals (provided by Claritas) for 13 age-by-gender cells to produce a poststratified weight (BSW_4). Males aged 18–24 years were combined with males aged 25–34 years, because of the small sample size in the younger age group.

Finally, BSW_4 was ratio-adjusted to produce a final weight (FINALWT) such that the sum of the weights in each state equaled the average of the total adult population across the six states. FINALWT was used to produce the estimates presented in the analyses below because it gave each state an "equal" contribution to the combined state estimates (i.e., the estimates were not dominated by California and Texas).

RDD TELEPHONE SURVEY

The ABS mail pilot surveys were conducted in parallel with the ongoing, monthly RDD data collection, thereby facilitating the comparison of results across the two designs. Telephone survey data from the six participating states for the months of March, April, and May 2005 were used in this analysis. These data were weighted to account for sampling designs, poststratified using the same gender and age categories specified for the mail survey data, and ratio-adjusted so that the sum of the FINALWTs in each state equaled the average of the adult population totals across the six states. More details on BRFSS design and methodology are available elsewhere (Mokdad, Stroup, and Giles 2003) and at http://www.cdc.gov/brfss.

RESPONSE RATE CALCULATIONS

To maximize comparability between the mail and telephone surveys, outcome disposition codes and response rate calculations recommended by AAPOR were used (AAPOR 2006). AAPOR provides a set of case outcome codes for RDD telephone surveys and mail surveys of specifically named persons. For the telephone survey, the original BRFSS disposition codes were mapped to the AAPOR-specified codes and response rates were calculated using AAPOR response rate formula #4. Because the AAPOR mail survey disposition codes apply to surveys in which the respondent's name is known upfront, some modifications were required to handle sampled cases that might not be identified with an eligible residence. Survey packets that were returned from the USPS as undeliverable were coded according to the reason given for nondelivery. Cases in which the survey packet could not be delivered due to an address problem, an address was no longer in service, or because the unit was vacant, including packets marked "cannot be delivered" (no reason given), "cannot be delivered as addressed," "insufficient address," "no mail receptacle," "no such number," "PO box closed," and "vacant," were treated as ineligible.

Determining eligibility in a self-administered mail survey in the absence of a completed questionnaire is more difficult since we cannot determine if someone aged 18 or older resides in the household. Given this, one approach would be to consider all returned cases without a completed interview to be "undeliverable cases with unknown eligibility." However, given that the vast majority of households in the United States typically have at least one adult, we decided it would be more accurate for response rate calculations if returned cases where we could reasonably infer that an occupied household had been reached be considered "eligible interviews." This would have the effect of actually lowering response rates, rather than treating these as "unknown eligibility" where only a portion of the cases would be counted toward the response rate denominator. To do so, returns without a completed questionnaire were determined to be "eligible noninterviews" if (a) someone at the address returned a blank questionnaire in the return envelope or (b) if the case was part of the group where a surname was used on the envelope and the reason for return indicated that "addressee not available" or "addressee no longer at this address." The former is considered a refusal and the latter is assumed to be a household and further assumed to have at least one eligible respondent who did not complete the questionnaire.

Finally, all cases in which no return (either from the respondent or from the USPS) was received were considered to have unknown eligibility and a percentage of these cases were included in the response rate denominator. Unfortunately, determining the residency rate to apply to cases with either an "undeliverable – unknown eligibility" or "no questionnaire returned" disposition was not a clear-cut process. AAPOR only provides guidance for such calculations for mail surveys where the sample members' names are known

upfront (that is, it is a very safe assumption that all or nearly all returns are eligible cases). Using a variant of the methodology used in estimating residency rates in RDD surveys, we initially calculated the residency rates based on cases with known eligibility. Using that approach, approximately 75 percent of the nonrespondent cases were determined to be likely eligible households. Other studies (such as Iannacchione, Staab, and Redden 2003), however, estimate the residency rate to be closer to 90 percent, a percentage which has yet to be empirically confirmed. Like RDD surveys, therefore, there are several potential ways in which this percentage could be calculated. Because of the screening conducted when the sample was selected, we were reasonably confident that the 75 percent rate was low. In the absence of any other empirical basis upon which to make this decision, therefore, we calculated all response rates using an assumption that 90 percent of the undeliverable and no-return cases were eligible households. We believe that the 90 percent estimate is likely on the higher side, so the resulting response rates are "conservative" estimates – that is, there is a higher likelihood that the "true" response rates are higher than those reported here rather than lower.

COST CALCULATIONS

Cost is an important component in the evaluation of any survey design. The data collection costs per 1,000 completed interviews were calculated for both the telephone and mail surveys (assuming a design involving an initial questionnaire mailing, a follow-up postcard, and a second questionnaire mailing) using (1) actual unit costs for materials and supplies based on the pilot study experience, (2) production statistics from the pilot effort, and (3) estimates of industry averages for direct hourly rates and indirect cost rates (i.e., fringe benefits, general and administrative expenses, indirect technical costs, and materials support expenses). Other costs assumed to be nearly equivalent regardless of the survey design were not included, such as overall project management, survey design development, and post-data collection weighting and analysis.

Results

DESCRIPTION OF MAIL SURVEY SAMPLE UNITS AND MATCH RATES

In total, 10,080 addresses were sampled for the ABS mail survey (1,680 per state). The states varied considerably in the ways in which their residents received mail. For instance, nearly two-thirds (62 percent) of North Carolina residents received their mail curbside, compared to less than one-in-five (17 percent) of those living in California. Conversely, a higher percentage (38 percent) of Californians received their mail via either a residential cluster box or a delivery point within a building (i.e., residential central) than did residents of the five other states surveyed. Likewise California residents

(8 percent) along with Texas residents (8 percent) were more likely than residents of the four other states to have their mail delivered to some type of PO box.

The surname match rates were relatively high, ranging from 78 percent in New Jersey to 66 percent in Texas. Surname-matching rates varied considerably, however, depending on how a household received its mail. Among households where mail was delivered curbside, via door-to-door (walking route), or door-slot delivery, the surname match rates were approximately 84 percent. These rates were lower among residential cluster (71 percent) and residential central (48 percent) mail recipients. Among PO box holders, the percentage of surnames identified was significantly lower at 14 percent.

Although telephone numbers for ABS sample units were not a part of the analysis presented here, they were identified for a related follow-up to verify within-household selection (Battaglia et al. in press). The percentage of telephones matched to addresses was slightly lower than the surname match rates, ranging from 66 percent in North Carolina to 52 percent in California. Again, the match rates varied considerably by delivery type: residential curb service (74 percent), residential walking/slot mail route (72 percent), residential cluster (62 percent), residential central (40 percent), and PO box (8 percent). One additional finding of interest was that we were able to match telephone numbers to 62 percent of the addresses classified as nonresponding, potentially eligible households. Additional follow-up by telephone, therefore, while not used in this pilot for completing interviews due to resource constraints, appears quite feasible.

MAIL SAMPLE EFFICIENCY

A total of 3,010 completed mail surveys were obtained across the six states, representing 2,550 unique households (since some households were asked to complete interviews with multiple adults). At the household level, the final disposition of cases was as follows: 2,550 completed questionnaires; 50 eligible noninterviews; 29 undeliverable cases with unknown eligibility; 6,593 cases with no returns resulting in unknown eligibility; 857 undeliverable cases considered ineligible; and 1 case deemed ineligible due to age (respondent reported being younger than 18 years of age).

Not surprisingly, there was variation across both type of address and state in terms of the percentage of addresses determined to be ineligible and those with one or more completed interviews (see table 1). Among traditional city-style addresses, 26.7 percent resulted in a completed interview, while 6.2 percent were determined to be ineligible across the six states. For PO boxes, the percentage of completed interviews was lower (16.6 percent) and the percentage of ineligible cases was higher (12.7 percent) than for city-style addresses. There was also a greater variation in rates across states, with completion rates varying from 4.5 percent (New Jersey) to 20.0 percent (California). The overall rates for

Table 1. Percentage of Completed Interviews and Confirmed Ineligibles by Type of Address by State

Type of address	Total	State					
		CA	IL	NJ	NC	TX	WA
City-style							
Sampled addresses (*n*)	8,968	1,521	1,476	1,454	1,504	1,473	1,540
Confirmed ineligible (%)[a]	6.2	6.2	5.2	3.7	6.9	8.6	6.5
Completed interview (%)[b]	26.7	24.7	31.2	18.4	27.5	24.9	32.7
Post office box							
Sampled addresses (*n*)	561	125	63	89	90	109	85
Confirmed ineligible (%)	12.7	16.8	9.5	10.1	13.3	13.8	9.4
Completed interview (%)	16.6	20.0	12.7	4.5	18.9	18.3	22.4
Throwback or drop unit							
Sampled addresses (*n*)	215	7	81	79	11	22	15
Confirmed ineligible (%)	13.5	28.6	3.7	3.8	36.4	36.4	20.0
Completed interview (%)	16.3	14.3	19.8	13.9	9.1	18.2	13.3
Vacant unit							
Sampled addresses (*n*)	307	22	60	42	75	68	40
Confirmed ineligible (%)	63.2	68.2	50.0	73.8	69.3	67.6	50.0
Completed interview (%)	8.5	0.0	11.7	4.8	5.3	7.3	20.0
Seasonal unit							
Sampled addresses (*n*)	29	5	0	16	0	8	0
Confirmed ineligible (%)	20.7	40.0	NA	12.5	NA	25.0	NA
Completed interview (%)	17.2	20.0	NA	12.5	NA	25.0	NA

[a]Calculated as number of confirmed ineligible addresses/total number of sampled addresses.
[b]Calculated as number of households with at least one completed interview/total number of sampled addresses.

throwback and drop units were similar to those of PO boxes (16.3 percent completion rate; 13.5 percent ineligible rate); however, there was a greater variation across states both in terms of the percentage of total sampled addresses which were either throwback or drop units and in terms of the percentage of cases determined to be ineligible. Among vacant units, 63.2 percent of the addresses were determined to be ineligible, while 8.5 percent resulted in a completed interview. By far, seasonal units were the smallest address-type category which accounted for just 29 of the 10,080 total sampled addresses.

EFFECT OF DESIGN FACTORS ON MAIL SURVEY RESPONSE

Examining the effect of various survey design experiments embedded in the mail survey after obtaining a completed interview from at least one respondent in the addresses sampled, table 2 provides the results of a logistic regression model predicting the effects of the design components on the odds of obtaining

Table 2. Logistic Regression Model: Odds of Receiving a Completed Survey by Survey Design Feature

Address type	Completed interview from total addresses mailed	
	AOR	(95% CI)
Other type	1.00	
City-style	2.27***	(1.74, 2.95)
PO box	1.83***	(1.30, 2.58)
Postcard		
Not sent	1.00	
Sent	1.12*	(1.02, 1.22)
Second questionnaire		
Not sent	1.00	
Sent	1.58***	(1.44, 1.73)
Surname on mailing		
No name available	1.00	
Name not used	2.01***	(1.77, 2.29)
Name used	1.83***	(1.62, 2.09)
Respondent selection		
Any adult	1.00	
Next birthday	0.91	(0.81, 1.02)
All adults[a]	0.90	(0.81, 1.01)
(*n*)	(10,080)	

NOTE.—AOR = adjusted odds ratio; CI = confidence interval.
[a]At least one completed interview received from the household.
Significance: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

a completed survey from all of the addresses to which a questionnaire was mailed. The odds of receiving a completed interview were 127 percent higher than all other types of addresses (i.e., seasonal, drop-point, throwback, and vacant units) if a city-style address was available and 83 percent higher if a PO box was used. The odds of receiving a completed questionnaire using a family name or surname on the mailing label were 83 percent higher than addresses for which no surname could be identified. However, not using a surname when one was available also had a significant positive effect, doubling the odds of a completed survey (101 percent higher). Sending a second questionnaire improved the odds of a completed survey by 58 percent and sending a postcard reminder one week after the original mailing improved the odds by 12 percent. The within-household respondent selection method used (i.e., any adult, next birthday, or all adults) did not have a significant effect on the odds of receiving a completed survey (see Battaglia et al. in press) for a more detailed analysis of the effects of within-household selection techniques).

Next, we calculated the response rates for the various treatment groups (e.g., combinations of surname use, postcard reminder, and second mailing). As

Table 3. Response Rate by Survey Design Group

Treatment group	Estimated eligible households	Response rate
Name not used, postcard, second questionnaire	782	40.4
Name not used, no postcard, second questionnaire	790	39.8
Name used, postcard, second questionnaire	810	38.0
Name used, no postcard, second questionnaire	803	33.9
No name match, postcard, second questionnaire	500	29.8
Name not used, postcard, no second questionnaire	815	29.0
Name used, postcard, no second questionnaire	807	27.4
No name match, no postcard, second questionnaire	490	25.9
Name not used, no postcard, no second questionnaire	814	25.3
Name used, no postcard, no second questionnaire	810	24.8
No name match, no postcard, no second questionnaire	574	18.3
No name match, postcard, no second questionnaire	576	16.8

NOTE.—Response rate calculated using American Association for Public Opinion Research Response.

Response rate formula #4 (AAPOR 2006). The percentage of mail survey cases with unknown eligibility included in the response rate denominator was set at 90% for all states.

shown in table 3, we obtained the highest response rates for the groups where a name was available but not used and a second questionnaire was mailed. The addition of a postcard reminder to these two factors had little effect on response rates (40.4 percent versus 39.8 percent). The lowest response rates were for the groups where no surname was identified and no second mailing was sent.

COMPARISON OF RESPONSE RATES

Considering all cases in the ABS mail survey, we found that in Washington the mail survey resulted in a substantially higher household-level response rate (i.e., where at least one mail survey was returned from the sampled address) than did the telephone survey (see table 4). California, Illinois, New Jersey, and Texas had rates that were statistically equivalent across the two modes. In North Carolina, the state with the highest RDD response rate, the mail survey's response rate was nearly 15 percentage points lower than the RDD rate.

However, when examining only those cases in the treatment group that received a second mailing, we found that the difference in rates was much starker, with the mail survey performing significantly better in five of the six states: Washington (+6.7 percent), Texas (+5.4 percent), California (+4.5 percent), Illinois (+4.1 percent), and New Jersey (+3.7 percent). In North Carolina, the second mailing markedly improved the response rates for

Table 4. Comparison of DSF Mail Survey and RDD Telephone Survey Response Rates by State and Experiment Condition

State	Response rates		
	RDD telephone survey % (*n*)	DSF mail survey: All cases % (*n*)	DSF mail survey: Cases in 2nd mailing group[a] % (*n*)
Ca	29.4 (5,771)	28.1 (1,432)	33.9*** (691)
Il	35.8 (3,323)	33.7 (1,456)	39.9*** (720)
NJ	22.5 (14,965)	20.0 (1,450)	26.2*** (713)
NC	45.8 (9,782)	31.1*** (1,402)	37.0*** (691)
Tx	31.1 (6.902)	29.0*** (1,375)	36.5*** (661)
Wa	34.1 (17,304)	36.9*** (1,443)	40.3*** (698)

NOTE.—Response rate calculated using American Association for Public Opinion Research.

Response rate formula #4 (AAPOR 2004). The percentage of mail survey cases with unknown eligibility included in the response rate denominator was set at 90% for all states.

RDD = random-digit dialed; DSF = Delivery Sequence File; *n* = estimated number of households.

[a]Includes all cases randomly assigned to this treatment group, including those which complete the survey on the first mailing and did not require a second mailing.

Significance: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

the mail survey, yet the rate was still significantly lower than that obtained by the telephone survey.

COMPARISON OF DEMOGRAPHIC CHARACTERISTICS

We also looked at the demographic characteristics obtained using the telephone and mail surveys and compared these with results from the 2003 Current Population Survey (CPS). The CPS totals presented here were only from the six states included in the pilot and the CPS weights, like the pilot data weights, were adjusted so that the sum of the weights in each state equaled the average of the total adult population across the six states. The six-state CPS totals were then used as a "gold standard" against which the BRFSS telephone and mail results were compared. Estimates for the telephone and mail surveys were poststratified to adjust for sex and age differences using 2000 Census estimates updated for 2004 by Claritas. Both the telephone and mail surveys differed significantly from the CPS estimates in a number of characteristics (see table 5). Most striking were the differences in the respondents' education levels. In the telephone survey, 59.7 percent of the respondents reported having at least some college education, as did 71.8 percent of those who responded to the mail survey. Both of these results were higher than the 53.8 percent estimated by the CPS.

Table 5. Comparison of Weighted Demographic Characteristics, DSF Mail Survey, RDD Telephone Survey, and Current Population Survey

Demographic characteristics	CPS population estimates[a] (%)	RDD telephone survey (%)	DSF mail survey (%)	Significant levels: RDD versus CPS	DSF versus CPS	RDD versus DSF
Sex				n.s.	n.s.	n.s.
Male	48.5	48.7	48.3			
Female	51.5	51.3	51.7			
Age				n.s.	n.s.	n.s.
18–34	32.6	32.2	32.0			
34–54	29.4	30.6	30.5			
55–64	23.2	21.5	22.1			
65+	14.8	15.6	15.4			
Race				.001	.001	.001
White, non-Hispanic	64.9	68.5	76.1			
Other	35.1	31.5	23.9			
Education				.001	.001	.001
Less than high school	16.9	13.7	7.8			
High-school diploma/GED	29.3	26.5	20.4			
Some college or more	53.8	59.7	71.8			
Income				n.s.	.05	.01
<$50,000	53.6	54.5	51.4			
$50,000+	46.4	45.5	48.6			
Marital status				.001	.01	n.s.
Married/couple	56.6	60.2	59.1			
Not married/single	43.4	39.8	40.9			
Number of children in household				.001	n.s.	.001
None	59.8	56.8	61.0			
One or more	40.2	43.2	39.0			

Continued.

In terms of other demographic groups, the telephone survey overestimated the percentages of white, non-Hispanics; persons in households with incomes of $50,000 or more; and married people, and underestimated the percentage of persons in households with three or more adults. The mail survey also differed significantly from the telephone survey with regards to household education

Table 5. Continued

Demographic characteristics	CPS population estimates[a] (%)	RDD telephone survey (%)	DSF mail survey (%)	Significant levels: RDD versus CPS	DSF versus CPS	RDD versus DSF
Number of adults in household				.01	.001	.001
One	16.2	16.7	19.3			
Two	54.9	56.2	59.5			
Three	28.9	27.1	21.2			
Metropolitan statistical area (MSA)				n.s.	.001	.001
In MSA	86.2	86.8	89.7			
Not in MSA	13.8	13.2	10.3			
[*n*]	[32,963]	[18,780]	[3,010]			

NOTE.—Data are weighted to adjust for sample design, poststratified by sex and age, and ratio-adjusted so that state sample sizes are equivalent.

CPS = Current Population Survey; RDD = random-digit dialed, DSF = Delivery Sequence File.

[a]CPS data include only the six pilot study states: California, Illinois, New Jersey, North Carolina, Texas, and Washington.

level and income as well as number of children and adults in the household. The mail survey also differed significantly from both the CPS and RDD estimates with respect to metropolitan statistical area (MSA) status. Of the mail survey respondents, 89.7 percent lived within an MSA and 10.3 percent lived outside of an MSA (i.e., in a less urbanized area). This latter percentage compares to 13.8 percent from the CPS and 13.2 percent from the RDD survey.

We next examined the success of the mail survey in reaching cell phone only households and households with no telephone, both of which are missed by RDD surveys. We compared findings with estimates from interviews conducted during January through June 2005 as part of the National Health Interview Survey (NHIS), a face-to-face survey with a relatively high response rate. As shown in table 6, 6.5 percent of the adults who responded to the DSF-based mail survey indicated that their household could only be reached by cell phone. This finding for the combined six states in the pilot was similar to the national figure of 6.7 percent reported for the NHIS (Blumberg et al. 2006). Approximately 1 percent of the mail survey respondents stated that they had no telephone access in their household, compared with 1.7 percent of respondents interviewed in the NHIS.

Table 6. Percentage of Adults by Type of Household Telephone Access

Household telephone access	National Health Interview Survey % (95% CI)	BRFSS DSF mail survey % (95% CI)
Land-line	91.6 (91.1, 92.1)	92.6 (90.0, 94.0)
Land-line only	–	*14.9 (13.5, 16.4)*
Land-line and cellular phone	–	*77.7 (75.7, 79.6)*
Cellular phone only	6.7 (6.2, 7.2)	6.5 (5.1, 8.2)
No telephone	1.7 (1.5, 1.9)	1.0 (0.6, 1.4)
[*n*]	[33,614]	[2,947]

NOTE.—Based on interviews NHIS conducted from January to June 2005.
SOURCE.—Blumberg et al. (2006).
CI = confidence interval; *n* = estimated number of households.

COMPARISON OF COSTS

The operational costs of conducting the telephone survey ($79,578 per 1,000 completed interviews) were 12 percent greater than the costs associated with the mail survey ($70,969 per 1,000 completed interviews), assuming a design which included two questionnaire mailings with a follow-up postcard in between (table 7). Although the cost of materials was higher for the mail survey (rates including indirect/overhead charges: $3,938 for telephone survey, $49,600 for mail survey), the telephone survey was much more labor intensive for the same number of completed interviews (rates including indirect/overhead charges: $75,640 for telephone survey, $21,369 for mail survey). The higher indirect rates for labor (estimated to average 150 percent) compared with the indirect costs of materials and supplies (estimated to average 25 percent) further exacerbated these differences.

Discussion

Mail surveys conducted with respondents selected using address-based sampling methods show some promise as an alternative or complementary approach to RDD surveys. In this study, the ABS mail survey produced significantly higher response rates than those obtained in the RDD surveys in five of the six states studied when a second questionnaire mailing was used. The benefit of a second questionnaire mailing was consistent with the findings of other mail surveys (Dillman 2000). The use of a reminder postcard sent one week after the initial mailing provided a modest, but not statistically significant boost to response rates.

Additionally, differences were found in participation rates between respondents with addresses with a surname match and those where a surname could

Table 7. Cost Comparisons per 1,000 Completed Interviews for Conducting an RDD Telephone Survey versus a DSF-Based Mail Survey (With Two Questionnaire Mailings and a Postcard Follow-Up)

	RDD telephone survey	DSF mail survey[a]
Assumptions		
Number of sampled telephone numbers/addresses (per 1,000 completed interviews)[b]	5,000	2,722
Cost calculations for materials/supplies		
Telephone sample ($0.08 per number)/mail sample ($0.11 per address)[c]	$400	$299
Telephone connect charges ($0.55 per number)[c]	$2,750	NA
Printing and postage for mail survey package (@ $6.80 per address)[c]	NA	$37,019
Return postage (@ $1.00 per completed interview)[c]	NA	$1,000
Printing and postage for postcard reminder (@ $0.50 per address)[c]	NA	$1,361
Subtotal for direct cost of materials/supplies	*$3,150*	*$39,680*
Subtotal for indirect costs of materials/supplies (@ 25%)[d]	*$788*	*$9,920*
Total cost for materials/supplies (direct and indirect)	$3,938	$49,600
Cost calculations for labor		
Hours of interviewer time required (@ 2.75 hours/completed interview)[b]	2,750 hours	NA
Hours to print and assemble mailing packages (@ 100 packages/hour)[b]	NA	54 hours
Hours to handle postcard mailing (@ 750 per hour)	NA	4 hours
Hours of receipt/control time required (per 1,000 completed interviews)[b]	NA	500 hours
Hours of data entry time required (per 1,000 completed interviews)[b]	NA	219 hours
Hours of supervisor/monitor/quality control time required (@ 25% of interviewer/receipt-control/data entry time)[d]	688 hours	194 hours

Continued.

Table 7. Continued

	RDD telephone survey	DSF mail survey[a]
Interviewer/receipt-control/data entry time ($8.00 per hour)[c]	$22,000	$6,217
Supervisor or monitor time ($12.00 per hour)[d]	$8,256	$2,331
Subtotal for direct labor costs	*$30,256*	*$8,548*
Subtotal for indirect labor costs, including fringe benefits (@ 150%)[d]	*$45,384*	*$12,822*
Total cost for labor (direct and indirect costs)	$75,640	$21,369
Total cost of materials/supplies and labor (absent fee/profit) per 1,000 completed interviews	$79,578	$70,969

NOTE.—Comparison includes only costs of actual data collection and does not include other costs such as survey design, statistical support, analysis, or project management (other than direct supervision costs noted in the table).

[a]Costs based on mail survey design yielding the highest response rate, which includes two questionnaire mailings to all sampled addresses with a postcard follow-up between questionnaire mailings.

[b]Based on production statistics from pilot study.

[c]Based on cost data from pilot study.

[d]Based on estimates of average rates across survey research industry.

not be identified, with the former being more likely to respond regardless of whether the name was actually used on the mailing envelope. This finding is similar to the differences found in RDD surveys between telephone numbers with an identifiable address and those without an address match (Link and Mokdad 2006). It appears that persons who are more readily identifiable in public databases, such as those used for surname- or address-matching, tend to be more willing to participate in surveys than people who are more difficult to identify. Although the differences in participation between the two surname-identified groups were not statistically significant, there are potential issues that might make not using the surname preferable, even when available. If the surname match is incorrect, household members may be more likely to discard the mailing without opening it. Although the differences in participation rates seen here were not statistically significant, the group in which surnames were available but not used in the mailing had the highest overall response rates. Use of a surname may also influence respondent selection, particularly in households where adults may not share the same last name. Finally, use of a surname may raise concerns about confidentiality among some respondents leading them to alter their responses, particularly to sensitive questions (Link et al. 2006).

The ABS mail survey also provided access to households with only cell phones, and to a smaller degree, to households with no telephone coverage. The former group is increasingly becoming a focus of concern among researchers, whereas the latter group has always been unreachable by telephone surveys. The percentage of cell phone only households across the six states examined here was similar to the percentage reported at the national level (Blumberg et al. 2006). Unfortunately, there are currently no state-level data on the percentage of cell phone only households with which to compare the pilot study findings.

The mail survey was also advantageous in that it cost less to conduct. To obtain the same number of completed interviews, the telephone survey cost was 12 percent higher than the amount required for the mail survey.

Nonetheless, the ABS mail survey approach had some drawbacks. First, improvement in response rates were obtained only in those states where the RDD response rates were low (i.e., below 50 percent). In North Carolina, where the RDD response rate was above 45 percent, the mail survey response rate was significantly lower than the telephone response rate, even when two questionnaire mailings were sent. Second, the mail survey obtained responses from a much higher percentage of non-Hispanic whites and people who had at least some college education and from a significantly lower percentage of persons who do not live in an MSA than did either the RDD survey or the CPS. This skewed distribution across these key demographic groups raises some concerns about potential bias in the estimates (see Link et al. 2006 for more detailed analysis of this issue). Third, use of the mail survey approach would likely force some fundamental changes in the way in which a surveillance system, such as BRFSS,

currently operates. Mail surveys require a longer fielding period (typically eight weeks or more) than the current monthly schedule for the BRFSS telephone survey. Use of a mail survey would also reduce the length and flexibility of the BRFSS questionnaire. The telephone version of the BRFSS contains a core survey of 70–75 questions (asked in all states), optional modules of 1–20 questions (standardized topic modules that can be adopted by the states), and state-added question modules of 1–50 questions (typically unique to each state, focusing on state-specific health issues). The 2005 mail survey pilot tested only the core questionnaire. Lengthening the mail questionnaire could increase respondents' reluctance to complete the survey, and customizing each state survey to include the optional or state-added modules would significantly increase the operational complexity of administering the survey.

Another issue that is not addressed completely in this study is the potential of multiplicity of mail addresses by including non-city-style addresses in the sampling frame (i.e., PO boxes, drop-point units, etc.). Because this was a pilot study, we wanted to maximize coverage of housing units and so we included all residential address types in the sampling frame: city style, vacant, seasonal, throwbacks, and drop-point units. The throwback addresses (0.3 percent of total addresses) and drop-point unit addresses (2.0 percent of total addresses) do not necessarily represent duplication of units in the sampling frame, but the inclusion of drop-point units may lead to some subjectivity as to which housing unit associated with a drop point receives the survey mailing. This could be handled in the sample design by creating a separate stratum for drop points and including all drop-point units associated with the sample drop points in the sample (i.e., a one-stage cluster sample design). Given the small percentage of drop-point units in the sampling frame, this approach may not be warranted in relation to the bias that may be incurred.

Potential duplication in the frame caused by PO boxes is a more important issue because residential PO boxes account for 7 percent of the addresses in the sampling frame. As noted earlier, however, it is unclear under what conditions this overlap is most likely to occur. Because this was a pilot survey and we needed to balance respondent burden issues with the desire to obtain as much information on mail delivery as possible, we decided not to add a question to the sample addresses that are PO boxes asking them whether they also have home mail delivery and vice versa for those with city-style addresses. Inclusion of such questions would allow for refinement of the weight adjustment to account for multiplicity and should be a focus of future research with ABS-based samples.

The study also highlights areas where data collection efficiencies may be gained. In addition to city-style addresses, it appears that inclusion of PO boxes, throwback and drop-point units is important for both coverage and the nonignorable number of completed interviews obtained from these types of addresses. The same does not appear to apply, however, to addresses identified as vacant or seasonal by the UPSP. More than 60 percent of the addresses

identified as vacant units were confirmed to be ineligible addresses. Although the percentage of vacant units resulting in a completed interview was relatively high in some states (20 percent in Washington), the number of completed interviews from this address type as a percentage of the total number of completed interviews was quite small (8 of 532 in Washington). Exclusion of vacant units from an ABS sample design is unlikely, therefore, to have a significant negative effect on coverage bias. Likewise the extremely small number of addresses designated as seasonal units argues for their exclusion as well.

While the DSF appears to be an effective frame for conducting address-based sampling of the general population, its true potential may be in facilitating mixed-mode surveys. Crossreferencing addresses with other public databases yielded telephone numbers for half to two-thirds of the addresses depending on the state. Moreover, among the subset of nonrespondents cases with unknown eligibility that received two mail questionnaires, over 60 percent had identifiable telephone numbers. Although additional research will be required to determine how accurately these telephone numbers match with the addresses, early indications are that conduct of a telephone survey follow-up to the mail survey is quite feasible. Moreover, address-based sampling may facilitate the more cost-effective use of other interviewing modes, such as web surveys or interactive voice response (IVR). Households could be sampled through an address-based frame, such as the DSF, then provided a link to a web site, given the telephone number for an IVR survey, mailed a hardcopy questionnaire, or any combination of these approaches. Recent studies have shown that combining telephone surveys with either web or mail survey options can produce higher response rates in general population surveys than use of telephone alone (Link and Mokdad 2006). Resources permitting face-to-face surveys could also be added to this mix, particularly since use of the DSF was initially tested as a means of identifying households for such surveys (Iannacchione, Staab, and Redden 2003; O'Muircheartaigh, Eckman, and Weiss 2003; Staab and Iannacchione 2004). The DSF, therefore, has the potential to serve as a sampling base for a wide variety of single or multimode survey designs.

A great deal of study is needed before use of address-based sampling can be recommended as a standard sampling approach for ongoing surveys such as the BRFSS. The findings do, however, offer encouragement, particularly for states and areas with low RDD response rates, urban areas where address coverage is higher, and surveys where all households are eligible. Future research efforts should continue to evaluate the expansion of address-based coverage as more rural areas adopt city-style addresses that conform to 911 emergency number rules. Use of the DSF in particular as a sampling frame for the conduct of surveys via other modes (telephone, web, IVR, face-to-face, etc.) as well as combinations of modes needs to be explored more fully as complements to RDD designs. Given the continued decline in RDD response rates and the increased use of cell phones it seems clear that an alternative design is needed to fill a growing gap as the new mainstay for survey research.

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L. Responsive Design for Household Surveys – Tools for Actively Controlling Survey Errors and Costs

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Responsive design for household surveys: tools for actively controlling survey errors and costs

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Summary. Over the past few years surveys have expanded to new populations, have incorporated measurement of new and more complex substantive issues and have adopted new data collection tools. At the same time there has been a growing reluctance among many household populations to participate in surveys. These factors have combined to present survey designers and survey researchers with increased uncertainty about the performance of any given survey design at any particular point in time. This uncertainty has, in turn, challenged the survey practitioner's ability to control the cost of data collection and quality of resulting statistics. The development of computer-assisted methods for data collection has provided survey researchers with tools to capture a variety of process data ('paradata') that can be used to inform cost–quality trade-off decisions in realtime. The ability to monitor continually the streams of process data and survey data creates the opportunity to alter the design during the course of data collection to improve survey cost efficiency and to achieve more precise, less biased estimates. We label such surveys as 'responsive designs'. The paper defines responsive design and uses examples to illustrate the responsive use of paradata to guide mid-survey decisions affecting the non-response, measurement and sampling variance properties of resulting statistics.

Keywords: Multiphase sampling; Paradata; Propensity models; Responsive design; Survey non-response

1. Introduction

In recent years two phenomena have combined to prompt consideration of new design options for sample surveys of household populations in wealthier countries of the world:

(a) the growing reluctance of the household population to survey requests has increased the effort that is required to obtain interviews and, thereby, the costs of data collection (de Leeuw and de Heer, 2002; Groves and Couper, 1998) and
(b) the growth of computer-assisted data collection efforts provides tools to collect new process data about data collection efforts (Hapuarachchi *et al.*, 1997; Couper, 1998; Scheuren, 2001).

The first phenomenon has threatened survey field budgets with increased risk of cost overruns, missed response rate targets and shortfalls in meeting goals for numbers of interviews. The second phenomenon provides survey researchers with unprecedented amounts of information about the data collection processes. This paper describes a set of design approaches to use the second to ameliorate the damages of the first.

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Established methods for survey design generally adhere to the following three-part recipe: prespecification and standardization of all aspects of design, implementation of those specifications and analysis conditional on the design protocols. These time-tested methods were developed to control sampling and measurement errors in the survey process, and they remain effective in survey applications where survey costs and errors are subject to small uncertainty. Today, however, uncertainty abounds.

The traditional survey design options include various tools to reduce survey errors, but many have cost implications. For example, the presence or absence of sample clustering often affects standard errors of estimates and also costs. Repeated call-backs to reduce non-contact of sample units increases interviewer costs but reduces non-response rates (which are often linked to non-response error). The use of alternative modes of data collection (e.g. mail, telephone or face-to-face interviews) can affect measurement errors, but they also affect costs. The use of incentives can affect rates of co-operation but may increase total costs. Although sampling variance is a common concern in most of these issues, the major focus is bias, increasingly bias due to non-response. How much these alternative features improve the quality of survey statistics and how much they affect costs often have no certain answers before data collection. Hence, prespecified optimal designs are almost never achieved in practice.

In this paper, we describe an approach that is termed 'responsive survey design'. By way of definition, responsive survey designs

(a) preidentify a set of design features potentially affecting costs and errors of survey estimates,
(b) identify a set of indicators of the cost and error properties of those features and monitor those indicators in initial phases of data collection,
(c) alter the features of the survey in subsequent phases based on cost–error trade-off decision rules and
(d) combine data from the separate design phases into a single estimator.

Although there are similarities to sequential analysis in its use of accumulating data, we make no pretence that our concept of responsive design represents a theoretical breakthrough as significant as sequential analysis (Wald, 1947) was for experimental testing. Nor do we wish to claim that we have invented new tools or even substantially refined methods for surveys. Techniques for replicated, two-phase and adaptive sampling (Cochran, 1977; Thompson and Seber, 1996) have been described by others and are used in practice. Likewise, adaptive flexible procedures for questionnaire design, respondent selection and incentives, refusal conversion and other aspects of the survey process are the subject of a substantial literature and have been employed in survey practice.

This paper is a discussion of key components of responsive survey design, defining the terms, and presenting practical examples of the components: 'design phases', in Section 2; the role of randomized experiments, in Section 3; then the notion of 'phase capacity', in Section 4; how the use of process data (or 'paradata') aids responsive design, in Section 5; how early phases can include indicators that are sensitive to error properties being monitored, in Section 6; finally, in Section 7 we describe the notion of complementary design features.

2. The notion of a design phase

Responsive designs are organized about design phases. A design phase is a time period of a data collection during which the same set of sampling frame, mode of data collection, sample design, recruitment protocols and measurement conditions are extant. For example, a survey may start

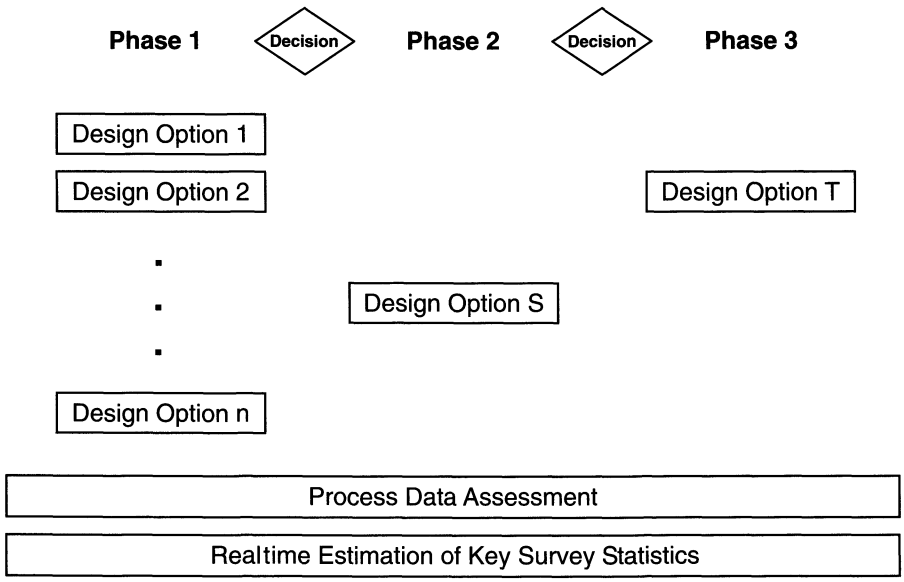

Fig. 1. Illustration of a three-phase responsive design

with a mail questionnaire attempt in the first phase, follow it with a telephone interview phase on non-respondents to the first phase and then have a final third phase of face-to-face interviewing. Sometimes phases are simultaneously conducted, e.g. when there is a randomized set of question modules assigned to sample replicates. Sometimes phases are sequentially conducted in a survey design (we use such an empirical example below) and apply to subsets of the sample respondents that are neither independent nor random samples (e.g. special incentives and procedures for final non-response follow-up, like those which are used in the American Community Survey). Note that this use of 'phase' includes more design features than merely the sample design, which are common to the term 'multiphase sampling' (Neyman, 1938).

Fig. 1 illustrates the key components of a three-phase responsive design, in which the first phase is mounted with n design options that are applied simultaneously (possibly on different replicate subsamples). Examples of these design options might include the level of incentive that is offered, the number of follow-up calls to non-respondent households, the use of a short or long version of a questionnaire or alternatives for the number of sample people to select per household. During phase 1 (as displayed at the bottom of Fig. 1) process data, called paradata (Couper, 1998), are collected to inform the researcher of the interviewer hours that are spent calling on sample households, driving to sample areas, conversing with household members and interviewing sample people.

At the end of phase 1, the researcher makes a decision about the phase 2 design options that appear to be prudent (the middle portion of Fig. 1). This decision will be guided by the information on costs and sensitivity of values and standard errors of key statistics. Phase 2 usually includes, whenever possible, a switch of recruitment protocol for the remaining unresolved phase 1 cases to the phase 2 protocol. Phase 3 is often a phase that is introduced to control the costs of the final stages of data collection while attaining desirable non-response error features for key statistics. This might involve a subsampling of remaining non-respondents, the use of different modes of data collection, the use of larger incentives, etc. After the third phase has been completed, the data from all three phases are combined to produce the final survey estimates.

2.1. Example of design phases

Arguably, the most traditional responsive design option is the use of two-phase sampling for non-response (Hansen and Hurwitz, 1946; Deming, 1953). In the first phase, all possible measurements using an initial mode and recruitment protocol are executed. When all cases that can possibly be measured under the first phase design have been completed, a probability subsample of the non-respondent cases is selected. A more expensive and (theoretically) totally successful method of data collection is applied to this subsample. The resulting sample statistics weight the subsampled cases by the inverse of their second phase selection probability (multiplied by any other selection weights).

It can be shown that such statistics, when linear in form, are unbiased estimates of population parameters, *if the second-phase sample of non-respondents is completely measured.* In practice, complete measurement is never achieved and second-phase response rates are functions of the nature of the first-phase non-response, the mode, incentives and efforts that are used in the second phase. It is possible that the inclusion of the second-phase respondents can increase the bias of the combined estimates. Ideally the researcher can evaluate the effects of the two-phase sampling by using some external criterion.

The Chicago Mind and Body Survey was an epidemiological survey of the Chicago, Illinois, household population and was based on a two-stage area probability sample. Face-to-face interviews, of about 2 hours in length, were administered to about 3100 people. The first phase used a single set of design features and collected about 2000 interviews by using a promised incentive of $60 and call-backs guided by the discretion of the interviewer. In early active monitoring of field costs and production rates, forecasts of the final response rate and number of completed interviews fell below the targets desired.

Phase 2 introduced two new design features. First, a second-phase subsample was drawn, using stratification based on interviewers' subjective assessments of the likelihood that a non-final case would co-operate under the phase 2 data collection protocol. A sampling fraction of 0.5 was used in a stratum that was judged to have low propensities to respond; a sampling fraction of 1.0 was used for the high propensity stratum. The second-phase recruitment protocol increased the incentive from $60 to $100, with a fixed number of call-backs. Finally, a third-phase protocol was implemented, on all remaining non-respondent cases, raising the incentive to $150 and limiting effort to one contact.

2.2. Evaluation of design phase alternatives

There are two evaluative opportunities with this example. Were the interviewers successful in predicting the response propensities for cases in the second phase? Yes, they were. Sample cases that interviewers expected to have low propensities achieved a second-phase response rate of 38.5%; the high propensity stratum, 73.7%. Were the second and third phases effective in avoiding the large inflation of costs per interview that are typical in the end stages of a survey? In the first phase of the survey the average number of interviewer hours per interview was 19.2, and interviewers drove on average 86 miles per interview. We would expect that additional efforts on the remaining non-respondent cases would require more calls per completed interview. Despite this expectation the hours per interview in the second-phase sample were reduced to 15.4, with 87 miles driven. The full cost of an interviewer is approximately $25 per hour (including all indirect costs) and they are reimbursed at $0.375 per driven mile. Taking into account the travel costs also, the second phase protocol produced interviews costing on average $45 less than those of the first phase. The third phase, which changed from an incentive of $100 to $150, required an average 19.9 hours per interview, with 88 miles driven per case. In short, interviewers can provide

useful information for stratification of second-phase samples, and second-phase designs that alter the benefit structure to be more appealing to the remaining non-respondents can achieve attractive cost features.

3. The value of embedded randomized experiments in initial design phases

The initial phases of a responsive design assemble information about the cost and error trade-offs of alternative data collection strategies. In essence the ideal initial phase of the survey provides an evaluation about the performance of all key design alternatives that are considered by the researcher. Thus, after the first phase has been completed, the researcher has sufficient information to identify the optimal design for the second phase of the survey. For example, prepaid incentives are often used to increase response propensities of sample units. Since incentives that have little effect on response propensities unnecessarily increase total costs of the survey, it is useful to know the effects of incentives. In the first phase of the data collection, comparisons between cases offered incentives and those who were not offered incentives would improve the researcher's evaluation of whether later phases should use incentives.

The comparisons of alternative data collection protocols that are mounted in the first phases are best made when the different protocols were applied to units that have the same characteristics on the survey variables, the same base response probabilities and the same measurement error tendencies. Such a state is best achieved by randomized assignment to probability subsamples.

3.1. Example of randomized experiments in initial design phases

The National Comorbidity Survey—Replication (NCS—R) (Kessler *et al.*, 2004) was a US national area probability sample survey that was designed to measure the prevalence and severity of mental health disorders in the US household population. Household screening and the majority of interviews were conducted in person, although interviewers were permitted to conduct telephone interviews, once contact with the designated respondent had been established. Because the cost of the NCS—R interview was a function of the unknown prevalences and comorbidities of the mental health disorders, the first phase of the survey prepared for second-phase design contingencies (as in Fig. 1 above). Specifically, the computer-assisted personal interview code for the household screening interview was designed to select more than one sample person in a random subsample of approximately 25% of all households containing two or more eligible adults. In all other households, a single respondent was randomly designated for interview. Phase 1 of the study was therefore structured to evaluate two design options, one *and* two respondents per household. Survey interview data and paradata that were gathered in the experience with the initial sample replicates were used to inform the investigators about the potential costs and errors of selecting up to two respondents in a single household. The decision rule for the preferred within-household sample design was a function of costs, response rates and clustering effects on sampling precision.

The paradata that were available for realtime monitoring of the cost and error properties of the phase 1 design included sample control information such as total calls (in person and by telephone) and the intermediate or final disposition for each call to the sample case. The computer-assisted personal interview survey responses were processed through the mental health diagnostic coding algorithms within several days of completion of the interviews to enable statistical evaluation of the prevalence of disorders in the full NCS—R sample and its subclasses, including second respondents.

3.2. Evaluation of randomized experiments in initial phases

There are three evaluative questions that we can answer for this example. First, did selecting a second adult in a subsample of NCS—R households with two or more eligible adults reduce survey costs? The number of call attempts (additional to those for the first respondent) and the mode of the attempt (in person or by telephone) are indicators of the relative costs of selecting a second adult relative to that required to identify and interview a single designated respondent in a sample household. The average number of calls to complete the second adult interview in a household was 4.7 compared with an average 7.2 calls to complete an interview with a single primary respondent. One contributing factor to this efficiency is the fact that over 18% of all secondary respondents completed the NCS–R on the same visit as the primary respondent. In addition, a higher proportion of all calls to the second adult respondents were made by telephone, avoiding additional travel costs.

A second question concerns the added potential for non-response bias from the decision to select a secondary respondent. The combined screening and interview response rate for the NCS—R primary respondent sample was 70.9%. Conditional on a successful household screen, the response rate for the NCS—R second-adult sample was 80.4%. If we incorporate the 89.7% screening response rate for the total NCS—R household sample, the estimated overall response rate for secondary sample adults is 72.1%—which is slightly better than for the primary respondent sample.

A third major concern in selecting a second adult respondent in the household is that the experience of the primary adult respondent may affect the second adult's willingness to cooperate or bias their responses. We compared primary and second-adult estimates of several key NCS—R mental health diagnostic measures. These estimates are restricted to only sample adults in the subsample of households where two respondents were selected. The only significant difference is in the estimated rate of lifetime experience with major depression—which was 13.4% for the primary respondents and 16.1% for the secondary respondents in the NCS—R sample of households with two respondents. Comparisons based on other *Diagnostic and Statistical Manual* IV mental health diagnoses and a broad set of demographic and socio-economic characteristics found no further significant differences between the primary and second respondents where two sample adults were selected.

The fourth and final tool for evaluating the NCS—R phase 1 design is an empirical comparison of the relative sampling variance for the one *versus* two respondents per household design. Selecting a second respondent introduces intrahousehold correlations in the data that typically will lead to increases in variances of sample estimates based on a given sample size. Offsetting the effects of the intrahousehold correlation, the decision to select a second respondent reduces the variation in the selection weights, reducing variances for weighted estimates. Table 1 presents an empirical evaluation of the effect on the variance of selecting a second respondent from eligible sample households. Estimated design effects (Kish, 1965) are compared for two subsamples of the NCS—R data set. The first subsample includes the 3105 primary and secondary respondents from the phase 1 subsample of households in which two adults were selected. The second subsample is a random selection of 3180 single respondents from the balance of the NCS—R sample households in which a selection of a second respondent was possible (but was not made).

The results in Table 1, although based on a small number of sample estimates, suggest that the NCS—R phase 1 option to select a second adult respondent in eligible households may have resulted in an average increase of 10–15% (prevalence estimates) to as much as 33% (demographic characteristics) in the variance of sample estimates that were contributed by households with two or more eligible adults.

Table 1. Sample design effects of the phase 1 design choice to select two respondents in NCS—R sample households with two or more adults

Sample statistic	*Design effect for prevalence estimates in multiple-adult households*	
	1 respondent per household design	*2 respondents per household design*
Diagnostic and Statistical Manual IV lifetime diagnosis		
Alcohol dependence	1.118	1.066
Drug dependence	0.983	1.290
Generalized anxiety disorder	1.131	1.409
Major depression hierarchy	1.015	1.231
Panic disorder	0.898	1.016
Social phobia	1.224	1.023
Average for diagnoses	1.061	1.172
Demographic characteristics		
Age ⩾65 years	1.240	1.292
High school education	1.819	1.449
Low income	1.226	2.585
Married	—	1.901
US born	2.799	2.449
African American	1.875	2.247
Average for demographic characteristics	1.493	1.987

At the conclusion of phase 1 of the NCS—R, the field budget appeared to be in line with its target. The continuing review of the expected savings in costs and the expected increase in design effects for sample estimates led to a decision not to expand the use of a second adult respondent in phase 2 of the data collection. The value of mounting the first phase with multiple-sampling options was that the decision for the second-phase within-household sample was informed by real field data.

4. The notion of phase capacity

Statistical inference from sample surveys has traditionally conditioned on sample design features (Little, 2004). As is increasingly obvious with probability sample surveys, the estimates can also be affected by the level of effort that is expended to obtain participation of sample units (Lynn *et al.*, 2002). Hence, key to the operation of responsive designs is the notion that each set of design features (e.g. the sample design, mode of data collection and recruitment protocol) brings with it a maximum level of quality for a given cost. Phase capacity is the stable condition of an estimate in a specific design phase, i.e. a limiting value of an estimate that a particular set of design features produces. (Although a full mean-square error treatment of the estimate might be considered, in practice, survey management is focused on biasing potentials of terminating a phase.) When the phase achieves stability of an estimate, it can be said to be 'fully matured' or to have reached its phase capacity. One example of phase capacity is the stability of an estimate as a function of the number of call-backs that are made to sample cases to acquire an interview. Since the productivity of a phase usually declines over call-backs (in terms of adding new complete-data records to the respondent file), the stability of estimates is a function of both the magnitude of late cases to the file and their values on the survey variables.

The existence of a phase capacity for a given statistic requires that, as a sample replicate becomes more fully measured using the features of a given phase, key estimates approach their limiting value under the phase. Thus, when stability is reached for values of key survey estimates, the phase capacity has been reached. Usually the earliest point of stability is cost attractive, i.e. detecting phase capacity as soon as possible permits more resources for later phases. However, it is important to note that not all error properties are functions of effort (e.g. mode switches as a recruitment protocol feature).

4.1. Example of phase capacity analysis

A common outcome is that the early days of the data collection are quite productive of contacts and interviews, but that the last days of the data collection period are quite inefficient. The current theories about survey participation (Groves *et al.*, 1999; Baumgartner *et al.*, 1998) posit that different sets of influences act on sample people to determine their likelihood of participation. For some, the topic of the survey is of great interest; for others, the use of an incentive is important; for others, the sponsor or data collection organization evokes interest. As Groves and Couper (1998) showed, the number of questions and comments by both respondents and interviewers decline over the course of repeated contacts with a sample unit. Hence, because of the declining percentage of interviews that are obtained with each additional call, we speculate that the amount of change in non-response bias itself declines over call-backs. As the phase matures, all of the influences on participation have manifested themselves and on-going efforts generate 'more of the same'—most of all the reasons for refusing or accepting and most of all the situational factors have been experienced by interviewers and respondents.

The US National Survey of Family Growth (NSFG) cycle 6 (National Center for Health Statistics, 2005) is an area probability sample of males and females age 15–44 years. Oversamples of teenagers, African-Americans and Hispanics were introduced so that separate estimates of key fertility statistics could be computed on those groups. Indeed, there were 18 age × gender × race or ethnicity groups that had targeted interview counts. Screening interviews with sample households collected household roster data to identify whether any people who were aged 15–44 years lived in the household. In age-eligible households, one and only one respondent was selected for a 'main' interview. Female main interviews required about 85 min; male interviews, 60 min. The targeted response rate for females was 80%; for males, 75%.

The complete NSFG cycle 6 field period included three responsive design phases and spanned 12 months beginning in March 2002 and ending March 2003. The approximate amount of time that was spent in each of the three phases was, for phase 1, 9 weeks, for phase 2, 37 weeks, and, for phase 3, 6 weeks. The first phase used a quarter sample of primary areas, a reduced interviewer corps and unlimited call-back rules. During the first phase, estimates of several key NSFG statistics were computed routinely.

Using charts like those which are presented in Fig. 2, the staff examined the effect of interviewer effort (as indicated by the number of contact attempts) on key statistics. Fig. 2 has two y-axes and two associated plots: one, the cumulative estimate of the statistic, using all interviews that had been collected on or before that call number. This cumulative plot uses the scale that is provided on the right-hand y-axis. The second plot—corresponding to the left-hand y-axis—is the value of the estimate based on the interviews taken only on a particular call number. As that plot moves to the right, the estimate is based on increasingly fewer cases; for that reason, the estimates become highly variable.

During the course of the data collection period, these plots were examined multiple times. The cumulative plot was examined to see at what call number the estimate began to show some

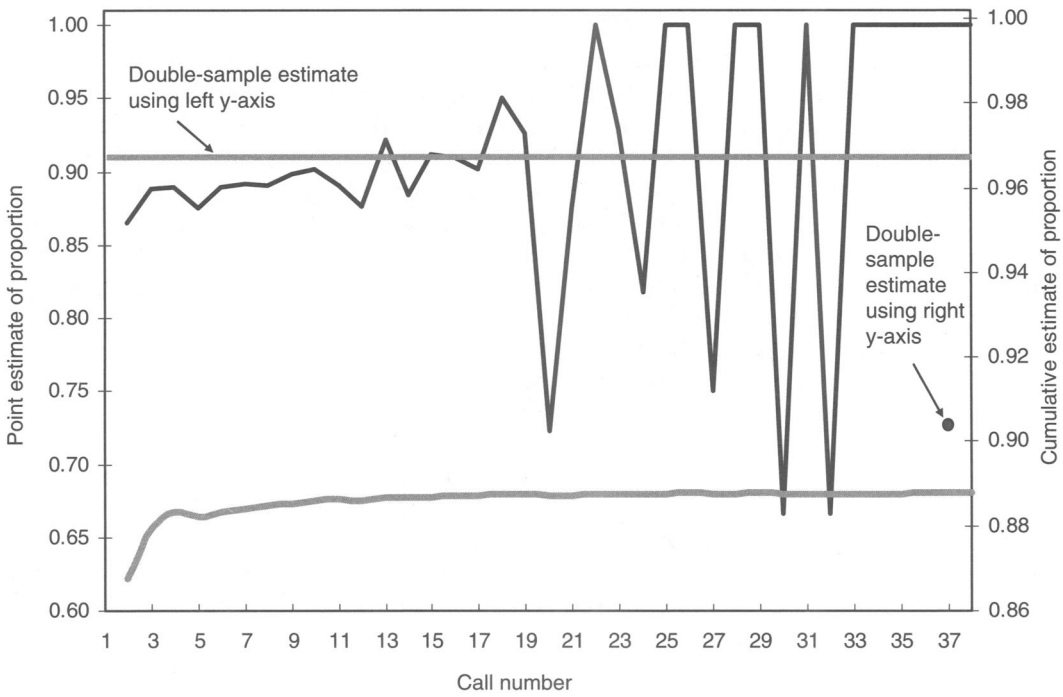

Fig. 2. Estimated proportion of females who ever had sexual intercourse by call number of interview, cumulated (———) and call specific (———)

stability. The call-specific estimate plot was examined for the direction of change in the early calls (i.e. 1–10). When there appeared to be a systematic pattern in the movement of the call-specific estimates, then closer attention was paid to the movement in the cumulative plot to see whether the changes were substantively important. Simultaneously, multivariate models that were estimated on call records and time reports from interviewers tracked the average costs of a call on a sample case.

The conclusion after examining these plots of key estimates over the course of the data collection period was that 10–14 calls produced stable cumulative estimates on the vast majority of the key estimates. ('Stability' here was defined as values that would yield the same substantive conclusion.) This analysis during phase 1 led to the choice of the design option for the later phases that a maximum of 10–14 calls would be made on sample cases. It is useful to note that estimates for some key statistics might display a 'local' maximum or minimum, such that stability of estimates occurs and then disappears at later numbers of calls. Choosing to have the maximum phase 1 effort (at least on some replicates) to be quite large is useful to protect against this outcome.

4.2. Evaluation of phase capacity analysis

On the basis of the phase 1 experience, it is estimated that up to 9% of the screener call attempts were eliminated in phase 2 and 3 screening. A cost analysis suggested that the marginal time that was required for each screener call was 4.2 min. At the volume of interviewer activities that was forecasted for this survey, this represented a saving of approximately 800–1000 interviewer hours for the entire survey.

5. Paradata inputs to design phase evaluation

Responsive designs require enriched process data, which were termed paradata by Couper (1998), to guide decisions that were made during data collection. Paradata can be proxy indicators of costs or errors. They can include data collection administrative data, such as records of contact attempts on sample cases, travel distance and time to reach sample cases and hours spent by interviewers on different tasks during interviewing. They can also include sampling frame data that might be useful in allocating data collection resources, such as the level of urbanicity of a sample unit (which is correlated with the effort that is required to produce an interview), the existence of multiunit structures (which typically require more visits to make contact) or demographic information that might be recorded on the sampling frame. They can also include *de novo* observations taken on sample units that might be proxy indicators of how difficult the sample case might be to gain survey participation, likely characteristics of the unit on key survey variables or whether the measurement errors of completed cases might be distinctive.

Paradata are valuable in responsive designs to the extent that they are good predictors of the propensity of a sample case to participate in the survey, the costs of gaining that participation, the non-response error impacts of failing to gain data on the case or the measurement error properties of data that are obtained from the case. For example, Lynn (2003) demonstrated how observations on multiunit structures and entrance door intercoms predict the amount of effort that is required to contact sample households.

5.1. Example of paradata inputs to design phases

Before the use of computer-assisted interviewing systems, interviewers (and perhaps their supervisors) were given the responsibility of making judgments about the likelihood that individual active sample cases would become respondents. As computer-assisted systems have matured, researchers can use paradata that are collected via the systems to build predictive response propensity models, i.e. it is possible at the end of each working day of the survey to estimate the probability that the next call on a sample case will produce an interview, given a set of values on paradata. To create propensity models that have predictive value, paradata on sample cases must be expanded over those which are normally collected.

In the NSFG, the process information that was collected for the design decisions began at the listing stage of the sample and ended at the last call on the last case. A brief review of the data lies below:

(a) *observations on each interviewer*—
  (i) experience in interviewing tasks and
  (ii) performance on training;
(b) *observations on segments made by people listing addresses*—
  (i) evidence of abandoned or unoccupied structures,
  (ii) extent of commercial, church, school and other activity,
  (iii) impediments to physical access (e.g. walled subdivisions),
  (iv) evidence of non-English speakers in the neighbourhood and
  (v) evidence of safety concerns for the interviewer;
(c) *observations about each listed housing unit made by people listing addresses*—
  (i) impediments to access to the unit (e.g. locked gates),
  (ii) number of housing units in the structure,
  (iii) evidence of children (e.g. toys visible) and

(iv) evidence of an adult at home during the day;

(d) *observations on each call to the unit—*
   (i) the time of day,
   (ii) the day of the week and
   (iii) the outcome of the call;

(e) *observations on each call yielding a contact with a household member—*
   (i) whether the householder asked a question,
   (ii) whether the householder noted that it was a bad time to talk and
   (iii) whether the householder delivered a negative statement about the survey request;

(f) *observations for each interviewer day—*
   (i) the number of hours spent travelling to the segment,
   (ii) the number of hours spent on administrative activities,
   (iii) the number of hours spent attempting screening interviews and
   (iv) the number of hours spent attempting main interviews.

Each of these items of data was included on the basis of prior studies indicating their relationship to the difficulty of contacting sample households or the difficulty of persuading them to co-operate with an NSFG interview.

Such a paradata design yields a nested data structure. Interviewers are the main production units under study; their productivity is affected by the sampling area characteristics that they have been assigned, the characteristics of the sample segment and housing unit, and the nature of calls and contacts on the case. Needless to say, the complexity of the paradata rivals that of the interview data themselves.

We built two models to estimate the propensity of a case to be interviewed on the next call. These models were discrete time hazard models (Singer and Willett, 1993) using call record data as time-varying covariates. They were logistic models predicting the odds of obtaining an interview on the next call, given a set of prior experiences with the sample case. In essence, each call was a separate data record; the data record contained all the observations on the segment and

Table 2. Discrete hazard model coefficients predicting the probability of a screening interview on the next call attempt

Predictor	*Coefficient*
Intercept	−9.37†
Urban = 1	−0.21‡
Access problems in segment = 1	−0.015
Residential neighbourhood = 1	0.11‡
Evidence of non-English speakers = 1	0.031
Evidence of safety concerns = 1	0.088‡
Evidence of unit level access impediments = 1	−0.42‡
Large multiunit structure = 1	−0.10‡
Number of prior calls	−0.12‡
Some prior contact with unit = 1	8.74‡
Number of prior contacts	−0.065‡
Some negative statements by householder = 1	−1.42‡
Last contact statements from householder = 1	0.65
Some questions asked in earlier contact = 1	−0.085‡
Questions asked in last contact = 1	0.056

†$p < 0.05$, assuming a simple random sample of calls.
‡$p < 0.01$, assuming a simple random sample of calls.

individual sample units made by the person listing the addresses and the recorded behaviours of the household members that occurred in prior calls. One model attempted to predict the likelihood that a case that had not yet provided a screener interview (a short household roster determining age eligibility for people in the household) would do so on the next call. It had the predictors that are displayed in Table 2, with their associated coefficients. The model was built in two steps; first a stepwise procedure using the variables at the segment, unit and call level was employed. Then the model was respecified using past literature and theories that were applicable to the response propensity. This second step removed some nonsensical features of the stepwise specification.

Table 2 shows very large positive effects on screener interview propensity of prior contact with the case (coefficient 8.74) and negative effects of expressions of some resistance from the householder (coefficient −1.42). The latter indicator was derived from results of prior studies that showed that what householders say to interviewers is predictive of their later decisions (Groves and Couper, 1998). There are relatively large negative effects of the number of prior calls (coefficient −0.12 for each additional call). Impediments to access reduce the propensity of an interview in general. Cases in large urban areas display lower propensities. We found that these models comported with the expert knowledge of field supervisors but offered a compact statistical summary to sort active cases into different groups based on the likelihood of successful measurement.

Table 3 shows a similar display of coefficients for a model predicting the propensity of a main interview (a long fertility questionnaire) on the next call. This model showed that there

Table 3. Discrete hazard model coefficients predicting the probability of a main interview on the next call attempt

Predictor	*Coefficient*
Intercept	−3.95†
Urban = 1	−0.12†
Uninhabited structures in segment = 1	−0.037
Public housing project = 1	0.071
Residential neighbourhood = 1	0.044
Evidence of non-English speakers = 1	0.023
Evidence of Spanish speakers = 1	0.039
Evidence of safety concerns = 1	0.0081
Some prior contact with unit = 1	4.58†
Resistance displayed on earlier contact = 1	−2.28†
Large multiunit structure = 1	0.13†
Evidence of unit level access impediments = 1	−0.088‡
Evidence of security measures in unit = 1	−0.016
Sample person is a teenager = 1	0.25†
Sample person is male = 1	−0.11†
Sample person is African-American = 1	−0.017
Sample person speaks Spanish = 1	−0.30†
Household has only one member = 1	0.30†
Previous call was a contact = 1	1.50†
Some statements by householder = 1	−1.43†
Last contact statements from householder = 1	0.71
Some questions asked in earlier contact = 1	0.060
Questions asked in last contact = 1	0.24†
Number of prior calls	−0.066†
Number of prior contacts	0.12†

†$p < 0.01$, assuming a simple random sample of calls.
‡$p < 0.05$, assuming a simple random sample of calls.

were strong positive effects of having prior contact with the unit (coefficient 4.58), the prior call being a contact (coefficient 1.50) and the number of prior contacts (coefficient 0.12 for each additional contact). Negative effects of notable magnitude were associated with cases where some resistance was displayed in earlier contact (coefficient −2.28), whether the householder made some statement during an earlier contact (coefficient −1.43) (these tend to be negative statements) and the number of prior calls on the case (coefficient −0.066 for each additional call). The main model could examine the effects of person level characteristics of the selected respondent on the propensity and found the expected positive effects of the respondent being a teenager (coefficient 0.25), negative effects of being male (coefficient −0.11) and negative effects of a Spanish-speaking respondent (coefficient −0.30).

These models were used several times during the data collection period to predict a screening and interview propensity for each active case. The expected propensities for screening and interview were summed over all cases within a sample segment (weighting the screener model expected values by the expected eligibility of the households). Two uses were made of the segment totals of expected values:

(a) during phase 2, segments were grouped into categories with low, medium and high total propensities, for use by supervisors to direct the work of interviewers to the most promising areas, and
(b) at the end of phase 2, segments were grouped into quartiles that formed strata for the phase 3 sample.

We discuss the results of that phase 3 sample design.

5.1.1. Phase 3 sample design

On the basis of the propensity models above, the 783 sample segments of phase 1–2 were stratified on two major dimensions: the number of cases in the segment that were not finalized and the total expected propensities for active cases in the segment.

Phase 3 used a stratified sample of segments, with all non-respondent cases in a selected segment included in the phase 3 sample. This was chosen on the basis of cost model estimates that were computed during phases 1 and 2 that showed that about 38% of an interviewer's working day was spent in travel. If the phase 3 sample maximized the clustering of the subsample, costs could be reduced. Note that this design option placed large emphasis on the cost efficiency of the phase 3 design to produce interviews, not on the minimization of standard errors of the resulting data set. The range of relative sampling fractions over the 16 strata was of the order of 1–4. Simulations before the selection suggested an increase in variance due to the additional selection weighting of approximately 20%. The highest selection probabilities were assigned to those segments with large total expected propensities to be interviewed or large numbers of active cases. The smallest selection probabilities for the phase 3 sample were assigned to segments with few active cases that had low propensities of being interviewed, given the models above.

5.2. Evaluation of use of paradata for design phase decisions

We assess whether the costs of the third-phase efforts varied by the strata that were used in the third-phase sample. This can be addressed with several evaluative indicators. First, did response rates in phase 3 follow patterns that were expected from the stratification by expected propensities? For strata that were defined by expected propensities, the phase 3 response rate was 35% for eligible respondents in the lowest propensity stratum and 54% for cases in the highest propensity stratum. Thus, the stratification by propensity estimates was predictive of the phase 3

response rates. Second, did the costs of data collection vary systematically by propensity strata? The number of interviews that were obtained per call attempt varied only between 0.13 and 0.17 interviews per call. However, the higher propensity strata did have higher cost efficiencies. The strata that were defined by numbers of remaining active cases in the sample segment performed as expected, ranging from 0.13 to 0.20 interviews per contact attempt. As expected the segments with more active cases had higher cost efficiencies.

6. The notion of error-sensitive indicators

A valuable tool in implementing responsive designs is a set of 'leading indicators' of error sensitivity. A leading indicator of error sensitivity is a parameter whose estimate is maximally sensitive to phase capacity. The examples of such leading indicators are easiest for non-response-related phenomena. As Bethlehem (2002) has noted, the bias of the unadjusted respondent mean of variable y can be expressed as

$$\sigma_{yp}/\bar{p}$$

where the numerator is the covariance between the survey variable y and the response propensity p, and the denominator is the mean response propensity for the full sample. If the researcher can theoretically or empirically determine a y that is likely to have maximum covariance with the response propensity, then it can be monitored during the data collection. When response rate increases do not affect the point estimate, then it is likely that the phase in question has reached phase capacity for the given source of non-response being monitored.

6.1. Example of error-sensitive indicators

Statistics that are treated as leading indicators are ideally based on variables that are causes of a component of error that declines as a phase matures. For example, Groves *et al.* (2001) suggested the use of a statistic to measure the maximum level of non-contact error among all statistics in a survey. Candidates for y-variables would be any that are unusually sensitive to the likelihood of contact with the sample unit, i.e. p is the propensity to be contacted, and y is some variable that is highly correlated with that propensity. They examined the percentage of households that are occupied by one person, who is employed outside the home and lives in a unit that is subject to some sort of impediment to access (an answering machine or locked entrance). This is proffered as a candidate that has maximum sensitivity to non-contact error because a proximate cause of non-contact rates is the absence from the home of the sample person. The expectation is that, if the percentage of households with impediments to access and which are occupied by one employed person stabilizes over repeated application of the recruitment protocol (e.g. repeated call-backs), then the phase has reached capacity and some other recruitment protocol would be required to reduce non-contact error.

6.2. Evaluation of error-sensitive indicators

There are bench-mark possibilities for the chosen indicator. In the USA, the monthly labour force survey covers the household population and achieves response rates that are in the mid-90% range. Hence, the estimated percentage of households with impediments to access and which are occupied by one employed person can be obtained from that source. Using that estimate as a target quantity, it was found in a series of random-digit dialling studies that the estimate starts at 2.2% after one call and increases monotonically to 3.2% by 15 call attempts (Groves *et al.*, 2001). Between 10 and 15 call attempts the estimate moves from 3.12 to 3.15. They show

that none of the key estimates of the survey are subject to such great sensitivity to the number of call-backs.

If we assert that this estimate has a greater non-contact bias than any other estimate in the survey, then it achieves 3.12/3.15 or 99% of its phase capacity with a 10-call-back rule. Since each added call-back costs money, such changes in estimates could be used to assess the cost per unit reduction in non-contact error. Following this, decision rules for defining the end of the phase can be constructed.

7. The notion of complementary design features

Another concept in responsive design is that of complementary design features. Complementary design features are those that, when combined, offer minimum error properties among a set of features. They may be recruitment features that are attractive to different parts of the target population, when considering non-response, e.g. telephone contact for those in households with restricted physical access *versus* face-to-face contact. They may be measurement features or mode choices that best fit different statistics, e.g. using self-administered modes for sensitive items but face-to-face modes for items requiring burdensome retrospective recall.

7.1. Example of complementary design features

The NSFG provides an example of an attempt to employ complementary design features that were successful in measuring sample cases that were not measured in the initial phases. The third phase of the NSFG was designed to use a double sample of non-respondents. To assess what recruitment protocol might be successful on those sample people who failed to be measured in the initial protocols, the paradata of the initial phases needed to be studied.

In the NSFG, a set of key estimates were being monitored for sensitivity to extended call-backs and refusal conversions. In addition, the demographic patterns of response rates among screened eligible households were tracked. During this analysis, there were three notable outcomes: sample people aged 15–19 years had higher response rates than those in other age groups; the screener response rate was lower than that of prior similar studies; interviewer variability in co-operation rates were high, despite efforts to reduce that variability.

We sought to invent a phase 3 recruitment protocol that was distinctive from that used in phase 2. Such a distinction is necessary (but not necessarily sufficient) to attract sample people for whom the ingredients of the earlier phase protocol were not effective. The phase 3 recruitment protocol involved the following ingredients:

(a) use of the most productive interviewers on staff (this was an attempt to eliminate interviewers with demonstrated lower effectiveness at increasing base response propensities);
(b) increased use of proxy informants for the screening interview (this was an attempt to lower the burden for obtaining screener information);
(c) a prepaid incentive of $5 (*versus* no incentive) for cases that had not yet completed the screening interview (this was an attempt to increase the benefits of providing screener information);
(d) a prepaid incentive of $40 for the adult main interview (*versus* an incentive of $40 provided after the informed consent was signed) (this was an attempt to set incentives at levels that might be more attractive to sample people who were over 19 years of age);
(e) a promised additional incentive of $40 for a completed main interview.

We limited phase 3 to a 1-month period, following an 11-month combined period for phases 1 and 2.

7.2. Evaluation of complementary design features

The overall response rate at the end of phases 1 and 2 of the NSFG was approximately 64%, using the American Association for Public Opinion Research definition that uses an estimated rate of eligibility among the non-respondent screener cases (American Association for Public Opinion Research, 2004). The third-phase response rate was approximately 40%, which yielded a combined response rate of between 78% and 79%, using the approved American Association for Public Opinion Research double-sample computation. In that sense, the third-phase sample was a very successful increase in 1 month of the overall response rate.

Second, we assess the evidence regarding the non-response bias characteristics of the three-phase design. As always with non-response error, the evidence is indirect only. The NSFG attempts to control achieved interview counts on 18 different subpopulations defined by age, gender and race or ethnicity groups. Examining the phase 1–2 and overall response rates of the 18 subpopulations is one way to examine the imbalance of the phase 1 performance across these 18 subpopulations. The coefficient of variation of the response rates in phases 1 and 2 is 7.6% of the mean response rate; the same measure of variation for the overall rates is 4.4%, which is a large decrease in the variation in response rates. We take this as an indirect indication of reduced non-response error associated with age, gender, race and ethnicity variation. Fig. 3 shows that the variation is quite systematic by age of the sample people. At the end of the first two phases teenagers had a response rate 6 percentage points higher than for those in the oldest age group, with those who were 20–24 years old in between the two. At the end of the third phase the difference in response rates between the three groups was just 3 percentage points.

Are there indications of the effect on estimates of this reduced variation in response rates? We would expect that the effect on estimates of the phase 3 response rates would be to impact all the fertility experience variables that are a function of age. As expected, the proportion of females who ever had sexual intercourse, the lifetime number of sexual partners and a variety of other measures of sexual experience are higher among phase 3 respondents than among the first- and second-phase respondents.

All these findings are consistent with the findings of lower response rate variation by age of the sample people. The first two phases ended with a deficit of respondents who were 20 years old or older. (We believe that this is a function of an enhanced value of the incentive of $40 to teenagers in the phase 1–2 design relative to older sample people.) The third phase was more successful in attracting older respondents. The effect of this on key statistics of the survey is the prevalence of attributes that reflect longer sexually active lives.

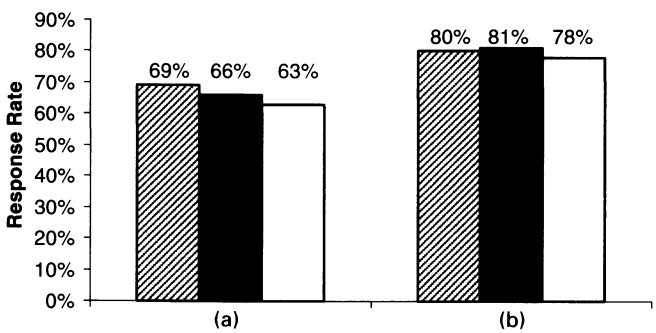

Fig. 3. Response rate by age group by phase: (▨, 15–19 years group; ■, 20–24 years group; □, 25–44 years group): (a) phases 1–2; (b) phases 1–3

8. Summarizing remarks

Responsive designs use paradata to guide changes in features of a data collection to achieve higher quality statistics per unit cost. Responsive designs require the creation and active use of paradata to determine when a phase of the survey has reached its phase capacity and what additional features might be complementary to those of the current phase.

This paper has provided five examples of responsive design features, each of which affects some aspect of survey costs and many of which appear to affect the error properties of resulting statistics. All the examples utilized realtime cost-related data and (proxy) indicators of sampling, non-response or measurement error properties of key survey statistics.

Responsive designs can reduce the cost inflation that is common in the later stages of survey data collection. They can provide a data set with a larger estimated proportion of respondents, when the combined probabilities of selection are reflected. When wise combinations of design options are chosen across sequential phases, responsive designs can offer evidence of reduced non-response errors.

9. Needed next steps in the development of responsive designs

It is appropriate to note that most of the invention of responsive designs has been driven not by formal theory and specified optimal design models but by the practical need to reduce risks of overruns of budget and the increasing non-response rate problem. As with all such developments, practice sometimes outpaces theory. Hence, we note some unanswered questions in responsive designs.

First, it is clear that, since responsive designs combine data from different recruitment, non-response and measurement protocols, the analyst requires an assessment of the effect of non-response and measurement error differences across phases. Assessing the set of alternative design options to be mounted in the first phase of the study, to inform choices of later phases, requires an intelligent assessment of likely cost efficient alternatives to the preferred design. Further, some survey resources are used in mounting the multiple-design options in the early phases. Studies on how best to do this are sorely needed.

Second, paradata are like all other survey data—they need conceptual development, measurement development and pretesting. Paradata are useful to the extent that they are proxy indicators of cost or error properties of the key survey statistics. The fact that they are 'proxy' indicators inherently means that there is a compromise between the rigour of the measurement and the utility of the measurement. The field is just beginning to exploit computer-assisted data collection systems to provide question timing data, digital audio recording of speech, interviewer observations using programmed function keys and complicated question contingencies.

Third, the field needs to study how the survey statistician should best model paradata from early phases. In a real sense, responsive designs are model-assisted designs, not just on sample design issues, but on all the aspects of the data collection. These models, as all models, are imperfect characterizations of the world. They need development, sensitivity analyses for alternative specifications, diagnostic scrutiny, studies of the meaning of outliers, etc.

Finally, variance estimation for survey statistics from multiphase designs with mixed protocols is complicated. Since early phases are used to collect information on cost and error properties for later phase decisions, all aspects of their realizations can contribute to variation in the final estimators combining data from several phases. Currently, variance computations condition on the realized cost and error properties of the initial phases. The use of independent or quasi-independent replicates coextensive with the design phases permits design-based

contrasts across replicates of estimates. The properties of traditional variance estimators for statistics based on combined design phases needs much work.

We expect that the continued pressures on sample surveys to control costs will lead to an increased use of responsive designs. We hope that a concurrent research programme will answer the questions above.

Acknowledgements

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M. Wireless Substitution: Early Release of Estimates from the NHIS, July-December 2013

National Health Interview Survey
Early Release Program

Wireless Substitution: Early Release of Estimates From the National Health Interview Survey, July–December 2013

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Overview

Preliminary results from the July–December 2013 National Health Interview Survey (NHIS) indicate that the number of American homes with only wireless telephones continues to grow. Two in every five American homes (41.0%) had only wireless telephones (also known as cellular telephones, cell phones, or mobile phones) during the second half of 2013—an increase of 1.6 percentage points since the first half of 2013 and 2.8 percentage points since the second half of 2012. However, these increases are smaller than those observed in previous years. This report presents the most up-to-date estimates available from the federal government concerning the size and characteristics of these populations.

NHIS Early Release Program

This report is published as part of the NHIS Early Release Program. Twice each year, the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS) releases selected estimates of telephone coverage for the civilian noninstitutionalized U.S. population based on data from NHIS, along with comparable estimates from NHIS for the previous 3 years. The estimates are based on in-person interviews that NHIS conducts continuously throughout the year to collect information on health status, health-related behaviors, and health care access and utilization. The survey also includes information about household telephones and whether anyone in the household has a wireless telephone.

Two additional reports are published regularly as part of the NHIS Early Release Program. *Early Release of Selected Estimates Based on Data From the National Health Interview Survey* is published quarterly and provides estimates for 15 selected measures of health. *Health Insurance Coverage: Early Release of Estimates From the National Health Interview Survey* is also published quarterly and provides additional estimates regarding health insurance coverage. Other Early Release Program products are released as needed.

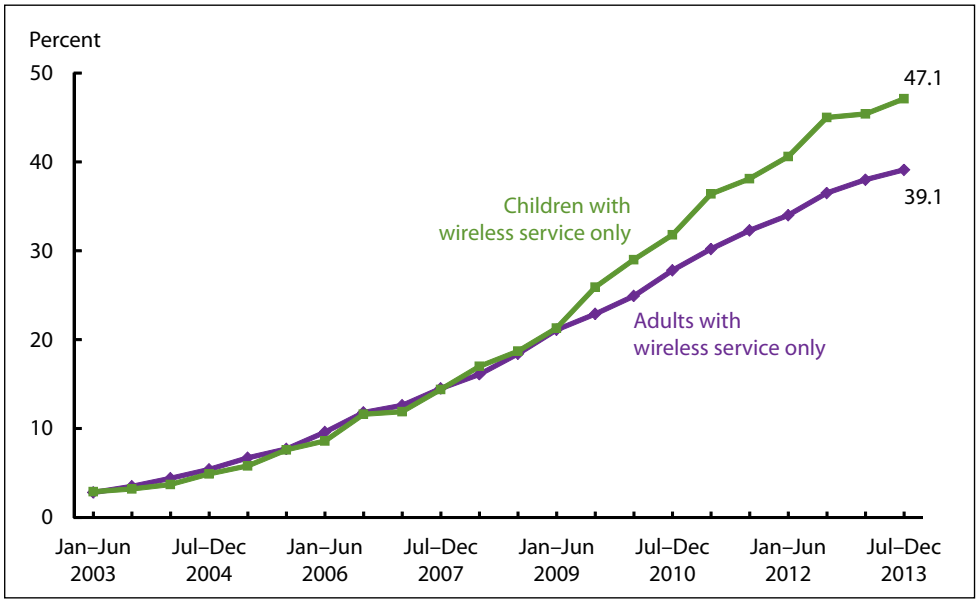
Methods

For many years, NHIS has asked respondents to provide residential telephone numbers, to permit the recontacting of survey participants. Starting in 2003, additional questions were asked to determine whether a family had a landline telephone. An NHIS family was considered to have landline telephone service if the survey respondent for the family reported that there was "at least one phone inside your home that is currently working and is not a cell phone." (To avoid possible confusion with cordless landline telephones, the word "wireless" was not used in the survey.)

An NHIS "family" is an individual or a group of two or more related persons living together in the same housing unit (a "household"). Thus, a family can consist of only one person, and more than one family can live in a household (including, for example, a household where there are multiple single-person families, as when unrelated roommates are living together).

The survey respondent for each family was also asked whether "anyone in

Figure. Percentages of adults and children living in households with only wireless telephone service: United States, 2003–2013



NOTE: Adults are aged 18 and over; children are under age 18.
DATA SOURCE: CDC/NCHS, National Health Interview Survey.

your family has a working cellular telephone." Families are identified as "wireless families" if respondents reported that someone in the family had a working cell phone at the time of interview. This person (or persons) could be a civilian adult, a member of the military, or a child.

Households are identified as "wireless-only" if they include at least one wireless family and if there are no families with landline telephone service in the household. Persons are identified as wireless-only if they live in a wireless-only household. A similar approach is used to identify adults living in households with no telephone service (neither wireless nor landline). Household telephone status (rather than family telephone status) is used in this report because most telephone surveys do not attempt to distinguish among families when more than one family lives in the same household.

From July through December 2013, information on household telephone status was obtained for 21,512 households that included at least one civilian adult or child. These households included 40,173 civilian adults aged 18 and over, and 13,714 children under age 18. Analyses of telephone status are presented separately for households, adults, and children in **Table 1**.

Analyses of demographic characteristics are based on data from the NHIS Person and Household Files. Demographic data for all civilian adults living in interviewed households were used in these analyses. "Household income" is the sum of the family incomes in the household. Estimates stratified by household poverty status are based on reported income only because imputed income values are not available until a few months after the annual release of NHIS microdata. Household poverty status was unknown for 21.5% of adults in these analyses.

Analyses of selected health measures are based on data from the NHIS Sample Adult File. Health-related data for one randomly selected civilian adult (the "sample adult") in each family were used in these analyses. From July through December 2013, data on household telephone status and selected health measures were collected from 17,967 of these sample adults.

Because NHIS is conducted throughout the year and the sample is designed to yield a nationally representative sample each month, data can be analyzed quarterly. Weights are created for each calendar quarter of the NHIS sample. NHIS data weighting procedures are described in more detail in a previous NCHS report (**Parsons et al., 2014**). To provide access to the most recent information from NHIS, estimates using the July–December 2013 data are being released prior to final data editing and final weighting. These estimates should be considered preliminary. If estimates are produced using the final data files, the estimates may differ slightly from those presented here.

Point estimates and 95% confidence intervals were calculated using SUDAAN software (RTI International, Research Triangle Park, NC) to account for the complex sample design of NHIS. Differences between percentages were evaluated using two-sided significance tests at the 0.05 level. Terms such as "more likely" and "less likely" indicate a statistically significant difference. Lack of comment regarding the difference between any two estimates does not necessarily mean that the difference was tested and found to be not significant. Because of small sample sizes, estimates based on less than 1 year of data may have large variances, and caution should be used in interpreting such estimates.

Telephone Status

In the second 6 months of 2013, two in every five households (41.0%) did not have a landline telephone but did have at least one wireless telephone (**Table 1**). Approximately 39.1% of all adults (about 93 million adults) lived in households with only wireless telephones; 47.1% of all children (nearly 35 million children) lived in households with only wireless telephones.

Although the percentage of households that are wireless-only continues to increase, there is evidence that the rate of growth may be slowing. Considering the annual change from the second 6 months of one year through the second 6 months of the next, the 2.8-percentage-point increase from 2012 through 2013 is less than the 4.2-percentage-point increase from 2011 through 2012 and the 4.3-percentage-point increase from 2010 through 2011. The annual growth from 2009 to 2010 was 5.2 percentage points (results not shown).

The percentages of adults and children living in wireless-only households has also been increasing over time (**Figure**), although neither the 1.1-percentage-point increase for adults from the first 6 months through the second 6 months of 2013 nor the 1.7-percentage-point increase for children over the same period was statistically significant.

The percentages of adults and children living without any telephone service have remained relatively unchanged over the past 3 years. Approximately 2.5% of households had no telephone service (neither wireless nor landline). About 5.2 million adults (2.2%) and 1.8 million children (2.5%) lived in these households.

Demographic Differences

The percentage of U.S. civilian noninstitutionalized adults living in wireless-only households is shown, by selected demographic characteristics and by survey time period, in **Table 2**. For July–December 2013, there are five demographic groups in which the majority live in households with only wireless telephones: adults aged 18–34, adults living only with unrelated adult roommates, adults renting their home, adults living in poverty, and Hispanic adults.

- Nearly two-thirds of adults aged 25–29 (65.7%) lived in households with only wireless telephones. This rate is greater than the rates for those aged 18–24 (53.0%) or 30–34 (59.7%). The percentage of adults living in households with only wireless telephones decreased as age increased beyond 35 years: 47.8% for those aged 35–44; 31.4% for those aged 45–64; and 13.6% for those aged 65 and over.
- Three in four adults living only with unrelated adult roommates (76.1%) were in households with only wireless

telephones. This rate is higher than the rates for adults living alone (46.6%) and for adults living only with spouses or other adult family members (31.0%).

- Three in five adults living in rented homes (61.7%) had only wireless telephones. This rate is more than twice the rate for adults living in homes owned by a household member (28.5%).
- Adults living in poverty (56.2%) were more likely than adults living near poverty (46.1%) and higher income adults (36.6%) to be living in households with only wireless telephones. (**Table 2**, footnote 3, gives definitions of these categories.)
- Hispanic adults (53.1%) were more likely than non-Hispanic white (35.1%) or non-Hispanic black (42.7%) adults to be living in households with only wireless telephones.

Other demographic differences were also noted:

- Men (40.4%) were more likely than women (37.9%) to be living in households with only wireless telephones.
- Adults living in the Midwest (43.7%), South (41.9%), and West (41.2%) were more likely than those living in the Northeast (24.9%) to be living in households with only wireless telephones.

Demographic Distributions

The demographic differences noted in the previous section are based on the distribution of household telephone status within each demographic group. When examining the population of wireless-only adults, some readers may instead wish to consider the distribution of various demographic characteristics within the wireless-only adult population.

Table 3 gives the percent distributions of selected demographic characteristics for adults living in households with only wireless telephones, by survey time period. The estimates in this table reveal that the distributions of selected demographic characteristics changed little over the 3-year period shown. The exceptions were related to age and home ownership status. From the second 6 months of 2010 to the second 6 months of 2013,

- Among all wireless-only adults, the proportion aged 35 and over has increased steadily. In the second 6 months of 2013, more than one-half of wireless-only adults (54.6%) were aged 35 and over, up from 47.6% in the second 6 months of 2010.
- Among all wireless-only adults, the proportion living in homes owned by a household member increased. In the second 6 months of 2013, 48.5% of wireless-only adults were living in homes owned by a household member, up from 43.3% in the second 6 months of 2010.

Selected Health Measures by Household Telephone Status

Many health surveys, political polls, and other types of research are conducted using random-digit-dial (RDD) telephone surveys. Until recently, these surveys did not include wireless telephone numbers in their samples. Now, despite operational challenges, most major survey research organizations are including wireless telephone numbers when conducting RDD surveys. If they did not, the exclusion of households with only wireless telephones (along with the small proportion of households that have no telephone service) could bias results. This bias—known as coverage bias—could exist if there are differences between persons with and without landline telephones for the substantive variables of interest.

The NHIS Early Release Program updates and releases estimates for 15 key health indicators every 3 months. **Table 4** presents estimates by household telephone status (landline, wireless-only, or phoneless) for all but two of these measures. ("Pneumococcal vaccination" and "personal care needs" were not included because these indicators are limited to older adults aged 65 and over.) For July–December 2013,

- The prevalence of having five or more alcoholic drinks in 1 day during the past year among wireless-only adults (29.0%) was substantially higher than the prevalence among adults living in landline households (17.2%). Wireless-only adults were also more likely to be current smokers than were adults living in landline households.
- The percentage without health insurance coverage at the time of interview among wireless-only adults under age 65 (25.2%) was greater than the percentage among adults in that age group living in landline households (14.7%).
- Compared with adults living in landline households, wireless-only adults were more likely to have experienced financial barriers to obtaining needed health care, and they were less likely to have a usual place to go for medical care. Wireless-only adults were also less likely to have received an influenza vaccination during the previous year
- Wireless-only adults (45.1%) were more likely than adults living in landline households (32.3%) to have ever been tested for human immunodeficiency virus (HIV), the virus that causes AIDS.

The potential for bias due to undercoverage remains a real threat to surveys conducted only on landline telephones.

Wireless-mostly Households

The potential for bias due to undercoverage is not the only threat to surveys conducted only on landline telephones. Researchers are also concerned that some people living in households with landlines cannot be reached on those landlines because they rely on wireless telephones for all or almost all of their calls.

In 2007, a question was added to NHIS for persons living in families with both landline and cellular telephones. The

respondent for the family was asked to consider all of the telephone calls his or her family receives and to report whether "all or almost all calls are received on cell phones, some are received on cell phones and some on regular phones, or very few or none are received on cell phones." This question permits the identification of persons living in "wireless-mostly" households—defined as households with both landline and cellular telephones in which all families receive all or almost all calls on cell phones.

Among households with both landline and wireless telephones, 33.6% received all or almost all calls on wireless telephones, based on data for July–December 2013. These wireless-mostly households make up 16.1% of all households. During the second 6 months of 2013, about 44 million adults (18.3%) lived in wireless-mostly households. This prevalence estimate was greater than, but not significantly different from, the estimate for the second 6 months of 2010 (17.4%).

Table 5 gives the percentage of adults living in wireless-mostly households, by demographic characteristics and by survey time period. For July–December 2013,

- Adults with college degrees (22.3%) were more likely to be living in wireless-mostly households than were high school graduates (16.5%) or adults with less education (12.4%).
- Adults living with children (22.6%) were more likely than adults living alone (9.4%), with roommates (11.2%), or with only adult relatives (18.1%) to be living in wireless-mostly households.
- Adults living in poverty (9.1%) and adults living near poverty (12.0%) were less likely than higher-income adults (22.1%) to be living in wireless-mostly households.
- Adults living in rented homes (12.4%) were less likely to be living in wireless-mostly households than were adults living in homes owned by a household member (21.0%).

Research by **Boyle, Lewis, and Tefft (2009)** suggests that the majority of adults living in wireless-mostly households are reachable using their landline telephone number. NHIS data cannot be used to estimate the proportion of wireless-mostly adults who are unreachable or to estimate the potential for bias due to their exclusion from landline surveys.

References and Other Sources of Information

For more information about the potential implications for health surveys that are based on landline telephone interviews, see

- Blumberg SJ, Luke JV. Reevaluating the need for concern regarding noncoverage bias in landline surveys. Am J Public Health 99(10):1806–10. 2009. Available from: http://ajph.aphapublications.org/cgi/content/abstract/99/10/1806.
- Blumberg SJ, Luke JV, Cynamon ML, Frankel MR. Recent trends in household telephone coverage in the United States. In: Lepkowski JM et al., eds. Advances in telephone survey methodology. New York: John Wiley and Sons, 56–86. 2008.
- Boyle JM, Lewis F, Tefft B. Cell phone mainly households: Coverage and reach for telephone surveys using RDD landline samples. Survey Practice 2(9). 2009. Available from: http://surveypractice.wordpress.com/2009/12/09/cell-phone-and-landlines/.

When including wireless telephone numbers in RDD surveys, researchers have many methodological, statistical, operational, legal, and ethical issues to consider. These issues have been described in a report from a task force of the American Association for Public Opinion Research (AAPOR). That task force included staff from CDC, and its report is available online:

- AAPOR Cell Phone Task Force. New considerations for survey researchers when planning and conducting RDD telephone surveys in the U.S. with respondents reached via cell phone numbers. Deerfield, IL: American Association for Public Opinion Research. 2010. Available from: http://aapor.org/cell_phone_task_force.htm.

The potential for bias may differ from one state to another because the prevalence of wireless-only households varies substantially across states. For more information about prevalence estimates at the state and local levels, see

- Blumberg SJ, Ganesh N, Luke JV, Gonzales G. Wireless substitution: State-level estimates from the National Health Interview Survey, 2012. National health statistics reports; no 70. Hyattsville, MD: National Center for Health Statistics. 2013. Available from: http://www.cdc.gov/nchs/data/nhsr/nhsr070.pdf.

For more information about NHIS and the NHIS Early Release Program, or to find other Early Release Program products, see

- NHIS home page at http://www.cdc.gov/nchs/nhis.htm.
- Early Release Program home page at http://www.cdc.gov/nchs/nhis/releases.htm.

- Parsons VL, Moriarity CL, Jonas K, et al. Design and estimation for the National Health Interview Survey: 2006–2015. National Center for Health Statistics. Vital Health Stat 2(165). 2014. Available from: http://www.cdc.gov/nchs/data/series/sr_02/sr02_165.pdf.

Suggested Citation

Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, July–December 2013. National Center for Health Statistics. July 2014. Available from: http://www.cdc.gov/nchs/nhis.htm.

Table 1. Percent distribution of household telephone status for households, adults, and children, by date of interview: United States, July 2010–December 2013

Date of interview	Number of households (unweighted)	Household telephone status						
		Landline with wireless	Landline without wireless	Landline with unknown wireless	Nonlandline with unknown wireless	Wireless-only	Phoneless	Total
		Percent of households						
July–December 2010	16,676	55.0	12.9	0.3	0.1	29.7	2.0	100.0
January–June 2011	20,133	55.0	11.2	0.2	0.1	31.6	2.0	100.0
July–December 2011	19,311	53.4	10.2	0.2	0.0	34.0	2.2	100.0
January–June 2012	20,608	52.5	9.4	0.2	0.0	35.8	2.1	100.0
July–December 2012	21,709	50.8	8.6	0.2	0.1	38.2	2.1	100.0
January–June 2013	19,765	49.5	8.5	0.1	0.0	39.4	2.3	100.0
July–December 2013	21,512	47.7	8.6	0.1	0.1	41.0	2.5	100.0
95% confidence interval[1]	…	46.53–48.92	8.05–9.15	0.06–0.16	0.02–0.11	39.82–42.28	2.22–2.79	…
		Percent of adults						
July–December 2010	31,791	59.4	10.7	0.3	0.1	27.8	1.8	100.0
January–June 2011	38,104	58.8	9.0	0.2	0.0	30.2	1.8	100.0
July–December 2011	36,564	57.3	8.3	0.2	0.0	32.3	1.9	100.0
January–June 2012	38,896	56.1	7.8	0.2	0.0	34.0	1.9	100.0
July–December 2012	40,839	54.4	7.0	0.2	0.1	36.5	1.9	100.0
January–June 2013	37,268	52.8	6.9	0.1	0.0	38.0	2.2	100.0
July–December 2013	40,173	51.5	7.0	0.1	0.1	39.1	2.2	100.0
95% confidence interval[1]	…	50.27–52.74	6.54–7.53	0.05–0.16	0.02–0.11	37.86–40.36	1.97–2.51	…
		Percent of children						
July–December 2010	11,815	59.8	6.2	0.1	0.1	31.8	2.0	100.0
January–June 2011	13,753	56.7	5.1	0.1	0.0	36.4	1.7	100.0
July–December 2011	13,028	54.7	4.8	0.1	0.0	38.1	2.2	100.0
January–June 2012	13,905	52.7	4.5	0.1	–	40.6	2.2	100.0
July–December 2012	14,083	49.5	3.4	0.1	0.1	45.0	1.9	100.0
January–June 2013	12,932	48.3	3.6	0.1	0.0	45.4	2.6	100.0
July–December 2013	13,714	46.4	3.8	0.1	0.0	47.1	2.5	100.0
95% confidence interval[1]	…	44.64–48.21	3.26–4.43	0.03–0.19	0.01–0.07	45.38–48.89	2.06–3.15	…

0.0 Quantity more than zero but less than 0.05.

… Category not applicable.

–Quantity zero.

[1]Refers to July–December 2013.

NOTE: Data are based on household interviews of a sample of the civilian noninstitutionalized population.

DATA SOURCE: CDC/NCHS, National Health Interview Survey, July 2010–December 2013.

Table 2. Percentage of adults living in wireless-only households, by selected demographic characteristics and calendar half-years: United States, July 2010–December 2013

Demographic characteristic	Calendar half-year							95% confidence interval[1]
	Jul–Dec 2010	Jan–Jun 2011	Jul–Dec 2011	Jan–Jun 2012	Jul–Dec 2012	Jan–Jun 2013	Jul–Dec 2013	
Race/ethnicity								
Hispanic or Latino, any race(s)	38.4	40.8	43.3	46.5	50.5	49.9	53.1	50.77–55.35
Non-Hispanic white, single race	25.0	27.6	29.0	30.4	32.9	35.1	35.1	33.59–36.61
Non-Hispanic black, single race	31.1	32.5	36.8	37.7	39.0	39.4	42.7	40.22–45.25
Non-Hispanic Asian, single race	27.0	27.7	31.6	33.4	34.4	35.2	38.1	34.79–41.59
Non-Hispanic other, single race	31.9	33.8	44.1	43.4	43.9	50.1	51.7	42.50–60.82
Non-Hispanic multiple race	36.1	39.3	36.7	40.2	45.3	46.2	45.7	40.11–51.45
Age (years)								
18–24	45.5	46.8	48.6	49.5	53.2	54.3	53.0	50.34–55.60
25–29	53.5	58.1	59.6	60.1	62.1	65.6	65.7	63.16–68.17
30–34	43.8	46.2	50.9	55.1	56.7	59.9	59.7	57.31–62.09
35–44	30.9	34.3	36.8	39.1	43.5	44.5	47.8	45.75–49.79
45–64	18.8	21.6	23.8	25.8	28.4	29.8	31.4	30.09–32.73
65 and over	7.7	7.9	8.5	10.5	11.6	12.6	13.6	12.42–14.81
Sex								
Male	29.0	31.4	33.7	35.2	38.0	39.7	40.4	39.00–41.73
Female	26.8	29.1	30.9	32.9	35.1	36.5	37.9	36.69–39.20
Education								
Some high school or less	29.2	32.1	34.7	36.4	42.4	41.7	41.8	39.73–43.97
High school graduate or GED[2]	27.6	30.8	32.7	33.9	35.9	37.2	38.8	37.15–40.43
Some post-high school, no degree	30.9	31.8	35.1	36.7	38.3	40.6	41.7	39.97–43.43
4-year college degree or higher	24.3	26.9	27.8	30.1	32.2	34.5	35.5	33.63–37.51
Employment status last week								
Working at a job or business	31.5	34.2	36.8	38.4	41.4	43.5	44.4	43.02–45.78
Keeping house	25.8	31.2	32.7	34.0	38.6	39.4	40.5	37.79–43.23
Going to school	38.6	35.3	40.8	41.9	46.0	48.1	46.3	42.23–51.49
Something else (incl. unemployed)	19.2	21.0	22.3	23.6	25.1	25.2	27.0	25.71–28.24
Household structure								
Adult living alone	36.8	38.0	41.3	43.0	43.9	46.4	46.6	44.65–48.54
Unrelated adults, no children	69.7	71.3	77.5	75.9	76.2	74.7	76.1	69.07–81.97
Related adults, no children	22.1	23.2	25.1	27.0	28.2	29.6	31.0	29.56–32.46
Adult(s) with children	29.4	33.6	35.4	37.2	42.2	43.6	44.8	43.12–46.40
Household poverty status[3]								
Poor	42.8	46.8	51.4	51.8	54.3	54.7	56.2	53.47–58.96
Near-poor	35.2	38.1	39.6	42.3	45.9	47.5	46.1	43.65–48.50
Not-poor	24.1	27.7	28.9	30.7	33.2	35.3	36.6	35.02–38.16

See footnotes at end of table.

Table 2. Percentage of adults living in wireless-only households, by selected demographic characteristics and calendar half-years: United States, July 2010–December 2013—*Continued*

Demographic characteristic	Calendar half-year							95% confidence interval[1]
	Jul–Dec 2010	Jan–Jun 2011	Jul–Dec 2011	Jan–Jun 2012	Jul–Dec 2012	Jan–Jun 2013	Jul–Dec 2013	
Geographic region[4]								
Northeast	17.2	18.8	20.6	23.1	23.6	27.1	24.9	21.89–28.15
Midwest	30.0	33.5	35.2	37.5	40.6	39.6	43.7	41.02–46.40
South	31.1	33.6	35.9	37.2	39.7	41.8	41.9	39.87–43.86
West	28.7	30.3	33.0	34.0	37.8	39.0	41.2	38.86–43.39
Metropolitan statistical area status								
Metropolitan	29.1	31.4	33.6	35.7	38.1	39.5	40.5	39.07–41.90
Not metropolitan	22.9	25.6	27.2	27.1	30.5	32.4	33.7	30.92–36.59
Home ownership status[5]								
Owned or being bought	17.7	20.6	21.2	23.2	25.4	27.2	28.5	27.22–29.76
Renting	50.3	52.5	56.0	58.2	59.7	61.5	61.7	60.15–63.30
Other arrangement	35.1	38.4	40.7	37.7	49.1	42.6	49.3	42.80–55.90
Number of wireless-only adults in survey sample (unweighted)	9,228	11,872	12,350	13,724	15,589	14,512	16,436	…

… Category not applicable.

[1]Refers to July–December 2013.

[2]GED is General Educational Development high school equivalency diploma.

[3]Based on household income and household size using the U.S. Census Bureau's poverty thresholds. "Poor" persons are defined as those below the poverty threshold. "Near-poor" persons have incomes of 100% to less than 200% of the poverty threshold. "Not-poor" persons have incomes of 200% of the poverty threshold or greater. Early Release estimates stratified by poverty status are based on reported income only and may differ from similar estimates produced later that are based on both reported and imputed income. NCHS imputes income when income is unknown, but the imputed income file is not available until a few months after the annual release of National Health Interview Survey microdata. For households with multiple families, household income and household size were calculated as the sum of the multiple measures of family income and family size.

[4]In the geographic classification of the U.S. population, states are grouped into the following four regions used by the U.S. Census Bureau: *Northeast* includes Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania; *Midwest* includes Ohio, Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska; *South* includes Delaware, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Oklahoma, Arkansas, and Texas; and *West* includes Washington, Oregon, California, Nevada, New Mexico, Arizona, Idaho, Utah, Colorado, Montana, Wyoming, Alaska, and Hawaii.

[5]For households with multiple families, home ownership status was determined by considering the reported home ownership status for each family. If any family reported owning the home, then the household-level variable was classified as "Owned or being bought" for all persons living in the household. If one family reported renting the home and another family reported "other arrangement," then the household-level variable was classified as "Other arrangement" for all persons living in the household.

NOTE: Data are based on household interviews of a sample of the civilian noninstitutionalized population.

DATA SOURCE: CDC/NCHS, National Health Interview Survey, July 2010–December 2013.

Table 3. Percent distributions of selected demographic characteristics for adults living in wireless-only households, by date of interview: United States, July 2010–December 2013

Demographic characteristic	Calendar half-year							95% confidence interval[1]
	Jul–Dec 2010	Jan–Jun 2011	Jul–Dec 2011	Jan–Jun 2012	Jul–Dec 2012	Jan–Jun 2013	Jul–Dec 2013	
Race/ethnicity								
Hispanic or Latino, any race(s)	19.5	19.0	19.1	20.3	20.6	19.7	20.5	18.82–22.34
Non-Hispanic white, single race	61.0	61.8	61.0	59.6	59.7	61.0	59.2	57.35–61.09
Non-Hispanic black, single race	13.0	12.5	13.1	12.7	12.3	12.0	12.6	11.53–13.76
Non-Hispanic Asian, single race	4.5	4.3	4.7	5.1	4.9	5.0	5.2	4.67–5.83
Non-Hispanic other, single race	0.7	0.8	0.9	0.8	0.8	0.9	1.0	0.70–1.35
Non-Hispanic multiple race	1.3	1.6	1.3	1.5	1.6	1.5	1.4	1.23–1.69
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Age (years)								
18–24	21.1	20.0	19.4	18.9	18.9	18.4	17.4	16.30–18.65
25–29	17.7	17.6	17.0	15.5	14.8	15.2	14.8	13.92–15.66
30–34	13.7	13.3	14.0	14.0	13.4	13.5	13.3	12.59–13.99
35–44	19.3	19.5	19.2	19.5	20.0	19.7	20.4	19.45–21.34
45–64	23.6	25.0	25.8	26.7	27.1	27.2	27.8	26.72–28.81
65 and over	4.7	4.5	4.6	5.5	5.7	6.0	6.4	5.78–7.05
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Sex								
Male	50.3	50.4	50.7	49.8	50.1	50.3	49.7	49.04–50.38
Female	49.7	49.6	49.3	50.2	49.9	49.7	50.3	49.62–50.96
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Education								
Some high school or less	15.4	15.6	15.2	15.2	16.1	15.0	14.5	13.58–15.44
High school graduate or GED[2]	28.1	27.8	28.2	27.1	27.4	26.7	26.9	25.83–27.98
Some post-high school, no degree	32.7	32.2	32.7	33.3	31.8	32.6	32.4	31.14–33.71
4-year college degree or higher	23.9	24.3	23.9	24.5	24.6	25.8	26.2	24.82–27.65
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Employment status last week								
Working at a job or business	68.8	68.5	69.0	69.3	68.9	69.7	70.1	69.02–71.12
Keeping house	5.5	5.9	5.6	5.3	5.8	5.9	5.7	5.21–6.13
Going to school	4.7	4.2	4.0	4.3	4.0	4.4	3.6	3.10–4.28
Something else (incl. unemployed)	20.0	20.3	20.6	20.2	20.5	19.2	19.8	18.92–20.81
Unknown, not reported	1.1	1.0	0.7	0.9	0.9	0.7	0.8	0.58–1.02
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Household structure								
Adult living alone	20.0	18.7	19.8	18.9	18.6	18.8	18.6	17.56–19.65
Unrelated adults, no children	4.0	4.3	4.0	3.8	3.1	3.2	2.9	2.24–3.69
Related adults, no children	36.0	35.3	35.8	36.9	35.7	35.8	36.9	35.60–38.28
Adult(s) with children	40.0	41.7	40.5	40.4	42.6	42.2	41.6	40.11–43.13
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…

See footnotes at end of table.

Table 3. Percent distribution of selected demographic characteristics for adults living in wireless-only households, by date of interview: United States, July 2010–December 2013—*Continued*

Demographic characteristic	Calendar half-year							95% confidence interval[1]
	Jul–Dec 2010	Jan–Jun 2011	Jul–Dec 2011	Jan–Jun 2012	Jul–Dec 2012	Jan–Jun 2013	Jul–Dec 2013	
Household poverty status[3]								
Poor	17.4	15.6	15.9	15.0	15.4	13.9	14.1	13.00–15.27
Near-poor	18.6	17.7	18.2	17.7	18.0	17.8	16.6	15.66–17.58
Not-poor	52.3	47.8	46.2	47.1	46.1	48.5	47.8	46.14–49.48
Unknown, not reported	11.7	18.8	19.8	20.2	20.6	19.7	21.5	20.16–22.90
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Geographic region[4]								
Northeast	11.0	11.1	11.7	12.4	11.7	12.6	11.3	9.63–13.15
Midwest	24.7	24.9	25.2	24.5	24.8	23.1	25.1	22.91–27.35
South	40.2	40.5	39.9	40.4	40.1	40.8	39.9	37.59–42.19
West	24.1	23.5	23.3	22.8	23.4	23.6	23.8	21.93–25.78
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Metropolitan statistical area status								
Metropolitan	82.7	82.8	82.3	83.9	82.6	82.8	82.6	80.34–84.58
Not metropolitan	17.3	17.2	17.7	16.1	17.4	17.2	17.4	15.42–19.66
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Home ownership status[5]								
Owned or being bought	43.3	47.0	44.2	46.5	46.6	48.0	48.5	46.65–50.27
Renting	54.2	49.9	53.3	51.2	50.9	49.6	49.1	47.28–50.99
Other arrangement	2.5	3.0	2.5	2.3	2.6	2.4	2.4	1.94–2.97
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	…
Number of wireless-only adults in survey sample (unweighted)	9,228	11,872	12,350	13,724	15,589	14,512	16,436	…

… Category not applicable.

[1]Refers to July–December 2013.

[2]GED is General Educational Development high school equivalency diploma.

[3]Based on household income and household size using the U.S. Census Bureau's poverty thresholds. "Poor" persons are defined as those below the poverty threshold. "Near-poor" persons have incomes of 100% to less than 200% of the poverty threshold. "Not-poor" persons have incomes of 200% of the poverty threshold or greater. Early Release estimates stratified by poverty status are based on reported income only and may differ from similar estimates produced later that are based on both reported and imputed income. NCHS imputes income when income is unknown, but the imputed income file is not available until a few months after the annual release of National Health Interview Survey microdata. For households with multiple families, household income and household size were calculated as the sum of the multiple measures of family income and family size.

[4]In the geographic classification of the U.S. population, states are grouped into the following four regions used by the U.S. Census Bureau: *Northeast* includes Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania; *Midwest* includes Ohio, Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska; *South* includes Delaware, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Oklahoma, Arkansas, and Texas; and *West* includes Washington, Oregon, California, Nevada, New Mexico, Arizona, Idaho, Utah, Colorado, Montana, Wyoming, Alaska, and Hawaii.

[5]For households with multiple families, home ownership status was determined by considering the reported home ownership status for each family. If any family reported owning the home, then the household-level variable was classified as "Owned or being bought" for all persons living in the household. If one family reported renting the home and another family reported "other arrangement," then the household-level variable was classified as "Other arrangement" for all persons living in the household.

NOTE: Data are based on household interviews of a sample of the civilian noninstitutionalized population.

DATA SOURCE: CDC/NCHS, National Health Interview Survey, July 2010–December 2013.

Table 4. Prevalence rates (and 95% confidence intervals) for selected measures of health-related behaviors, health status, health care service use, and health care access for adults aged 18 and over, by household telephone status: United States, July–December 2013

Measure	Household telephone status		
	Landline[1]	Wireless-only	Phoneless
Health-related behaviors			
Five or more alcoholic drinks in 1 day at least once in past year[2]	17.2 (16.09–18.45)	29.0 (27.30–30.69)	27.4 (21.68–33.99)
Current smoker[3]	15.2 (14.27–16.26)	22.4 (20.96–23.84)	21.4 (17.38–26.07)
Engaged in regular leisure-time physical activity[4]	36.4 (34.99–37.85)	40.9 (39.36–42.53)	32.2 (26.85–38.12)
Health status			
Health status described as excellent or very good[5]	57.4 (55.95–58.90)	63.8 (62.31–65.33)	57.9 (52.00–63.59)
Experienced serious psychological distress in past 30 days[6]	3.5 (2.96–4.07)	4.4 (3.80–5.08)	6.8 (4.37–10.49)
Obese (adults aged 20 and over)[7]	29.9 (28.41–31.50)	29.0 (27.50–30.48)	29.0 (23.56–35.16)
Asthma episode in past year[8]	3.3 (2.83–3.82)	3.5 (3.03–4.12)	3.4 (2.00–5.69)
Ever diagnosed with diabetes[9]	11.7 (10.86–12.52)	6.2 (5.50–6.91)	7.9 (5.10–11.89)
Health care service use			
Received influenza vaccine during past year[10]	46.5 (44.92–48.14)	31.8 (30.36–33.27)	26.2 (20.75–32.57)
Ever been tested for HIV[11]	32.3 (30.84–33.77)	45.1 (43.41–46.90)	40.4 (34.38–46.62)
Health care access			
Has a usual place to go for medical care[12]	90.2 (89.20–91.07)	74.9 (73.46–76.29)	75.0 (69.79–79.64)
Failed to obtain needed medical care in past year due to financial barriers[13]	5.4 (4.76–6.04)	10.9 (10.04–11.92)	10.7 (7.74–14.65)
Currently uninsured (adults aged 18–64)[14]	14.7 (13.36–16.10)	25.2 (23.54–27.00)	27.2 (22.09–32.90)
Number of adults in survey sample (unweighted)	9,648	7,875	444

[1]Includes households that also have wireless telephone service.

[2]A year is defined as the 12 months prior to interview. The analyses excluded adults with unknown alcohol consumption (about 1.1%).

[3]A person who had smoked more than 100 cigarettes in his or her lifetime and now smokes every day or some days. The analyses excluded adults with unknown smoking status (about 0.8%).

[4]Regular leisure-time physical activity is defined as engaging in light-moderate leisure-time physical activity for greater than or equal to 30 minutes at a frequency greater than or equal to five times per week, or engaging in vigorous leisure-time physical activity for greater than or equal to 20 minutes at a frequency greater than or equal to three times per week. Persons who were known to have not met the frequency recommendations are classified as "not regular," regardless of duration. The analyses excluded adults with unknown physical activity participation (about 2.2%).

[5]Health status data were obtained by asking respondents to assess their own health and that of family members living in the same household as excellent, very good, good, fair, or poor. The analyses excluded persons with unknown health status (about 0.1%).

[6]Six psychological distress questions are included in the National Health Interview Survey. These questions ask how often during the past 30 days a respondent experienced certain symptoms of psychological distress (feeling so sad that nothing could cheer you up, nervous, restless or fidgety, hopeless, worthless, that everything was an effort). The response codes (0–4) of the six items for each person were weighted equally and summed. A value of 13 or more for this scale indicates that at least one symptom was experienced "most of the time" or "all of the time" and is used here to define serious psychological distress.

[7]Obesity is defined as a body mass index (BMI) of 30 kg/m2 or more. The measure is based on self-reported height and weight. The analyses excluded adults with unknown height or weight (about 4.4%). Estimates of obesity are presented for adults aged 20 and over because the Healthy People 2020 objectives (http://www.healthypeople.gov) for healthy weight among adults define adults as persons aged 20 and over.

[8]Information on an episode of asthma or an asthma attack during the past year is self-reported by adults aged 18 and over. A year is defined as the 12 months prior to interview. The analyses excluded persons with unknown asthma episode status (about 0.1%).

[9]Prevalence of diagnosed diabetes is based on self-report of ever having been diagnosed with diabetes by a doctor or other health professional. Persons reporting "borderline" diabetes status and women reporting diabetes only during pregnancy were not coded as having diabetes in the analyses. The analyses excluded adults with unknown diabetes status (about 0.1%).

[10]Receipt of flu shots and receipt of nasal spray flu vaccinations were included in the calculation of flu vaccination estimates. Responses to these two flu vaccination questions do not indicate when the subject received the flu vaccination during the 12 months preceding the interview. In addition, estimates are subject to recall error, which will vary depending on when the question is asked because the receipt of a flu vaccination is seasonal. The analyses excluded adults with unknown flu vaccination status (about 2.5%).

[11]Individuals who received human immunodeficiency virus (HIV) testing solely as a result of blood donation were considered not to have been tested for HIV. The analyses excluded adults with unknown HIV test status (about 3.9%).

[12]Does not include a hospital emergency room. The analyses excluded persons with an unknown usual place to go for medical care (about 1.0%).

[13]A year is defined as the 12 months prior to interview. The analyses excluded persons with unknown responses to the question on failure to obtain needed medical care due to cost (about 0.1%).

[14]A person was defined as uninsured if he or she did not have any private health insurance, Medicare, Medicaid, Children's Health Insurance Program (CHIP), state-sponsored or other government-sponsored health plan, or military plan at the time of interview. A person was also defined as uninsured if he or she had only Indian Health Service coverage or had only a private plan that paid for one type of service such as accidents or dental care. The data on health insurance status were edited using an automated system based on logic checks and keyword searches. The analyses excluded adults with unknown health insurance status (about 1.0%).

NOTE: Data are based on household interviews of a sample of the civilian noninstitutionalized population.

DATA SOURCE: CDC/NCHS, National Health Interview Survey, July–December 2013.

Table 5. Percentage of adults living in wireless-mostly households, by selected demographic characteristics and calendar half-years: United States, July 2010–December 2013

Demographic characteristic	Calendar half-year							95% confidence interval[1]
	Jul–Dec 2010	Jan–Jun 2011	Jul–Dec 2011	Jan–Jun 2012	Jul–Dec 2012	Jan–Jun 2013	Jul–Dec 2013	
Total	17.4	18.2	17.8	17.6	18.0	17.7	18.3	17.51–19.09
Race/ethnicity								
Hispanic or Latino, any race(s)	17.2	16.3	17.0	16.1	17.4	16.4	16.6	15.29–17.95
Non-Hispanic white, single race	17.2	18.4	17.9	17.6	17.7	17.4	18.6	17.61–19.59
Non-Hispanic black, single race	16.2	18.4	17.1	17.6	18.6	19.0	18.2	16.17–20.48
Non-Hispanic Asian, single race	22.5	21.0	20.3	21.5	22.2	20.9	20.4	17.46–23.74
Non-Hispanic other, single race	23.8	17.6	15.6	15.1	12.5	22.7	14.1	9.08–21.27
Non-Hispanic multiple race	20.7	16.1	21.7	18.7	18.0	18.0	16.9	13.29–21.29
Age (years)								
18–24	18.7	20.1	18.9	20.1	18.2	18.6	20.0	18.32–21.74
25–29	16.8	16.3	15.8	15.0	17.0	14.8	14.5	12.95–16.27
30–44	21.6	21.9	21.2	20.7	21.2	20.7	20.0	18.78–21.22
45–64	18.9	19.8	19.9	19.3	20.3	19.8	21.6	20.50–22.82
65 and over	7.1	8.9	8.9	8.9	9.1	10.3	10.3	9.28–11.32
Sex								
Male	17.8	18.5	18.3	17.9	18.3	17.8	18.6	17.80–19.47
Female	17.1	17.9	17.3	17.3	17.7	17.6	18.0	17.15–18.81
Education								
Some high school or less	12.1	12.9	11.7	11.9	11.6	12.8	12.4	11.20–13.74
High school graduate or GED[2]	15.3	16.6	15.7	15.5	16.3	16.0	16.5	15.42–17.68
Some post-high school, no degree	18.9	20.0	19.4	19.1	19.3	18.6	18.9	17.74–20.08
4-year college degree or higher	21.3	21.1	21.4	21.0	21.5	20.7	22.3	21.13–23.47
Employment status last week								
Working at a job or business	20.5	21.6	20.9	20.6	21.1	20.2	21.4	20.41–22.37
Keeping house	16.7	14.9	16.6	15.5	17.5	19.0	16.9	15.02–18.90
Going to school	24.4	23.5	20.0	23.7	18.2	22.2	21.1	17.94–24.58
Something else (incl. unemployed)	10.2	11.3	11.4	10.8	11.6	11.7	11.4	10.56–12.28
Household structure								
Adult living alone	9.5	10.2	10.1	10.2	9.8	9.5	9.4	8.51–10.28
Unrelated adults, no children	13.4	*15.6	10.3	13.0	12.3	12.9	11.2	7.59–16.31
Related adults, no children	15.8	17.2	16.9	16.2	17.4	17.0	18.1	16.97–19.37
Adult(s) with children	22.7	22.8	22.5	22.4	22.4	22.2	22.6	21.33–23.93
Household poverty status[3]								
Poor	10.2	10.5	8.8	10.8	8.6	10.8	9.1	7.79–10.58
Near-poor	13.8	13.3	13.5	11.1	12.7	12.0	12.0	10.75–13.41
Not-poor	20.4	21.6	21.9	21.5	21.8	21.4	22.1	21.05–23.29

See footnotes at end of table.

Table 5. Percentage of adults living in wireless-mostly households, by selected demographic characteristics and calendar half-years: United States, July 2010–December 2013—*Continued*

Demographic characteristic	Calendar half-year							95% confidence interval[1]
	Jul–Dec 2010	Jan–Jun 2011	Jul–Dec 2011	Jan–Jun 2012	Jul–Dec 2012	Jan–Jun 2013	Jul–Dec 2013	
Geographic region[4]								
Northeast	18.5	19.5	17.9	18.9	20.0	18.2	20.1	18.42–21.90
Midwest	16.3	17.7	16.6	15.5	15.3	16.7	16.2	14.77–17.80
South	17.2	18.0	17.7	17.3	17.7	17.0	18.0	16.78–19.35
West	18.0	18.1	19.1	18.9	19.3	19.4	19.3	17.50–21.26
Metropolitan statistical area status								
Metropolitan	17.8	18.4	18.2	17.9	18.5	17.9	18.7	17.84–19.57
Not metropolitan	16.1	17.3	16.4	16.4	15.8	17.0	16.7	14.94–18.56
Home ownership status[5]								
Owned or being bought	19.4	20.0	19.9	19.9	20.1	20.0	21.0	19.95–22.17
Renting	13.0	13.9	13.5	12.7	13.0	12.8	12.4	11.41–13.49
Other arrangement	15.6	20.0	11.7	13.8	17.3	17.0	14.8	10.86–19.85
Number of adults in survey sample who live in landline households with wireless telephones (unweighted)	18,357	21,626	20,184	21,100	21,194	19,106	22,879	…

* Estimate has a relative standard error greater than 30% and does not meet standards for reliability or precision.

… Category not applicable.

[1]Refers to July–December 2013.

[2]GED is General Educational Development high school equivalency diploma.

[3]Based on household income and household size using the U.S. Census Bureau's poverty thresholds. "Poor" persons are defined as those below the poverty threshold. "Near-poor" persons have incomes of 100% to less than 200% of the poverty threshold. "Not-poor" persons have incomes of 200% of the poverty threshold or greater. Early Release estimates stratified by poverty status are based on reported income only and may differ from similar estimates produced later that are based on both reported and imputed income. NCHS imputes income when income is unknown, but the imputed income file is not available until a few months after the annual release of National Health Interview Survey microdata. For households with multiple families, household income and household size were calculated as the sum of the multiple measures of family income and family size.

[4]In the geographic classification of the U.S. population, states are grouped into the following four regions used by the U.S. Census Bureau: *Northeast* includes Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania; *Midwest* includes Ohio, Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska; *South* includes Delaware, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Oklahoma, Arkansas, and Texas; and *West* includes Washington, Oregon, California, Nevada, New Mexico, Arizona, Idaho, Utah, Colorado, Montana, Wyoming, Alaska, and Hawaii.

[5]For households with multiple families, home ownership status was determined by considering the reported home ownership status for each family. If any family reported owning the home, then the household-level variable was classified as "Owned or being bought" for all persons living in the household. If one family reported renting the home and another family reported "other arrangement," then the household-level variable was classified as "Other arrangement" for all persons living in the household.

NOTE: Data are based on household interviews of a sample of the civilian noninstitutionalized population.

DATA SOURCE: CDC/NCHS, National Health Interview Survey, July 2010–December 2013.