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REPORT 735

Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models

TRANSPORTATION RESEARCH BOARD
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Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

By Nanda Srinivasan
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This guidebook provides transferable parameters for both personal long-distance travel and rural travel for statewide travel models, including applications and limitations. The guide is a supplement to *NCHRP Report 716: Travel Demand Forecasting: Parameters and Techniques,* which focused on urban travel.

The report will be of broad interest to travel demand practitioners at state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and consultants developing multistate and national travel forecasting models, statewide and intercity passenger models, and large regional models, especially those covering areas of low-density rural development patterns and undeveloped lands. Areas with a significant proportion of tourist travel will also find this report to be useful in quantifying long-distance travel patterns.

In the last 15 to 20 years, many state departments of transportation (DOTs) have undertaken the development of statewide transportation planning demand models. These models are often used to help formulate policies, prioritize projects, and identify the potential revenue streams from toll road and other major transportation investments. Some of these models can provide input to urban models because of their ability to capture market segments not well represented in urban area forecasting tools. Because these models play such a significant role in the planning process, careful and thoughtful evaluation of how well statewide models reproduce existing travel markets, as well as their sensitivity to major market segments and behavioral responses, is an increasingly important consideration.

Most of the statewide models are built on practices originally developed for urbanized area forecasting. In the context of statewide forecasting, passenger- or person-based rural trip making and long-distance travel constitute important market segments, much more so than in urban models. Information describing these markets, and how they vary from state to state, is sparse and many states do not have the resources to initiate original data collection to develop a set of model parameters. Yet these same states have a pressing need to have confidence in reasonable data for personal rural and long-distance travel. This research addressed the applicability of recent national datasets to statewide analysis and analysed the transferability of parameters among statewide models.

The research was conducted by Cambridge Systematics, Inc. Information was gathered via all available national datasets, including the National Household Travel Survey, the American Travel Survey, and a database of statewide models. The guidebook will be of broad interest to the travel forecasting community at large.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models

The modeling of long-distance trips in statewide models differs from that of urban and regional models that focus on differentiating home-based from nonhome-based trips. Long-distance trips are more likely to be divided into categories by frequency of travel or by purpose such as recreational/tourist versus business-oriented trips. Such considerations are more likely to be indicative of long-distance variations by trip length, mode choice, and other aspects of travel.

Most statewide travel demand forecasting models are built upon practices originally developed for urbanized area modeling. In the context of statewide forecasting, rural trip-making and long-distance intercity travel constitute important market segments, much more so than in urban models. Information describing these markets, and how these markets vary from state to state, is somewhat sparse, and many states do not have the resources to initiate original data collection to develop a set of model parameters. Yet these same states have a pressing need to have confidence in reasonable data for rural and long-distance travel. Furthermore, for the states where local data collection has occurred, there is little basis to assess how reasonable their findings are compared with findings from other states.

Statewide models in smaller and more urbanized states do not typically distinguish between urban and rural travel. However, it is generally accepted that rural area trip patterns differ from intra-urban travel, and so most statewide models should attempt to distinguish between urban and rural trip-makers. While trip rates are readily available for transferability from urban and regional models, there are relatively few rural trip rates available to transfer for use in statewide travel demand models. Statewide models with trip generation rates derived from statewide surveys or the National Household Travel Survey (NHTS) Add-On samples stratified into urban and rural respondents are worth evaluating as a potential source of transferable parameters (http://nhts.ornl.gov/).

Documentation related to the validation of several statewide models is available; however, no comprehensive research assessing recent national datasets had previously been performed, and there had been no analysis of the transferability of parameters among statewide models prior to NCHRP Project 08-84. For urban models, there are several sources of validation and reasonableness checking such as *NCHRP Report 716: Travel Demand Forecasting: Parameters and Techniques* (Cambridge Systematics, Inc. et al., 2012) and the FHWA *Travel Model Validation and Reasonableness Checking Manual, Second Edition* (Cambridge Systematics, Inc., 2010c). These documents provide a set of excellent resources to evaluate urban models but do not provide any guidance on how nonurban (superregional, intercity, and statewide) parameters should be used, reasonable ranges of those parameters, and how those parameters should be modified for rural areas.

The American Travel Survey (ATS) (http://www.transtats.bts.gov/Tables.asp?DB_ID=505&DB_Name=American+Travel+Survey+(ATS)+1995&DB_Short_Name=ATS) was originally designed to obtain information on long-distance travelers; however, this survey was later discontinued and the more recent NHTS is not structured for a targeted sample size of long-distance trips. The 2009 NHTS Add-On programs in several states do provide usable data related to rural trip-making and, to a lesser extent, long-distance travel.

The objective of this research has been to develop and document transferable parameters for long-distance and rural trip-making for statewide models. It was envisioned that this report would act as a supplement to the NCHRP "quick response" guidance on model parameters and highlight reasonable sets of parameter ranges for rural and long-distance trip-making. It will be widely used by state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and consultants developing multistate and national travel forecasting models, statewide and intercity passenger models, and large regional models, especially those covering areas of low-density rural development patterns and undeveloped lands.

Differences in Rural and Long-Distance Trip-Making

In the context of statewide forecasting, rural trip-making and long-distance intercity travel constitute important market segments. Information describing these markets and how they vary from state to state has been sparse, and many states do not have the resources to initiate original data collection to develop a set of model parameters. Yet these same states have a pressing need for confidence in reasonable transportation planning results for rural and long-distance travel. Furthermore, for the states where local data are available, there has been little basis to assess how comparable their assumptions are with those from other states.

This topic is addressed in this study by identifying differences in rural and urban travel, in various states, from existing surveys. This includes preliminary analyses of 1995 ATS, 2001 NHTS, 2009 NHTS, and select statewide, superregional, and tourist survey data to (1) see how differences in rural and long-distance trip-making occur in different geographic regions and (2) identify any explanatory variables that could be used to adjust average values and reflect conditions in a particular state. The most recent NHTS contains over 20 separate add-on partners, some representing full states and some MPO planning areas (which may include rural areas within the MPO boundary).

It was important in conducting analysis that rural and long-distance data on transferable parameters be compared against urban short-distance data and typical model parameters. For example, according to the 2009 NHTS, short trips account for the vast majority of personal trips in the United States—three-quarters of vehicle trips are less than 10 miles in length. However, these trips account for less than one-third (28.9 percent) of all vehicle miles traveled (VMT). Trips of over 100 miles account for less than 1 percent of all vehicle trips, but 15.5 percent of all household-based vehicle miles. With the potential impact on VMT, travel demand forecasts depend on knowing more about the current amount and nature of long-distance and rural travel in the United States.

Statewide Model Statistics

This Guidebook explores the characteristics of statewide models further to identify sources that could be used in comparing, developing, and recommending trip production and attraction rates, friction factors, mode choice coefficients, and peak-to-daily/time-of-day factors, among other model parameters, for estimating rural and long-distance travel. The final report for NCHRP Statewide Model Validation Study (Cambridge Systematics, Inc., 2010d) included a series of tables describing model parameters and benchmark statistics from statewide models, including information on long-distance and rural trip purposes, where these were separated from typical urban model purposes. Some of the information in this Guidebook was derived either from recent work on the NCHRP Model Validation Report or prior work on national model research for FHWA.

Establishment of trip purposes used in statewide models is important because this largely determines the stratifications used in subsequent model statistics (i.e., these are reported by trip purpose). Some trip purposes in statewide models are duplicative, using different names but meaning the same thing. This has been fleshed out through discussions with state DOT contacts and their consultants. Some models differentiate short-distance from long-distance trip purposes while others do not. Therefore, although this task focuses primarily on long-distance trip purposes, it also includes home-based and nonhome-based trip purposes for relevant models that do not include separate long-distance purposes.

Model statistics compiled by trip purpose included aggregate trip rates, percent trips by purpose, average trip length/duration (in time and distance), vehicle occupancy rates, and mode splits.

General Guidance on Transferability of Model Parameters

This Guidebook provides general guidance on when and when not to transfer model parameters. General analysis by the research team has shown that **population density** is a potential indicator of model transferability. This is particularly the case with mode choice for long-distance travel, because private passenger vehicles predominate in long-distance travel in smaller-sized urbanized areas and rural areas while long-distance travel is more common on alternate modes in large metropolitan areas. Clearly, there is a relationship between population density and **available transportation modes** that also explains the mode choice issue. Density, in the sense of urban versus rural travel, shows up consistently in most analysis documented in this study with, for example, urban areas having higher trip rates but rural areas having higher average trip lengths.

With respect to analysis of **median income** impacts on trip-making, it stands to reason that lower income households would make fewer long-distance trips than higher income households. Likewise, household decisions on transportation modes for long-distance travel should include an income component. Analysis completed for this report deepens understanding of the relationship between income and rural trip-making.

Key employment types and industries can impact rural trip-making. A good example of this is tourism and lodging, which has a large need for low-income workers who cannot afford to live in **proximity to resort developments**. Such areas are also magnets for long-distance travel because visitors to resorts usually reside outside of the region.

The **source of the model parameter** is a key decision point in parameter transferability because there is a wide variety of sources considered in establishing such settings, including state DOT surveys (both household and intercept), surveys from adjacent or similar states, national surveys, MPO surveys, *NCHRP Report 716* and other model guidance documents, as well as other statewide models. Furthermore, smaller states (e.g., Rhode Island) might have more in common with urban and regional models than statewide models, with a smaller percentage of long-distance trip activity and dominated by urbanized land.

Clearly, long-distance model parameters should be derived from surveys with a statistically valid sample of such trip-makers. Rural model parameters require a survey with both urban and rural resident components in order to ensure that the resulting rates are in fact the result of differences in residential and/or work location and not just due to error in survey execution or design. Although reported statistics from statewide models and documentation of general guidance are useful to provide context, such comparisons are no substitute for analysis of travel survey data.

The limitations of the data sources must also be considered, especially as these relate to geographic limitations or trip definition. The minimum amount of data needed for the geography intended (national, regional, state, or metro area) must be assessed for each of the parameters. It is important for readers of this document to understand the limitations of the datasets used during this study when transferring parameters provided in this report.

Some potentially transferable parameters important to properly estimating long-distance and rural travel patterns and comparative benchmark statistics in statewide models are described below. Transferable parameters recommended for estimation include the following:

- Daily (weekday and weekend) rural trip rates per household by household characteristics (e.g., number of workers by industry) and by trip purpose;
- Monthly or annual long-distance trip rates per household by household characteristics (e.g., median income) and by type of trip (trip purpose);
- Friction factors, gamma functions, or utilities for rural travel by trip purpose;
- Friction factors, gamma functions, or utilities for long-distance travel by trip purpose;
- Auto occupancy rates for rural vehicle trips by trip purpose; and
- Party size for long-distance trips by trip purpose.

In addition to the transferable parameters recommended above, and the dynamics noted earlier in this Summary, reasonableness values are documented in this research for the following:

- Percent of rural trips by purpose;
- Percent of long-distance trips by trip purpose;
- Average (mean) person trip length of rural trips by mode and purpose;
- Average person trip length of long-distance trips by mode and trip purpose; and
- Percent of long-distance and rural trips by mode (private vehicle, rail/bus, air, other) and travel distance.

Consideration of Other Trip Characteristics

Beyond demographic and mobility characteristics are considerations as to what should constitute a statewide model trip. Even this varies among different statewide models, with a few that essentially do not include intra-urban trips (e.g., Louisiana). Trips could be defined by person, household, or even vehicle in some cases. Sometimes, it might make sense to include intermediate stops as trip ends; however, this would seemingly go against the concept of long-distance trips. In fact, what travelers typically think of as a "(round) trip" is what transportation planners consider a "tour." A few statewide models (e.g., Ohio, Oregon, and New Hampshire) use the concept of tours instead of trips.

For rural travel analysis, average weekday conditions would likely be preferable. Similar to regional models, while it might be best to exclude travel on weekends and holidays, such limitations would result in sample size problems. NHTS staff indicates that approximately 25–30 percent of surveys were conducted on weekend travel; however, weekend travel includes Friday after 6:00 p.m. (teleconference with Adella Santos, FHWA; Vidya Mysore and Frank Tabatabaee, Florida DOT; and Rob Schiffer, Cambridge Systematics, Inc. on August 10, 2011), a timeframe that is similar to other weekday evening peak periods in many regions. In states with a singular, well-defined peak season, consideration could be given to surveys that constitute peak season average weekday traffic instead of annual average daily traffic (AADT), although such a timeframe of analysis would not be recommended for a study on national transferability such as this.

Conversely, since long-distance travel is not an everyday occurrence in most households, monthly or annual statistics must at least be considered in survey analyses. Also, it is essential to include weekends and holidays in any survey analysis of long-distance travel because these time periods reflect where the greatest amount of such travel takes place. Consideration was given to developing time-of-day factors both for rural and long-distance trips during this study; however, with the infrequency of long-distance trips, use of trip rates by time of day might be overkill.

In addition to temporal considerations, there are other aspects to be considered in defining a trip for the purposes of research and analysis. The first of these is consideration of person trip versus vehicle trip analysis. Since the majority of statewide models deal with person trips and starting with vehicle trips almost precludes a mode choice process, the recommendation is to conduct survey analysis by person trip rather than vehicle trip. Long-distance trip-making was considered at two to three different thresholds to determine how parameters differ at each threshold.

Another consideration was how to deal with intermediate stops and whether these should constitute a trip end or not. Clearly, long-distance trips require stops for gas, food, and/or lodging. In the context of a regional model, these intermediate stops for shopping, etc., would each represent a unique nonhome-based trip. In the context of most statewide, multi-state, or national modeling, however, these intermediate stops are not of tremendous importance in defining and simulating a trip. On the other hand, it is probably worth considering an intermediate stop at the end of the day for lodging as the end of a daily trip, assuming the analysis is daily rather than monthly or annually. The location of intermediate stops, relative to congestion on Interstate highways or crossroads, could result in greater interest about intermediate travel patterns. The number and duration of stops was also addressed in this research.

The topic of intermediate stops also leads directly to consideration of tours versus trips. The previous lodging example might be better addressed as a stop during a tour, rather than the endpoint of the trip; however, the majority of statewide models are still trip-based. Those statewide models that are tour-based were developed using statewide travel surveys and, as a result, will not likely have as much use for transferable parameters. However, the preparation of tour-based parameters is beyond the scope of this project.

Process for Using Data Sources to Develop Parameters

A key analytical step in this research was to compare trip generation statistics for households in "rural" areas, using various rural definitions to assess if there are differences in trip-making. Such analyses also needed to account for urban trip characteristics to identify differences. Analytical comparisons necessitate a typology of rural activity, such as defining rural households nearer to urban centers versus those farther away. Another unique characteristic of some rural areas, yet more difficult to quantify, is proximity to major recreational areas.

Demographic profiles are also helpful, defining household characteristics such as size, life cycle, income, and/or number of workers by worker status and occupation. An interesting topic, should such data be available, would be to include comparisons of Internet availability and use this information to impute if rural households are more or less likely to shop online, based on a lack of options to shop locally. The propensity of rural residents to link trips is another unique factor as those with long daily commutes are likely to do their shopping and other personal business prior to leaving the urban area at the end of the work day.

The research team identified opportunities to leverage some of the analysis already conducted for urban transferable parameters (*NCHRP Report 716*) and much of the thinking on new typologies, especially sociodemographic, were helpful for NCHRP Project 08-84 efforts.

The Version 2 NHTS 2009 has a number of enhancements that were helpful for analytical purposes, including estimates based on the 2008 American Community Survey (ACS) and land-use descriptors for the household and workplace locations from Claritas/Neilson. Selected characteristics of urbanized areas from the annual "Highway Statistics" publication of the FHWA Office of Highway Policy Information (OHPI) can also potentially assist in defining characteristics that separate rural from urban settings.

Long-Distance Travel Parameters and Benchmarks

One key to implementing the analytical plan and developing transferable parameters was to obtain access to all datasets from the American Travel Survey (ATS) and identify trip purposes, average trip lengths, vehicle occupancies, and other statistics typified by long-distance travelers. The 1995 ATS datasets are dated; however, these data are the only long-distance data that provide statistically sound estimates of long-distance travel in and between the states.

Although the 2001 National Household Travel Survey (NHTS) had a long-distance component, this survey did not have sufficient samples to calculate estimates of long-distance travel for most states (New York and Wisconsin were exceptions to this, because of the large add-on in the former and stratified sampling of the latter, although neither add-on was included in the official 2001 NHTS long-distance file). The approach to using NHTS 2001 data was based on discussions with FHWA NHTS support staff, both past and present, as well as members of the research team with extensive experience using different versions of the NHTS. All of these discussions pointed to concerns over the use of NHTS 2001 for long-distance trips and at least some of these concerns are documented elsewhere in this study. All of the NHTS 2001 long-distance data were made available for use by the consultant team as well, including state add-on samples.

These two long-distance datasets can be used together, yet separately, since the 2001 questionnaire relied heavily on the 1995 ATS as a template. Definitional categories for mode and purpose are comparable. The study team also obtained readily available state DOT survey data and documentation from statewide household travel surveys for Michigan and Ohio. Additionally, the study team coordinated with Canadian officials to identify available long-distance travel parameters readily available from their recent household travel surveys. Finally, recent travel surveys using Global Positioning Systems (GPS) were mined for parameters on long-distance travel as well as rural parameters.

Transferable rural travel parameters largely focused on the 2009 NHTS and its State Add-On surveys. Analysis of variance (ANOVA) and other statistical tests were run on 2009 NHTS data in an attempt to identify which available attributes best explain differences in rural trip-making and whether certain parameters should be stratified for different conditions such as urban clusters and proximity to urbanized area boundaries.

Existing statewide models also played a significant role in this analytical plan, in terms of quantifying reasonableness ranges against which to compare resulting ATS/NHTS survey-based model parameters. Also, documented model parameters were identified for potential transferability to other statewide models, based on the characteristics of the state where the data were collected versus the state to which a parameter might be proposed for transferability. Interregional, or intercity, travel components are included in some statewide models to capture both intrastate and interstate trips. The core model design feature is the recognition that interregional travel is very different from urban area travel, where different set(s) of explanatory variables are involved or different sensitivities to levels of service.

A set of typical long-distance and rural trip purposes was established from this analysis so that model parameters could be stratified by such categories and reasonableness benchmarks could be established for percent trips by purpose. Mean trip length statistics, both in miles and minutes, also were estimated from the survey databases for use as benchmarks in future statewide model validation efforts; however, the survey analysis for this study did not include the calculation of state-by-state trip lengths.

As discussed previously, statewide models and travel surveys have used a range of thresholds to define long-distance trip-making. Most sources cited in this study used either 50, 75, or 100 miles as the minimum threshold for trips to be considered "long-distance." In an effort to maximize the number of long-distance trip samples, this Guidebook looks at model parameters at three different long-distance trip thresholds: 50–100 miles, 100–300 miles, and more than 300 miles. Separating 50–100 mile trips from 100–300 mile trips allows for differentiation of long-distance trips by the two most common thresholds, beginning and ending at 100 miles. The rationale for using 300 miles as another cutoff point is that preliminary data analysis indicated a mode shift from personal auto to air travel at this distance.

Rural Travel Parameters and Benchmarks

Identification of rural travel parameters took a different focus than long-distance travel parameters. First, rural trip-making data are well represented in the recent 2009 NHTS. Therefore, the study team was able to focus primarily on this one survey database, unlike the multiple and considerably older survey databases used to identify long-distance travel parameters. Second, the points of reference are quite different for rural trips. Long-distance travel characteristics were generally summarized by different trip length categories, whereas rural travel parameters required establishing typologies for classification and comparison against comparable statistics on travel in urbanized areas. Finally, the temporal issues for rural travel are not as complex as those for long-distance trips. For example, the database does not deal with international travel or multiple stops and the greater share of travel is on the weekdays, with a much smaller share of weekend travel than with long-distance trips.

The first step in the assessment of rural travel parameters was the identification of rural typologies and an exploration of how these different typologies can be used to describe the trip-making of rural households. This also includes the need to define what is and is not rural travel, and how typical rural travel behavior differs from that in more urban settings. These efforts started with a focus on attributes contained within the NHTS 2009 "DOT version" of the database, including the Claritas attributes described earlier.

The following attributes from the 2009 NHTS DOT version were used to identify potential rural typologies:

- URBAN—Identifies whether or not the home address is located in an urban area, typically defined as a concentrated area with a population of 50,000 or greater.
- URBRUR—Identifies whether or not the home address is located in a rural area.
- URBANSIZE—Population size of the urban area in which the home address is located.
- HBHUR—Urban/Rural Indicator, appended to the NHTS by Claritas (http://nhts.ornl.gov/2009/pub/UsersGuideClaritas.pdf). This classification reflects the population density of a grid square into which the household's block falls.
- HBRESDN—The number of housing units per square mile by block group.
- HBPOPDN—The population per square mile by block group.

Additionally, the rural typologies recommended as part of NCHRP Project 25-36 also were considered in this effort. The four typologies recommended by NCHRP Project 25-36: Impacts of Land Use Strategies on Travel Behavior in Small Communities and Rural Areas (http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2987) were as follows, along with the study definitions of each, as quantified by "commuting zones" developed by the USDA's Economic Research Service:

- Population Density—Computed as number of people divided by unit area of developed or developable land.
- Road Density—Calculated as road length in miles per square mile of developed or developable land.
- Land Use Mixture—A proxy of land-use mixture measuring how residents, jobs, and other activities are distributed in relation to each other.
- Variation in Population Density—Variation in population density distinguished where most residents are located in a relatively small set of concentrated areas at relatively high densities from locations where residents are spread more evenly.

This project did not pursue full consideration of commuting zones, which are defined in NCHRP Project 25-36 as "multicounty regions that convey the typical pattern of commuting trips in a spatially defined labor market: a much higher proportion of commuting trips have origins and destinations that are both inside the zone than those trips for which one end is outside" (Department of City and Regional Planning Center for Urban and Regional Studies University of North Carolina at Chapel Hill, 2011).

In place of data on commuting zones, the analysis presented here uses readily available data to simulate some of these typologies. Population Density already was an attribute included in the 2009 NHTS dataset so it was easily addressed. Road Density was calculated using the 2005 National Highway Planning Network and geographic information systems (GIS) tools, based on a simple formula of Road Length/Census Tract Area. The resulting Road Density was a continuous variable, so a regression analysis was conducted and then the variable was recoded as a categorical variable. There was no practical way to simulate land-use mixture or the variation in population density using the data readily available for this project.

One additional typology analyzed was "urban proximity" because the NCHRP Project 08-84 research team thought that the proximity to urban areas could impact the number and purpose of trips. Latitude/longitude address information was not stored for each household in the 2009 NHTS DOT database, which is necessary for accurate depiction in GIS. The database did have Census Tract and Block Group information, and this information was appended to an NHTS Census Tract/Block Group shapefile. Once the 2009 NHTS DOT database was joined to the NHTS CT/BG shapefile by a Census Tract/Block Group ID number, the households were spatially referenced to the Block Group. In cases where a Block Group was in proximity to multiple urban areas, distance to the closest urban area was applied. Unfortunately, Proximity to Urban Area did not show any clear trip rate trend, so the remaining analysis focused on the other measures.

Comparisons and Conclusions

The subject area of this study was wide ranging and although there are a multitude of ways to analyze the topic of rural and long-distance travel, there were limitations to the resources available for this study. Study findings were largely focused on the 1995 ATS for long-distance trips and 2009 NHTS for rural trip-making parameters. This section presents a few comparisons among the different surveys and travel parameters analyzed during this study.

Originally, it was intended to look at the impacts on long-distance trip rates of proximity to areas with substantial tourist activity. Unfortunately, the ATS and NHTS databases do not include information on proximity of residence to "tourist areas." Manual geocoding of known tourist sites was considered to analyze trip rates based on proximity to tourist areas; however, there were concerns about arbitrarily coming up with a list of tourist sites and possibly excluding some regionally important tourist sites. National parks are an obvious attraction and easily mapped as are the locations of well-known nonurbanized tourist areas such as Branson, Gatlinburg, the Outer Banks, etc. However, should every amusement park in the United States be included in such an analysis? Also, the "production" of long-distance trips would not likely be influenced so much by proximity to tourist areas, as would be trip attractions. This topic might be worthy of another research effort to provide a more objective assessment of differing types and sizes of rural tourist destinations. Rural accessibility/proximity to employment was also considered; however, the NHTS 2009 database had limited data on work location. Instead, proximity to urbanized areas was tracked in its relationship to rural trip production.

Trip rates for long-distance and rural trips were provided from several different sources. Table S.1 presents overall long-distance person trip rates per household from the 1995 ATS, 2001 NHTS, and recent GPS household surveys. Annual rates from the ATS and NHTS were divided by 365 days and rounded to two decimal places to derive a daily rate for comparison against a recent GPS survey database. As indicated, all survey databases result in daily person long-distance trip rates of 0.03–0.04 per household.

Likewise, total daily person rural trip rates were reported from several sources, including 2009 NHTS, Michigan DOT, and the GPS household survey database. As depicted in Table S.2, person trip rates per rural household appear to be in a relatively similar range for different stratifications of 2009 NHTS, while different subareas and years from the Michigan and Ohio surveys tend to show lower household trip rates by comparison. Rural trip rates

Table S.1. Comparative long-distance household trip rates.

Survey Data Source	Daily Person Trips per Household[a]
1995 ATS	0.03
2001 NHTS	0.03
Recent GPS Household Surveys	0.04 (average of four surveys)

[a] Annual trip rates were divided by 365 for 1995 ATS and 2001 NHTS, rounded to hundredths.

Table S.2. Range of comparative rural household trip rates.

Data Source	Daily Person Trips per Household
2009 NHTS	9.78–10.06 (dependent on stratification)
Michigan Travel Counts Surveys	7.64–9.41 (dependent on area and year)
Ohio Statewide Household Travel Survey	7.78 (no substratifications)
GPS Surveys	8.24–13.56

from the GPS household survey database fall within a range similar to the NHTS, Michigan, and Ohio household person trip rates. The impact of the recent economic recession on 2009 NHTS trip rates is unknown at this time and beyond the scope of this research effort.

A brief summary of findings and key conclusions based on survey analyses is presented below, with long-distance trips discussed first, followed by rural trips.

- Long-distance trip rates are generally consistent when compared among several data sources and years. The percentage of long-distance trips by purpose/type appears consistent between the 1995 ATS and 2001 NHTS long-distance component:
  - Business—28.38 percent for NHTS 2001 versus 22.25 percent for ATS;
  - Pleasure—54.84 percent for NHTS 2001 versus 58.97 percent for ATS; and
  - Personal Business—16.78 percent for NHTS 2001 versus 18.78 percent for ATS.
- Long-distance trips are generally longest for business purposes (954 miles) and shortest for personal business (704 miles), with pleasure trip lengths in the middle of the others (828 miles).
- Auto occupancy rates are considerably higher for long-distance trips (3.10) than urban or rural travel (1.54), lowest for long-distance business trips (2.11), and higher for other long-distance types (3.33–3.46).
- Private automobile is the dominant transportation mode for long-distance travel (82 percent); however, trip length and purpose/type figure prominently in shifting to air travel.
- Rural trip rates vary somewhat among different data sources; household trip rates from Michigan and Ohio surveys are generally lower than those from the 2009 NHTS, as depicted earlier in Table S.2.
- Rural trip rates (9.69) appear lower than suburban area trip rates (10.34), but otherwise are not that different from urban trip rates (9.36–9.50), using statistics based on one of several stratifications found in Appendix E.
- The percentage of rural work trips (12 percent) appears to be less than that experienced in most urban settings (typically 15–20 percent).
- Rural trip travel times (19–24 minutes, nonwork versus work) are generally shorter than urbanized areas with 1 million plus population and subway or rail (20–32 minutes, nonwork versus work).
- Rural auto occupancy rates (1.54) are generally higher than small- and medium-sized urbanized areas (1.49–1.52) but equal to, or lower than, the largest metropolitan areas (1.54–1.63).

It is strongly recommended that the rates provided in this study from the 1995 ATS for long-distance travel and 2009 NHTS for rural travel be considered for use where local trip rates are not available. Other trip rates in this report, including secondary source parameters (Michigan, Ohio, Canadian surveys, GPS surveys) and NHTS 2001 statistics, are provided for comparative purposes only.

CHAPTER 1

Introduction

The purpose of this introduction is to set the context and provide background for the remaining chapters of the Guidebook. This chapter also provides a brief overview of Guidebook contents. The research team worked closely with the project panel to outline the contents and organization of the Guidebook on rural and long-distance parameter transferability. The Guidebook is largely organized around the four steps of the modeling process, long-distance and rural trip purposes, different geographies, model applications, and some combination thereof. Additional background information was provided in the Summary and will not be repeated in ensuing chapters of the Guidebook.

1.1 Background

The identification of gaps in available data on long-distance and rural travel parameters resulted from a Statewide Model Peer Exchange sponsored by the National Academy of Sciences (NAS) Transportation Research Board (TRB) and held in Longboat Key, Florida, on September 23–24, 2004. The resulting Transportation Research Circular (Cambridge Systematics, Inc., 2005) from the peer exchange identifies rural area trip-making characteristics/parameters as the number one ranked research problem statement while long-distance travel data collection ranked number four. Since that time, a final report has been published for NCHRP Project 08-36B, Task 91, Validation and Sensitivity Considerations for Statewide Models (Cambridge Systematics, Inc., 2010d). This report includes the analysis of 30 different statewide models, documenting parameters such as average trip lengths and auto occupancy rates by trip purpose, including a number of long-distance trip purposes unique to particular statewide models.

Elsewhere, on the topic of long-distance travel, a scoping project for a national model (Cambridge Systematics, Inc., 2007) was funded through NCHRP. This scoping project laid the groundwork for subsequent phases of developing a national model focused on long-distance travel. This scoping project was followed by initiation of the American Long-Distance Personal Travel (LDPT) Data and Modeling Program (Oak Ridge National Laboratories, 2010). This new program looks to update the 1995 American Travel Survey (ATS), perhaps on a more regular basis, and begin the process of developing a behaviorally based national passenger demand model with multimodal modeling capabilities. At the same time, FHWA recently started work on developing a synthetic national origin-destination (O/D) matrix.

A variety of statistics, such as the number of travelers, person-miles traveled, and total travel receipts, indicate that travel and tourism are growing and are becoming increasingly important to the U.S. economy, notwithstanding the recent economic downturn. However, because the data used have not provided a uniform, standardized measure of long-distance travel, data often lack credibility. Small samples and demographic or economic models do not provide the statistical strength to make judgments about capital investment priorities or to understand travelers' decisions based on various price points.

1.2 Research Approach and Work Plan

The audience for NCHRP Project 08-84 consists of travel demand modelers with experience in the development and application of statewide and multistate models. Some of the recommendations from this study are also relevant to regional travel demand models, particularly those covering significant rural territory and areas with substantial tourist activity. The study will also be useful to researchers who wish to know more about rural and long-distance travel patterns in the United States. Transportation planners involved in policy decision-making about rural and intercity transportation and development patterns will also appreciate much of the information contained in this Guidebook.

NCHRP Project 08-84 has focused in part on readily available data and model parameters on long-distance travel. Although the 1995 ATS represents the largest survey conducted on long-distance travel to date, the most recent national source of long-distance passenger travel behavior is the 2001 National Household Travel Survey (NHTS), which defined long-distance trips as those that are 50 miles or more from home. Rural travel parameters can be derived from the more recent 2009 NHTS.

Varying length-based definitions (100 miles, 75 miles, and 50 miles from home) are difficult for respondents to conceptualize, leading to many trips reported as "long-distance" being shorter than typically defined trip lengths for these trips. This report uses statistics at different mileage thresholds. New approaches are described to analyze longer-distance travel. Of particular interest is travel between city (or regional) pairs. Even at the statewide modeling level, data on external and rural travel is poor or nonexistent.

The research conducted under this study was dually focused on synthesizing information from various models and an original contribution to transferable parameters. In addition to a synthesis of available models and documents, this Guidebook describes analysis of data from available surveys such as the NHTS and ATS, as well as surveys previously completed by team members and state DOTs, in order to develop original source material on transferable parameters.

1.3 Guidebook Organization

Chapter 2 of this Guidebook is focused on providing recommendations on the best stratifications for long-distance and rural trip-making based on statistical analyses for this project as well as coordination with other research efforts such as NCHRP Project 25-36 (Department of City and Regional Planning Center for Urban and Regional Studies University of North Carolina at Chapel Hill, 2011); national household-based surveys of long-distance travel, such as the ATS and NHTS; and statewide and regional travel surveys that address long-distance and rural travel markets. The latter includes statewide DOT surveys and NHTS Add-On surveys sponsored by state DOTs.

Chapter 3 of this report provides guidance on when to, versus when not to, transfer parameters, depending on available data sources and other considerations, expanding on discussions on this topic found in the Summary.

Chapters 4 through 6 focus on transferable model parameters and benchmarks for each step in the traditional four-step modeling process. Chapter 4 focuses on trip generation, Chapter 5 on trip distributions, and Chapter 6 on auto occupancy and mode choice. The report concludes with Chapter 7, which provides a summary of comparisons and conclusions.

As part of a project funded by FHWA, Oak Ridge National Laboratory (ORNL) (Oak Ridge National Laboratory, 2010), with support from University of Maryland (UMD) researchers, completed a comprehensive review of existing multimodal large-scale travel demand models to identify data sources and modeling options for long-distance travel and rural travel, including other national and multinational models. The age, objective, methodology, and data sources of selected long-distance and rural travel models from that review have been summarized in tabular form for reference in Appendix A of this report.

Appendix B is a discussion of household surveys from Canada and other countries that include information on rural and long-distance travel. This is followed by a discussion of modal-based information on long-distance travel, including passenger air, intercity bus, and intercity rail as provided in Appendix C. Appendix D is a synopsis of other demographic and O/D survey data, including new technologies used to identify travel patterns without direct interview of travelers. Appendix E focuses on a discussion of freight and nonfreight trucks because commercial traffic must be combined with passenger trips in order to get the full picture on rural and long-distance travel for statewide models. Appendix F provides background information on some of the statewide models reviewed for this Guidebook.

Appendixes G through I are not contained in this report but are available by searching for the report title on the TRB website. Appendix G presents a series of rural typology variables considered in stratifying model parameters and benchmarks and identifies the statistical significance of each. Appendix H contains rural trip production rates for several different cross-classification schemes and the trip rates associated with each. Finally, Appendix I provides additional information on auto occupancy rates.

CHAPTER 2

Long-Distance and Rural Area Data Sources

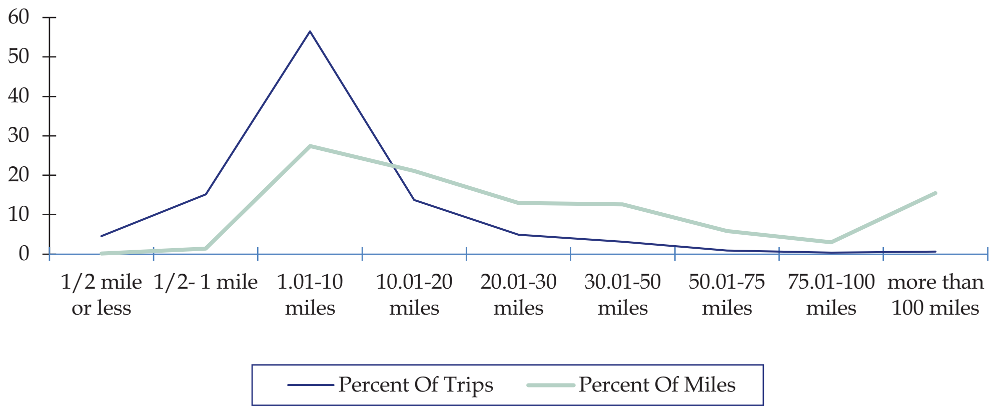
In the context of statewide forecasting, rural trip-making and long-distance intercity travel constitute important market segments. Information describing these markets and how they vary from state to state has historically been sparse, and many states do not have the resources to initiate original data collection to develop a set of model parameters. Yet these same states have a pressing need for confidence in reasonable transportation planning results for rural and long-distance travel. Furthermore, for the states where local data are available, there is little basis to assess how comparable their assumptions are with those from other states.

This chapter will address this topic by first identifying differences in rural and urban travel in various states from existing surveys. A high-level analysis of 1995 ATS, 2001 NHTS, 2009 NHTS, and select statewide, super-regional, and tourist survey data is provided in this chapter to highlight how differences in rural and long-distance trip-making occur in different geographic regions and to identify any explanatory variables that could be used to adjust average values and reflect conditions in a particular state. The most recent NHTS contains over 20 separate add-on partners, some representing full states and some MPO planning areas (which may include rural areas within the MPO boundary).

In conducting analysis, it is important that rural and long-distance data on transferable parameters be compared against urban short-distance data and typical model parameters. For example, according to the 2009 NHTS, short trips account for the vast majority of personal trips in the United States—three-quarters of vehicle trips are less than 10 miles in length. However, these trips account for less than one-third (28.9 percent) of all vehicle miles traveled (VMT). Trips of more than 100 miles account for less than 1 percent of all vehicle trips but 15.5 percent of all household-based vehicle miles, as illustrated in Figure 2.1. With the potential impact on VMT, travel demand forecasts depend on knowing more about the current amount and nature of long-distance and rural travel in the United States.

This chapter first assesses national data sources on personal long-distance and rural travel, with a focus on the 1995 ATS, 2001 NHTS, and 2009 NHTS. Long-distance travel includes air, intercity bus and rail, and personal vehicle as the primary modes. There is an acknowledged lack of sufficient data on long-distance trips, and too little understanding of how travelers make decisions regarding mode, what kinds of reasons people travel long-distance, and other basic characteristics of intercity, interstate, and long-distance travel. Information about surface modes (private vehicle and transit) are particularly important, since for distances less than 500 miles, surface transportation modes move the majority of people.

Next, this chapter describes available statewide and regional household travel surveys that include a significant sample of rural and/or long-distance trips. This includes a discussion of the Ohio Statewide and Long-Distance Travel Surveys, conducted in 2002–2003, which contacted 16,529 households, of which 2,049 made long-distance trips. This is followed by discussion of



Source: Author's analysis of NHTS 2009.

Figure 2.1. Vehicle trips and VMT by trip length.

the Michigan Travel Counts Study, conducted in 2004 and 2009, with both Michigan efforts including a retrospective component focused on trips of 100 miles or greater and sampling areas for rural travel. Following these main studies, the chapter includes details about other possible sources of rural or long-distance travel data, from recent and ongoing statewide and global positioning system (GPS) surveys to other superregional travel surveys and tourism surveys.

2.1 National Travel Surveys

This section provides an overview of the 1995 ATS, 2001 NHTS, and 2009 NHTS. Although the NHTS Add-On components are largely equivalent to statewide surveys discussed in the next section, these are still part of the national survey and use the same survey instrument and sampling plans.

American Travel Survey (ATS)

Overview: The ATS was a national survey of long-distance trips defined as 100 miles or more, one-way. Although over 15 years old, the 1995 ATS remains the primary source of information at the national, state, and metropolitan-area level about the amount and characteristics of long-distance travel flows between states and large metro areas.

Sample Detail: Sample selection for the ATS was based on households that had participated in the Current Population Survey (CPS) (http://www.bls.gov/cps/). The sample was based on Primary Sampling Units (PSU) (Lapham, undated), as defined below, and a selection of addresses within each PSU. The sample was distributed rather evenly across the states (a choice that generated some discussion) to ensure representation from each state. The sample for each state was designed to include two or more PSUs. All the PSUs were in urbanized areas, so no rural households are represented in the dataset. The person trip file contains 116,176 individuals who reported 556,026 long-distance trips during the survey year. "A trip is defined as each time a person goes to a place at least 100 miles away from home and returns."

PSUs are small geographic areas carefully selected to represent larger geographic areas. The PSUs were grouped into two strata; self-representing areas and nonself-representing areas. Self-representing areas generally consist of a single PSU used to represent an entire metropolitan area. The remaining areas, called nonself-representing, were formed by combining PSUs that possess similar characteristics, such as geographic region, population density, population growth rate, and proportion of nonwhite population, as stated in the ATS overview document. A sample of nonself-representing PSUs was selected to represent all of the PSUs in the stratum. A total of 729 PSUs were sampled—314 self-representing and 415 nonself-representing.

Survey Conduct: The households sampled in each of the PSUs were contacted four times, once each quarter, to report long-distance travel by the household members. If for some reason the household was not contacted during a quarter, when contact was next made information about the missing quarter was obtained. People who moved out or into the sample household were retained through recall and imputation. Since the sample was based on addresses, if new people moved into the household, the household remained part of the sample, and retrospective data about long-distance travel was collected from the new household members and used in imputation and weighting.

The study approach included use of a survey package mailed out to the household with a post card reminder. The retired CPS households that had telephone numbers on record were interviewed via computer-assisted telephone interview (CATI) while the rest were interviewed using computer-assisted personal interview (CAPI) and in-person visits (approximately 55 percent CATI and 45 percent CAPI).

Limitations of the ATS: The biggest concern with using the ATS is obviously the age of the data, now more than 15 years old. In the intervening decade and a half, major changes have occurred in economics and demographics, communication technology, and security precautions at airports, just to name a few.

In addition, the limitations of the survey to trips 100 miles or more one-way might impact assessing the full continuum of travel through the travel demand forecasting process. In the NHTS data series, 30 percent of long-distance trips were in a midrange distance, between 50 and 100 miles one-way, and these trips are underreported in the daily estimates of travel. Trips of this distance are important to many corridor analyses, but would be missing from the ATS. The lack of rural households (HHs) could be another limitation, especially if it is found elsewhere that rural HHs make more long-distance trips.

Uses of the ATS: The ATS was designed to be useful for multistate and corridor planning and research. The large sample size and representation from each of the states means that these data can be used to estimate state-to-state flows and even some flows between large metropolitan areas if the resulting margin of error (up to 20 percent) can be tolerated, a unique characteristic of the ATS. (Note that the margin of error can be calculated at the state-level based on existing reports, but data for recalculating new margins of error are not available.)

The long-range trips captured in the ATS have a significant non-auto mode share, another unique characteristic, and separate detail about recurring trips such as long commutes and weekend trips to second homes. In addition, intermodal connections are captured, allowing analysis of access modes to airports, intercity rail, and intercity bus stations.

In 1995, FHWA also conducted one of the national household surveys (then called National Personal Travel Survey), which also had a long-distance component (measuring trips of 75 miles or more taken within a 2-week period). After the release of the 1995 ATS and the 1995 NPTS, there was quite a bit of research to see if the surveys could be combined.

A number of similarities and dissimilarities were noted between the two data sources. For instance, the ATS was conducted using a panel, where the same household's reports for each quarter were used. On the other hand, the 1995 NPTS asked randomly selected households to report long-distance trips for just the 2 weeks prior to the assigned travel day. The short recall period, it was found, is more likely to miss infrequent travelers and perhaps overcount frequent travelers. ATS calculated trip distance based on trip origin (zip code centroid), trip destination, and mode used using a national network of highways and air routes. In 1995, the long-distance component of the NPTS calculated distance on the great circle distance of MSA centroid to MSA centroid, a less precise measure than one that uses network distance.

With these and other relevant differences in mind, the two surveys were combined into a single sample in the 2001 NHTS.

2001 National Household Travel Survey

Overview: The 2001 NHTS combined elements of the 1995 ATS and the 1995 NPTS into a single survey. The survey was designed to obtain trips to destinations 50 miles or more from home within the 4 weeks previous to the assigned travel day. The long-distance component was included in the national sample of 26,000 households, which included 60,000 people. In addition, the Add-On states of New York, Texas, and Wisconsin purchased a long-distance component along with the daily Add-On.

Sample Detail: The NHTS sample was a list-assisted random digit dialing (RDD) telephone sample, which means it consisted of randomly selected telephone numbers matched against known lists of commercial and nonworking numbers to maximize the "hit" rate of a working residential number. Numbers were only selected from working 100 blocks where at least two other numbers in the 100 block were assigned. This sample frame was updated quarterly to include newly assigned numbers on a regular basis.

The drawbacks of a telephone sample include the lower response rates (40 percent in NHTS 2001 compared to over 80 percent in 1995 ATS) and the lack of representation of very low-income households that might not have telephones. On the plus side, the geographic representation of the sample is much more widely spread, including households in all areas of the country weighted to Census division.

Survey Conduct: The NHTS sampled telephone numbers were preassigned a day of the week as a travel day, with the travel period being the 4 weeks previous to the travel day, so the travel period covers all days of the year. The selected household was sent a precontact letter with an incentive and then called and recruited into the survey. A packet of information was sent to the household with a second incentive. In this packet was a memory jogger for trip reporting (travel diary) and a map with the household location geocoded (from the address) with a 50-mile circle drawn around it and a reminder to respondents to keep track of any trips to places outside the circle. The data were collected via CATI.

Limitations of the 2001 NHTS: The goal of the long-distance component of the 2001 NHTS was to provide national-level statistics on basic parameters of long-distance travel, such as frequency of trips by mode and purpose. Analysis of the recall period of 28 days prior to the travel day shows lower-than-expected trip reporting for air and other trips not in private vehicles, when compared to the ATS. For example, the 1995 ATS had 18.02 percent of trips reported by air, while the NHTS had only 9.23 percent mode share for air (of trips 100 miles or more).

In addition, because of the short recall period, the unweighted sample size for 2001 NHTS long-distance is much smaller than the 1995 ATS—the 4-week travel period collected 45,165 long-distance trips compared to 550,000 in one year of ATS. Although these 4-week-period trips were expanded to represent 1 year of travel, the small sample limits the power of the data at anything less than a national overview.

Uses of the 2001 NHTS: The 2001 NHTS long-distance data has a couple of unique components that might be of interest. First, the data can be used to estimate the amount and type of midrange trips (less than 100 miles in length), a travel component that can be important to corridor planning.

Within this mileage range, where air's mode share is negligible, information on the amount and type of travel is useful. Second, the 2001 NHTS, because of the lowered mileage threshold, included information about recurring trips, such as long commutes, weekend trips to second homes, and medical trips. This is a unique source of data on the type and frequency of recurring long-distance trips.

Comparison of Select 1995 ATS and 2001 NHTS Travel Statistics

One of the key strategies to assess the data sources is to benchmark the estimated travel parameters against each other. Table 2.1 shows some of the trip-based estimates of travel, such as mode, purpose, and trip length, from the 1995 ATS and the 2001 NHTS. In an effort to maximize consistency of results, a mileage threshold of 100 miles was used for analyzing both surveys, even though the NHTS generally used a threshold of 50 miles or more to define long-distance

Table 2.1. Preliminary comparative statistics from ATS and NHTS.

Parameter Summary	1995 ATS More Than 100 Miles	2001 NHTS More Than 100 Miles[a]
Percent of Trips by Mode		
Private Vehicle	78.51	87.13
Air	18.02	9.23
Other	3.47	3.64
Percent of Trips by Purpose		
Business and Bus/Pleasure	22.42	25.69
Visit Friends/Relatives	32.58	26.31
Leisure	30.53	26.21
Personal/Family or Medical	11.93	9.56
Other	2.54	12.22
Overall Mean Trip Length in Miles (One-Way All Modes)[b]	411.88	457.57
Mean Trip Length – Air	1,003.21	2,088.78[c]
Mean Trip Length – Private Vehicle	276.53	301.54
Mean Trip Length – All Other	404.02	482.02
Mean Trip Length by Purpose in Miles (One-Way All Modes)		
Business and Bus/Pleasure	467.89	480.93
Visit Friends/Relatives	398.77	478.60
Leisure	406.70	516.44
Personal/Family or Medical	376.05	409.80
Other	316.03	276.28
Overall Travel Party Size (All Modes)	3.10	N/A
Travel Party Size – Air	2.98	N/A
Travel Party Size – Private Vehicle	2.42	N/A
Travel Party Size – All Other	9.34	N/A
Travel Party Size by Purpose		
Business and Bus/Pleasure	2.12	N/A
Visit Friends/Relatives	2.81	N/A
Leisure	3.93	N/A
Personal/Family or Medical	2.91	N/A
Other	6.34	N/A

[a] NHTS 2001 includes trips of 50 miles and more. For this analysis only trips of 100 miles and longer one-way were included.
[b] 1995 ATS "Round-Trip Distance" was divided in half to provide one-way estimates.
[c] NHTS Trip Distance includes extreme values. Trip length was capped at the 99th percentile (5,252.18 miles).

trips. Analysis of these parameters from the 1995 ATS and 2001 NHTS datasets results in similar estimates at the national level. Primary differences appear in the mode split, where the proportion of air travel is very different, and the mean trip length for air, potentially impacted by 9/11. Travel party size was included in this table, although this statistic could only be calculated for the ATS. For the auto mode, this measurement would essentially represent an auto occupancy rate. Further analysis—at a smaller geography, for household-based estimates, or to estimate travel for different demographic groups—may reveal greater dissimilarities between the ATS and NHTS.

The two surveys were also investigated for estimating trip generation rates. A key issue to consider in this regard is the timeframe for consideration. Since few households make over 100-mile trips on a daily basis, it was decided to look at such trips on an *annual* basis instead. Using this timeframe, the ATS indicates aggregate trip rates of 7.00 trips per household and 4.79 trips per person (18 years of age and older). More complete listings of potentially transferable parameters are provided in subsequent chapters of this report.

2009 National Household Travel Survey

One of the important characteristics for rural travel parameters is transferability across geographies. The 2009 NHTS is an interesting source of data for rural travel parameters because it includes rural samples from all over the nation. (The NHTS uses the Census definition of "rural," that is any census block or block group outside of an urbanized area or urban cluster; on the 2009 NHTS the Census 2000 delineation is coded.) This makes it possible to compare household-based travel parameters between urban and rural households, which could start to inform the understanding about geographic differences in travel for the same demographic categories of households or persons.

Urban household travel behavior can differ between different areas of the country (e.g., between households in the Northeast and households in the West). One can expect that rural household travel might likewise not be homogeneous, but would vary across locations as well as between socioeconomic classes.

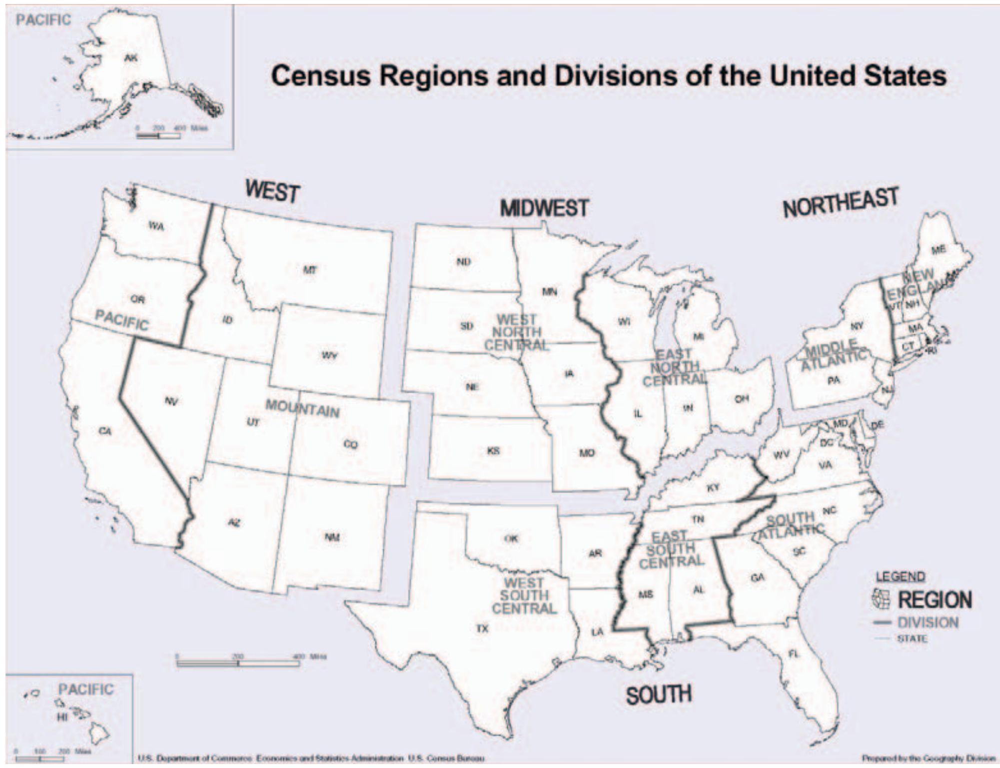
Table 2.2 shows the sample distribution of all rural households in the 2009 NHTS. A total of 43,583 households in rural areas completed the survey. Figure 2.2 shows a map of the Census divisions and their constituent states.

The distribution is uneven across Census divisions because of the participation of the Add-Ons. The South Atlantic division has so many samples because nearly every state in the division included an Add-On (Florida, Georgia, South Carolina, North Carolina, and Virginia) and all had large samples that included rural areas. The other Census divisions are represented by only

Table 2.2. NHTS 2009 sample of rural households.

Item	Rural Samples[a]
All Rural (National)	43,583
New England	1,560
Mid-Atlantic	5,721
East North Central	2,355
West North Central	2,684
South Atlantic	19,293
East South Central	1,570
West South Central	6,228
Mountain	1,727
Pacific	2,445

a Includes Add-On samples.



Source: http://www.census.gov/geo/www/us_regdiv.pdf

Figure 2.2. Census regions and divisions.

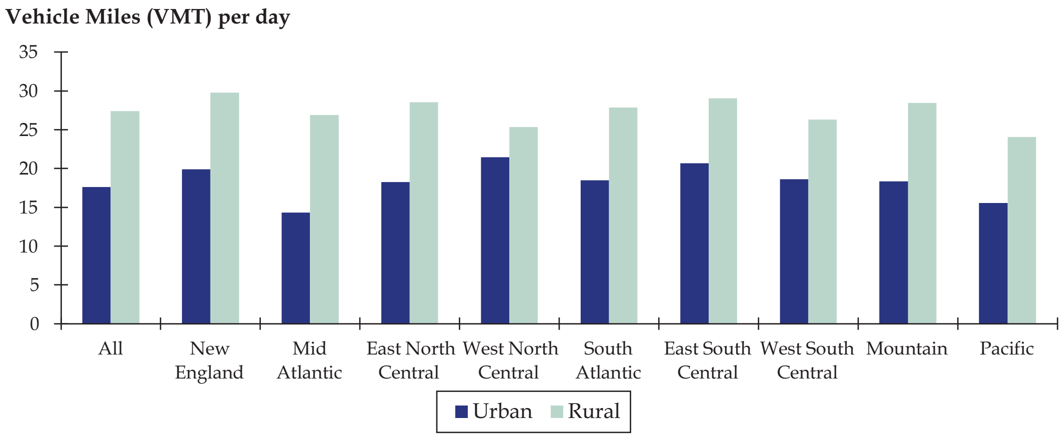
one or two Add-Ons, such as West North Central, which includes the Add-Ons in South Dakota and Iowa, or East North Central, which includes the Add-Ons in Wisconsin and Indiana. Other divisions, such as Pacific, have only one Add-On, in this case the large sample in California.

Table 2.3 and Figure 2.3 compare a few important travel estimates from the national sample for urban and rural households and the same estimates for each Census division. For the purposes of this analysis, rural trips were those that begin and/or end in rural areas.

Table 2.3. Travel parameters for urban and rural households by Census division, 2009 NHTS.

	Person Trips per Person		Average Vehicle Trip Length (Miles)		VMT per Household		VMT per Person	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
All	3.8	3.6	8.0	12.0	43.5	72.1	17.6	27.4
New England	3.8	3.9	9.0	11.7	47.7	79.5	19.9	29.8
Mid-Atlantic	3.8	3.7	7.7	11.6	35.6	70.9	14.3	26.9
East North Central	4.0	3.6	7.7	11.8	43.2	75.9	18.3	28.6
West North Central	4.1	3.6	8.2	10.6	48.3	63.2	21.5	25.3
South Atlantic	3.7	3.6	8.3	12.6	44.4	72.0	18.5	27.8
East South Central	3.8	3.4	8.7	13.3	46.7	75.0	20.7	29.1
West South Central	3.8	3.7	8.2	12.3	47.0	72.6	18.6	26.3
Mountain	4.0	3.8	7.6	12.0	46.0	76.6	18.3	28.5
Pacific	3.8	3.7	7.4	10.6	42.1	64.6	15.6	24.1

Source: Author's analysis of 2009 NHTS, includes travel on weekends and holidays.



Source: Author's analysis of 2009 NHTS, includes travel on weekends and holidays.

Figure 2.3. VMT per person for urban and rural households by Census division.

As Table 2.3 shows, the number of person trips per person does not vary much between urban and rural households. Overall, people in urban households make on average 3.8 trips per day, compared to people in rural households who make 3.6. These per capita estimates include people who reported travel and people who did not, by all modes and for all purposes, and across all days, including weekends and holidays. In developing final travel parameters for rural travel demand estimation and forecasting, weekday-only estimates will be preferable.

However, estimates of vehicle travel, such as vehicle trip length and VMT per household, vary quite a bit more between urban and rural areas. The average vehicle trip length for urban households is 8 miles compared to 12 for rural households (50 percent farther). As a result, overall vehicle miles of travel per capita in urban areas is 17.6 miles on average compared to 27.4 for people in rural areas (including people ages 5 and older).

There are differences in these major estimates between regions of the country for both urban and rural households. For instance, VMT per person is lowest for households in the Pacific division rural areas (24.1 miles per day), and almost 25 percent higher per household for rural areas in New England (29.8 miles per day). This analysis is preliminary, and the apparent differences in travel demand across geography may disappear when normalized for household size, number of vehicles, and other traditional cross-classifications, or they may not.

Although each state Add-On had a separate sampling scheme, they all included rural households, either as a distinct sample strata (such as in Florida) or as part of a population-proportionate sample (such as Texas and California). Figure 2.4 shows a map of the state Add-Ons to the 2009 NHTS. Table 2.4 shows the number of rural households sampled and weighted for each of the state Add-Ons. Remember that the sum of all rural households in the 2009 NHTS is 43,583 of which 39,739 are from Add-On states and the remainder are part of the national sample in non-Add-On states.

Table 2.5 shows the same comparative travel characteristics (VMT per household, VMT per person, average vehicle trip length and person trips per person) for urban and rural households in the 15 Add-On states. As with the national and Census division comparisons, large differences were not observed across estimates of the person trips per household between rural and urban or between state Add-Ons—in fact, they all round to four, except for rural areas in Wisconsin. But vehicle travel estimates are very different. For example, the average vehicle trip length in rural areas in Georgia is 14 miles, the highest of all rural estimates of vehicle trip length, compared to its neighbors of Florida and South Carolina, with averages of 11.7 and 11.8, respectively. Note that all three of these states are in the same Census division of South Atlantic.

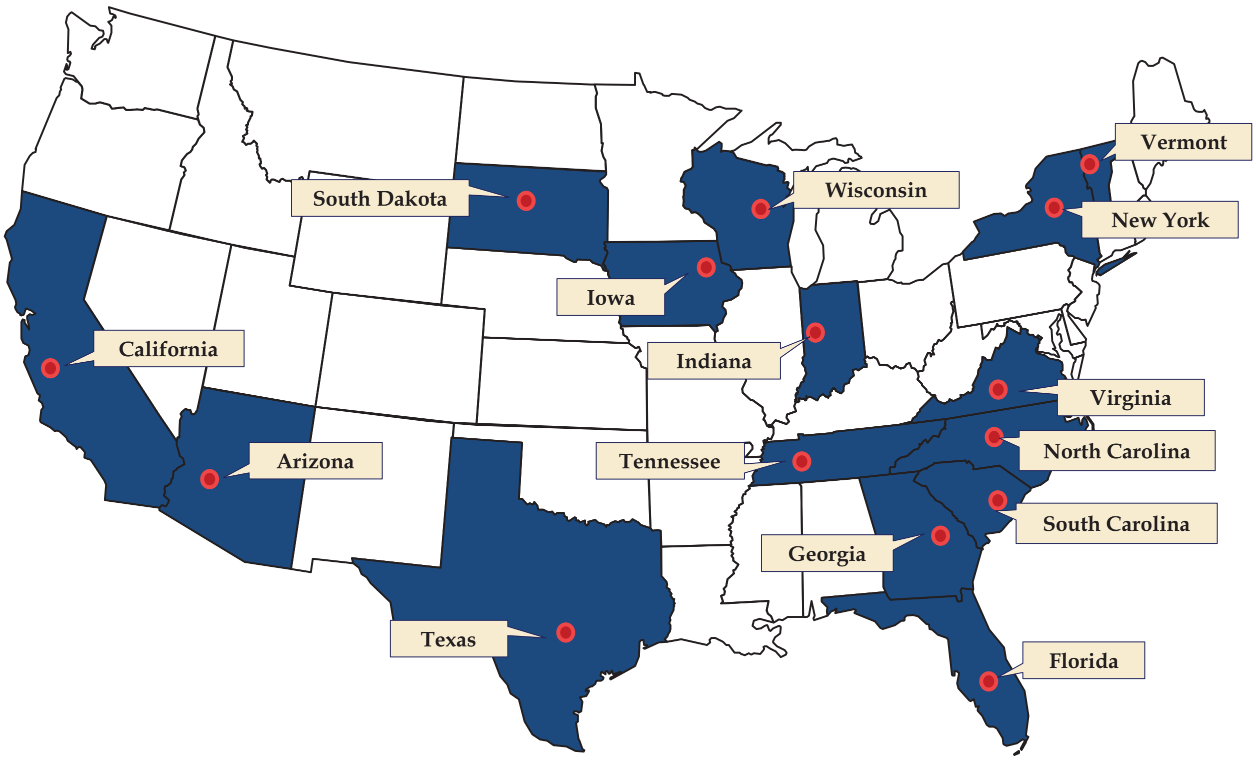


Figure 2.4. 2009 NHTS state Add-Ons.

Table 2.4. Sampled and weighted number of rural households in the 2009 NHTS Add-On states.

State	Sample Size (Rural Households)	Weighted Households	Weighted Persons
Arizona	1,163	422,238	1,248,929
California	2,148	958,264	2,718,128
Florida	3,251	1,057,714	2,771,537
Georgia	3,569	1,136,647	3,016,386
Iowa	1,359	509,618	1,276,488
Indiana	1,133	674,247	1,796,446
North Carolina	4,664	1,478,175	3,742,939
New York	5,452	1,100,822	2,911,999
South Carolina	1,974	671,261	1,731,758
South Dakota	654	162,405	387,506
Tennessee	1,114	897,829	2,378,480
Texas	5,902	1,610,731	4,572,820
Virginia	5,551	838,240	2,147,874
Vermont	1,137	153,587	382,281
Wisconsin	668	753,627	1,884,870
Sum of All Add-Ons	**39,739**	**12,425,406**	**32,968,440**

Table 2.5. Travel parameters for urban and rural households by Add-On state, 2009 NHTS.

	Person Trips per Person		Average Vehicle Trip Length (Miles)		VMT per Household		VMT per Person	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Arizona	3.9	3.8	8.5	11.0	49.2	78.4	19.2	26.5
California	3.8	3.5	7.6	11.7	44.0	71.0	15.7	25.0
Florida	3.6	3.7	7.7	11.7	41.0	68.6	17.1	26.2
Georgia	3.7	3.5	8.8	14.0	48.8	83.0	19.2	31.3
Iowa	4.1	3.7	6.5	9.7	34.8	57.2	16.1	22.9
Indiana	3.7	3.6	7.2	11.1	38.2	70.8	16.7	26.6
North Carolina	3.8	3.6	8.6	11.3	45.6	63.9	20.0	25.2
New York	3.7	3.5	6.3	10.5	24.0	60.3	9.4	22.8
South Carolina	3.9	3.6	8.2	11.8	47.1	69.3	19.8	26.9
South Dakota	4.1	3.8	7.1	10.8	43.6	58.2	19.2	24.4
Tennessee	3.7	3.5	9.1	11.7	49.2	70.3	22.1	26.5
Texas	3.8	3.5	8.5	12.1	48.9	74.1	18.8	26.1
Virginia	3.8	3.5	8.0	12.4	43.5	72.5	18.1	28.3
Vermont	3.9	3.6	7.3	10.4	38.2	59.3	17.8	23.8
Wisconsin	4.0	3.3	7.8	11.9	42.7	62.5	18.9	25.0
Average	3.83	3.58	7.81	11.47	42.59	67.96	17.87	25.83

Source: Author's analysis of NHTS 2009, includes travel on weekends and holidays.

Analysis of the Florida 2009 NHTS Add-On surveys, conducted for the Florida DOT (Florida Department of Transportation and Cambridge Systematics, Inc., 2010), indicated a significant difference in average trip length when comparing mean values for urban and rural households. Preliminary analysis of the 2009 Florida Add-On found the average trip length for home-based work (HBW) trips to be 25.7 minutes in urban settings and 29.6 minutes for rural households. Average trip lengths provided elsewhere in this report from the 2009 NHTS national sample were only provided in miles traveled for all trip purposes.

2.2 Statewide Household Travel Surveys

The Ohio and Michigan Departments of Transportation (DOTs) have made significant investments in the documentation of demographic and travel behavior characteristics of those residing in the state. This has included statewide household travel surveys with a sizeable sample of rural residents. The Ohio and Michigan DOTs also conducted long-distance household travel surveys, with some overlap in households that completed both surveys. Recent and ongoing statewide household surveys for California, Oregon, and Utah are described in a later section of this chapter due to their recent nature.

Ohio Statewide Household Travel Survey

The Ohio Statewide Household Travel Survey was conducted from 2001 to 2003. Sponsored by the Ohio DOT, the purpose of this survey was to document statewide and regional travel patterns in order to update travel demand models. (Unless otherwise noted, the details in this section are from NuStats, *Technical Memorandum: 2002–2003 Ohio Statewide Household Travel Survey*, prepared for the Ohio Department of Transportation, August 2004.) A total of

16,112 households were surveyed, of which 2,530 households are located in rural Ohio, defined as outside an MPO area. The survey was conducted using state-of-the-practice methods, including recruiting households to participate, mailing travel diaries to them, and retrieving the travel details by phone or mail.

All members of participating households reported travel for either a 24- or 48-hour period. Travel days covered all seven days of the week, and travel days were assigned throughout the fall and spring periods, except for weekdays immediately preceding or following a holiday. The survey documented the following data elements:

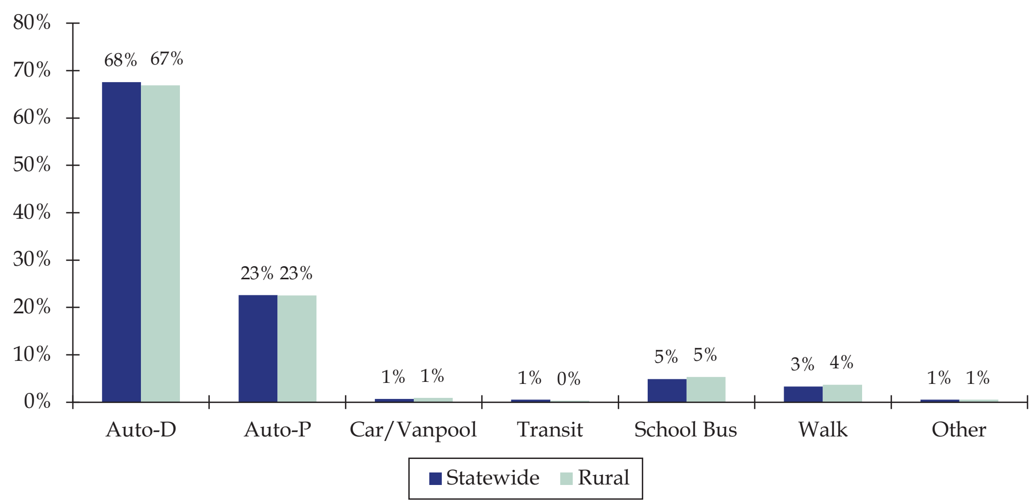
- **Household Demographics—**Household size, household vehicles, dwelling type, home ownership, home location, and income;
- **Person Demographics—**Age, gender, relationship, licensed driver status, employment status, work location and other work-related details, student status, and school type and location;
- **Travel Behavior Characteristics—**Activity, travel mode, origin and destination of travel (geocoded to *x-y* coordinates), trip purpose, travel party size and composition, and arrival and departure times.

The following is a summary of relevant weighted travel statistics obtained overall and for the rural households, as documented in the final report for the survey:

- The overall average daily trip rates were 7.90 trips per household and 4.94 trips per person. For the rural households, these statistics were 7.78 trips per household and 4.79 trips per person.
- At the statewide level, trips averaged 18.4 minutes in length. Work trips averaged 20.9 minutes and shopping trips averaged 15.0 minutes. In rural areas, trips averaged 18.8 minutes summed for all purposes. Work trips averaged 21.0 minutes and those for shopping averaged 16.2 minutes for rural areas.
- Ninety percent of all trips statewide were made by auto (driver or passenger). For the rural households, auto accounted for 89 percent of all trips. Figure 2.5 depicts the distribution of travel by modes statewide and in rural areas.

Ohio Statewide Long-Distance Travel Survey

In 2002, the Ohio DOT embarked on designing and conducting a long-distance travel survey as a supplement to its statewide household travel survey. (Unless otherwise noted, the details in



Source: NuStats Technical Memo, *Ohio Statewide Household Survey*, Table 7.7.

Figure 2.5. Travel modes from Ohio Statewide Household Survey.

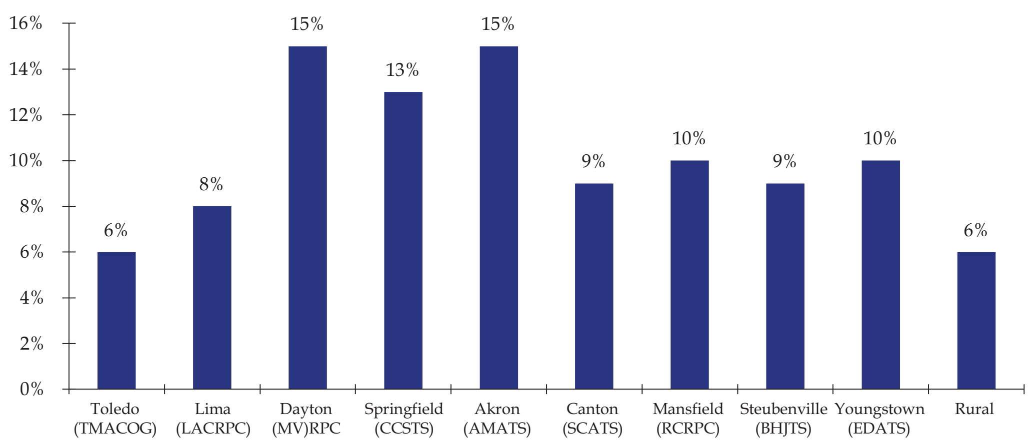
this section are from NuStats, *Technical Memorandum: 2002–2003 Ohio Long-Distance Travel Survey*, prepared for the Ohio Department of Transportation, March 2005.) Over the 2-year study period, long-distance travel data were obtained from more than 8,000 households across the state, of which 6,113 were summarized in the report. For this study, a long-distance trip was defined as a nonwork trip of 40 miles or longer. (In Appendix E of the NuStats report, the CATI survey question LDQ1 asks about travel 50 miles or more away from home.) The long-distance survey asked respondents to list any trips over 40 miles, even though over 50 miles is the long-distance threshold defined in the model. The lower 40-mile threshold was used in the survey realizing that respondents might leave out valid *over* 50 trips with a 50-mile survey cut-off. Reported trips between 40 and 50 miles were later excluded during model development.

There were three approaches used in collecting the data: a 2-week retrospective survey administered to households that were participating in the statewide household travel survey; a 2-week retrospective survey administered to randomly sampled households not participating in the statewide household travel survey; and a 4-week prospective survey of nonhousehold travel survey households that were prescreened and identified as having a probability of making a long-distance trip. Long-distance travel was documented for all household members, regardless of age for the specified time period. Trips were recorded regardless of the day of week (i.e., weekday or weekend). However, trips were not recorded during the summer or during a week where a holiday was observed.

The survey documented the following data elements:

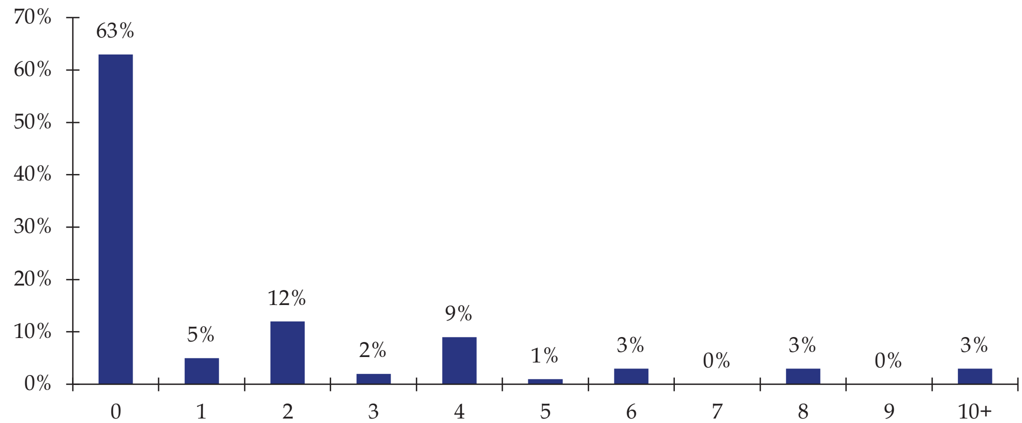
- **Household Demographics—**Household size, household vehicles, dwelling type, home ownership, home location, and income;
- **Person Demographics—**Age, relationship, employment status, work location, worker occupation and industry, student status, and school type and location; and
- **Travel Behavior Characteristics—**Number of noncommute long-distance trips, destination of travel, trip purpose, mode of travel, travel party size, and intermediate stops.

The resulting Technical Memorandum summarized key statistics obtained from this survey for households completing the 2-week retrospective surveys (both those linked to the statewide household travel survey as well as those that were not). (The Ohio DOT has provided access to the full dataset for use in this analysis.) The overall trip rate was 6.44 for nonwork long-distance household trips per 2-week nonholiday and nonsummer period. More than one-third (37 percent) of the 2.5 million Ohio households reported some level of long-distance trips. As shown in Figure 2.6, households from Akron, Dayton, and Springfield were more likely to



Source: NuStats Technical Memo, *Ohio Statewide Long-Distance Travel Survey*, Table F.2.

Figure 2.6. Geographic distribution of households reporting long-distance travel from Ohio Long-Distance Travel Survey over 2 weeks.



Source: NuStats Technical Memo, *Ohio Statewide Long-Distance Travel Survey*, Table F.28.

Figure 2.7. Number of long-distance travel trips reported per household from Ohio Long-Distance Travel Survey over 2 weeks.

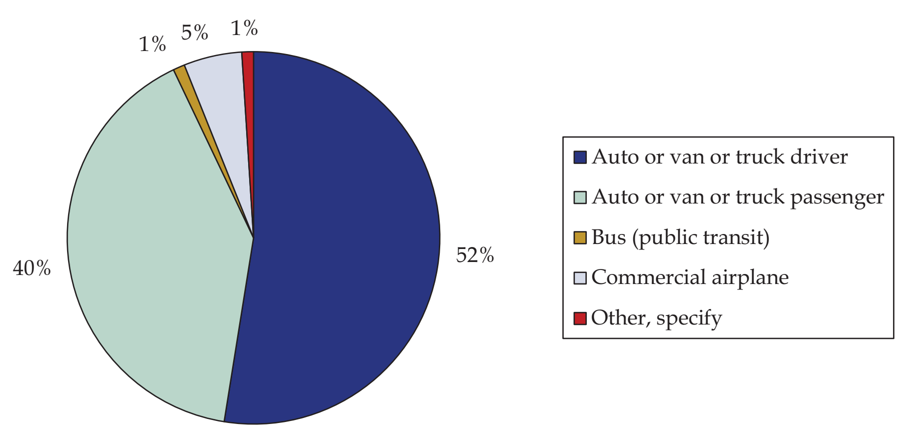
report long-distance travel as compared to those from other parts of the state. This is due to their proximity to a larger urbanized area.

The majority of households (63 percent) reported no long-distance trip-making during the 2-week reference period, as indicated in Figure 2.7. The vast majority of long-distance trips (92 percent) were made by auto, either driver or passenger. As depicted in Figure 2.8, travel by air was a distant second at 5 percent of long-distance trips reported.

An important feature of the Ohio survey is that the prescreened prospective sample was only used as a way to establish detailed characteristics of long-distance trips for micro-simulation while the random retrospective sampling established tour rates. This survey design allowed for obtaining adequate samples for micro-simulation even though the prospective sample is obviously biased to households likely to make such trips.

Michigan Statewide Household Travel Surveys

In 2004, Michigan DOT undertook an extensive survey of 14,280 Michigan households (http://www.michigan.gov/documents/MDOT_TravCharTR_Final20060804_167340_7.pdf).



Source: NuStats Technical Memo, *Ohio Statewide Long-Distance Travel Survey*, Table 7.29.

Figure 2.8. Long-distance trip travel modes from Ohio Long-Distance Travel Survey.

The survey documented basic demographics and 48 hours of weekday travel information for all household members regardless of age. For sampling purposes, the state was divided into seven geographic areas, including three rural areas: southern lower peninsula rural (2,059 households), northern lower peninsula rural (2,073 households), and upper peninsula rural (2,027 households). A second round of household surveys was conducted in 2009.

The survey documented the following data elements (http://www.michigan.gov/documents/MDOT_travelcounts_results_Appendices_20_to_24_142289_7.pdf.):

- **Household Demographics—**Household size, household vehicles, household workers, home location, and income;
- **Person Demographics—**Gender, age, relationship, driver's license status, transit pass status (and if one is held, what type and cost), educational attainment, student status, school type and location, employment status, industry, and work location; and
- **Travel Behavior Characteristics—**Origin and destination of travel, activities at origin and destination, travel mode(s), travel party (if travel by auto), and parking cost.

The following is a summary of relevant travel statistics obtained statewide and for the rural households, as readily available in the final report for the survey.

- The overall average weekday **48-hour** person trip rates were 17.3 trips per household and 6.9 trips per person. In the southern lower peninsula rural area, the 48-hour statistics were 17.1 trips per household and 6.7 trips per person. In the northern lower peninsula rural area, the statistics were 15.5 trips per household and 6.3 trips per person. For households in the upper peninsula rural area, the average 48-hour trip rates were 16.0 trips per household and 6.7 trips per person.
- Average **daily** household trip rates were estimated at 8.70 trips per household, statewide. In contrast, the average daily trip rates for the three rural areas were 8.54 trips per household in the southern lower peninsula rural area, 7.75 trips per household in the northern lower peninsula rural area, and 8.00 trips per household in the upper peninsula rural area.

Michigan Statewide Long-Distance Travel Surveys

Both the 2004 and 2009 MDOT "Travel Counts" statewide travel survey efforts included a long-distance travel survey component, in which long-distance trips were defined as any trip of more than 100 miles away from home that occurred in the 3 months prior to the survey.

In terms of the data collection approach, the long-distance supplemental questions were printed directly into the travel log, with the instructions to "please provide the following information for ALL trips you took within the last 3 months, greater than 100 miles (one-way) from home" (http://www.michigan.gov/documents/mdot/mdot_MTC_II_appendices_333723_7.pdf). By including the questions in the travel log, long-distance travel was requested for all household members, regardless of age for the specified time period. In the first effort, travel diary data were recorded from April 4 to June 10, 2004, then again from September through December 2004 (http://www.michigan.gov/documents/MDOT_travelcounts_results_Final_Report_142283_7.pdf). In the second effort, travel was recorded September through December 2009, so long-distance data reflects late summer and fall of 2009.

In both efforts, the survey documented the following data elements:

- **Household Demographics** (through the household travel survey component)—Household size, household vehicles, household workers, home location, and income;
- **Person Demographics** (through the household travel survey component)—Gender, age, relationship, driver's license status, transit pass status (and if one is held, what type and cost), educational attainment, student status, school type and location, employment status, industry, and work location;

Table 2.6. Michigan travel counts long-distance trip rates.

	2004 Survey	2009 Survey
Number of Households	14,818[a]	1,975
Number of Long-Distance Trips	37,338	4,567
Household Trip Rate (3-Month Period)	2.18	2.31
Household Annual Trip Rate	7.34	6.25

Source: Abt SRBI Comparison Report, *Michigan Travel Counts Survey*, Table 5.16.

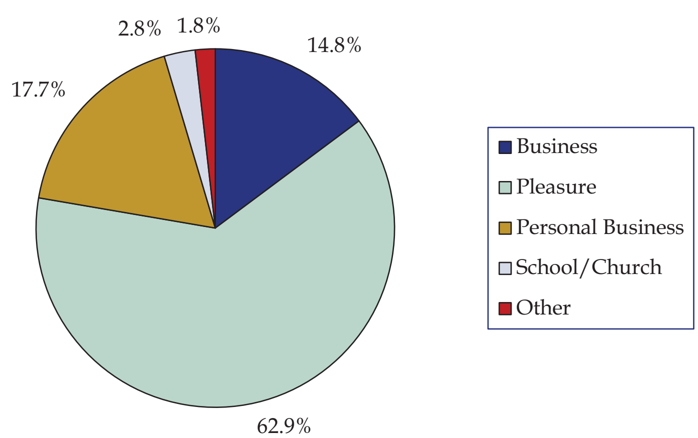
[a] The difference in number of households in the 2004 survey reflects initial results (14,818) versus results after additional data cleaning (14,280).

- **Travel Behavior Characteristics—**Origin and destination of travel, activities at origin and destination, travel mode(s), travel party (if travel by auto), and parking cost; and
- **Long-Distance Travel Behavior Characteristics—**Destination (city and state or country if international), day of departure and day of return, primary reason for trip, primary mode to destination and transportation used at destination, and the number of times this specific trip was made during the 3-month period and the past 12 months.

A total of 14,280 households from across the state were surveyed in the 2004 effort, with each member of the household completing a 24-hour travel diary. Both diaries included the long-distance 3-month retrospective log at the front of the diary. Table 2.6 summarizes the number of surveys, reported trips, and estimated long-distance trip rates resulting from each survey effort.

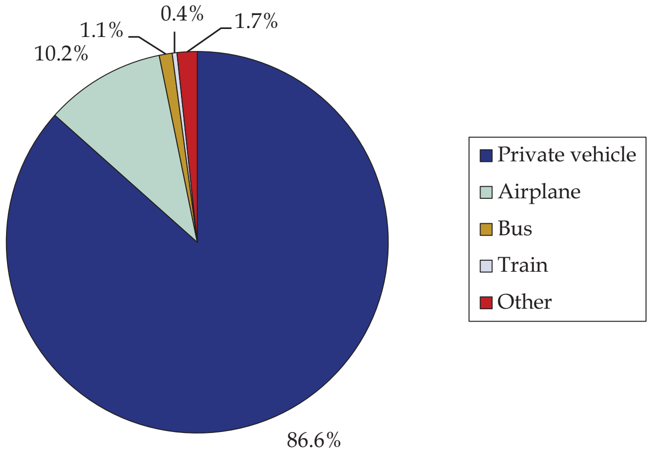
The documentation of long-distance travel is more extensive in the 2004 survey compared to what is available for the 2009 survey. Figure 2.9 presents 2004 survey findings with respect to long-distance travel. In terms of trip purpose, the majority of long-distance trips were reported for pleasure (63 percent), followed by trips for personal business (18 percent) and business purposes (15 percent).

The majority of long-distance trips were made by private auto (87 percent), as depicted in Figure 2.10. Air travel accounted for 10 percent of the trips, while bus and train accounted for very small proportions of the long-distance travel. (**Note that for business trips,** airplane travel accounts for 23 percent of all trips.)



Source: Michigan DOT Travel Characteristics Technical Report, Figure 45.

Figure 2.9. Michigan travel counts, long-distance trip purpose.



Source: Michigan DOT Travel Characteristics Technical Report, Figure 46.

Figure 2.10. Michigan travel counts, long-distance travel mode.

Other pertinent findings from the 2004 Michigan long-distance surveys include

- The majority of long-distance trips (60 percent) are to destinations within the state, and
- In rural areas, most long-distance trips are for personal business. According to the Michigan DOT, this "indicates that the services available from trade centers within 100 miles of these locations lack amenities available" in the larger cities.

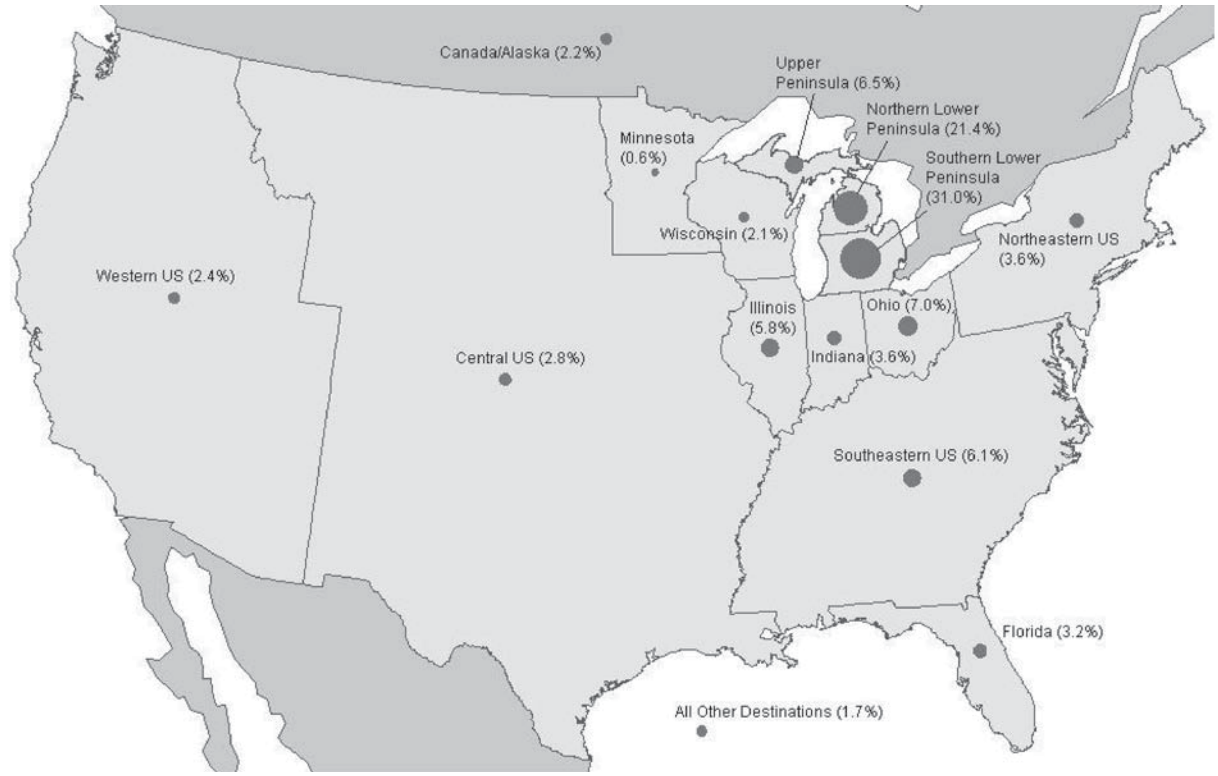
Although trip distances were not provided in the summary data, the Michigan DOT did include a map summarizing the proportion of long-distance trips to different areas of the United States. This map, see Figure 2.11, shows that most trips are to surrounding areas in state and in neighboring states, with the exception of Florida attracting a large number of Michigan "snowbirds" and tourists.

2.3 Supplemental Sources of Rural and Long-Distance Data

In addition to the surveys discussed above, there are other survey sources that could be useful in developing the rural and long-distance transferable parameters. These sources are considered secondary because they are (1) recently completed and without complete documentation, (2) currently being fielded and thus unavailable, or (3) require data mining to obtain useful results for this study. These include

- Front Range Travel Counts Long-Distance Survey (Colorado),
- California Statewide Travel Survey,
- Oregon Household and Activity Survey, and
- Tourism surveys.

For these secondary travel surveys, the travel survey team either recently completed data collection (so the data would be available to inform this study but a report with results has not yet been issued), collected relevant data as a naturally occurring event during the travel diary period but did not analyze it separately (so the data would be available to inform this study but will require some mining efforts), or knows currently travel surveys are being conducted that document the needed data (so the data would be available at some point to inform future studies). Similarly, tourism surveys are usually conducted for economic development purposes, but contain some O/D detail. They are summarized here because the data may be useful in estimating the relative attractiveness of certain areas over others for long-distance travel in particular.



Source: Michigan DOT Travel Characteristics Technical Report, Figure 44.

Figure 2.11. Michigan travel counts, long-distance trip destinations.

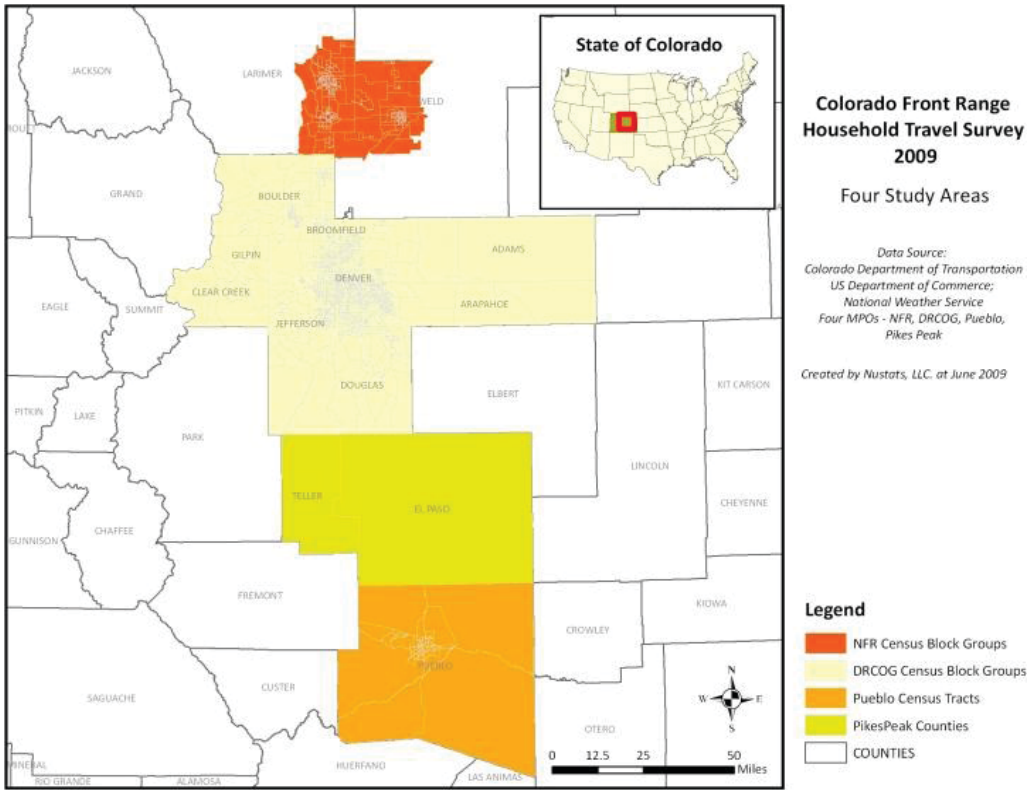
Front Range Travel Counts Long-Distance Survey

The Front Range Travel Counts Survey (FRTC) is a comprehensive study of the demographic and travel behavior characteristics of Colorado Front Range residents across four MPO regions: North Front Range (Fort Collins), Denver, Colorado Springs, and Pueblo, as depicted in Figure 2.12. The objective of the survey effort is to document demographic and travel behavior characteristics across the Front Range in order to support travel demand modeling and answer travel-related questions.

As part of the FRTC, a household travel survey was conducted in all four MPO regions. In addition, surveys were conducted to obtain data regarding commercial travel, travel into and out of the region, and residential travel that was more than 50 miles in distance. Data collection for the effort was conducted from 2009 to 2011. At the time of this report, the project was in the post-collection data processing stage.

As indicated in Figure 2.12, the study area includes metropolitan Denver, but also the smaller urban and rural communities along the I-25 corridor. A total of 12,415 regional households completed the 24-hour diary study. When analyzed, the geographic diversity will help to document differences in travel for rural versus nonrural households. In addition, within the household travel survey design, respondents were instructed to report all trips within the study area. Of more than 115,000 trips in the cleaning stage, approximately 889 trips are preliminarily flagged as being 50 miles or longer one-way. Of these 889 long-distance trips, one-fourth reflect a work commute.

Given the expectation that long-distance travel would be a relatively rare event, a long-distance survey was added as a supplement to the household travel survey in order to document residential travel more than 50 miles in distance. This supplemental survey was conducted in two stages. First, for all households where data collection had been completed and the household indicated an interest in participating in follow-up studies, the household was mailed a long-distance log and asked to record all travel 50 miles or longer for noncommute purposes made by the household



Source: NuStats, 2011.

Figure 2.12. Front Range study area.

members in the 2 weeks prior to a reference date (logic being that the commute trips would be captured in the 24-hour travel logs while all other long-distance trips were less regular and thus might not be captured in the 24-hour travel logs). Second, for households in the data collection stage of the survey, the long-distance log was provided in the same packet as the 24-hour travel diary and households were asked to record all travel 50 miles or longer that was not a work commute trip made by household members in the 2 weeks prior to the travel date. For this second group of households, if no long-distance travel was reported, the household was asked for the date and location of their last trip that met the definition of a long-distance trip.

One-fourth (25 percent) of all households reported a long-distance trip, with a total of 8,680 trips in post-collection processing. This suggests that the unweighted trip rate is approximately 2.77 long-distance trips per household per 2-week period. These data have not been processed for summary statistics yet, weighted, or expanded. Comparisons of long-distance trip-making among different household travel surveys in this report are preliminary and reflect different thresholds for identifying long-distance travel.

California Statewide Household Travel Survey

The California DOT (Caltrans) is currently conducting a statewide household travel survey (http://www.scag.ca.gov/modeling/mtf/presentations/012611/mtf012611chts.pdf). The projected sample size is 60,000 households, with most households completing a 24-hour weekday diary but some completing a 48-hour diary to capture weekend travel. The design includes a purposeful oversample of rural areas and a supplemental long-distance survey. When completed in 2012, this will provide a rich source of information for both rural and long-distance research.

The last statewide household travel survey in California was conducted in 2000/2001 (http://www.dot.ca.gov/hq/tsip/tab/documents/travelsurveys/2000_Household_Survey.pdf). A total of

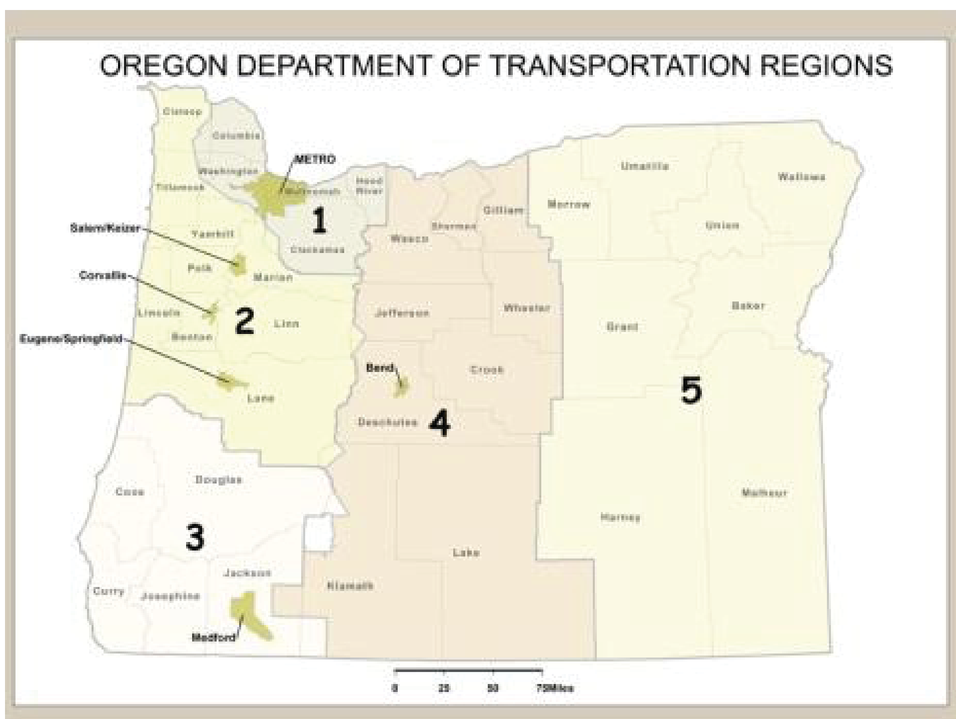
17,040 households participated in the survey, documenting demographic and travel behavior characteristics in a 24-hour diary study, conducted using state-of-the-practice methods. Data elements included household size, income, vehicle ownership, employment status of each household member, and housing unit type as well as trip times, mode, activity at location, origin and destination, and vehicle occupancy. As with the Front Range effort, rural areas were surveyed and long-distance travel was obtained as it naturally occurred during the travel period. Thus, with data mining, this older survey may provide insights to aid in the estimation of rural and long-distance travel parameters.

Oregon Household Activity Survey

The Oregon Household Activity Survey is a statewide effort to document demographic and travel behavior characteristics of its residents (http://www.oregon.gov/ODOT/TD/TPAU/Survey.shtml). Launched in 2009, the survey will provide insights gleaned from over 17,000 households that are providing 24-hour travel details for all household members. In terms of documenting rural travel, the sampling plan was designed to cover the entire state, especially the rural areas outside the metropolitan areas in the state as shown in Figure 2.13. In addition, this effort instructs respondents to report all travel within the State of Oregon, so intercity travel can be captured. The Oregon DOT is currently considering a long-distance supplemental survey.

Recent Global Positioning System (GPS) Surveys

Several recent GPS-based household surveys have been analyzed for results relevant to rural and long-distance travel. Similarities in designs across these studies influence some of the results (e.g., weekend versus weekday proportions). In addition, the studies purposefully assigned the GPS units to long-distance commuters. The GPS-based survey statistics compiled for this analysis include the following, along with the breakdown of long-distance, rural, and urban trips for each survey:



Source: http://sites.nustats.com/otas/

Figure 2.13. Map of Oregon.

- Atlanta Household Travel Surveys (2011):
  - 580 long-distance trips (1%);
  - 16,932 rural trips (26%); and
  - 48,098 urban trips (73%).
- Denver Household Travel Surveys (2010):
  - 395 long-distance trips (1%);
  - 9,836 rural trips (24%); and
  - 31,377 urban trips (75%).
- Massachusetts Household Travel Surveys (2010):
  - 176 long-distance trips (1%);
  - 3,349 rural trips (24%); and
  - 10,325 urban trips (75%).
- Chicago Household Travel Surveys (2008):
  - 102 long-distance trips (1%);
  - 1,572 rural trips (10%); and
  - 14,032 urban trips (89%).

Additional information on these GPS surveys can be obtained at the following web addresses:

- Atlanta Regional Commission/Atlanta Household and Activity Travel Survey/2011 (http://www.atlantaregional.com/transportation/travel-demand-model/household-travel-survey).
- Denver Regional Council of Governments/Front Range Travel Survey/2010 (http://www.drcog.org/index.cfm?page=RegionalTravelBehaviorInventory).
- Massachusetts Department of Transportation/Massachusetts Statewide Household Travel Survey/2010 (http://sites.nustats.com/travelsurvey/faq).
- Chicago Metropolitan Agency for Planning/Travel Tracker household travel survey for Chicago/2008 (http://www.cmap.illinois.gov/travel-tracker-survey).

Tourism Surveys

Surveys conducted to track tourism visits are another source of data regarding long-distance travel. These surveys are conducted at state, regional, and location-specific levels, conducted primarily to inform economic development efforts and fine-tune marketing campaigns. From a travel behavior point of view, these surveys do not document the key variables necessary to inform the development of parameters or for use in a model. However, they provide qualitative details that can suggest attraction rates for existing tourist areas, thereby improving the fit of a long-distance model.

Statewide Tourism Surveys

Tourism can play a large role in some states' economic budgets. Some states conduct surveys of visitors to improve tourist's needs. Examples of the data available from state surveys that might help with forecasting long-distance travel are shown in Table 2.7. The transferability of such surveys, usually collected in high tourism states, should probably be limited to other states with a large tourist component to their economy.

Regional Tourism Surveys

Some regions conduct surveys of visitors to learn what motivates tourists to visit their attractions. Regional survey findings vary by location. Specific locations obtain different survey results. Each region's results will determine the type of variables needed to predict future visitor numbers. Results from two regional surveys are shown in Table 2.8.

National and State Park Surveys

Many national and state parks collect visitor information from patrons using surveys. Their surveys are collected routinely with an abundance of data. A majority of the information collected varies by park location. Four park survey results are shown in Table 2.9.

Table 2.7. Statewide tourism surveys.

Characteristic	State of Oregon	State of Hawaii	State of Florida
Data Collection Methods	Online survey	Combined surveys and statistics from other sources	Combined surveys and statistics from other sources, including international
Universe (or Sample Size)	512 (sample)	6,517,054 visitors	80,879,000 visitors
Data Collection Duration	April 29 to May 17, 2005	2009	2009
Origins	California (14%); Oregon (14%); Washington (6%); Florida (4%); Arizona (4%); Pennsylvania (4%)	Continental U.S., Japan, Canada, Europe, Other; U.S. West – 2,718,818 (by air); U.S. East – 1,561,468 (by air); 96,606 (by cruise ship)	Canada 2,644,000 (3%); Domestic 71,246,000 (88%); Overseas 6,989,000 (9%)
Group Size	N/A	Average 2.1	Average 2.3[a]
Age	N/A	N/A	46[a]
Travel Mode	N/A	6,517,054 visitors arrived by air; 96,606 visitors by cruise ship	41,509,000 (51.3%) air; 39,370,000 (48.7%) non-air

[a] Domestic trips only (auto and air).

Table 2.8. Regional tourism surveys.

Characteristic	Yuma Area, Arizona	Cape Cod, Massachusetts
Data Collection Methods	Paper Surveys	Online Survey
Sample Size	1,316	N/A
Data Collection Duration	January 2010 to December 2010	2006
Origins	One-fourth from Arizona (26.9%), (25.2%) came from California. After California, the other top 10 states for domestic visitors were Washington, Texas, Oregon, Michigan, Illinois, Florida, Nevada, Maryland and Virginia. Within Arizona, Greater Phoenix area accounted for 48.1%, 25% were from Pima County. Among foreign visitors, Canadians accounted for 70.3%, United Kingdom provided 11.9% of visitors.	Average: Massachusetts (42%), Connecticut (16%), and New York (10%)
Group Size	Average 2.6; only 9.2% had children under 18	Spring 2006 – 49% traveled as a couple; summer 2006 – 31% traveled as a family; fall 2006 – 63% traveled as a couple
Age	Average 51 years old	Average 31-45 years old
Travel Mode	Three-fourths of visitors to the Yuma area (75.5%) traveled in an automobile – 57.6% in a private car and 17.9% in a rental car; in addition, 13.2% traveled in a RV/camper, 7.4% by airplane, and 2.3% by motorcycle	N/A
Stay Duration	Day visitors spent an average of 3.6 hours in the Yuma area while overnight visitors spent an average of 2.7 nights	Spring 34% stayed 1-2 days and 17% stayed 3-4 days; summer 25% were here on a day trip while 30% stayed 3-4 days; fall 33% were here on a day trip and 34% stayed 1-2 days

Table 2.9. National and state park surveys.

Characteristic	Grand Canyon National Park	Pennsylvania – Ohiopyle (SW), Pymatuning (NW), Greenwood Furnace (SC), Parker Dam (NC), Ridley Creek (SE), and Lackawanna (NE)	Wyoming – Bear River, Boysen, Buffalo Bill, Curt Gowdy, Edness Kimball Wilkins, Glendo, Guemsey, Hawk Springs, Hot Springs, Keyhole, Medicine Lodge, Seminole, Sinks Canyon	Chickamauga and Chattanooga National Military Park, Fort Oglethorpe, Georgia
Data Collection Methods	Intercept surveys at the park	25- to 35-minute interviews at the park	Interviews – every 5th vehicle at park entrances	Postcard intercept surveys and license tag O/D
Sample Size	4,451 surveys returned (57% rate of return)	1,139 (adults over 18)	3,914	597
Data Collection Duration	September 2003 to August 2004	summer 2008 (Memorial Day through Labor Day)	2009	July 2003
Who Traveled	California (12.2%), Arizona (8.9%), Texas (4.8%), Florida (3.4%), and New York (3.2%). Foreign origins (17%), United Kingdom (3.8%), Canada (3.5%), Japan (2.1%), Germany (1.9%), and Netherlands (1.2%)	N/A	Half from out-of-state	Park trips (17%) and cut-through trips (83%)
Group Size	Average 3.4; only 30% had children under 18	Average 5; majority visited in groups of 1-3	Average 3.14	Average 2.3
Age	Average 48.5	Mostly between 36-50	Average 36.3	N/A
Education	85.2% some college	Advanced education		N/A
Repeat Visitors	58.6% first time; 41.4% repeat		64% previous visitors	N/A
Travel Mode	Private vehicles (59.7%) combined with rental vehicles (37.4%) were used by 97.1% of respondents. Allowing for multiple responses, commercial airlines (16.4%) and RVs (7.8%, private and rental).	N/A	75% travel with travel trailer, motor home, or other camping unit	Auto (96.7%)

(continued on next page)

Table 2.9. (Continued).

Characteristic	Grand Canyon National Park	Pennsylvania – Ohiopyle (SW), Pymatuning (NW), Greenwood Furnace (SC), Parker Dam (NC), Ridley Creek (SE), and Lackawanna (NE)	Wyoming – Bear River, Boysen, Buffalo Bill, Curt Gowdy, Edness Kimball Wilkins, Glendo, Guemsey, Hawk Springs, Hot Springs, Keyhole, Medicine Lodge, Seminole, Sinks Canyon	Chickamauga and Chattanooga National Military Park, Fort Oglethorpe, Georgia
Origins	Traveling largely in personal vehicles, visitors averaged 792 miles of driving in Arizona, most often using Interstate 40 as a travel corridor (60.1%).	Day users, passive recreationists (picnickers, beach/pool users), lower-income, and minority visitors were more likely to say that the proximity of the study park to their home was excellent and were more likely to visit only that state park (and visit more frequently than other groups).	Half from out-of-state, 40% of boaters were from Colorado	Not reported
Stay Duration	N/A	Day visitors	Overnight visitors (average 45.3 hours)	N/A

CHAPTER 3

Transferability and Typologies

This chapter of the Guidebook identifies alternate approaches and contexts to developing parameters that are more fully developed in later chapters. Although some of the suggestions in this chapter were not feasible to undertake in the final analysis for this study, these are still important considerations should additional analysis be warranted in the future, either at the national level or for the purposes of individual statewide model development efforts.

This chapter provides general guidance on when and when not to transfer model parameters by identifying conditions and parameters conducive to transferability, depending on available data sources and other considerations, and expanding on discussions about this topic found elsewhere in this report. This chapter also describes procedures for consideration in conducting analysis, both for this study and future research by others at the state or regional level. Transferability, analysis procedures, and typology topics covered in this chapter include the following:

- Conditions conducive to transferability—Demographic and geographic considerations as well as availability of local data;
- Parameters to be considered for transferability—Which parameters are easiest to estimate and have sufficient data to support transferability;
- Temporal analysis considerations—Daily, monthly, annually, time of day, seasonality, weekdays, weekends, etc.;
- Other aspects of "trip" definition—Consideration of intermediate stops, trips versus tours, etc.;
- Proposed process to use datasets for developing transferable parameters—Identifying what model parameters can be estimated, where applicable, from these datasets and the level/type of effort involved;
- Limitations of all datasets—Identifying geographic, trip type, or modal limitations in the accuracy of the data;
- Minimum amount of local data required to assess the reasonableness of parameters—How the resulting parameters can be tested or compared for reasonableness; and
- Long-distance and rural typologies—How to stratify households, trips, and areas.

Later chapters of this report quantify some of the general guidance and analysis procedures provided in this chapter by model step.

3.1 Conditions Conducive to Transferability

A set of draft rules must be established indicating conditions conducive to transferability and those that are not. Such considerations will include, but not be limited to, the following:

- Population densities;
- Median income;

- Available transportation modes;
- Key employment types/industries;
- Proximity to tourist destinations; and
- Source of model parameter.

Population density is a potential indicator of model transferability. This is particularly the case with mode choice for long-distance travel, as private passenger vehicles predominate in long-distance travel in smaller-sized urbanized areas and rural areas while long-distance travel is more common on alternate modes in large metropolitan areas. Clearly there is a relationship between population density and **available transportation modes** that also explains the mode choice issue. Density explains some differences in trip rates, trip lengths, and auto occupancies of urban versus rural trip-makers.

With respect to analysis of **median income** impacts on trip-making, it stands to reason that lower-income households make fewer long-distance trips than higher-income households. Likewise, household decisions on transportation modes for long-distance travel include an income component. The Guidebook chapter on trip generation provides additional understanding on the relationship between income and rural trip-making.

Key employment types and industries can impact rural trip-making. A good example of this is tourism and lodging, which has a large need for low-income workers who cannot afford to live in **proximity to resort developments.** Such areas are also magnets for long-distance travel since visitors to resorts usually reside outside of the region.

The **source of the model parameter** is a key decision point in parameter transferability because there is a wide variety of sources considered in establishing such settings, including state DOT surveys (both household and intercept), surveys from adjacent or similar states, national surveys, MPO surveys, *NCHRP Report 716* and other model guidance documents, as well as other statewide models. Furthermore, smaller states (e.g., Rhode Island) might have more in common with urban and regional models than statewide models, with a smaller percentage of long-distance trip activity and dominated by urbanized land.

Clearly, long-distance model parameters should be derived from surveys with a statistically valid sample of such trip-makers. Rural model parameters require a survey with both urban and rural resident components in order to ensure that the resulting rates are in fact the result of differences in residential and/or work location and not just due to error in survey execution or design. Although reported statistics from statewide models and documentation of general guidance are useful to provide context, such comparisons are no substitution for analysis of travel survey data.

The limitations of the data sources must also be considered, especially as these relate to geographic limitations or trip definition. The minimum amount of data needed for the geography intended (national, regional, state, or metro area) must be assessed for each of the parameters.

3.2 Parameters to Be Considered for Transferability

Some potentially transferable parameters that are important to properly estimating long-distance and rural travel patterns and comparative benchmark statistics for statewide models are described in this section. Potentially transferable parameters include the following:

- Daily (weekday and weekend) rural trip rates per household by household characteristics (e.g., number of workers by industry) and by trip purpose;
- Monthly or annual long-distance trip rates per household by household characteristics (e.g., median income) and by type of trip (trip purpose);
- Friction factors, gamma functions, or utilities for rural travel by trip purpose;

- Friction factors, gamma functions, or utilities for long-distance travel by trip purpose;
- Auto occupancy rates for rural vehicle trips by trip purpose; and
- Party size for long-distance trips by trip purpose.

In addition to the transferable parameters itemized above, and the dynamics noted earlier in this chapter, reasonableness values are documented in later chapters for the following:

- Percent of rural trips by purpose;
- Percent of long-distance trips by trip purpose;
- Average (mean) vehicle trip length of rural trips by mode and purpose;
- Average vehicle trip length of long-distance trips by mode and trip purpose; and
- Percent of long-distance and rural trips by mode (private vehicle, rail/bus, air, other) and travel distance.

Other parameters and benchmarks more difficult to quantify, and less likely transferable, include intermodal connections (e.g., dropped off/drive and park at airports); percent of non-traveling households by type; and percent of trip destinations to locations within the same state or to another state.

3.3 Temporal Analysis Considerations of Transferability

Defining what constitutes a statewide model trip is also important to a discussion on transferability. Even this varies among different statewide models, with a few that essentially do not include intra-urban trips (e.g., Louisiana). Trips could be defined by person, household, or even vehicle in some cases. Sometimes, it might make sense to include intermediate stops as trip ends; however, this would seemingly go against the concept of long-distance trips. In fact, what travelers typically think of as a "(round) trip" is what transportation planners consider a "tour." A few statewide models (e.g., Ohio, Oregon, and New Hampshire) use the concept of tours instead of trips.

For rural travel analysis, average weekday conditions would likely be preferable. Similar to regional models, while it might be best to exclude travel on weekends and holidays, such limitations could result in sample size problems. NHTS staff have indicated that approximately 25–30 percent of 2009 NHTS surveys were conducted on weekend travel; however, weekend travel includes Friday after 6:00 p.m. (teleconference with Adella Santos, FHWA; Vidya Mysore and Frank Tabatabaee, Florida DOT; and Rob Schiffer, Cambridge Systematics, Inc. on August 10, 2011), a timeframe that is similar to other weekday evening peak periods in many regional models. In states with a singular, well-defined peak season, consideration could be given to only including surveys that constitute peak season average weekday traffic instead of annual average daily traffic (AADT), although such a timeframe of analysis would not be recommended for a study on national transferability such as this.

Conversely, since long-distance travel is not an everyday occurrence in most households, monthly or annual statistics are appropriate for survey analyses. Also, it is essential to include weekends and holidays in any survey analysis of long-distance travel because these time periods reflect where the greatest amount of such travel takes place. Consideration was given to developing time-of-day factors both for rural and long-distance trips during this study; however, with the infrequency of long-distance trips, use of trip rates by time of day might be overkill.

3.4 Other Aspects of Trip Definition for Transferability

In addition to temporal considerations, there are other aspects to be considered in defining a trip for the purposes of research and analysis of transferable parameters. The first of these is consideration of person trip versus vehicle trip analysis. Since the majority of statewide models deal with person trips and starting with vehicle trips almost precludes a mode choice process, transferable parameters in this study are provided for person trips rather than vehicle trips. Long-distance trip-making was considered at 2–3 different thresholds to determine how parameters differ at each threshold.

Another consideration is how to deal with intermediate stops and whether these should constitute a trip end or not. Clearly, long-distance trips require stops for gas, food, and/or lodging. In the context of a regional model, these intermediate stops for shopping, etc., would each represent a unique nonhome-based trip. In the context of most statewide, multistate, or national modeling, however, these intermediate stops are not of tremendous importance in defining and simulating a trip. On the other hand, it is probably worth considering an intermediate stop at the end of the day for lodging as the end of a daily trip, assuming the analysis is daily rather than monthly or annually. The location of intermediate stops, relative to congestion on Interstate highways or crossroads, could result in greater interest about intermediate travel patterns. The number and duration of stops will also be addressed in this research.

The topic of intermediate stops also leads directly to consideration of tours versus trips. The previous lodging example might be better addressed as a stop during a tour rather than the endpoint of the trip; however, the majority of statewide models are still trip-based. Those statewide models that are tour-based were developed using statewide travel surveys and, as a result, will not likely have as much use for transferable parameters. However, the preparation of tour-based parameters is beyond the scope of this report. Hence, the number of intermediate stops for long-distance trips is provided later in this Guidebook based on analysis of the 1995 ATS.

3.5 Process for Developing Transferable Parameters

Datasets with the greatest potential for developing transferable parameters for rural travel are the 2009 NHTS and readily available analyses from the Michigan and Ohio statewide travel surveys. New and ongoing surveys in California, Colorado, Oregon, and Utah could also prove useful in documenting rural travel patterns. Transferable parameters for long-distance travel are best derived through a combination of the 2001 NHTS, 1995 ATS, and readily available analyses from the Michigan and Ohio long-distance travel surveys.

The development of transferable parameters from any of these household diary surveys requires some level of significance testing to identify what comparisons, typologies, geographies, and time periods best explain or influence the characteristics of rural and long-distance travel. The following dynamics must be considered in the analytical process:

- **Comparisons—**Comparisons should include rural versus urban households and long-distance trips versus routine (urban and rural) travel.
- **Typologies—**Rural and long-distance travel should be analyzed by household characteristics such as income, number of workers, household size, auto availability, etc. "Type" or purpose for long-distance trips can be equated to ATS categories of business, pleasure, and personal business while rural trips can be described using typical home-based and nonhome-based purposes, similar to urban models.
- **Geographies—**Rural areas should be analyzed by type such as proximity to/distance from urbanized boundary, land-use density, and/or roadway density.
- **Time Periods—**This topic is repeated here due to its importance in framing the analysis and results described in subsequent chapters. For rural travel, average weekday conditions would likely be preferable (excluding weekends and holidays, similar to regional models); however, since long-distance travel is not an everyday occurrence in most households, monthly or

annual statistics must be considered (including weekends and holidays) in analyzing long-distance trip-making.

Use of tourist survey data and Canadian travel behavior data would require additional resources for data procurement or access to free sample subsets of these data with limitations and caveats covering their use in this study. Therefore, similar to the Michigan and Ohio surveys, analysis was limited to readily available statistics provided by others.

In cases where statistics have been summarized from reports, research studies, and data that does not include travel diaries, the best likely achievable product is providing reasonableness values, similar to those provided in later chapters of this Guidebook, that can be used in assessing the validity of statewide, multistate, and national models or to use as a point of comparison or verification against analytical results from this study.

The development of transferable parameters and reasonableness values used statistical analysis software (e.g., SAS 9.2) to look at issues of significance, variance, and dispersion. Each dataset was analyzed independently, since estimation of error cannot be done on the combined datasets. The NHTS datasets estimate margin of error using a replicate weight file containing 99 replicate weights prepared for each household and person. Estimates of error in the ATS data are limited to margins of error in published reports, and simple standard deviations, which do not take into account the probability of selection from a PSU sample design.

A cluster analysis was considered to develop homogeneous sets or clusters of households, person, and/or trip characteristics using the variance (margin of error where available, simple standard deviation where not). Instead, regression analysis was used to determine what independent variables are most explanatory in predicting variations in trip rates, average trip lengths, and auto occupancies by type or purpose. This study included coordination efforts with NCHRP Project 25-36, "Impacts of Land Use Strategies on Travel Behavior in Small Communities and Rural Areas" and its development of rural typology using cluster analysis. The pros and cons of using a common typology are addressed elsewhere in this Guidebook.

A top-down analytical approach to analyzing rural travel started with the 2009 NHTS national sample. This sample is population proportionate and includes rural households from all parts of the United States in proportion to their incidence, or about 22 percent of sampled households overall. Using those data, rural travel indicators were developed from a national perspective, establishing a benchmark against differences in travel. Such an analysis provides a normative set of values for national urban and national rural travel characteristics. These benchmark values formed the beginning of our understanding of how rural travel characteristics differ from the types of data used in traditional urban travel forecasting models.

NHTS also uses Census geography to divide the nation into smaller areas (e.g., Census region or division). This second level of geographic analysis could benefit the process of dividing rural travel characteristics into specific typologies; however, parameter values described later in this Guidebook maximized use of the entire sample, rather than diluting the data into subsamples by Census geography.

Finally, in the 2009 NHTS, 15 states purchased supplemental samples and all of them included rural households. The travel of rural households in these Add-On states is a third level of geographic analysis. Smaller, non-Add-On states had a minimum of only 250 households sampled for the entire state. In those states there would be too few rural samples to make robust estimates of rural travel. This process could help determine what final geography the data supports to create transferable parameters that have the widest applicability (e.g., Add-On states already have rural samples for their statewide models, so perhaps the audience for this report is more than likely the non-Add-On states). Parameters described in later sections of this Guidebook were based on analysis that included NHTS Add-On data.

3.6 Limitations of Datasets

Each dataset identified in this Guidebook has limitations that impact the estimation of transferable model parameters. Some of the key limitations of each dataset are identified below:

- **1995 ATS—**Potential concerns over the age of the data, there are no rural samples (the PSUs were all in urbanized areas), and no ability to estimate true error;
- **2001 NHTS—**Similar concerns over the age of the data, low mode differentiation, especially low air estimates (partially due to 9/11), and extreme values in trip lengths need to be trimmed;
- **2009 NHTS—**No long-distance trips, large and comparable rural sample but not all states are represented in the Add-Ons; and
- **Michigan and Ohio Surveys—**One could assert that parameters from these surveys might only apply to highly populated states with manufacturing as a key driver of the economy. Availability of other recent and ongoing statewide and superregional household surveys also helped identify areas of compatibility and inconsistency.

It is anticipated that some travel modes might be underrepresented in these surveys as none were stratified to achieve a target number of responses by mode. Access to additional modal-based data from Amtrak, Federal Aviation Administration (FAA) enplanements, and possibly Greyhound would be needed to back up this statement.

In the interest of not over-specifying based on available data, rural trip purposes have been limited to home-based work (HBW), home-based nonwork/other (HBNW/HBO), and non-home-based (NHB). For long-distance estimates, modes were limited to those most commonly reported, and trip types to the three main trip purposes consistent with ATS definitions (business, pleasure, and personal business). An understanding of household characteristics that influence the likelihood of making long-distance trips and mode selection for such trips also are addressed in the analysis.

3.7 Minimum Amount of Local Data Required

The only local data needed for analysis are general statistics culled from available statewide model reports, as documented in subsequent chapters of this report. In order to confirm the usefulness of the resulting model parameters, testing of parameter settings could be conducted on one or more existing statewide travel demand forecasting models by future users of this document. Reasonableness values can be assessed against different statewide models to document their usefulness.

Cautionary statements of transferability were included earlier in this chapter such that modelers understand the conditions under which transferable parameters are recommended for use in statewide models. Local data collection is always preferable to borrowed parameters as long as sufficient funding is available to conduct these surveys.

As noted earlier, this study also included coordination with NCHRP Project 25-36, including cluster analyses to define a rural typology for analysis purposes. The cluster analysis makes use of "commuting zones" established by the U.S. Department of Agriculture (http://www.ers.usda.gov/briefing/rurality/lmacz/). Variables under consideration with NCHRP Project 25-36 include population density, road density, land-use mixture, and variation in population density. A rural typology is critical in establishing the transferability of model parameters.

3.8 Long-Distance and Rural Typology Considerations

This section describes alternative stratifications for long-distance and rural trip-making based on statistical analyses for this project as well as coordination with other research efforts. A key analytical step in this research has been to compare trip generation statistics for households in "rural" areas, using various definitions to assess resulting differences in trip rates. As noted elsewhere, such analyses also must account for urban trip characteristics as a point of comparison.

Analytical comparisons necessitate a typology of rural activity, such as defining rural households nearer to urban centers versus those farther from large activity centers. Another unique characteristic of some rural areas, yet more difficult to quantify, is proximity to major recreational areas. For example, trip activity is likely different for rural areas in proximity to national parks, beach areas, and casinos, than rural areas that are largely focused on agriculture, mining, and forestry.

Demographic profiles are also helpful, defining household characteristics such as size, lifecycle, income, and/or number of workers by worker status and occupation. An interesting topic, should such data become available in the future, would be to include comparisons of Internet availability and use this information to impute if rural households are more or less likely to shop online, based on a lack of home-based shop trips. The propensity of rural residents to link trips is another unique factor because those with long daily commutes are likely to do their shopping and other personal business prior to leaving the urban area at the end of the work day. While such intermediate stops might not be important to statewide models, as discussed previously, there might be reason to analyze this with an eye toward regional models covering large rural territories.

The selected rural characteristics could be analyzed for households in each state, and in state clusters, such as Census division, to determine what trip generation statistics may be transferable to areas without original data to support a rural trip generation model. The research team has identified opportunities to leverage some of the analysis already conducted for urban transferable parameters (*NCHRP Report 716*) and much of the thinking on new typologies, especially sociodemographic, would be helpful for this effort.

The Version 2 NHTS 2009 has a number of enhancements that can be helpful for analytical purposes, including estimates based on the 2008 American Community Survey (ACS) and land-use descriptors for the household and the workplace locations from Claritas/Neilson. This is an important source of comparable land-use definitions when looking at trip generation estimation from state to state. Claritas has developed a "floating density" estimate based on contiguous 2-mile-square grids across the country, which evens out some of the variability in density based on Census tract area. Selected characteristics of urbanized areas from the annual "Highway Statistics" publication of the FHWA Office of Highway Policy Information (OHPI) can also potentially assist in defining characteristics that separate rural from urban settings.

Trip rates for households in similar sociodemographic classes, such as number of workers or income, were estimated to see how much of the difference can be accounted for by traditional methods. This is the point at which it could be useful to conduct analyses with and without weekends and holidays. As noted earlier, removing households and persons with weekend and holiday travel days will reduce the sample sizes by approximately 30 percent and increase the margin of error overall. Significance testing, along with measures of variance, could be useful to inform readers of this report of possible future paths and other considerations.

Looking at the distribution of trips by purpose might highlight sources of variance. The trip purposes used in trip generation are generalized travel purposes, such as home-based work (HBW), home-based other (HBO), and nonhome-based (NHB). It is certainly possible to look at rural trip generation for these purposes, but the very high VMT per person and per household hints at long work trip lengths. Research on trip chaining has indicated that people with longer commutes are more likely to stop along the way than other commuters (McGuckin, N., Zmud, J., and Nakamoto, Y., 2005). HBW is coded as direct trips between home and work, and so longer commutes with an intervening stop might not be included in the HBW category but pushed into NHB, possibly skewing the resulting percents. Auto occupancy is another important travel parameter that could vary substantially between states, by trip purpose, and by the sociodemographic class of the household.

Ultimately, it could be useful to create transferable "types" of rural areas that do not rely on Census or state designation, but truly tie the variations in travel to land-use characteristics of the rural household location, and that can be applied across geography. Evaluating rural areas based on roadway density would be helpful as a step to analyzing location variation. Another consideration would be to classify rural areas based on proximity to urbanization and other readily available characteristics.

Another ideal step toward creating a typology of rural areas could include acquiring data on the major industry for households in that rural area. For example, areas dependent on agriculture or manufacturing would potentially have different travel characteristics. In the 2009 NHTS, Claritas added detail to the file that might possibly be helpful at some point. For households that report a workplace location, the following information is available for that workplace location at the Census tract level:

- Percent of workers Agriculture/Mining/Construction;
- Percent of workers Finance/Insurance/Real Estate;
- Percent of workers Manufacturing;
- Percent of workers Retail;
- Percent of workers Services;
- Percent of workers Transportation/Communications/Utilities; and
- Percent of workers Wholesale Trade.

Since these data are tied to the workplace location and not the household, supplemental analysis would be required to explore their usefulness for this task. At the household location, only workers by retail or nonretail are coded (at the block group level).

In addition to the major industry of a household's workers, an important question is how far away are desirable destinations, such as entertainment or shopping opportunities? Of course, it is possible to use the reported trip lengths for shopping and entertainment to cluster rural households into groups, but that leaves households where nobody reported a shopping or entertainment trip on the travel day outside of the typology. With a complete source of information on MPO and urbanized boundaries, the research team looked at coding rural areas within and outside of these boundaries as a way to get at distance characteristics. Such analyses would need to be sensitive to varying levels of urbanization and the political nature of MPO boundaries throughout the United States.

Proximity to modal alternatives and urban areas impacts the quantity, trip purpose, and travel mode of rural and long-distance trips. The biggest problem with using modal proximity in a rural typology is that the NHTS and ATS do not include information on respondents' proximity to transportation modes. Therefore, such a typology would require manual coding of modal proximity information into survey records or identifying some sort of access variable based on existing attributes. Proximity to urban areas is easier to address, especially if Metropolitan Statistical Areas (MSAs) or Consolidated MSAs are used to define urban proximity, because these measures are already in the NHTS.

The problem with any rural typology based on distance to attractions is the effort and information required to code the location data. In conducting analysis with NHTS and other survey databases, researchers must keep in mind how the transferred rural estimations would be applied—in other words, how easy it would be for statewide planners to obtain the same data for the rural households or areas in their state in order to correctly apply the travel rates.

A rural typology could be based on several other factors. The goal is to choose factors that both explain perceived differences in travel rates or type and that can be reasonably quantified for different rural areas in individual states. Following are three more alternate approaches to further refining the definition of "rural" households that could be explored further using the 2009 NHTS. The NHTS variable names and unweighted sample sizes are provided for convenience in capital letters:

- **Census-defined rural households that fall inside or outside of a CMSA—**Of the NHTS households that are classified as "Rural" by Census definition, a slight majority are located within CMSAs (using URBRUR and HHC_MSA<'0000' for not in a CMSA). In essence, over 50 percent of Census-defined rural households are located within the boundaries of MSAs or CMSAs.
- **Housing Unit Density (HBRESDN)—**Nearly 30,000 households classified as rural fall in the lowest coded density (zero-99 housing units per square mile). More than 10,000 fall in the next coded level (100 to 499 housing units per square mile). The remainder are spread out across other density codes. These density calculations are appended to the NHTS file by Claritas and are based on Census estimates at the block group level of geography.
- **Major Employment Type (based on employment of residents at household location, not employment at place of work)—**These data are available from FHWA as an Additional Variable File (Claritas) and have the following variables of interest: percent of employees in Agriculture, Mining, Construction (WTINDAGR), percent of employees in Manufacturing (WTINDMAN), percent of employees in Retail and Service (WTINDRET, WTINDSVC), and other designations (WTINDTRN, WTINDFIN, WTINDWHL or Transportation, Finance and Wholesale, respectively).

These and perhaps other "typing" variables can be analyzed to see if differences in household travel between various rural areas of the country, or even within a state, can be explained. The same ANOVA cluster analysis that was conducted for *NCHRP Report 716* for the rural households in the NHTS dataset was used as part of NCHRP Project 8-84 with an expanded statistical analysis to see if these factors are significant.

Below are some specific approaches for developing weekday trip generation rates for rural households that maximize the use of statistical analyses already conducted as part of *NCHRP Report 716.*

- At a minimum, trip rates (daily weekday person trips per person) should be presented in the format of cross-classification trip production rates presented in *NCHRP Report 716,* which

found that trip rates were not statistically different for households in different population sizes. Therefore the report presents urban trip generation data by different trip purposes. The purposes used in *NCHRP Report 716* are as follows:
  - Home-based work;
  - Home-based nonwork;
  - Home-based school;
  - Home-based other; and
  - Nonhome-based.
- The purposes that came out as significant in a preliminary rural trip length cluster analysis for this study were: HBW, HBShop, HB Recreation, and all others. Since these purposes do not map onto each other, some additional consolidation is recommended (HBW, HBO, NHB).
- Percent of trips and trip rates per person per household have been developed, by purpose and for "All." Should such information be available, consideration could also be given to typical driving ages in rural areas and impacts to school trip lengths.

In addition, this study should develop auto occupancy factors for the same purposes and "All." It was very helpful to "recycle" the SAS code from the development of the *NCHRP Report 716* trip generation tables for this study, or at least to be reminded to use the same assumptions, omissions, etc.

CHAPTER 4

Trip Generation Parameters and Benchmark Statistics

This, and subsequent sections on transferable parameters and benchmark statistics, will follow a similar format. The first subsection will provide benchmark statistics and parameters from existing statewide models. This will be followed by a discussion of analytical approaches used to estimate transferable parameters. Next will be a presentation of long-distance transferable parameters and benchmarks. Each section will then conclude with rural travel parameters and benchmarks.

The section on trip generation specifically touches on alternate trip generation approaches to statewide models, and statewide model trip purposes, as well as differences between urban, rural, and long-distance trip-making. This will be followed by a presentation of transferable trip production rates and guidance on making adjustments to these parameters. This section will also provide benchmark statistics on aggregate trip rates and percent trips by purpose.

4.1 Long-Distance and Rural Trip Generation Benchmark Statistics from Statewide Models and Other Sources

This section of the trip generation chapter explores the characteristics of statewide models further to identify sources that could be used in comparing, developing, and recommending trip production rates for estimating rural and long-distance travel. Other statewide model statistics such as friction factors, mode choice coefficients, and peak-to-daily/time-of-day factors, and other model parameters, are summarized later in Sections 5.1, 6.1, and 7.1, which are devoted to other steps in the four-step modeling process. Other secondary sources of model parameters and benchmarks are provided for comparative purposes.

Statewide Model Parameters and Benchmarks

The final report for the NCHRP Statewide Model Validation Study (Cambridge Systematics, Inc., 2010d) included a series of tables describing model parameters and benchmark statistics from statewide models, including information on long-distance and rural trip purposes, where these were separated from typical urban model purposes. Some of this information was derived either from recent work on the NCHRP model validation report or prior work on national model research for FHWA.

Establishment of trip purposes used in statewide models is important because this will largely determine the stratifications used in subsequent model statistics (i.e., these are reported by trip purpose). Some trip purposes in statewide models are duplicative, using different names but meaning the same thing. This has been fleshed out through discussions with state DOT contacts

Table 4.1. Percentages of long-distance trips in statewide models.

	Long-Distance Threshold in Miles	Long-Distance Threshold in Minutes	Long-Distance Trips	Total Trips	Percentage Long Distance
Arizona	50	–	–	–	–
California	100	–	–	–	–
Florida	50	–	176,587	52,281,363	0.34%
Georgia	–	75	418,000	31,223,000	1.34%
Indiana	–	–	280,395	25,158,208	1.11%
Louisiana	100	–	75,087	11,717,965	0.64%
Massachusetts	–	–	957,046	22,951,483	4.17%
Mississippi	100	–	212,862	7,095,161	3.00%
Ohio	50	–	248,628	36,702,991	0.60%
Utah	–	–	68,866	7,313,412	0.94%
Virginia	–	100	1,071,566	37,868,443	2.83%
Wisconsin	50	–	42,966	71,313,993	0.06%

and their consultants. Some models differentiate short-distance from long-distance trip purposes while others do not. Where long-distance trips are separated from routine travel, the percent of long-distance trips varies widely in statewide models from less than 1 percent (Florida, Louisiana) to greater than 4 percent (Massachusetts); this may reflect, to some extent, the close proximity of densely developed urbanized areas, resulting high levels of through-trip activity, long-distance commuting, and other unique factors that make transferability of this statistic difficult. Also, reported statistics make use of different thresholds for long-distance travel.

Trip generation model statistics compiled by trip purpose include aggregate trip rates and percent trips by purpose. In many cases, states have incorporated methods for forecasting long-distance trips along with shorter regional trips in their statewide models. In most cases, statewide models incorporate truck and auto long-distance trips; however, in some cases, additional modes are incorporated such as air and intercity transit. The threshold for defining long-distance trips also varies among statewide models, with some states considering trips over 100 miles to be long distance, and others considering 50 miles or 75 minutes as long distance.

Table 4.1 is a summary of the percentage of trips that are long-distance for each statewide model, along with a breakdown of each state's definition for long-distance trips, as reported in available technical reports. Long-distance trip production rates were documented for Georgia and Wisconsin statewide models only, as depicted in Tables 4.2 and 4.3. No trip attraction rates were found for rural or long-distance travel in any of statewide model documents reviewed. These tables, as well as other statewide model statistics found in subsequent sections, depict passenger trips except where noted otherwise. The numbers found in these tables, in all cases, came directly from statewide model technical reports because the study team was not tasked with obtaining and executing these models.

Bureau of Transportation Statistics

In May 2006, the Bureau of Transportation Statistics (BTS) published findings from the 2001 NHTS on long-distance trip-making. A number of these statistics could be useful as transferable parameters or benchmark statistics against which to compare statewide model results. Although later tasks in this study will include data analysis of 2009 NHTS, 2001 NHTS, 1995 ATS, and other relevant state survey datasets, it was thought that information from the BTS report, *America on the Go, Findings from the National Household Travel Survey* (U.S. Department of Transportation,

Table 4.2. Georgia long-distance internal and external trip rates by purpose, income, area, and persons per household.

Income	Area	Persons per Household	HBW-IE (GA Int-Ext)	HBW-II (GA Internal)	HBO-II (GA Internal)	NHB-II (GA Internal)
Low	Urban	1	0.008	0.001	0.036	0.005
		2	0.045	0.002	0.063	0.009
		3	0.025	0.003	0.083	0.020
		4	0.077	0.005	0.060	0.154
	Rural	1	0.045	0.045	0.016	0.010
		2	0.020	0.043	0.087	0.130
		3	0.091	0.003	0.045	0.040
		4	0.056	0.167	0.667	0.056
Non-Low	Urban	1	0.016	0.003	0.013	0.010
		2	0.046	0.005	0.041	0.017
		3	0.051	0.009	0.041	0.054
		4	0.051	0.015	0.127	0.036
	Rural	1	0.015	0.002	0.032	0.021
		2	0.035	0.022	0.104	0.042
		3	0.052	0.007	0.095	0.087
		4	0.070	0.022	0.081	0.059

Source: Atkins, *Development of Statewide Model Draft Report*, prepared for Georgia Department of Transportation, April 15, 2011.

Table 4.3. Wisconsin daily long-distance trip rates by purpose, household size, and number of autos.

	1 Household Member			2 Household Members			3 Household Members			4 Household Members		
	0 Autos	1 Auto	2 Autos	0 Autos	1 Auto	2 Autos	0 Autos	1 Auto	2 Autos	0 Autos	1 Auto	2 Autos
Business												
Appleton/Oshkosh/Green Bay	0.00000	0.00367	0.01316	0.00000	0.00479	0.01997	0.00000	0.00057	0.02917	0.00000	0.00792	0.03429
Madison	0.00046	0.00545	0.02347	0.00000	0.00624	0.02737	0.00000	0.01451	0.02480	0.00000	0.06359	0.03617
All other MPOs	0.00145	0.00633	0.03949	0.00145	0.01656	0.02953	0.00145	0.00829	0.04266	0.00145	0.02101	0.04851
SEWRPC Region	0.00148	0.00405	0.00851	0.00148	0.00370	0.02202	0.00148	0.00251	0.01687	0.00148	0.00909	0.03399
Rest of Wisconsin	0.00060	0.00647	0.04464	0.00060	0.01875	0.02487	0.00060	0.00590	0.04473	0.00060	0.02524	0.05001
Personal Business												
Appleton/Oshkosh/Green Bay	0.00133	0.00293	0.00576	0.00133	0.01358	0.01133	0.00133	0.01370	0.02396	0.00133	0.01475	0.02079
Madison	0.00352	0.00427	0.00583	0.00352	0.01175	0.01246	0.00352	0.01092	0.01461	0.00352	0.00836	0.02078
All other MPOs	0.00107	0.00436	0.01110	0.00107	0.01415	0.02099	0.00107	0.01373	0.03127	0.00107	0.03690	0.02986
SEWRPC Region	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895	0.00895
Rest of Wisconsin	0.00077	0.00479	0.01266	0.00077	0.01523	0.02234	0.00077	0.01025	0.03376	0.00077	0.04535	0.03144
Pleasure												
Appleton/Oshkosh/Green Bay	0.00752	0.01399	0.02085	0.00752	0.05138	0.06096	0.00752	0.05508	0.07750	0.00752	0.05330	0.12458
Madison	0.01538	0.01773	0.01712	0.01538	0.04875	0.06335	0.01538	0.04614	0.08682	0.01538	0.07146	0.12193
All other MPOs	0.00684	0.01829	0.02851	0.00684	0.04550	0.07099	0.00684	0.04713	0.08072	0.00684	0.06755	0.09718
SEWRPC Region	0.00717	0.01443	0.01740	0.00717	0.03076	0.05512	0.00717	0.03350	0.06772	0.00717	0.02557	0.07727
Rest of Wisconsin	0.00440	0.01575	0.26130	0.00440	0.03908	0.05959	0.00440	0.05192	0.08034	0.00440	0.08730	0.10344

Source: Cambridge Systematics, Inc. and HNTB, *Wisconsin Statewide Model –Passenger and Freight Models*, prepared for Wisconsin Department of Transportation, September 2006.

Table 4.4. 2001 long-distance trips by purpose and mode.

		Percent Trips by Mode				
LD Purpose	Percent by Purpose	Personal Vehicle	Air	Bus	Train	Other
Pleasure	55.5%	90.4%	6.7%	2.2%	0.5%	0.2%
Business	15.9%	79.3%	17.8%	0.8%	1.6%	0.5%
Commuting	12.6%	96.4%	1.5%	0.5%	1.7%	0.0%
Personal Business	12.6%	89.3%	4.7%	5.6%	0.3%	0.1%
Other	3.4%	96.6%	1.9%	0.5%	0.0%	1.0%
Total	**100.0%**	**89.5%**	**7.4%**	**2.1%**	**0.8%**	**0.2%**

Source: BTS.

Research and Innovative Technology Administration, Bureau of Transportation Statistics, 2006) fit into the context of this discussion.

This 2006 BTS analysis of long-distance trips identified characteristics such as percent of trips by mode and purpose, as depicted in Table 4.4. According to BTS' analysis, over 50 percent of long-distance trips would be considered for the purposes of pleasure, with another 16 percent of trips occurring for business purposes. Travel modes are fairly consistent for most long-distance purposes with the exception of business trips, which are far more likely to use air travel than other long-distance trip purposes. This shows the importance of modeling long-distance business trips separately from other LD trip types when modeling multiple transportation modes.

Oak Ridge National Laboratories

A 2006 report, *Trends in New York State Long-Distance Travel* (Oak Ridge National Laboratory, 2006), produced by staff from the Oak Ridge National Laboratory, provides a number of statistics on long-distance travel patterns based on analyses of 1995 ATS and 2001 NHTS data for residents of, and visitors to, the State of New York. Statistics provided in this report include growth in long-distance trips, the number of person trips, trips per person, miles per person, and miles per trip tabulated by means of transportation, trip purpose, income, age, and gender. These statistics are not necessarily transferable to other states but could be useful in benchmark checking against comparable statistics calculated from other surveys or for other states. A 2009 NHTS Update to this report is under way and select chapters are available for downloading (https://www.dot.ny.gov/divisions/policy-and-strategy/darb/dai-unit/ttss/nhts/2009-comparision-report).

Statewide Travel Surveys by State DOTs

The Ohio statewide model considers long-distance trips to be 50 miles or greater, excluding work tours (Ohio Department of Transportation, Report-Ohio-LongDistanceTravelModule-Extracted.pdf Section 4.7, LDT). Background information on the Ohio Long-Distance Travel Survey was provided in Section 2.5 of this report. Attention was focused on summary statistics that already were reported in available survey documentation. Section 2.5 provides graphs depicting the frequency of, and travel modes used in, long-distance trip-making based on the Ohio surveys. In addition to concerns over resource sufficiency to analyze additional state datasets using SAS as part of this research effort, there is the issue of whether or not a supplemental analysis of state DOT datasets would provide the same results as previously reported, due to weighting/expansion and tools used in the analysis.

The Ohio statewide travel survey documentation provided to the study team did include person trip rates per household (7.78) and person (4.94) for rural versus urban settings (7.56–8.76 per HH and 4.83–5.49 per person, depending on the specific urban area).

The survey documentation, however, does not include long-distance trip rates, trips by purpose, trip distribution factors, average trip lengths, mode splits, or auto occupancy rates. Beyond sociodemographic characteristics of survey respondents and the graphs and charts previously depicted in earlier chapters of this Guidebook, information was also provided on the number of stops (60.9 percent made stops) for long-distance trips and the percent of nonhome-based long-distance trips (53 percent).

Section 2.6 of this report provides background information on the Michigan surveys, including annual long-distance household trip rates (7.34 in 2004 and 6.25 in 2009), trip purposes, travel modes, and long-distance trip distribution by state. The difference between Michigan long-distance trip rates and those based on ATS (10.15) and 2001 NHTS (12.32) excluding 50–100 mile trips, indicate potential issues of transferability as long-distance trips were defined as 100 miles or greater in the Michigan surveys. Considerable information was provided in the Michigan documentation about trip characteristics that are more relevant to the discussion of rural trip rates in Chapter 3 of this report.

The Michigan statewide household survey documentation provided household person trip rates for different urban and rural stratifications. Table 4.5 depicts person trip rates per household for the first and second Michigan Travel Counts Surveys (2004 and 2009, respectively). Nonurbanized and rural household and person trip rates are depicted in bold underlined text,

Table 4.5. Michigan TCS rural versus urban household trip rates.

			HH Trip Rates		Person Trip Rates	
Sample Areas	**Households Weighted**	**Persons Weighted**	**Unweighted**	**Weighted**	**Unweighted**	**Weighted**
Estimated Number of HHs, Persons, and Trips by MTC I (2004)						
SEMCOG	1,846,277	4,638,216	9.09	9.14	3.62	3.64
Small Cities (0-50k pop)	**129,369**	**296,162**	**9.74**	**8.82**	**3.89**	**3.85**
Upper Peninsula Rural	**87,115**	**209,919**	**8.35**	**8.40**	**3.49**	**3.49**
Northern Lower Peninsula Rural	**206,210**	**501,075**	**8.08**	**7.96**	**3.30**	**3.27**
Southern Lower Peninsula Rural	**394,588**	**1,044,969**	**8.98**	**9.41**	**3.53**	**3.55**
TMAs	579,415	1,465,017	9.68	9.53	3.78	3.77
Small Urban Modeled Areas	545,557	1,360,511	9.29	9.39	3.75	3.77
State Total	3,788,531	9,515,870	9.05	9.17	3.63	3.65
Estimated Number of HHs, Persons, and Trips by MTC II (2009)						
SEMCOG	2,071,786	4,820,277	7.73	8.60	3.66	3.70
Small Cities (0-50k pop)	147,121	315,640	9.10	8.14	3.96	3.80
Upper Peninsula Rural	90,553	212,970	7.29	7.64	3.28	3.25
Northern Lower Peninsula Rural	218,238	520,125	7.32	7.93	3.30	3.33
Southern Lower Peninsula Rural	412,944	1,078,905	8.07	9.15	3.43	3.50
TMAs	622,928	1,519,419	8.34	8.83	3.65	3.62
Small Urban Modeled Areas	593,556	1,399,086	7.87	8.72	3.68	3.70
State Total	**4,157,125**	**9,866,421**	**7.97**	**8.63**	**3.57**	**3.64**

Source: Michigan Travel Counts Surveys.

Table 4.6. Travel day statistics from recent GPS-based surveys.

	Long-Distance		Rural		Urban	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Overall	68%	32%	77%	23%	79%	21%
Atlanta	66%	34%	75%	25%	79%	21%
Denver	72%	28%	78%	22%	80%	20%
Massachusetts	68%	32%	86%	14%	88%	12%
Chicago	64%	36%	73%	27%	75%	25%

Source: Geostats based on recent GPS-based travel surveys.

separately for small cities, upper peninsula, northern lower peninsula, and southern lower peninsula. With the exception of the more heavily populated southern lower peninsula, nonurbanized households exhibit lower weighted trip rates than urban households. This finding is somewhat contrary to the 2009 NHTS analysis in Appendix G, unless most of the Michigan urbanized household surveys were conducted in suburban settings, since suburban households showed higher trip rates than rural households in the 2009 NHTS. It is also worth noting that the differences found among nonurbanized areas of Michigan might indicate limitations to transferability.

Recent and Ongoing GPS Surveys in the United States

Table 4.6 depicts the split between weekend and weekday travel from recent GPS surveys described earlier in Section 2.3 of this Guidebook. These splits, after survey expansion, are similar in each survey. In all cases, as expected, the percent of weekend trips is highest for the long-distance trips (most 30 percent or higher) when compared against urban and rural travel.

Table 4.7 depicts four different trip/demographic measurements for each of the four surveys and overall, for the same three different geographic definitions found in the prior two tables. Daily trip production rates for long-distance trips are low, as expected. Rural trip production rates are substantially higher than urban rates for these four surveys, although the rates are comparable to analysis of 2009 NHTS, as described later in this chapter.

Table 4.7. Trips and households from recent GPS-based surveys.

	Number of Trips				Trip Production Rate			Average Household Size			Average Number of Vehicles/HH		
	Long Distance	Rural	Urban	All Trips	Long Distance	Rural	Urban	Long Distance	Rural	Urban	Long Distance	Rural	Urban
Overall	1,253	31,689	103,832	6.20	0.04	9.39	5.23	2.85	2.86	2.75	2.23	2.18	2.05
Atlanta	580	16,932	48,098	5.92	0.03	8.24	5.03	2.89	2.85	2.77			
Denver	395	9,836	31,377	6.11	0.04	9.42	4.85	2.77	2.81	2.68	2.22	2.16	2.07
Massachusetts	176	3,349	10,325	5.90	0.04	13.56	5.04	2.92	2.96	2.82	2.27	2.21	2.02
Chicago	102	1,572	14,032	7.89	0.05	8.86	7.05						

Source: Geostats based on recent GPS-based travel surveys.

Table 4.8. Canadian residents' long-distance trips by percent purpose.

Trip Duration: Total – Domestic Travel (Age 18+): Person Trips with the Destination in Canada

*** Row Percents ***	Total	Main Trip Purpose:			
Standard person trip stub variables >>> Final Data <<<		Pleasure, Vacation, Holiday	Visiting Friends or Relatives	Business and All Conferences or Conventions	Shopping and Other
Total Long-Distance Trips:	100.00%	36.99%	46.72%	5.40%	10.90%
Single-Day Long-Distance Trips	100.00%	34.43%	45.59%	5.14%	14.84%
Overnight Long-Distance Trips	100.00%	40.79%	48.41%	5.77%	5.03%

Source: Travel Survey of Residents of Canada.

2010 Travel Survey of Residents of Canada

As described in Appendix B, the Travel Survey of Residents of Canada (TSRC) is designed to measure the size and status of Canada's tourism industry at the national level. Through direct contact with Canadian officials, the research team was able to obtain a spreadsheet data analysis of the 2010 TSRC. Without direct access to the data, which would have required additional budget for purchasing data, this study was limited to information provided in this spreadsheet.

Table 4.8 depicts the percent of long-distance trips by purpose, with single-day travel separated from overnight travel. Although the trip purposes used in the TSRC are different from those found in the ATS, business-related trips are considerably less in the TSRC, at slightly more than 5 percent, versus the ATS at 22 percent. These statistics are from fully weighted survey data; however, without additional analysis, it is unclear whether the lower percent is a function of sampling or that long-distance business travel is considerably less common than in the United States.

4.2 Analytical Approach to Estimating Long-Distance and Rural Trip Generation Parameters and Benchmarks

One key to implementing the analytical plan and developing transferable parameters was to obtain access to all datasets from the American Travel Survey (ATS) and identify trip purposes, average trip lengths, vehicle occupancies, and other statistics typified by long-distance travelers. The 1995 ATS datasets are dated; however, these data are the only long-distance data that provide statistically sound estimates of long-distance travel in and between the states.

Although the 2001 National Household Travel Survey (NHTS) had a long-distance component, this survey did not have sufficient samples to calculate estimates of long-distance travel for most states (New York and Wisconsin were exceptions to this, because of the large Add-On in the former and stratified sampling of the latter, although neither Add-On was included in the official 2001 NHTS long-distance file). The approach to using NHTS 2001 data was based on discussions with FHWA NHTS support staff, both past and present, as well as members of the research team with extensive experience using different versions of the NHTS. All of these discussions pointed to concerns over the use of NHTS 2001 for long-distance trips and at least some of these concerns are documented elsewhere in this report. All of the NHTS 2001 long-distance data, including state Add-On samples, were made available for use by the research team as well.

These two long-distance datasets can be used together, yet separately, since the 2001 questionnaire relied heavily on the 1995 ATS as a template. Definitional categories for mode and purpose are comparable. The study team also obtained readily available state DOT survey data and documentation from statewide household travel surveys for Michigan and Ohio. The research team also coordinated with Canadian officials to identify available long-distance travel parameters readily available from their recent household travel surveys. Finally, recent travel surveys using Global Positioning Systems (GPS) were mined for parameters on long-distance travel as well as rural parameters.

Transferable rural travel parameters largely focused on the 2009 NHTS and its state Add-On surveys. Analysis of variance (ANOVA) and other statistical tests were run on 2009 NHTS data in an attempt to identify which available attributes best explain differences in rural trip-making and whether certain parameters should be stratified for different conditions such as urban clusters and proximity to urbanized area boundaries.

Existing statewide models also played a significant role in this analytical plan, in terms of quantifying reasonableness ranges against which to compare resulting ATS/NHTS survey-based model parameters. Also, documented model parameters were identified for potential transferability to other statewide models, based on the characteristics of the state where the data were collected versus the state to which a parameter might be proposed for transferability. Interregional or intercity travel components are included in some statewide models to capture both intrastate and interstate trips. The core model design feature is the recognition that interregional travel is very different from urban area travel, where different sets of explanatory variables or different sensitivities to levels of service are involved.

A set of typical long-distance and rural trip purposes was established from this analysis so that model parameters could be stratified by such categories and reasonableness benchmarks could be established for percent trips by purpose. Mean trip length statistics, both in miles and minutes, also were estimated from the survey databases for use as benchmarks in future statewide model validation efforts; however, the survey analysis for this study did not include the calculation of state-by-state trip lengths.

As discussed previously, statewide models and travel surveys have used a range of thresholds to define long-distance trip-making. Most sources cited in this study used either 50, 75, or 100 miles as the minimum threshold for trips to be considered "long-distance." In an effort to maximize the number of long-distance trip samples, this report looks at model parameters at three different long-distance trip thresholds: 50–100 miles, 100–300 miles, and more than 300 miles. By separating out 50–100 mile trips from 100–300 miles, this allows for differentiation of long-distance trips by the two most common thresholds, beginning and ending at 100 miles. The rationale for using 300 miles as another cutoff point is that preliminary data analysis indicated a mode shift from personal auto to air travel at this distance. The remainder of this section of the chapter on trip generation focuses on the data sources used for parameter estimation, along with some general comparisons among sources.

American Travel Survey (ATS)

As stated elsewhere, the 1995 ATS is still seen as the most robust sample of long-distance travel behavior, in spite of its age. The ATS was entirely focused on long-distance travel, unlike the 2001 NHTS, which also surveyed typical daily urban and rural travel patterns. There are numerous ways to analyze the data. For this study, household frequencies and statistical means were calculated separately for all households and per capita as well. Trip rates and frequencies also were calculated separately for annual and daily conditions. The reason for this is that long-distance trips are not an “every day” occurrence for most households. Trip rates were initially calculated on an annual basis using the ATS and then divided by 365 to provide daily trip rates as an option for users of this report. Since the ATS reported annual trips, long-distance trip characteristics in this Guidebook are likewise summarized as annual trips.

Another consideration was whether to include weekdays and/or weekends, of which both were calculated. According to available documentation on the ATS “each trip was classified as a weekend trip or as not a weekend trip. A weekend trip is a trip of one to five nights, including a Friday and/or Saturday night stay. Travelers who stay one or two nights away, including a Friday or Saturday night are defined as regular weekend travelers. Those who stay three to five nights away, including a Friday and/or Saturday night stay are defined as long weekend travelers” (http://www.bts.gov/publications/1995_american_travel_survey/an_overview_of_the_survey_design_and_methodology/index.html). Based on this description it was not practical to summarize only weekday trips because some of the “weekend” trips were partially “weekday” trips. Furthermore, analysis of weekday-only trips resulted in a dramatic drop in long-distance trip rates that would be inconsistent with results from other long-distance surveys. Therefore, long-distance trip statistics found in this report include both weekday and weekend trips.

Cross-classification was used to evaluate different attributes against one another, as well as to calculate trip rates based on socioeconomic characteristics. The latter used household size by income, which is consistent with one cross-classification scheme used and documented in the previously referenced *NCHRP Report 716* on urban transferable parameters.

It is important to note that the ATS did not include trips of 50–100 miles in length, and so there are no 50- to 100-mile trips in the ATS statistical tables in this chapter. Statistics reported in the next section on parameters from the 2001 NHTS do include 50- to 100-mile trips, consistent with the lower long-distance trip threshold used in that survey. Statistics for 50- to 100-mile trips are presented only for analysis of the 2001 NHTS survey.

Table 4.9 is an assessment of household trip rates by trip purpose and the relevant trip distance categories noted earlier. As shown in this table, a typical household generates 10.15 trips of over 100 miles, or 0.0278 daily long-distance trips (annual trip rate divided by 365 days). Trips were grouped into three purposes: business, pleasure, and personal business. Pleasure trips had the highest average trip rate for all three distance categories while the majority of trips were 100–300 miles for all trip purposes.

Table 4.10 compares trip rates by household income level and mileage range. A review of this table shows that the highest-income group has the greatest long-distance trip rate for both mileage categories. Trip rates show that the propensity of making long-distance trips, and the length of those trips, has a lot to do with household income.

Table 4.9. ATS annual trip rates by distance/purpose, round-trip.

	Purpose	-300 miles	> 300 miles	Total
01	Business	1.37	0.91	2.28
02	Pleasure	4.08	2.13	6.21
03	Personal Business	1.19	0.47	1.66
	Total	6.64	3.51	10.15

Source: 1995 ATS.

Table 4.10. ATS annual trip rates by distance/income, round-trip.

	Income	-300 miles	> 300 mi	Total
01	$0-$24,999	2.97	1.30	4.27
02	$25,000-$99,999	8.48	4.34	12.82
03	$ 100,000+	13.78	12.49	26.26
	Total	**6.64**	**3.51**	**10.15**

Source: 1995 ATS.

Table 4.11 provides information from the 1995 ATS on weekday versus weekend long-distance travel based on three trip purposes. Not surprisingly, business and personal business trips are less likely to occur on weekends when compared to pleasure trips, of which over 50 percent involve weekend travel. As noted earlier, some portion of the "weekend" trips in fact take place on weekdays, and so the term "not weekend" was chosen instead of "weekday." Simply put, the "not weekend" trips are those that take place entirely on weekdays, with no portion of the long-distance trip taking place on a weekend.

Table 4.12 presents the number of long-distance intermediate stops by trip/tour purpose. More than 90 percent of long-distance trips did not include any stops. The percent of intermediate stops is highest for business trips and lowest for personal business trips. The trip, including all intermediate stops, could be analogous to the concept of a trip tour.

2001 National Household Travel Survey

The 2001 NHTS database also was used to develop long-distance model parameters and benchmarks similar to those produced using the 1995 ATS. A primary reason for developing these statistics using the 2001 NHTS was to overcome concerns about the age of the 1995 ATS data. Use of the 2001 NHTS was considered acceptable for long-distance analysis because this survey included a targeted sample of long-distance trips, unlike the more recent 2009 NHTS database. Unfortunately, there are several shortcomings with the 2001 long-distance survey component, including the following:

- Much lower response rate using a telephone survey approach for the 2001 NHTS versus the panel survey approach used in the 1995 ATS;
- Shorter recall period of the 2001 NHTS also resulted in a much smaller sample size of long-distance trip-makers (45,000 in 2001 NHTS versus 550,000 in 1995 ATS);

Table 4.11. ATS annual frequency by purpose/weekend trip, *round-trip.*

	Purpose	Not Weekend	Weekend	Total	Percent Weekend
01	Business	85,261	33,910	119,171	28.45%
02	Pleasure	156,188	159,595	315,783	50.54%
03	Personal Business/Other	67,097	33,469	100,566	33.28%
	Total	**308,546**	**226,974**	**535,520**	
	Trip %	58%	42%	100%	

Source: 1995 ATS.

Table 4.12. Annual frequency by stops from destination/purpose, round-trip.

	Purpose		2	3	4	Total	Percent Stop/ Purpose
01	Business	106,212	2,059	7,515	3,385	119,171	10.87%
02	Pleasure	293,727	8,243	8,412	5,401	315,783	6.98%
03	Personal Business	94,888	2,470	1,998	1,210	100,566	5.65%
	Total	**494,827**	**12,772**	**17,925**	**9,996**	**535,520**	**7.60%**
	Percent Stops by Number	92.40%	2.38%	3.35%	1.87%	100.00%	

Source: 1995 ATS.

- The impacts of 9/11 on travel resulted in a much lower share of air travel in the 2001 NHTS when compared against the 1995 ATS; and
- Thresholds used to define long-distance trips differ between the two surveys with 1995 ATS defined as 100 miles or greater and 2001 NHTS as more than 50 miles.

Chapter 2 of this Guidebook described the latter difference as a potential strong point of NHTS 2001 as a way of obtaining information on these mid-range 50–100 mile trips. Analysis of 2001 NHTS long-distance trip data showed a sizeable sample of 50–100 mile trips (21,500 out of 45,000 trips, or nearly 48 percent of the 2001 NHTS long-distance sample), such that exclusion of these trips for NHTS 2001 statistics would be problematic. Hence, 50–100 mile trips were included for NHTS 2001 analyses.

Table 4.13 depicts annual long-distance household trip rates from the 2001 NHTS, including 50–100 mile trips. The overall trip rate (excluding the 50–100 mile trips) is 12.32, about 21 percent higher than the 1995 ATS trip rate of 10.15. The patterns within the cross-classification table are relatively similar between the two surveys (i.e., which cells have higher or lower rates than others).

It is worth noting that the percentages of trips by purpose are somewhat similar between the two long-distance surveys, as follows:

- Business—28.38 percent for NHTS 2001 versus 22.25 percent for ATS;
- Pleasure—54.84 percent for NHTS 2001 versus 58.97 percent for ATS; and
- Personal Business—16.78 percent for NHTS 2001 versus 18.78 percent for ATS.

Rural Typologies

Identification of rural travel parameters took a different focus than long-distance travel parameters. First, rural trip-making data are well represented in the recent 2009 NHTS. Therefore, the

Table 4.13. 2001 NHTS annual trip rates by distance/purpose.

	Purpose	50-100 Miles	100-300 Miles	> 300 Miles	Total
01	Business	4.04	1.85	0.97	6.85
02	Pleasure	5.71	5.08	2.39	13.17
03	Personal Business/Other	1.78	1.52	0.52	3.83
	Total	**11.53**	**8.45**	**3.87**	**23.85**
				100+ Mile Trip Rate	**12.32**

Source: 2001 NHTS.

research team was able to focus primarily on this one survey database, unlike the multiple and considerably older survey databases used to identify long-distance travel parameters. Second, the points of reference are quite different for rural trips. Long-distance travel characteristics were generally summarized by different trip length categories, whereas rural travel parameters required establishing typologies for classification and comparison against comparable statistics on travel in urbanized areas. Finally, the temporal issues for rural travel are not as complex as long-distance trips. For example, the database does not deal with international travel or multiple stops, and the greater share of travel is on the weekdays, with a much smaller share of weekend travel than with long-distance trips.

The first step in the assessment of rural travel parameters was the identification of rural typologies and an exploration of how these different typologies can be used to describe the trip-making of rural households. This also includes the need to define what is and is not rural travel and how typical rural travel behavior differs from that in more urban settings. These efforts started with a focus on attributes contained within the NHTS 2009 "DOT version" of the database, including the Claritas attributes described earlier in this Guidebook.

The following similar, yet not identical, attributes from the 2009 NHTS DOT version were used to identify potential rural typologies:

- URBAN—Identifies whether or not the home address is located in an urban area, typically defined as a concentrated area with a population of 50,000 or greater;
- URBRUR—Identifies whether or not the home address is located in a rural area;
- URBANSIZE—Population size of the urban area in which the home address is located;
- HBHUR—Urban/Rural Indicator, appended to the NHTS by Claritas (http://nhts.ornl.gov/2009/pub/UsersGuideClaritas.pdf)—this classification reflects the population density of a grid square into which the household's block falls;
- HBRESDN—The number of housing units per square mile by block group; and
- HBPOPDN—The population per square mile by block group.

Additionally, the rural typologies recommended as part of NCHRP Project 25-36, "Impacts of Land Use Strategies on Travel Behavior in Small Communities and Rural Areas" and described earlier also were considered in this effort. The four typologies recommended by NCHRP Project 25-36 were as follows, along with the study definitions of each, as quantified by "commuting zones" developed by the USDA's Economic Research Service:

- **Population Density—**Computed as number of people divided by unit area of developed or developable land;
- **Road Density—**Calculated as road length in miles per square mile of developed or developable land;
- **Land-Use Mixture—**A proxy of land-use mixture measuring how residents, jobs, and other activities are distributed in relation to each other; and
- **Variation in Population Density—**Variation in population density distinguished where most residents are located in a relatively small set of concentrated areas at relatively high densities from locations where residents are spread more evenly.

This project did not pursue full consideration of commuting zones, which are defined in NCHRP Project 25-36 as "multicounty regions that convey the typical pattern of commuting trips in a spatially defined labor market: a much higher proportion of commuting trips have origins and destinations that are both inside the zone than those trips for which one end is outside" (Department of City and Regional Planning Center for Urban and Regional Studies, University of North Carolina at Chapel Hill, 2011).

In place of data on commuting zones, the analysis presented here uses readily available data to simulate some of these typologies. Population Density already was an attribute included in the 2009 NHTS dataset so it was easily addressed. Road Density was calculated using the 2005 National Highway Planning Network and geographic information systems (GIS) tools, based on a simple formula of Road Length/Census Tract Area. The resulting Road Density was a continuous variable, so a regression analysis was conducted and then the variable was re-coded as a categorical variable. There was no practical way to simulate land-use mixture or the variation in population density using the data readily available for this project.

One additional typology analyzed was "urban proximity" because the NCHRP Project 8-84 research team thought that the proximity to urban areas could impact the number and purpose of trips. Latitude/longitude address information was not stored for each household in the 2009 NHTS DOT database, which is necessary for accurate depiction in GIS. The database did have Census tract and block group information, and this information was appended to an NHTS Census tract/block group shapefile. Once the 2009 NHTS DOT database was joined to the NHTS CT/BG shapefile by a block group ID number, the households were spatially referenced to the block group. Figure 4.1 depicts a map of concentric rings formed during the proximity analysis, zoomed into north Florida/south Georgia, as an example. In cases where a block group was in proximity to multiple urban areas, distance to the closest urban area was applied. Unfortunately, Proximity to Urban Area did not show any clear trip rate trend, and so the analysis focused on the other measures.

As noted previously, while it would have been ideal to use a national land coverage database to identify subcategories of rural areas such as exurban, agricultural, and recreational, the research

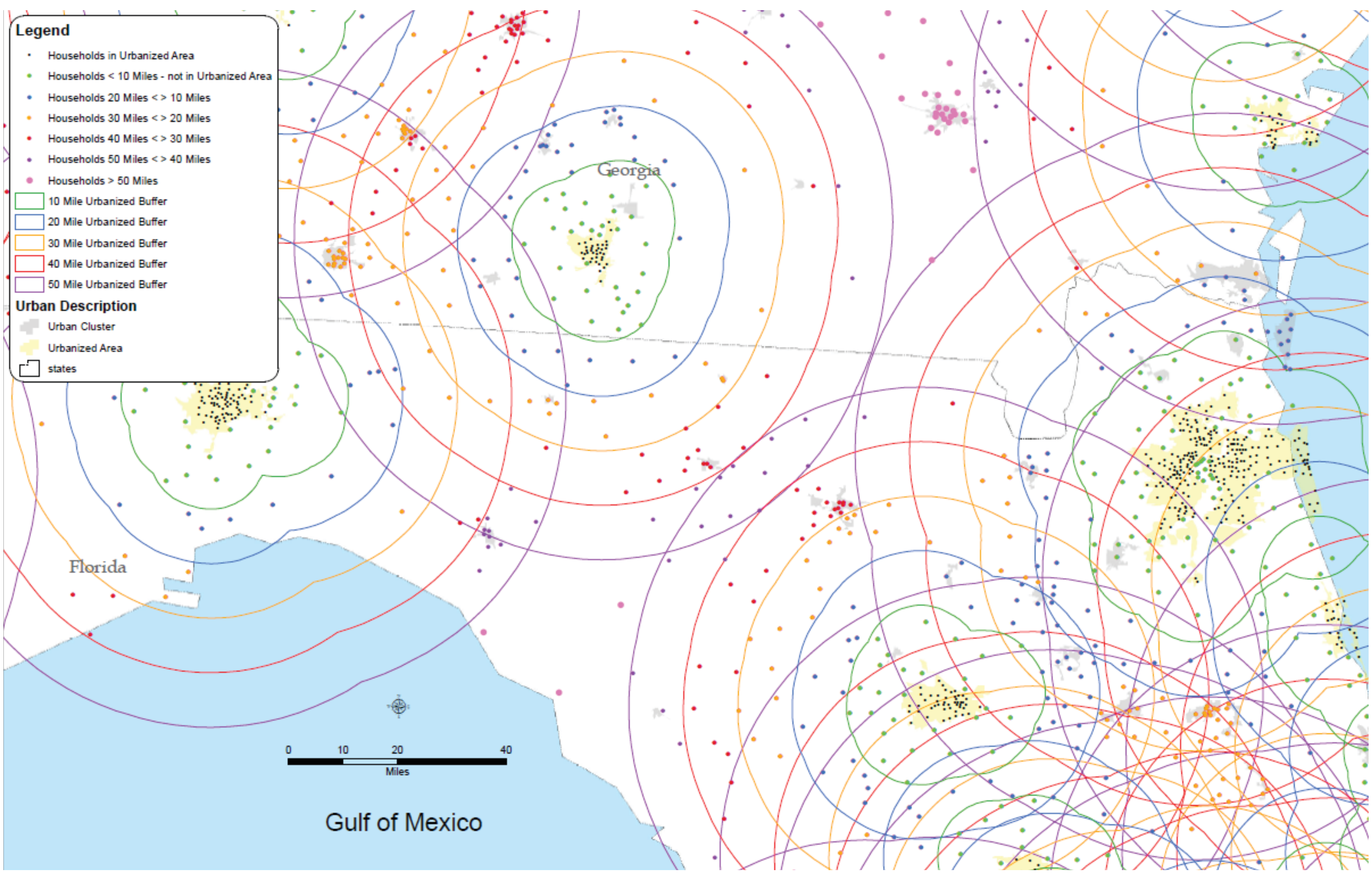


Figure 4.1. Example map depicting proximity to urban area.

team had concerns over how to define and classify rural areas. It was thought that proximity to urbanized area, residential density, and roadway density allowed for a more objective classification of rural households.

In order to narrow the number of rural typologies used in recommending transferable rural parameters, analysis of variance (ANOVA) and t-tests were conducted on each of the typologies discussed below. The trending of trip rates up or down in relation to different settings for each attribute also was reviewed to further ascertain the explanatory power of each typology variable. In some cases, the number of categories was narrowed to assess the viability of each. Appendix G includes a separate page for each typology variable, along with t-test values for each category, analytical and trend observations, and revisions to the number of categories for each attribute.

Four typologies were subsequently recommended for the purposes of calculating transferable rural trip production rates. These four typology variables were as follows:

1. **HBHUR—**Urban/Rural Indicator reflecting population density of a grid square;
2. **URBAN—**Whether or not the home address is located in an urban area;
3. **URBRUR—**Whether or not the home address is located in a rural area; and
4. **HBRESDN—**Number of housing units per square mile by block group.

Table 4.14 depicts how these typology attributes could interact and be cross-classified into three dimensions for trip generation, focusing on the first three attributes to deal with different geographies and the latter, housing units per square mile (HBRESDN), being applied against all rural and urban categories. The number of 2009 NHTS household samples by row and column also is provided in parentheses. Cells with "N/A" represent combinations of three attributes that should not exist. For example, rural areas should not also be classified into suburban, second city, or urban. This approach is further refined into a set of trip production rates cross-classified by socioeconomic household characteristics, and specified by trip purpose, as described in a later section of this chapter.

2009 National Household Travel Survey

With its large sample size of rural households, the 2009 NHTS was the principal source of rural travel model parameters described in this study. Based on the rural typology analysis described in the previous section, four trip production cross-classification matrix sets were prepared. As with long-distance rates, socioeconomic data used in the cross-classification scheme are income (three categories) by household size (five categories). Each set includes separate trip rates for home-based work, home-based nonwork, and nonhome-based purposes, as well as separate rates for each substrata included with the typology. The substrata for each cross-classification set are depicted below (the underlined strata reflect the rural components/subsets of each set):

- **HBHUR—**Town and Country, Suburban Areas, Secondary City, Urban All;
- **URBAN—**Not in Urbanized Area, Urbanized Area;
- **URBRUR—**In Rural Area, In Urban Area; and
- **HBRESDN—**Low Density (0–999 units/square mile), Medium Density (1,000–9,999 units/square mile), High Density (10,000+ units/square mile).

Although the definition of what is predominantly rural changes from one attribute/set to another, if the underlined categories above are compared, there is little difference in the trip rates. For example, the total number of person trips per household for all trip purposes is 9.72 for URBRUR, 9.83 for URBAN, and 9.56 for HBHUR. A more significant difference is shown using HBRESDN with a total trip rate of 11.76, although it is not clear how much of this lower housing unit density category consists of rural households. Appendix H depicts trip rates for

Table 4.14. Recommended rural typology variables.

		HBRESDN		
		Housing units per sq mile – Block group		
URBRUR	**URBAN**	**0-999 (75,937)**	**1,000-9,999 (52,450)**	**10,000-999,999 (2,120)**
Household in urban/rural area	**Home address in urbanized area**			
Rural (38,014)	Not in an urban area (38,014)			
	(In an urban cluster – placeholder)	N/A	N/A	N/A
Urban (92,493)	In an urban area (79,569)			
	In an area surrounded by urban areas (51)[a]			
	In an urban cluster (12,873)			
Household in urban/rural area	**Urban/Rural indicator – Block group**			
Rural (38,014)	Town and Country (38,014)			
	Suburban (N/A)	N/A	N/A	N/A
	Second City (N/A)	N/A	N/A	N/A
	Urban (N/A)	N/A	N/A	N/A
Urban (92,493)	Town and Country (24,227)	N/A	N/A	N/A
	Suburban (30,491)			
	Second City (23,550)			
	Urban (14,225)			
Size of urban area in which home address is located	**Urban/Rural indicator – Block group**			
Not in an urbanized area (50,938)	Town and Country (50,938)			
	Suburban (N/A)	N/A	N/A	N/A
	Second City (N/A)	N/A	N/A	N/A
	Urban (N/A)	N/A	N/A	N/A
All other categories combined – AKA urbanized (79,569)	Town and Country (11,303)	N/A	N/A	N/A
	Suburban (30,491)			
	Second City (23,550)			
	Urban (14,225)			

Note: Numbers in parentheses represent 2009 NHTS sample sizes for each category. Sample size numbers were found to be somewhat inconsistent among different urban/rural attributes and categories. "N/A" reflects an attribute combination that does not exist/would be illogical.

[a] Probably should merge with "In an urban area" due to small sample size.

each category of every variable analyzed for estimating transferable trip production rates. The tables in Appendix H include both rural and urban trip rates using definitions unique to each attribute/rate set.

4.3 Long-Distance Trip Generation Model Parameters

For the purposes of recommending transferable long-distance parameters, it was decided to focus on the 1995 ATS due to its larger sample size and based on the similarity of trip frequencies by purpose between the ATS and 2001 NHTS long-distance component.

Although there are a multitude of ways these parameters can be summarized, this report uses the following considerations in reporting long-distance model parameters:

- Include all days of the week (weekends and weekdays);
- Report parameters on an annual (rather than daily) basis;
- Exclude trips less than 100 miles in length;
- Limit analysis to domestic travel (no international trips); and
- Report at the household level rather than person level (per capita rates).

The primary reason for including weekday *and* weekend travel is that ATS weekend travel includes weekday trips that include a weekend component. Furthermore, average annual daily traffic (AADT), by definition, includes both weekdays and weekends. Annual, rather than daily, trips are reported because this is how ATS trips were reported. Trips less than 100 miles in length were excluded because the ATS did not include these trips. International travel was excluded because these trips are not included in most statewide passenger models and these trips tend to skew trip length. Finally, household, rather than per capita, trip rates were selected because these are more commonly found in four-step travel demand models.

All transferable parameters are calculated for the predominant three trip purposes (Business, Pleasure, and Personal Business) and total trips (All Purposes). The transferable parameters are described below and in subsequent chapters by model step.

Trip Generation: Long-Distance Person Trip Production Rates

For transferable long-distance trip production rates, it was decided to cross-classify socio-economic characteristics of each household in a comparable manner to *NCHRP Report 716*. The recommended cross-classification scheme for long-distance trip production rates is household income by household size. The correlation between income and long-distance trip-making is significant.

For the purposes of cross-classification, household size is stratified into five categories, similar to *NCHRP Report 716,* whereas household income was collapsed into three categories. It also was decided to report annual trip rates since daily and monthly trip rates resulted in very low values.

Table 4.15 depicts recommended long-distance person trip production rates for the three trip purposes. Since this study is primarily focused on passenger travel, the reader should refer to *NCHRP Report 716* for a summary of sample truck trip generation rates derived from multiple sources. Appendix E of this report also provides metrics on rural versus urban truck travel.

4.4 Rural Trip Generation Model Parameters

All rural travel parameters summarized in this section of the report were derived from statistical analysis of 2009 NHTS datasets. As with long-distance parameters, the rural parameter discussion is divided into separate chapters reflecting each step in the typical model chain.

Table 4.15. Annual long-distance person trip production rates.

Income by HH Size		1	2	3	4	5+	Total
Business Trip Rates by Household Size/Income							
01	<$25,000	0.44	0.80	0.88	0.99[a]	1.59	**0.66**
02	$25,000-$99,999	2.34	2.62	2.97	3.24	3.80	**2.90**
03	$100,000+	3.70	8.00[a]	8.20[a]	8.40[a]	8.54	**8.61**
	Total	**0.99**	**2.35**	**2.70**	**3.24**	**3.51**	**2.28**
Pleasure Trip Rates by Household Size/Income							
01	<$25,000	1.70	3.49	3.50[a]	5.10	5.15	**2.77**
02	$25,000-$99,999	3.88	6.70	8.42	9.77	11.93	**7.84**
03	$100,000+	4.76	11.51	14.15	18.91	21.27	**14.59**
	Total	**2.32**	**6.03**	**7.48**	**9.46**	**10.77**	**6.21**
Personal Business Trip Rates by Household Size/Income							
01	<$25,000	0.41	1.12	1.16	1.51	2.05	**0.84**
02	$25,000-$99,999	1.03	1.63	2.15	2.66	3.75	**2.08**
03	$100,000+	0.46	2.56	2.78	3.99	4.79	**3.07**
	Total	**0.58**	**1.53**	**1.94**	**2.53**	**3.38**	**1.66**
Total Annual Trip Rates by Household Size/Income							
01	<$25,000	2.54	5.41	5.48	7.28	8.79	**4.27**
02	$25,000-$99,999	7.25	10.95	13.54	15.67	19.48	**12.82**
03	$100,000+	8.92	22.87	24.72	34.03	34.60	**26.26**
	Total	**3.89**	**9.91**	**12.12**	**15.22**	**17.66**	**10.15**

[a] Indicates where estimated trip rates were manually adjusted and smoothed.

Trip Generation: Rural Trip Production Rates

From each of the four trip rate stratifications described in Section 4.2, URBAN showed the fewest trip rate anomalies (cells having higher or lower trip rates than expected compared to adjacent cells). Table 4.16 depicts unchained rural trip rates using URBAN as the 2009 NHTS attribute to differentiate between rural and urban households. Only two minor anomalies were identified in this table. HBW trip rates for highest-income four-person households and NHB 5+ person households were initially lower than found in adjacent trip rate cells (those with lower-income or household size). Rates were subsequently adjusted and smoothed for these two cells.

The resulting total person trip rate per rural household using the URBAN attribute is 10.06, as opposed to an urbanized area trip rate of 9.91 as depicted in Appendix H. Urbanized area trip rates do vary by subcategory, such as secondary cities (9.50), suburban (10.34), and nonsuburban or second city urbanized (9.36). Some of these differences could possibly be minimized through testing of alternate socioeconomic cross-classification schemes. Trip rate comparisons found in Appendix G show a strong correlation between housing density and trip rates, with lowest housing density trip rates being the highest at 9.60 and highest density housing trip rates the lowest at 7.77. In theory, opportunities for mixed-use development are more prevalent in higher density areas, thus reducing the trip rate, as opposed to lower density areas where mixed uses are less common, resulting in more trip-making to satisfy household needs. It is also possible that some of these differences might be explained by differences in household size, with testing of alternative cross-classification schemes.

Table 4.16. Rural person trip production rates: HH size by income, URBAN attribute identifies rural HHs.

HH Person Trip Rates: In Other (Rural) Areas, All Trip Purposes

Trip Rates	HH Size					
Income	**1**	**2**	**3**	**4**	**5+**	**Total**
Less than $25,000	2.8	6.4	9.9	15.0	15.6	6.8
$25,000-$99,999	4.2	7.9	12.8	17.5	22.1	10.2
Above $100,000	5.1	8.8	14.0	20.1	26.2	14.0
Total	**3.6**	**7.8**	**12.5**	**18.0**	**20.9**	**10.0**

In Other (Rural) Areas HBW

Trip Rates	HH Size					
Income	**1**	**2**	**3**	**4**	**5+**	**Total**
Less than $25,000	0.2	0.8	1.3	1.5	1.7	0.7
$25,000-$99,999	0.7	1.2	2.1	2.4	2.5	1.5
Above $100,000	0.9	1.6	2.3	2.4[a]	2.6	1.9
Total	**0.5**	**1.2**	**2.0**	**2.2**	**2.3**	**1.4**

In Other (Rural) Areas HBNW

Trip Rates	HH Size					
Income	**1**	**2**	**3**	**4**	**5+**	**Total**
Less than $25,000	1.6	3.8	5.9	9.7	10.8	4.2
$25,000-$99,999	1.9	4.0	6.8	10.1	13.8	5.6
Above $100,000	2.2	4.0	7.2	11.4	15.2	7.4
Total	**1.8**	**4.0**	**6.7**	**10.4**	**13.1**	**5.6**

In Other (Rural) Areas NHB

Trip Rates	HH Size					
Income	**1**	**2**	**3**	**4**	**5+**	**Total**
Less than $25,000	0.8	1.7	2.6	3.8	4.0[a]	1.7
$25,000-$99,999	1.5	2.6	3.9	4.9	5.7	3.1
Above $100,000	1.9	3.1	4.4	6.4	8.3	4.6
Total	**1.3**	**2.5**	**3.8**	**5.2**	**5.4**	**3.0**

Source: 2009 NHTS.

[a] Indicates where estimated trip rates were manually adjusted and smoothed.

Cross-classification matrices are also provided for auto availability and number of workers, consistent with cross-classification schemes documented in *NCHRP Report 716*. Rural trip production rates for auto availability by household size are found in Table 4.17, while number of workers by household size are depicted in Table 4.18.

Overall, Table 4.17 (auto availability) has slightly lower total weekday trip rates than Table 4.16 (income). There are only three instances where the reverse is true, households with 5+ members for all purposes and NHB; and households with 3 members for HBW. Whereas Table 14.12 produced four trip rate anomalies, there are only two small anomalies in Table 14.13, depicted in underlined italics.

Table 4.17. Rural person trip production rates: HH size by auto availability, URBAN attribute identifies rural HHs.

In Other (Rural) Areas, All Trip Purposes

Trip Rates	HH Size					
Autos/HH	1	2	3	4	5+	Total
0 Veh	2.3	6.2	9.1	12.0	13.5	4.9
1 Veh	3.8	6.9	11.4	14.4	15.8	6.4
2 Veh	4.6	7.9	12.4	18.2	21.4	11.8
3+ Veh	4.6	8.1	13.8	19.5	25.1	15.3
Total	**3.6**	**7.6**	**12.4**	**17.8**	**20.9**	**9.7**

In Other (Rural) Areas HBW

Trip Rates	HH Size					
Autos/HH	1	2	3	4	5+	Total
0 Veh	0.2	0.7	1.2	1.1	1.2*	0.5
1 Veh	0.5	0.8	1.2	1.5	1.4	0.8
2 Veh	0.6	1.4	2.0	2.1*	2.2	1.6
3+ Veh	1.0	1.5	2.6	3.0	3.3	2.5
Total	**0.5**	**1.2**	**2.0**	**2.2**	**2.3**	**1.3**

In Other (Rural) Areas HBNW

Trip Rates	HH Size					
Autos/HH	1	2	3	4	5+	Total
0 Veh	1.3	3.7	5.7	7.9	9.9	3.1
1 Veh	1.8	3.8	6.7	9.0	11.1	3.6
2 Veh	2.2	3.9	6.5	10.7	13.4	6.5
3+ Veh	2.3	3.9	7.1	10.8	14.6	8.3
Total	**1.7**	**3.9**	**6.7**	**10.4**	**13.1**	**5.4**

In Other (Rural) Areas NHB

	HH Size					
Autos/HH	1	2	3	4	5+	Total
0 Veh	0.7	1.7	2.2	2.9	3.0*	1.2
1 Veh	1.3	2.2	3.4	3.8	3.9*	2.0
2 Veh	1.7	2.5	3.8	5.4	5.7	3.6
3+ Veh	1.2	2.6	4.0	5.7	7.0	4.5
Total	**1.2**	**2.4**	**3.7**	**5.2**	**5.4**	**2.9**

Source: 2009 NHTS.

* Indicates where estimated trip rates were manually adjusted and smoothed.

Table 4.18. Rural person trip production rates: HH size by number of workers, URBAN attribute identifies rural HHs.

In Other (Rural) Areas, All Trip Purposes

Trip Rates	HH Size					
HH Size	1	2	3	4	5+	Total
0 worker	2.796	5.863	8.456	11.721	12.494	4.952
1 worker	4.249	7.436	11.247	15.733	18.245	8.750
2 worker	0.000	9.438	14.136	19.545	23.806	14.610
3+ worker	0.000	0.000	16.316	23.564	27.678	22.544
Total	**3.605**	**7.607**	**12.452**	**17.868**	**20.962**	**9.783**

In Other (Rural) Areas HBW

Trip Rates	HH Size					
HH Size	1	2	3	4	5+	Total
0 worker	0.003	0.011	0.009	0.049	0.074	0.010
1 worker	0.966	1.148	1.298	1.460	1.500*	1.166
2 worker	0.000	2.403	2.752	2.665	2.688	2.580
3+ worker	0.000	0.000	4.993	4.808	5.414	5.063
Total	**0.539**	**1.211**	**2.026**	**2.226**	**2.342**	**1.378**

In Other (Rural) Areas HBNW

Trip Rates	HH Size					
HH Size	1	2	3	4	5+	Total
0 worker	1.931	4.088	5.603	8.807	9.688	3.483
1 worker	1.691	3.914	6.650	9.646	11.975	4.878
2 worker	0.000	3.825	7.125	11.152	15.113	7.655
3+ worker	0.000	0.000	6.637	11.773	14.417	10.963
Total	**1.797**	**3.937**	**6.700**	**10.434**	**13.139**	**5.453**

In Other (Rural) Areas NHB

	HH Size					
HH Size	1	2	3	4	5+	Total
0 worker	0.862	1.764	2.844	2.865	2.900*	1.459
1 worker	1.593	2.374	3.299	4.628	4.832	2.706
2 worker	0.000	3.211	4.259	5.728	6.005	4.376
3+ worker	0.000	0.000	4.687	6.983	7.847	6.518
Total	**1.269**	**2.459**	**3.726**	**5.209**	**5.482**	**2.951**

Source: 2009 NHTS.

* Indicates where estimated trip rates were manually adjusted and smoothed.

Table 4.19. Rural trips by purpose.

Typology/NHTS 2009 Attribute	URBANR – Other (Not Urbanized)		HBHUR – Town and Country		HBRESDEN – 0-999 Units/ Square Mile		URBRUR – Rural Areas		Average
Trip Purpose	No. of Trips	%	No. of Trips	%	No. of Trips	%	No. of Trips	%	%
Rural Home-Based Work	63,057	11.82		12.03	23,194	12.60	29,983	12.26	12.06
Rural Home-Based Nonwork	308,005	57.74	218,398	54.41	96,301	52.31	129,875	53.09	55.19
Rural Nonhome-Based	162,405	30.44	134,711	33.56	64,619	35.10	84,761	34.65	32.74
Non Urban Totals – All Purposes	533,467	100.00	401,388	100.00	184,114	100.00	244,619	100.00	100.00

Source: 2009 NHTS.

The percentage of rural trips by purpose could be a useful statistic for use in model validation and reasonableness checking. Assuming the weighted number of surveys for 2009 NHTS adequately reflects the share of rural versus urban trips, the percentage of rural trips by purpose has been summarized in Table 4.19. Since the definition of rural varies somewhat from one NHTS attribute/typology to another, the number and percentage of trips by purpose was estimated for each of these typologies and subsequently averaged. Regardless of the attribute used to identify rural households, the results show a considerably smaller percentage of home-based work trips than commonly found in urban areas. This is not entirely surprising in a population that generally consists of a higher-than-average share of farmers, retirees, and unemployed, as well as above average household sizes (http://205.254.135.7/emeu/recs/recs2005/hc2005_tables/hc3demographics/pdf/tablehc8.3.pdf).

CHAPTER 5

Trip Distribution Parameters and Benchmark Statistics

The discussion on Trip Distribution will focus largely on the process of developing friction factor gamma functions and trip length frequency distribution curves from travel survey data, how a transferable set of friction factors was developed for this study, and provision of transferable friction factor gamma functions along with guidance on which to use and when. Benchmark statistics will also be provided on average trip lengths by purpose for rural and long-distance travel. Additional guidance will be provided on the variability of mean trip length and how to normalize distribution patterns. Chapter sections will follow the same order and content as Chapter 4 on trip generation; however, background text on analytical procedures will not be repeated here.

5.1 Long-Distance and Rural Trip Distribution Benchmark Statistics from Statewide Models and Other Sources

Section 4.1 provided background information on the summary of available statewide model statistics on rural and long-distance travel, along with statistics borrowed from other sources. This section provides trip distribution statistics from statewide models and other sources.

Statewide Model Statistics

Table 5.1 is a summary of average trip lengths for long-distance trips by statewide model (in time and distance). Average trip lengths vary by long-distance purpose and model/state; some states report this statistic by miles, others by minutes of travel, and some by both; long-distance trip lengths vary from a low of 122 minutes to a high of 304 minutes. Some states included multistate trips in reporting these statistics while other states did not, resulting in yet another issue affecting transferability.

Bureau of Transportation Statistics

As noted in the previous chapter, the Bureau of Transportation Statistics (BTS) published findings in May 2006 from the 2001 NHTS on long-distance trip-making. Table 5.2 is derived from the same 2006 BTS report and depicts long-distance trips by distance category. According to BTS' analysis, 90 percent of long-distance trips are less than 500 miles.

Recent and Ongoing GPS Surveys in the United States

Table 5.3 depicts several different measures of trip length, including distance, travel time, stopped time, and time spent idling, from recent GPS surveys described earlier in Section 2.3

Table 5.1. Average trip length of long-distance trips in statewide models.

	Average Trip Length				
	By Purpose (Minutes or Miles[a])				
	Business	Tourist	Other	Total Minutes	Total Miles
Arizona (Passenger)	–	–	–	213	206
Arizona (Truck)	–	–	–	228	257
Florida	–	–	–	127	–
Georgia	–	–	–	131	–
Indiana	–	–	–	121	–
Louisiana	–	–	–	168	–
Ohio					146
Texas (Miles)	200	–	199	–	200
Utah	89	–	81	85	–
Virginia (Interstate)	284	308	318	303	–
Virginia (Intrastate)	127	124	126	126	136

Source: BTS.

[a] Listed in minutes unless otherwise indicated.

Table 5.2. 2001 long-distance trips by trip distance.

Distance	Trips
50-499 Miles	90.0%
500-999 Miles	5.0%
More Than 1,000 Miles	5.0%

Source: BTS.

Table 5.3. Trip length statistics from recent GPS-based surveys.

	Trip Distance (Miles)			Trip Duration (Minutes)			Stop Time (Hours)			Idle Time (Minutes)		
	Long-Distance	Rural	Urban	Long-Distance	Rural	Urban	Long-Distance	Rural	Urban	Long-Distance	Rural	Urban
Overall	88.59	8.12	4.69	91.13	14.36	11.11	3.91	3.93	3.32	0.93	1.40	0.86
Atlanta	95.46	8.08	5.36	93.84	13.89	11.50	3.98	4.03	3.54	0.74	0.43	0.64
Denver	83.30	7.99	3.98	85.74	14.05	9.78	4.41	4.25	3.35	0.86	3.04	0.85
Massachusetts	79.12	8.47	3.72	89.57	16.58	10.53	2.55	2.48	2.21	1.74	1.56	1.86
Chicago	86.39	8.64	4.70	99.28	16.68	13.17						

Source: Geostats based on recent GPS-based travel surveys.

Table 5.4. ATS average trip length in miles by purpose, one-way.

		Mean	Standard Deviation
01	Business	477	1,208
02	Pleasure	414	1,097
03	Personal Business	352	961
	Total	418	1,105

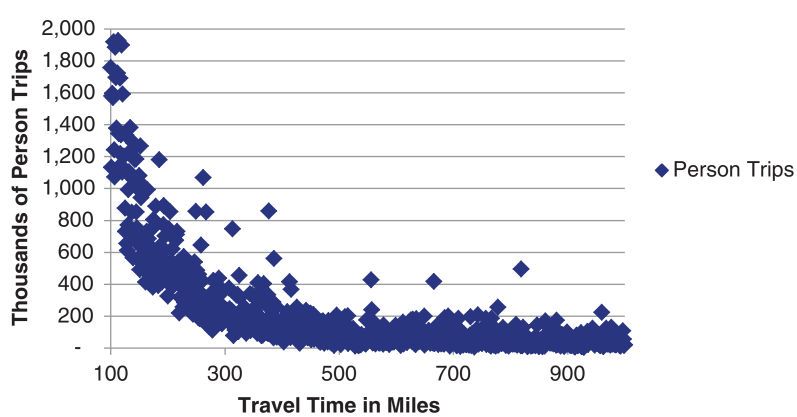
of this Guidebook. Statistics are provided for all four surveys as well as the sum of all by long-distance, rural, and urban trip-making categories. Mean long-distance trip length, for the four surveys summarized, exceeds 85 minutes or 79 miles. In virtually every survey and trip length measure, rural trip lengths are longer than urban averages.

5.2 Analytical Approach to Estimating Long-Distance and Rural Trip Distribution Parameters and Benchmarks

The same analytical procedures described previously in Section 4.2 on trip generation were applied to trip distribution. Mean trip lengths and standard deviations for each long-distance trip purpose are found in Table 5.4, based on analysis of ATS data. Although average trip lengths in urban models are usually summarized by travel time, mileage is a more appropriate measure for long-distance trips since travel times were generally reported as hundreds of minutes with a wide variation in travel time. Average trip lengths for business trips were highest while lowest for personal business trips. The average long-distance trip length for all households was 836 miles.

5.3 Long-Distance Trip Distribution Model Parameters

ATS trip records were sorted by travel time increment in order to calculate a set of friction factor gamma functions for each trip purpose. ATS trip length frequency distribution curves are depicted in Figures 5.1 through 5.3 for each trip purpose. Table 5.5 depicts the resulting long-distance friction factor gamma function parameters by purpose. It should be noted that these gamma



[a] For readability purposes, the curves depicted in Figures 5.1 through 5.2 were capped at 1,000 miles and 2 million trips.

Figure 5.1. Trip length frequency for long-distance business trips.[a]

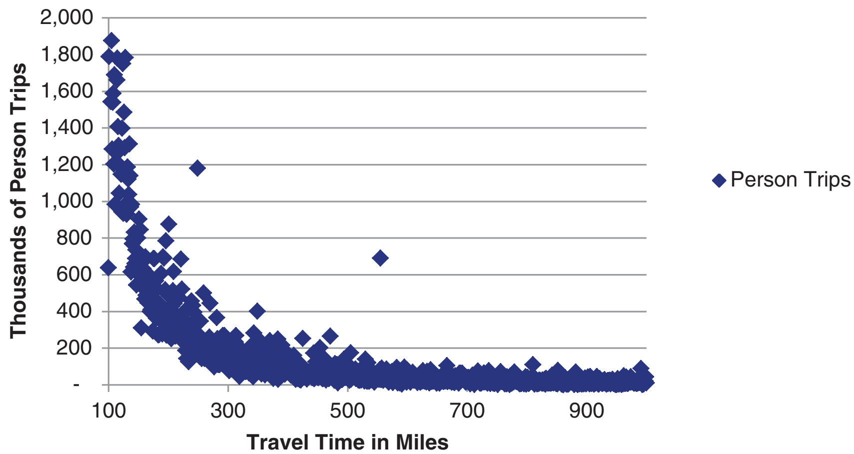


Figure 5.2. Trip length frequency for long-distance pleasure trips.

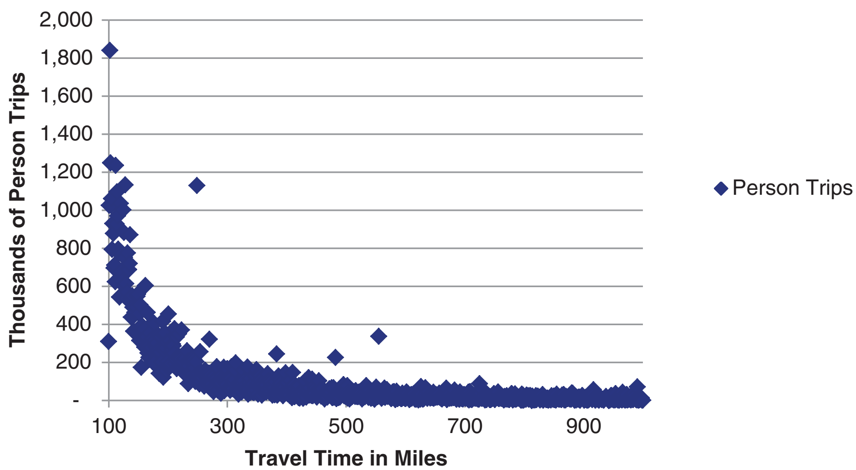


Figure 5.3. Trip length frequency for long-distance personal business trips.

Table 5.5. Long-distance trip distribution gamma function parameters.

	LD Business		LD Pleasure		LD Personal Business	
	"b"	"c"	"b"	"c"	"b"	"c"
Long-Distance Trips	-0.421	-0.0022	-0.578	-0.0023	-0.567	-0.0024

Source: 1995 ATS.

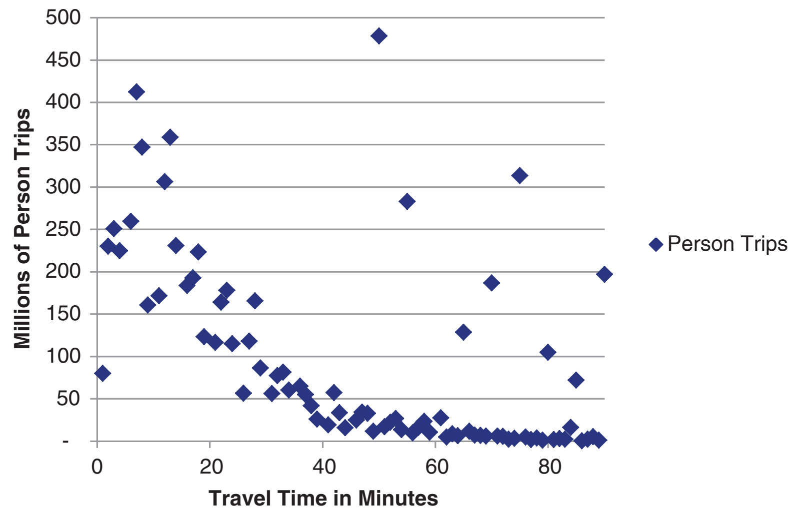


Figure 5.4. Trip length frequency for rural home-based work trips.

functions reflect reported trip lengths, without any smoothing or confirmation against network skims. Therefore, these gamma functions should only serve as potential starting points for Gravity Model calibration. It should also be noted that the Gravity Model has significant shortcomings when used to distribute long-distance trips, particularly as it relates to the attractiveness of zones.

5.4 Rural Trip Distribution Model Parameters

Similar to the rural trip rate calculations, the NHTS URBAN attribute was used to isolate nonurban households for analysis of trip length frequency distributions and gamma function parameters. The 2009 NHTS trip records were sorted by travel time increment, excluding urban households, in order to calculate a set of friction factor gamma functions for each trip purpose. NHTS 2009 trip length frequency distribution curves for all modes combined are depicted for each trip purpose in Figures 5.4 through 5.6. Although these graphs clearly depict some trips that

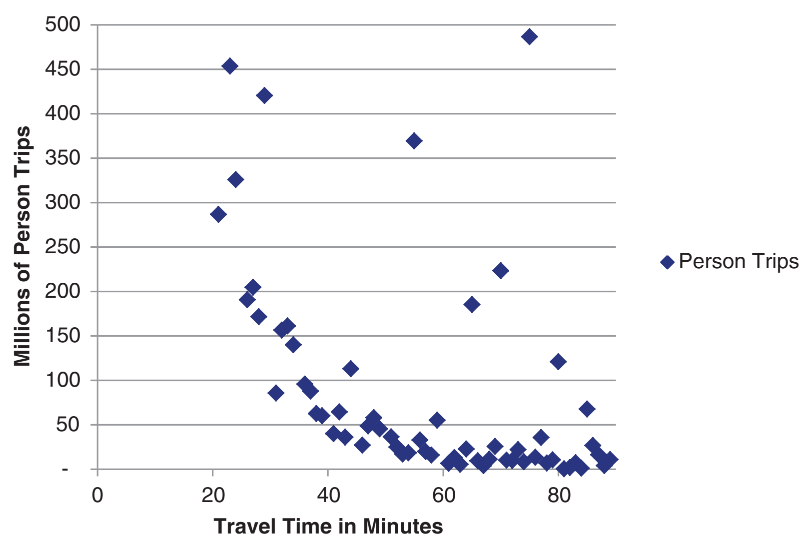


Figure 5.5. Trip length frequency for rural home-based nonwork trips.

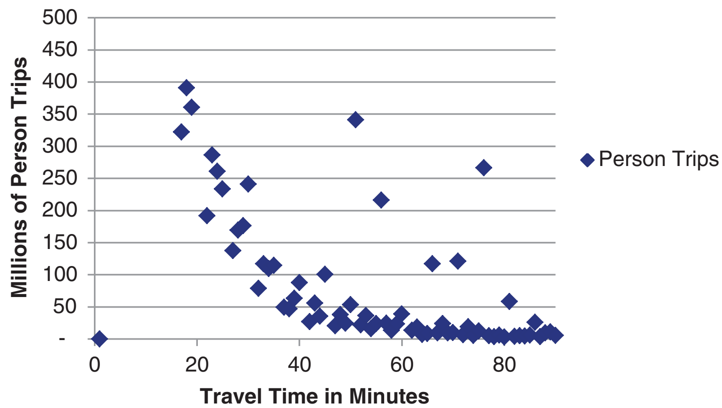


Figure 5.6. Trip length frequency for rural nonhome-based trips.

would otherwise be calculated as "long-distance," the occurrence of these trips is purely coincidental because there was no sampling strategy for long-distance trips in NHTS 2009. Graphs are scaled to match by purpose, meaning that curves were depicted with trips limited to 500 million along the y-axis and 90 minutes in length along the x-axis.

Table 5.6 depicts preliminary long-distance friction factor gamma function parameters by purpose. These gamma function parameters reflect weekday trips by rural households only from 2009 NHTS data. The same precautions noted earlier for the long-distance gamma functions apply here (i.e., lack of smoothing, etc.).

Average trip length, although not a model parameter, is an important benchmark statistic used in assessing the validity and reasonableness of trip distribution model results. Table 5.7 depicts average trip lengths in minutes of travel time for home-based work, home-based nonwork, and nonhome-based trip purposes. These tables, originally prepared for *NCHRP Report 716,* depict average trip lengths for a variety of urban area sizes and travel modes, in minutes of travel time (although low sample sizes for some markets, such as transit trips in smaller areas, meant that *NCHRP Report 716* does not include this detailed breakdown). *NCHRP Report 716* analyses also excluded weekend trips.

The urban statistics are only provided for comparative purposes against rural trip lengths depicted in bold text. On average, rural HBW trips are longer than those in urbanized areas with populations of less than 1 million. For areas in excess of 1 million population, due to excessive congestion, HBW trip lengths are higher than those in rural areas. HBNW auto trips are longer in rural areas than urbanized areas; however, the reverse is generally the case with other transportation modes. Finally, rural NHB trips are greater than or equal to comparable trip lengths in urbanized areas, with the exception of very large urbanized areas with rail and for modes other than auto, consistent with trip-chaining studies (sample sizes for transit trips in areas under 1 million population are too low for the means to be statistically significant).

Table 5.6. Rural trip distribution gamma function parameters.

	Home-Based Work		Home-Based Nonwork		Nonhome-Based	
	"b"	"c"	"b"	"c"	"b"	"c"
Rural Trips	-0.053	-0.0495	-0.079	-0.0635	-0.049	-0.063

Source: 2009 NHTS.

Table 5.7. Rural versus urban average trip lengths in minutes.

Urban Size	Auto Mean	Transit Mean	Nonmotorized Mean	All Modes Mean
Home-Based Work Trips				
1 million or more with subway or rail	29	53	18	32
1 million or more without subway or rail	25	64	19	26
Between 500,000 and 1 million	22	46	17	22
Between 200,000 and 500,000	21	63	18	22
Less than 200,000	20	33	18	20
Not in an urbanized area (Rural/Small Urban)	**24**	**58**	**11**	**24**
All trips	24	55	16	25
Home-Based Nonwork Trips				
1 million or more with subway or rail	18	48	16	20
1 million or more without subway or rail	17	48	15	18
Between 500,000 and 1 million	15	46	16	16
Between 200,000 and 500,000	16	50	15	16
Less than 200,000	17	32	15	17
Not in an urbanized area (Rural/Small Urban)	**19**	**45**	**14**	**19**
All trips	18	47	15	18
Nonhome-Based Trips				
1 million or more with subway or rail	21	39	13	20
1 million or more without subway or rail	19	38	14	19
Between 500,000 and 1 million	18	45	15	18
Between 200,000 and 500,000	18	58	15	18
Less than 200,000	17	50	18	18
Not in an urbanized area (Rural/Small Urban)	**19**	**47**	**14**	**19**
All trips	19	42	14	19

Source: 2009 NHTS/*NCHRP Report 716*. Analysis also excluded weekend trips.

CHAPTER 6

Auto Occupancy and Mode Choice Parameters

Many statewide models are "highway only" in the sense that the models only simulate highway modes of transportation. Therefore, the mode choice section of the Guidebook must also include guidance on transferability and a set of transferable auto occupancy rates. The surveys available for NCHRP Project 8-84 were not necessarily conducive to developing mode choice constants or coefficients. Benchmark statistics on travel mode by distance, income, and other characteristics will also be provided.

6.1 Long-Distance and Rural Mode Choice Benchmark Statistics from Statewide Models and Other Sources

Statewide Model Statistics

Table 6.1 provides information on input auto occupancy rates for long-distance trips by statewide model. Not surprisingly, auto occupancy rates are generally lowest for business trips and highest for tourist trips, the latter frequently including entire families traveling together on the same trip(s).

Auto occupancy rates are clearly lower for long-distance business travelers (1.33 to 1.86) than other types of long-distance trip-makers (2.06 to 3.44); long-distance auto occupancy rates are also generally higher than those found in typical urban travel models, where work trips are in the neighborhood of 1.10 and other purposes rarely top 1.8.

Bureau of Transportation Statistics

As noted in previous chapters, the Bureau of Transportation Statistics (BTS) published findings in May 2006 from the 2001 NHTS on long-distance trip-making. Tables 6.2 through 6.4, focused on mode splits, are also derived from the same 2006 BTS report and depict long-distance trips by geography and mode, geographical size and mode, and income and mode, respectively. According to BTS' analysis of 2001 NHTS long-distance travel, respondents from urban areas were more likely to use air as a travel mode (9 percent) than their rural counterparts (3 percent) as depicted in Table 6.2. Also, the larger the metropolitan area, the less likely respondents are to make long-distance trips by auto, as evidenced by Table 6.3. Finally, as depicted in Table 6.4, respondents with higher incomes were more likely to use air transportation for long-distance travel while lower-income groups were more likely to use intercity bus for long-distance travel.

Table 6.1. Auto occupancy rates in statewide models.

	Auto Occupancy Rates			
	By Purpose (Minutes or Miles)			
	Business	Tourist	Other	Average
California	–	–	–	1.34
Florida	1.10	2.60		1.85
Indiana	–	–	–	3.06
Louisiana	1.86	3.44	2.64	2.65
Mississippi (Interstate)	1.39	2.55	2.05	2.00
Mississippi (Intrastate)	1.50	2.55	2.26	2.10
Utah	1.33	–	2.06	1.70
Virginia	1.82	2.69	2.69	1.82

Source: NCHRP 836 Task 91: Validation and Sensitivity Considerations for Statewide Models.

Table 6.2. 2001 long-distance trips by geography and mode.

	Personal Vehicle	Air	Other Modes
Urban	87.0%	9.0%	4.0%
Rural	95.0%	3.0%	2.0%

Source: BTS.

Table 6.3. 2001 long-distance trips by geographical size and mode.

	Personal Vehicle	Other Modes
MSA More Than 1 Million	85.0%	15.0%
MSA Less Than 1 Million	92.0%	8.0%
Outside of MSA	96.0%	4.0%

Source: BTS.

Table 6.4. 2001 long-distance trips by income and mode.

Income	Personal Vehicle	Air	Other Modes[a]
Less Than $75,000	91.0%	5.0%	4.0%
More Than $75,000	84.0%	14.0%	2.0%

Source: BTS.
[a]Income ranges of less than $25,000 and more than $25,000 were used for other mode/bus trips.

Table 6.5. Canadian residents' long-distance trips, party size by purpose.

Trip Duration: Total – Domestic Travel (age 18+): Person-Trips with the Destination in Canada

*** Column Percents ***	Main Trip Purpose				
Standard Person-Trip Stub Variables >>> Final Data <<<	Total	Pleasure, Vacation, Holiday	Visiting Friends or Relatives	Business and All Conferences or Conventions	Shopping and Other
Household Party Size:	100.00%	100.00%	100.00%	100.00%	100.00%
1 Person	44.32%	40.18%	43.57%	81.16%	43.31%
2 Persons	36.56%	37.89%	36.74%	16.43%	41.25%
3 Persons	8.74%	9.48%	9.04%	1.08%	8.71%
4 Persons	7.61%	9.30%	7.58%	0.87%	5.39%
5 Persons	2.25%	2.51%	2.51%	0.43%	1.17%

Source: 2010 Travel Survey of Residents of Canada.

2010 Travel Survey of Residents of Canada

Table 6.5 provides information on party size of long-distance trips by purpose according to the previously referenced TSRC. Not surprisingly, the majority of business trips have a party size of one person (81.16 percent) while less than 50 percent of the other three "discretionary" purposes are one-person trips.

In terms of other statistics of interest from the TSRC:

- Over 90 percent of long-distance trips are made via private automobile. The same is true for every trip purpose except for business trips, which are 73 percent auto trips, 14 commercial aircraft, 3 percent bus, and 2 percent train.
- Forty-three percent of business trips are made by households with annual incomes greater than $100,000. This same income group represents one-fourth to one-third of long-distance travelers for other trip purposes.
- The survey includes trips of shorter distance; however, 40–79 kilometers (about 25–49 miles) is the most common travel distance for all trip purposes. Business trips tend to be longer than other types, with 28 percent in the 80–159 kilometer range, 19 percent in the 160–319 kilometer range and 15 percent in the 320–799 kilometer range.

6.2 Analytical Approach to Estimating Long-Distance and Rural Mode Choice Parameters and Benchmarks

The same analytical procedures described previously on trip generation and distribution were applied to mode choice. ATS statistics on party size and mode choice are provided in this section. Party size was summarized by trip purpose as auto occupancy was not asked of ATS respondents. Of course, it is only indicative of auto occupancy for trips taken by personal vehicle. As depicted in Table 6.6, a party size of three or more occupants was the most common for long-distance trips at more than 45 percent, followed by two-person party sizes at 33 percent. The average party size was similar for pleasure and personal business trips (slightly less than 3.5) but considerably lower for business trips, with a mean of 2.1.

Table 6.6. ATS annual frequency by purpose/party size, round-trip.

		Business	Pleasure	Personal Business	Total	Percentage for All Trips
01	1 Person	61,639	39,225	14,246	115,110	21.49
02	2 Persons	31,779	107,389	37,764	176,932	33.04
03	3+ Persons	25,753	169,169	48,556	243,478	45.47
	Total	**119,171**	**315,783**	**100,566**	**535,520**	**100**
	Mean	**2.107**	**3.332**	**3.456**	**3.077**	
Percent by Purpose		22.25	58.97	18.78	100	

Source: 1995 ATS.

Mode of travel was evaluated by trip purpose as well as distance category. Table 6.7 depicts the number and percent of long-distance trips by mode and distance category. Personal vehicle is by far the most common transportation mode for long-distance trips at nearly 82 percent. Air travel is second at just under 15 percent, although for trips of 300 miles or greater, the air mode is around two-thirds as much as the frequency of personal vehicle trips. Remaining modes each represent less than 2 percent of long-distance trips.

Table 6.8 depicts the number of long-distance trips by mode and trip purpose along with the percent of long-distance trips by the three trip purposes. In terms of the percentage of trips by purpose, nearly 60 percent of long-distance trips were categorized as "pleasure," while 22 percent were "business" trips, and 19 percent were for "personal business." Air travel represents a much greater percentage of business trips (33,370 out of 119,171 trips = 28 percent) than other types of long-distance trips (11 percent for pleasure trips and 9 percent for personal business trips).

6.3 Mode Choice: Long-Distance Auto Occupancy Rates

Most statewide passenger travel demand forecasting models focus on the highway mode because most states have limited intrastate intercity air, rail, or bus travel. The ATS sample of nonhighway modes is sufficient for providing mode splits, as depicted earlier, by trip purpose and travel distance in Tables 6.6 and 6.7, but ATS data are largely insufficient for estimating logit mode choice parameters for calibration. FHWA has a research project underway, Development

Table 6.7. ATS annual frequency by distance/mode, round-trip.

		100-300 Miles	> 300 Miles	Total	Percent Mode
01	Personal Vehicle	336,744	100,672	437,416	81.68
02	Air	11,275	66,816	78,091	14.58
03	Bus	7,026	2,904	9,930	1.85
04	Train	1,502	944	2,446	0.46
05	Commercial Vehicle	2,813	3,679	6,492	1.21
06	Waterborne	170	166	336	0.06
07	Other	559	250	809	0.15
	Total	360,089	175,431	535,520	**100.00**
Percent by Distance		67.24	32.76	**100**	

Source: 1995 ATS.

Table 6.8. ATS annual frequency by purpose/mode, round-trip.

		Business	Pleasure	Personal Business	Total
01	Personal Vehicle	81,652	268,533	87,231	437,416
02	Air	33,370	36,107	8,614	78,091
03	Bus	963	5,735	3,232	9,930
04	Train	861	1,325	260	2,446
05	Commercial Vehicle	2,144	3,197	1,151	6,492
06	Waterborne	54	251	31	336
07	Other	127	635	47	809
	Total	119,171	315,783	100,566	535,520
	Percent by Purpose	22.25	58.97	18.78	**100**

Source: 1995 ATS.

of Long-Distance Multimodal Passenger Travel Modal Choice Model, that may provide calibrated model parameters.

Therefore, the key transferable parameter for the mode choice step is the auto occupancy rate, used to convert person trips to vehicle trips for highway assignment. Table 6.9 provides mean auto occupancy rates for each long-distance trip purpose. Auto occupancy rates are considerably higher for long-distance trips than those typically (less than 2.0) found in urban and regional planning models. Table 6.5 provided a breakdown of long-distance trips by each of three auto occupancy categories. Auto occupancy rates were calculated using the ATS Party Size attribute for auto trips only.

6.4 Mode Choice: Rural Auto Occupancy Rates

Mode splits are not very relevant to rural trip-making because few rural communities provide fixed-route bus services. Commuter rail and express bus are not common modes for connecting rural households to urban work destinations. Therefore, the key transferable parameter for the rural mode choice step is the auto occupancy rate, similar to the earlier discussion on long-distance travel.

Table 6.10 provides mean auto occupancy rates for each rural trip purpose, as well as statistics for urbanized areas for comparison. Auto occupancy rates in rural areas (bold font) seem to fall somewhere in the middle of urbanized groupings, generally higher than small- and medium-sized urbanized areas but lower than the largest urbanized areas. Auto occupancy rates are depicted in Appendix I for two-plus and three-plus occupant automobiles and daily, a.m., and p.m. peak periods.

Table 6.9. Long-distance auto occupancy rates.

		Mean	Standard Deviation
01	Business	2.11	2.51
02	Pleasure	3.33	2.97
03	Personal Business	3.46	3.96
	Total	**3.10**	**3.17**

Source: 1995 ATS.

Table 6.10. Rural versus urban average auto occupancy rates.

	Trip Purpose			
Urban Size/Population	**Home-Based Work**	**Home-Based Nonwork**	**Nonhome-Based**	**All Trips**
1 million or more with subway or rail	1.06	1.77	1.68	1.54
1 million or more without subway or rail	1.11	1.78	1.69	1.63
Between 500,000 and 1 million	1.06	1.71	1.65	1.50
Between 200,000 and 500,000	1.12	1.72	1.52	1.49
Less than 200,000	1.11	1.65	1.64	1.52
Not in an urbanized area	**1.11**	**1.69**	**1.67**	**1.54**
All areas	1.10	1.72	1.66	1.55

Source: *NCHRP Report 716*/2009 NHTS.

CHAPTER 7

Comparisons and Conclusions

7.1 Comparisons

Study findings were largely focused on the 1995 ATS for long-distance trips and 2009 NHTS for rural trip-making parameters. This section presents a few comparisons among the different surveys and travel parameters analyzed during this research.

Originally, it was intended to look at the impacts on long-distance trip rates of proximity to areas with substantial tourist activity. Unfortunately, the ATS and NHTS databases do not include information on proximity of residence to "tourist areas." Manual geocoding of known tourist sites was considered to analyze trip rates based on proximity to tourist areas; however, there were concerns about arbitrarily coming up with a list of tourist sites manually and possibly excluding some regionally important tourist sites. National parks are obvious attractions and easily mapped as are locations of well-known nonurbanized tourist areas such as Branson, Gatlinburg, the Outer Banks, etc. However, should every amusement park in the United States be included in such an analysis? Also, the "production" of long-distance trips would not likely be influenced so much by proximity to tourist areas, as would be trip attractions. This topic might be worthy of another research effort to provide a more objective assessment of differing types and sizes of rural tourist destinations. Rural accessibility/proximity to employment was also considered; however, the NHTS 2009 database had limited data on work location. Instead, as discussed earlier in this report, proximity to urbanized areas was tracked in its relationship to rural trip production.

Trip rates for long-distance and rural trips were provided from several different sources in this report. Table 7.1 presents overall long-distance person trip rates per household from the 1995 ATS, 2001 NHTS, and recent household GPS surveys. Annual rates from the ATS and NHTS were divided by 365 days and rounded to two decimal places to derive a daily rate for comparison against the recent GPS survey database. As indicated, all survey databases result in daily person long-distance trip rates of 0.03–0.04 per household.

Likewise, total daily person rural trip rates were reported from several sources, including 2009 NHTS, Michigan DOT, and the GPS household survey database. As depicted in Table 7.2, person trip rates per rural household appear to be in a relatively similar range for different stratifications of 2009 NHTS, while different subareas and years from the Michigan and Ohio surveys tend to show lower household trip rates by comparison. Rural trip rates from the GPS household survey database fall within a similar range to the NHTS, Michigan, and Ohio household person trip rates. The impact of the recent economic recession on 2009 NHTS trip rates is unknown at this time and beyond the scope of this research effort.

Table 7.1. Comparative long-distance household trip rates.

Survey Data Source	Daily Person Trips per Household[a]
1995 ATS	0.03
2001 NHTS	0.03
Recent GPS Household Surveys	0.04 (average of four surveys)

[a]Annual trip rates were divided by 365 for 1995 ATS and 2001 NHTS, rounded to hundredths.

7.2 Conclusions

A brief summary of findings and key conclusions based on survey analyses are presented below in bullet format for ease of reference, with long-distance trips discussed first, followed by rural trips.

- Long-distance trip rates are generally consistent when compared among several data sources and years. The percentage of long-distance trips by purpose/type appears consistent between the 1995 ATS and 2001 NHTS long-distance component, based on analysis conducted specifically for this study as follows:
  - Business—28.38 percent for NHTS 2001 versus 22.25 percent for ATS;
  - Pleasure—54.84 percent for NHTS 2001 versus 58.97 percent for ATS; and
  - Personal Business—16.78 percent for NHTS 2001 versus 18.78 percent for ATS.
- Long-distance trips are generally longest for business purposes (954 miles) and shortest for personal business (704 miles), with pleasure trip lengths in the middle of the others (828 miles).
- Auto occupancy rates are considerably higher for long-distance trips (3.10) than urban or rural travel (1.54), lowest for long-distance business trips (2.11), and higher for other long-distance types (3.33–3.46).
- Private automobile is the dominant transportation mode for long-distance travel (82 percent); however, trip length and purpose/type figure prominently in shifting to air travel.
- Rural trip rates vary somewhat among different data sources; household trip rates from Michigan and Ohio surveys are generally lower than those from the 2009 NHTS, as depicted in Table 7.2.
- Rural trip rates (9.69) appear lower than suburban area trip rates (10.34), but otherwise, are not that different from urban trip rates (9.36–9.50), using statistics based on one of several stratifications found in Appendix G.
- The percentage of rural work trips (12 percent) appears to be less than that experienced in most urban settings (typically 15–20 percent).

Table 7.2. Range of comparative rural household trip rates.

	Daily Person Trips per Household
2009 NHTS	9.78-10.06 (dependent on stratification)
Michigan Travel Counts Surveys	7.64-9.41 (dependent on area and year)
Ohio Statewide Household Travel Survey	7.78 (no substratifications)
GPS Surveys	8.24-13.56

- Rural trip travel times (19–24 minutes, nonwork versus work) are generally shorter than urbanized areas with 1 million plus population and subway or rail (20–32 minutes, nonwork versus work).
- Rural auto occupancy rates (1.54) are generally higher than small- and medium-sized urbanized areas (1.49–1.52) but equal to or lower than the largest metropolitan areas (1.54–1.63).

It is strongly suggested that the rates provided in this study from the 1995 ATS for long-distance travel and 2009 NHTS for rural travel be considered for use where local trip rates are not available. Other trip rates in this report, including secondary source parameters (Michigan, Ohio, Canadian surveys, GPS surveys) and NHTS 2001 statistics, are provided for comparative purposes only.

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APPENDIX A

Recent Examples of Long-Distance Travel Demand Studies (ORNL, UMD)

Table A.1. Recent examples of long-distance travel demand studies (ORNL, UMD).

Model/Study	Geographic Detail	Modes	Trip Purposes	Demand Components	Model Objectives	Method	Explanatory Variables	Data Sources
UNITED STATES								
TSAM (Ashiabor, Baik et al (2007-2008))	County level	Car, Air, SATS, (Bus, Rail)	Business / Non-Business	TG (trip generation), TD (trip distribution), MC (mode choice), TA (traffic assignment)	Nested and mixed logit models were developed to study national-level intercity transportation in the United States. The Transportation Systems Analysis Model	Nested Logit/Mixed Logit	Travel time, Travel Cost, Household Income, Region Type	ATS 1995 for model calibration. In addition Virginia Tech conducted travel surveys
Koppelman (1990)	City/Metro Pairs (using data from NTS 1977)	Car, Air, Bus, Rail	Business / Non-Business	TG, TD, MC, Service Class Choice	Develop a behavioral framework and model system for intercity travel	Disaggregate Nested Logit Model	Travel time, cost, departure frequency, distance between city pairs, household income, structure, and size, employment, museum	1977 NTS, supplemented with data on intercity leverl of service
Koppelman and Sethi (2005)	Only mode choice/service class choice from surveys	Car, Air, Rail Sleeper, Rail Premium Coach, Rail Economy Sleeper	NA	MC, Service Class Choice	This research integrates the considerable progress that has been made in relaxing the assumption of independence across alternatives and the homogeneity of error variance/covariance across observations within the context of closed form extensions of the MNL/NL models.	MNL Model, nested logit, and generalized nested logit	Cost, schedule convenience, overnight dummy, quality of service, group size, income, distance	The data for this study is drawn from Stated Preference, SP, surveys of both existing rail users (1,000 respondents) and travelers using other intercity travel modes; air, automobile, and bus; referred to as non-users (400 respondents). Rail users were recruited by a self-administered survey conducted in Fall 1998 on-board intercity trains serving long distance travel markets, more than 250 miles. The non-user sample, selected to provide a comprehensive geographical coverage across the US, was recruited from a random sample of households in which at least one member had made a long distance intercity trip in the recent past.
Coldren et al (2003)	City pairs in the U.S.	Air	NA	Itinerary Share Models	This study reports the results of aggregate air-travel itinerary share models estimated at the city-pair level for all city-pairs in the US. These models determine the factors that influence airline ridership at the itinerary level and support carrier decision-making.	Aggregate multinomial logit	Level-of-service, connection quality, carrier, carrier market presence, fares, aircraft size and type, and time of day.	Passenger bookings data were obtained from a compilation of Computer Reservation Systems (CRS). Air carrier schedule information was obtained and is commercially available from the Official Airline Guide (OAG). Finally, market size and fare data were obtained from the 'Superset' data source (Data Base Products, Inc.). This is quarterly market size and fare data generated from the raw 10% sample of flown data collected by the US Department of Transportation.
Jin and Horowitz (2008)	Time of Day Choice Modeling based on NHTS	Car, Air, Other	Work/School, Return Home, Personal Business, Social Recreation	Time of Day Choice	This study explores the timing–scheduling decision-making behavior for long, occasional, and exceptional travel, rather than habitual, repetitive trips.	multinomial logit model	Travel time, travel companions, activity duration, age, gender, education level, household income, household size, automobile ownership, presence of a child	2001 National Household Travel Survey daily-trip survey data Enhanced with the use of a preference survey that was conducted by e-mail or by face-to-face interviews. Fourteen responses were collected and 20 long trips were recorded.
Epstein et al 2009						Microsimulation		
INDIVIDUAL STATE STUDIES								
Michigan	2307 instate TAZs, 85 outstate TAZs	Car	HB work/biz, HB soc/rec/vac, HBO, NHB work/biz, NHB	TG, TD, TA	Development, maintenance and application of a Statewide Travel Demand Model.	Used TransPlan and TransCAD	Household size, income, travel cost, area type	NPTS data used for calibration, CTPP for validation
Oregon	2950 zones (instate and within a 50 mile radius). Each zone fits within about 14.5 million grid cells ranging from 30x30 meters to 300x300 meters	Car drive, car shared, urban transit, air, AMTRAK, intercity bus, walk, bicycle	home-based, work-based	TG, TD, MC, TA	Develop a tranportation land use model to understand daily traffic patterns by using microsimulation techniques	Microsimulation (Monte Carlo) and logit models	regional economics and demographics, production allocations and interactions, houshold allocations, land development, commercial movements, household travel, and transport supply	Household surveys, OD surveys, on-board surveys, specialized surveys
Maryland	1607 zones (Maryland, Delaware and Washington DC as a whole, and parts of New Jersey, Pennsylvania, Virginia, and West Virginia. A regional model (U.S, Mexico, and Canada) includes information on long-distance travel demand for 189 zones.	Car, air, rail, bus	Home Based Work, Journey to Work, Journey at Work, School, Home Based Shop, Home Based Other	TG, TD, MC, TA	Development of a Statewide Travel Demand Model.	Gravity model and nested logit model. A microsimulation technique is introduced for long-distance travel using the NHTS.	Socioeconomics and demographics (population, income, occupation status, household size, number of workers), travel time, travel cost	Travel surveys, NHTS, CTPP, Census

CORRIDOR STUDIES (N. Amer.)								
Cambridge Systematics (2006)	TAZs	Main mode: car, air, conventional rail, and HSR. For Access/Egress: Drive/Park, Drop off, Rental, Taxi, Transit, Walk/Bike	Business, Commute, Recreation, Other	TG, TD, MC, Access/Egress MC	To develop a new ridership forecasting model that would serve a variety of planning and operational purposes: To evaluate high-speed rail ridership and revenue on a statewide basis; To evaluate potential alternative alignments for high-speed rail into and out of the San Francisco Bay Area; and To provide a foundation for other statewide planning purposes and for regional agencies to	Trip frequency. Multinomial Logit Models	Employment & Household Characteristics • Trip Purpose/Distance Class • Level of Service • Accessibility • Region • Traveling Party Size	The travel survey data used for this project was a combination of new surveys collected for the project and existing surveys from regional and state agencies. After combining these surveys, 6,882 completed surveys were available to use for model estimation
Volpe Center (2008)	County and MSA level	Car, air, existing and high speed rail, bus	Business / Non-Business	Direct demand modeling	Evaluation of High-Speed Rail Options in the Macon-Atlanta-Greenville-Charlotte Rail Corridor	Logit model	travel time, travel cost, frequency, income	Base year demand statistics from Amtrak, DOT Office of Aviation Analysis, 1995 OD Data. Direct Demand Modeling
Bhat (1995)	Corridor: Toronto-Montreal.	car, air, train	Paid Business	Mode choice	The model is estimated to examine the impact of improved rail service on business travel in the Toronto-Montreal corridor.Travel demand models used to forecast future intercity travel and estimate shifts in mode split in response to a variety of potential rail service improvements (including high-speed rail) in the Toronto-Montreal corridor.	Heteroscedastic extreme value model using a maximum likelihood technique	travel time, travel cost, income, frequency, city type	Travel surveys were conducted in the corridor to collect data on intercity travel by four modes (car, air, train and bus). Sample size = 2,769 business travelers. See KPMG Peat Marwick & Koppelman, 1990 for a detailed description of this data.
Bhat (1997)	Canadian interciy dataset: Toronto Montreal Corridor	car, air, train	Paid Business	Mode choice	This article uses an endogenous segmentation approach to model mode choice. This approach jointly determines the number of market segments in the travel population, assigns individuals probabilistically to each segment, and develops a distinct mode choice model for each segment group.	Endogenous Segmentation Mode Choice Model	income, sex (female or male), travel group size (traveling alone or traveling in a group), day of travel (weekend travel or weekday travel), (one-way) trip distance, frequency of service, total cost, in-vehicle travel time and out-of-vehicle travel time, large city indicator	Canadian interciy dataset from VIA Rail, assembled in 1989. The data includes soeiodemographie and general trip-making characteristics of the traveler, and detailed information on the current trip (purpose, party size, origin and destination cities, etc.). The assembly of level-of-service data was done by KPMG Peat Marwick for VIA Rail. Sample size = 3593 business travelers
EUROPEAN STUDIES								
LMS (Netherlands)	National. 1308 Zones plus 55 external zones	Car driver, car passenger, train, bus/tram/metro, slow traffic	1. home-work 2. business (home-based) 3. business (non-home based) 4. Shopping 5. education (<12) 6. other, children 7. education (12+) 8. social-recreative	TG, TD, MC, TA	To predict the long-term impact of (policy) measures with respect to reducing traffic congestion, traffic unsafety, and air pollution in the future. The outcomes of the model may contribute to new or adapted policy measures. Three types of policy decisions are supported by LMS: 1. calculate situations without new policies; 2. estimate effects of a package of policy measures; 3. estimate effects of one policy measure.	Disaggregate tour frequency model	TG: Most important are: structure of household, licence holding and car availability in household, sex, age, educational level, income, licence holding and activity of person. TD/MC: Attraction variables of destination (employees, education places, number of residents, density of employees or population, business district) Accessibility variables (travel time, costs) Socio-economic attributes (licence holding, car availability, part/full time, age band, income band).	National Travel Survey. Especially from 1995 with 68.000 households
SISD (Italy)	Italy. 270 national zones, 62 external	Car, Bus, air, interregional train, intercity train, sleeping train	1. workplace commuting 2. work and professional business 3. university education 4. leisure and tourism 5. other purpose	TG, TD, MC, TA	1. to simulate the behavior of transportation systems 2. formulate management and planning policies 3. check the effectiveness of proposed interventions 4. official data source	Disaggregate tour frequency model	TG: Attraction variables (number of residents, employees, location, accessibility logsum) Socio-economic attributes of individual/ household (income category, age band, sex, employment status, education level, license holding dummies, car availability). TD/MC: Employees, hotel beds, same region dummy, travel time and cost per mode, frequency, income group, cars available, license holding dummies.	Interviews with 16.000 families, border-crossing interviews, traffic counts.

(continued on next page)

Table A.1. (Continued).

Model/Study	Geographic Detail	Modes	Trip Purposes	Demand Components	Model Objectives	Method	Explanatory Variables	Data Sources
STREAMS (EU)	Member Countries of the EU. 201 Internal zones, 27 external outside EU, 4 external zones for the rest of the world	Car, air, coach, rail, air	1. commuting and business (<40 km) 2. shopping, personal business, education, visits (<40 km) 3. charter holdiday (>40 km) 4. business and commuting (>40 km) 5. international independent holiday (>40 km) 6. domestic holiday (>40 km)	TG, TD, MC, TA	1. to develop a multi-modal network based transport model of the EU covering passengers and freight 2. to produce an initial reference forecast of transport in the EU 3. to develop new modeling software	Aggregate trip frequency model	TG: Age, employment, car availability, household structure (aggregate average per distinguished population group). TD/MC: Full time employed persons, total population, tourism arrivals (bed spaces), gross value added.	NTS UK, NTS other countries, Eurobarometer survey (1998)
NTM 4 (Norway)	454 domestic zones	1. car driver 2. car passenger 3. public transport 4. slow traffic 5. air (long-distance model) 6. sea (long-distance model)	Short distance: 1. home based commuting 2. home based business 3. Education 4. work based business 5. shopping/personalbusiness 6. social visit 7. recreation, other Long distance (>100km): 1. work/education 2. Business 3. social visit 4. Recreation 5. services and other	TG, TD, MC, TA	Original objective: To make predictions of the impact of policy measures to reduce the environmental effects of private travel. Added: capability of forecasting traffic on specific infrastructure links	Disaggregate tour frequency model	Comparable and based on LMS (Netherlands)	National Travel Survey (5,800 households)
SAMPERS (Sweden)	700 domestic zones, which are disaggregated into 9000 subzones. 180 zones in foreign countries.	1. car 2. train (several types) 3. coach / regional bus 4. air (for long distances) 5. car+ferry (for long distances) 6. walk-on ferry (for long distances) 7. Walk 8. bicycle	Short distance: 1. Work 2. Business 3. School 4. Social 5. Recreation 6. Other Long distance (domestic plus international): 1.private 2. Business	TG, TD, MC, TA	To predict demand effects of new infrastructure and services, changing incomes, different population structure, changes in trade and industry. To serve as a basis for calculation of traffic safety effects, environmental effects, energy consumption, accessibility effects, effects of policy measures.	Disaggregate tour frequency model	Comparable and based on LMS (Netherlands)	NTS Sweden 1994-1998 and interviews from fixed link projects
NTM (Denmark)	1300 zones	1. car 2. train (several types) 3. coach / regional bus 4. air	Short distance: 1. Work 2. Business 3. Shopping 4. Recreation 5. Other Long distance (domestic): 1.private 2. Business	TG, TD, MC, TA	To predict effects of long-distance high-speed train services and other infrastructure investments	Disaggregate tour frequency model	Comparable and based on LMS (Netherlands)	NTS Denmark 1993
NTM (Switzerland)	755 domestic zones, 67 foreign zones	car, train	work, vacation, other	TG, TD, MC, TA	To make predictions of the impact of policy and infrastructure measures.	Aggregate trip frequency model, logit mode choice. Agent-based simulation		Household survey 1994, O-D Survey, traffic counts
BVWP (Austria)	676 domestic zones, 205 foreign zones	car, train, coach/regional bus	1. work 2. Business 3. School 4. Shopping 5. Leisure 6. other	TG, TD, MC, TA	To predict demand effects of new infrastructure and services, changing incomes, different population structure, changes in trade and industry. Optimize of National Transport Conception, environmental effects	Aggregate trip frequency model		Households urvey 1995-1996, O-D Survey, traffic counts
BVWP (Germany)	360 domestic zones, 83 foreign zones	1. car, 2. Train 3. bus (regional) 4. air 5. Bicycle 6. Walk	1. work 2. Business 3. Shopping 4. Education 5. Vacation 6.leisure and other	TG, TD, MC	To predict demand effects of new political situations in Europe and infrastructure and transport policy, socio-demography and economic, changes in trade and industry.	Aggregate trip frequency model		Household survey, previous BVWP
MATISSE (France)	Links with OD distances varying from 50-2500km	Car, air, rail	Business, private	TG, TD, MC, TA	The model was developed to analyse long distance passenger traffic (trips >50 km), focusing on France.	Disaggregate trip frequency model	Travel time, cost, group size, time of day, car availability, fare reduction, quality of service	French household survey "Transports 1981-1982".

Model/Study	Geographic Detail	Modes	Trip Purposes	Demand Components	Model Objectives	Method	Explanatory Variables	Data Sources
NTM (Great Britain)	2496 National Trip End Model (NTEM) Zones	Car Driver, Car Passenger, Bus, Rail, Metro, Taxi, Cycle, Walk	HB work, HB Employer's Business, HB Education, HB PB/Shopping, HB Recreation/Visiting Friend & Relatives, HB holidays and day trips, NHB Employer's Business, NHB Other	TG, TD, MC, Route Choice, TA	The Department for Transport's National Transport Model (NTM) has been developed over a number of years, and has been used by the Department for forecasting travel trends for over 10 years, primarily for the purposes of producing the annual road traffic forecast report, policy formation, and strategic analysis of options, predominantly for England and Wales.	Nested Logit Model	Person type, Household income (indirectly through car ownership model), household type, gender, travel cost, travel time	NTS 2000
Bel (1997) Spain	Spanish rail network by province	train, car	NA	NA	This paper specifies and empirically estimates, an explanatory model to evaluate the impact of travel time changes on inter-urban rail demand.	Double logarithmic form	Travel time, dummy variable for 'increase in air service frequency'	1987 and 1991 operating data from train operator: Red National de Ferrocarriles Espaiioles (RENFE)
TRANS-TOOLS	NUTS3 based zonal system of 1269 zones within Europe	Road, rail, air	Business, private, tourism	TG, TD, MC, TA	TRANS-TOOLS had the objective to produce a European transport network model covering both passenger and freight, as well as intermodal transport, which overcomes the shortcomings of current European transport network models and provided the Commission with an in house updated instrument of simulation. The objective of the project was to build on the experience of existing transport models and implement a number of improvements that are the basis of the development of an integrated policy support tool for transport at EU level.	Non-linear logit function	Travel cost, travel time, frequency, number of transfers, population, GDP, employment, car ownership	ETIS-BASE (data categories: socio-economic, freight demand, passenger demand, transport infrastructure network, freight services and costs, passenger services and cost, external effects). See TRANS-TOOLS Report for more information
MYSTIC Project (PDC 2000)								
STEMM	1269 zones	car, air, rail	Business, private, vacation	TG, TD, MC				
OTHER NON-U.S. STUDIES								
Yao and Morikawa (2005) - Japan	6 zones from questionaires, 147 zones from the NTS	Car, air, Rail (conventional, HSR, Shinkansen), bus	business, non-business, home-based, non home based	trip generation, distribution, mode choice, route choice	to develop an integrated intercity travel demand modeling system suitable for substantial changes in service level.	Regression model and Nested Logit Models with route choice	TG: Accessibility, population, working population in service sector. TD: logsum MC, zonal GDP per capita, share of working population, business attractiveness, non-business attractiveness. MC: Travel cost, travel time, access time, frequency, value of travel time savings.	The model utilizes combined estimation across multiple data sources such as SP/RP surveys at six major rail stations, and aggregate data from the 2000 NTS
Aldian and Taylor (Australia - 2003) - Indonesia	Intercity Central Java. Number of zones unknown	Car only	NA	TG, TD, TA	A new approach to modelling inter-city travel that combines a behavioural travel demand model and a direct demand model. Fuzzy multicriteria analysis is applied to calculate aggregate utilities (trip production power and zone attractiveness).	Fuzzy multicriteria analysis. It adopts the structure of disaggregate models, but the deterministic part of utility function is developed at aggregate level. The multinomial logit model is applied to calculate trip distribution	TG: population density, gross domestic regional product. TD: road user cost (distance, road geometry, ride quality), number of hotel rooms	1996 national origin destination survey

Note: Demand Components: TG = Trip Generation, TD = Trip Distribution, MC = Modal Choice, TA = Traffic (Route) Assignment.

APPENDIX B

Travel Behavior Data from Other Countries

This appendix presents a summary of Canadian, European, and other data sources that document long-distance travel behavior. There are five primary sources of Canadian personal travel data that were evaluated: the Canadian Census, provincial travel surveys, the Travel Survey of Residents of Canada, Canadian Travel Survey, and the Rural and Small Town Canada Analysis Bulletin. This appendix also discusses Canadian tourism-related surveys and European studies on long-distance travel.

For the purposes of this report, the research team analyzed readily available documentation on rural and long-distance travel from these sources, in order to both document what data might be available in the development of rural and long-distance parameters as well as whether the data were suitable for such an application. It should be noted that some of the Canadian data appears to be well suited to support the development of long-distance travel parameters. However, most are only available for a fee.

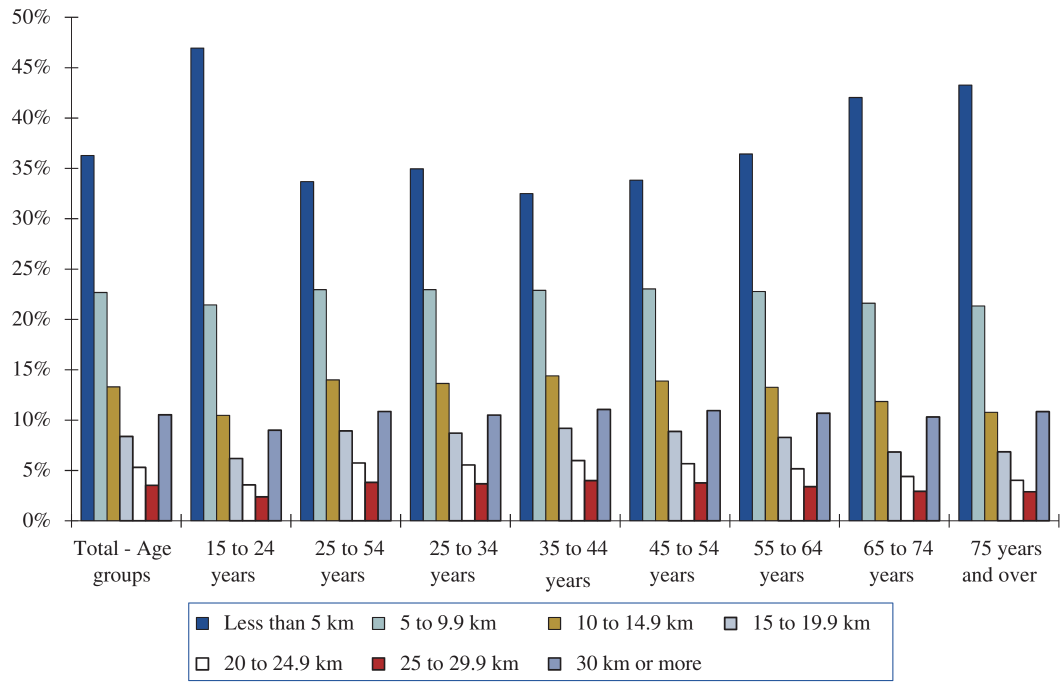
The appendix concludes with a summary of studies regarding long-distance travel that were conducted outside of North America.

B.1 Canadian Census

Similar to the U.S. Census, the Canadian Census obtains details about workplace and typical mode to work, which can be used to estimate commute work flows, distance traveled, and travel modes for the commute trip. The Canadian Census is conducted every 5 years. The most recent Census was conducted in 2006, and the next one is scheduled for May 2011 (http://census2011.gc.ca/ccr_r000-eng.htm). Based on a preliminary assessment of publicly available data summaries, the 2006 Census does not appear to contain sufficient records with long-distance commutes to aid in the development of transferable model parameters for this project. However, the coverage in rural areas of the country appears to provide sufficient observations of rural commuters to inform the development of rural parameters.

According to publicly available data summaries from the 2006 Census, 1,376,340 of the 13,069,895 commuters (or approximately 10 percent) reported a commute distance of 30 kilometers (18.64 miles) or more. (For a fee, the disaggregate data is available to further delineate the commute distances and also to assess differences in urban/rural commute characteristics.) Average commute distance by age is shown in Figure B.1.

As in the United States, commuters travel to work predominantly by auto, as shown in Figure B.2. However, use of transit is higher in Canada than what is observed in the United States, as indicated in Figure B.3. From available documentation the differences in travel



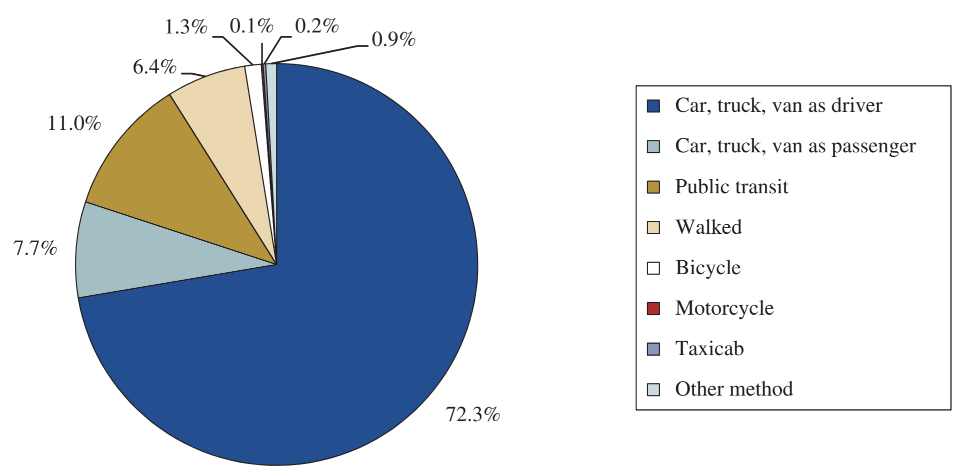
Source: 2006 Canadian Census.

Figure B.1. Average commute distance by age—2006 Canadian Census.

mode by urban versus rural commuters and the extent of public transit trips for long-distance travel are not clear.

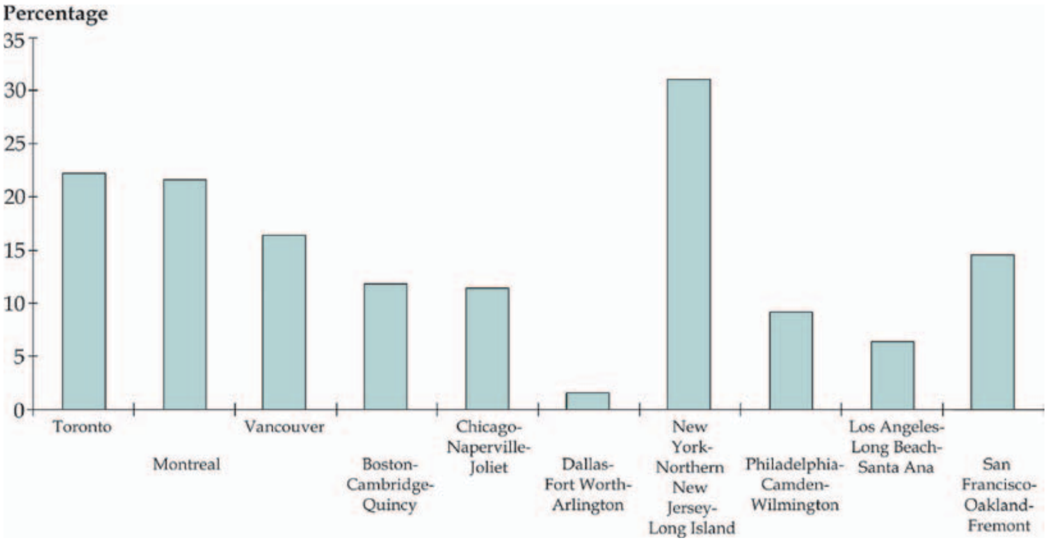
B.2 Provincial Travel Surveys

Canadian officials conduct travel surveys to document travel behavior and to develop regional travel demand models. As is typical in the United States, these surveys document long-distance travel as it occurs naturally during the assigned travel period. Two of the better-known provincial travel surveys are the Transportation Tomorrow Survey in Toronto and the Greater Vancouver



Source: 2006 Canadian Census.

Figure B.2. Commute by transportation mode—2006 Canadian Census.



Sources: American Community Survey, 2006; and Statistics Canada, Census of Population, 2006.

Figure B.3. Proportion of workers using public transportation for work—U.S. versus Canada for select metropolitan areas.

Trip Diary Survey. Based on a preliminary review of the results of these surveys, neither appears to have sufficient observations of rural households or long-distance trips to support the development of transferable model parameters.

Transportation Tomorrow Survey

The Transportation Tomorrow Survey (TTS) is an ongoing data collection program in the Toronto metropolitan region (http://www.dmg.utoronto.ca/transportationtomorrowsurvey/index.html). It is sponsored by the Transportation Information Steering Committee, which includes 21 local, regional, provincial, and transit agencies in the Greater Toronto area. The survey itself is conducted by the Data Management Group, which is associated with the Department of Civil Engineering at the University of Toronto. The survey was first conducted in 1986, with adjustments in methods and administration over time.

The most recent survey, in 2006, documented demographic and travel behavior details for 149,000 households in the greater Toronto area. Travel behavior was reported for a 24-hour weekday for all household members ages 11 and older. The number of data elements obtained in this survey is less than what is typically obtained in U.S. surveys, focusing only on key attributes needed for modeling (http://www.dmg.utoronto.ca/pdf/tts/2006/regional_travel_summaries/TTS_report4_full.pdf), as follows:

- **Household Characteristics—**Location of residence, dwelling type, household size, and household vehicles;
- **Person Characteristics—**Age, gender, employment and student status, possession of a driver's license and transit pass, location of work and school, availability of parking at work, occupation, and whether the worker worked at home on the travel day;
- **Travel Information—**Nature of trip (start time, trip purpose, origin and destination) and means of travel (travel mode and detailed transit routes); and
- **Trip—**defined as a one-way movement between two locations for a single purpose.

Within the TTS sampling area, four sampling regions had fewer than 100 persons per square kilometer (ppsk): Peterborough (35 ppsk), Dufferin (37 ppsk), Wellington (75 ppsk), and Simcoe

(87 ppsk). Of the 149,631 households that participated in the 2006 TTS, 12,586 reside in these four sampling areas (http://www.dmg.utoronto.ca/pdf/tts/2006/expansion2006.pdf). Depending on how "rural" is defined for this study, the TTS may be useful in the development of rural travel parameters.

Long-distance travel was not explicitly requested as part of the TTS. However, reported average trip lengths by mode suggest that some long-distance trips were captured: auto drivers at 5.6 kilometers, auto passengers at 4.1 kilometers, transit users at 6.3 kilometers, and train riders at 30.2 kilometers. Although median, minimum, and maximum values are not reported, the TTS does not appear to include sufficient observations of long-distance trips to be useful in this effort.

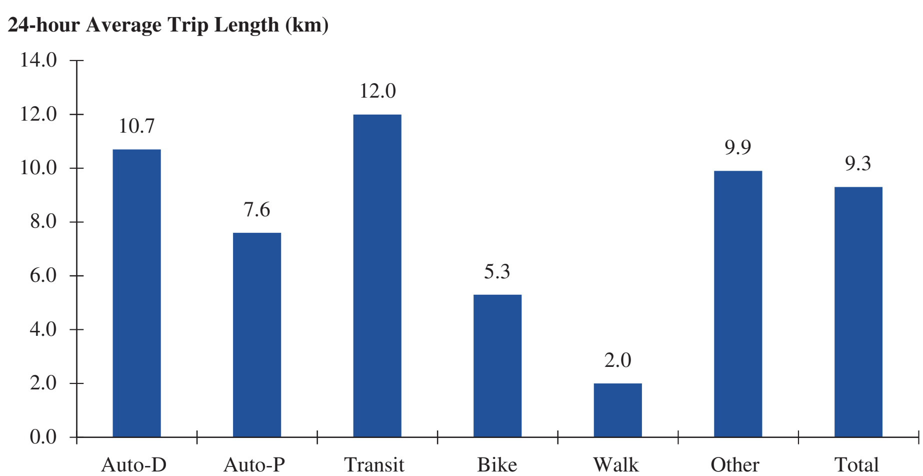
Greater Vancouver Trip Diary Survey

In 2008, the British Columbia Ministry of Transport and the Greater Vancouver Transportation Authority funded the Regional Trip Diary Survey (http://info.nathanp.org/Reports, scroll to Transportation Section for 2008 TransLink Trip Diary Survey Report.pdf). The survey was conducted by the Mustel Group and Halcrow. Prior surveys were most recently conducted in this region in 1994, 1999, and 2004.

The 2008 survey was designed to document 24-hour weekday travel behavior characteristics of regional residents. A total of 17,603 households agreed to participate in the effort, reporting a total of 92,187 trips. The study was conducted in the fall of 2008, using a combination of online and mail-out/telephone retrieval methods to obtain the following:

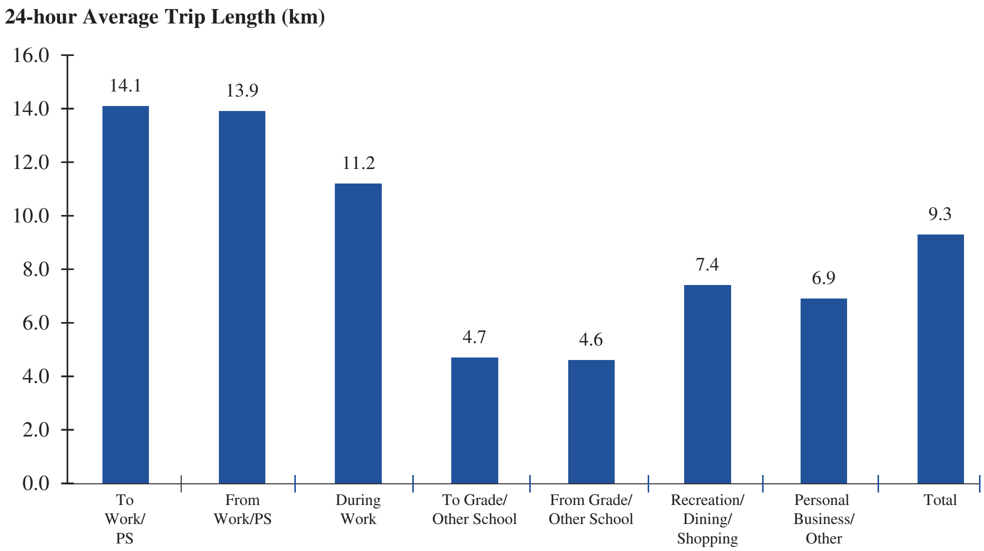
- **Household Characteristics—**Household size, household vehicles, and household location;
- **Person Characteristics—**Age, gender, driver's license status, public transit usage and fare payment, employment status and related employment information, student status and related school information; and parking at work or school; and
- **Travel Information—**Number of trips, trip purpose, travel mode, travel party size if traveled by auto, time of day of travel, origins and destinations of travel, and land use at destination.

The final report documents an overall 24-hour average trip length of 9.3 kilometers (or 5.78 miles). Average trip lengths by travel mode and trip purpose are shown in Figures B.4 and B.5 based on kilometers. As noted in both, the short trip lengths suggest that these data would not be useful in constructing the necessary long-distance parameters. In addition,



Source: TransLink's 2008 Regional Trip Diary Survey – Final Report, Exhibit 3.11a.

Figure B.4. Vancouver survey trip length by mode.



Source: TransLink's 2008 Regional Trip Diary Survey – Final Report, Exhibit 3.11a.
Note: PS = Post-secondary school.

Figure B.5. Vancouver survey trip length by purpose.

details regarding the population of the study area suggest that the study area is predominantly urban and would not have sufficient rural cases to support the rural analysis.

B.3 Travel Survey of Residents of Canada

The Travel Survey of Residents of Canada (TSRC) is a supplemental survey to the Canadian Labour Force Survey, which is a monthly survey of approximately 54,000 households regarding employment levels. (Unless otherwise noted, the details in this section come from http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3810&lang=en&db=imdb&adm=8&dis=2) The TSRC was initiated in 2005, and by 2009, there were about 7,000 responses per month with each month documenting about 3,500 trips. The study is sponsored by Statistics Canada, the Canadian Tourism Commission, provincial governments, and federal organizations. It is designed to measure the size and status of Canada's tourism industry at the national level. As such, it measures the volume, characteristics, and economic impact of domestic travel. A precursor to the TSRC is the Canadian Travel Survey, which is summarized in the next section of this appendix.

"The objectives of the [TSRC] survey are to provide information about the volume of trips and expenditures for Canadian residents by trip origin, destination, duration, type of accommodation used, trip reason, mode of travel, etc.; to provide information on travel incidence and to provide the sociodemographic profile of travelers and nontravelers." Data obtained through the TSRC that are potentially relevant to the development of transferable parameters for long-distance travel include

- Total volume of same day and overnight trips taken by the residents of Canada with destinations in Canada;
- Main purpose of the trip/key activities on trip;
- Modes of transportation (main/other) used on the trip;
- Use of travel packages and associated spending and use of motor coach/other guided tours;
- Demographics of adults that took or did not take trips; and
- Travel party composition.

OD_R01 Please think about all of the out-of-town trips you took that ended last month, that is in (reference month), (reference year). The trips could have been for visiting friends or relatives, for pleasure, vacation or holiday, for personal or business reasons.

OD_Q01 Did you take any out-of-town trips of one or more nights away from home that ended last month, that is in (reference month), (reference year)?
1 Yes
2 No .... (Go to OD_Q03)
DK, RF .... (Go to OD_Q03)
Coverage: All respondents.

OD_Q02 How many? (Overnight trips)
____(2 spaces) [Min: 1 Max: 31]
DK, RF
Coverage: Respondents who took at least one overnight trip.

OD_Q03 Did you take any same day out-of-town trips of at least 40 kilometers one-way last month?
INTERVIEWER: If the respondent is not sure, explain that we mean trips to any destinations that are located 40 kilometers or more from their place of residence and in which they left and returned home on the same day. Forty kilometers is equivalent to about 25 miles. We are interested in one-way distance only.
1 Yes .... (Go to OD_Q04)
2 No
DK, RF .... (Go to OD_C05)
Coverage: All respondents.

OD_Q04 How many? (same-day trips)
____(2 spaces) [Min: 1 Max: 40]
DK, RF

Source: http://www.statcan.gc.ca/imdb-bmdi/instrument/3810_Q3_V7-eng.pdf

Figure B.6. TSRC questions to document long-distance travel.

The long-distance trips are obtained for the month prior to the TSRC interview. Figure B.6 shows the question series used to obtain the number of long-distance trips.

The TSRC is administered predominantly by CATI. A small portion of interviews are conducted using CAPI. The sample consists of a cross-sectional subset of those who completed the Canadian Labour Force Survey. The interviews are largely conducted with the sampled household member; proxy reporting is permitted only under very strict conditions. In Canada, the Labour Force Survey is mandatory, but the TSRC is voluntary. According to Statistics Canada, the Labour Force Survey has a 90 percent participation rate, while the TSRC has a "slightly lower response rate of 80 percent with a travel incidence rate of about 30 percent" (http://www.statcan.gc.ca/imdb-bmdi/document/3810_D3_T9_V1-eng.pdf).

The high response rates, combined with an apparent low level of proxy reporting suggests that the travel documented therein is fairly representative of the Canadian long-distance travel market. Data summaries are available, as well as the dataset itself, for varying costs.

B.4 Canadian Travel Survey

The Canadian Travel Survey (CTS) is the precursor to the Travel Survey of Residents of Canada (TSRC). This survey was conducted as a supplemental survey to the Canadian Labour Force Survey. It was initiated in 1979, became an ongoing survey in 1980, and was last administered in 2005 as a quarterly survey (http://www.statcan.gc.ca/imdb-bmdi/document/3810_D2_T9_V1-eng.pdf). The study was sponsored by Statistics Canada, the Canadian Tourism Commission, provincial governments, and federal organizations. Like the TSRC, it was designed to measure

Table B.1. Differences between CTS and TSRC.

Criteria	CTS	TSRC
Target Population	Age 15+	Age 18+
Overnight Trips Captured (Regardless of Distance)	All	Only those "out of town"
Same-Day Trips Captured – Distance	Ontario residents: 40 kilometers or more All others: 80 kilometers or more	All: Only those 40 kilometers or more from home to a destination "out of town"

the size and status of Canada's tourism industry and measured the volume, characteristics, and economic impact of domestic travel. (Unless otherwise noted, the summary for this section comes from http://www.statcan.gc.ca/imdb-bmdi/document/3810_D1_T7_V1-eng.pdf)

The CTS obtained long-distance travel details for all-day trips of 80 kilometers (approximately 50 miles) or longer (one-way only), except for Ontario residents, who reported on details for all-day trips of 40 kilometers or longer. Trips involving at least an overnight stay (or longer) were documented regardless of length. To be recorded, the trip must have taken place in the referenced month. Trips excluded: "commutes between home and work or school; one-way moves to a new residence; trips made by members of the operating crew of a bus, plane, truck, etc.; ambulance rides to hospitals or clinics; trips originating outside Canada; and trips lasting more than 1 year." Table B.1 shows the main differences in recorded trips in the CTS and its replacement, the TSRC.

The following are statistics from the 2004 CTS (the most recent summary document located) (http://www.statcan.gc.ca/pub/87-212-x/87-212-x2004000-eng.pdf, Tables 2.2, 2.3, 2.5, 2.7). These statistics reflect travel from throughout the year, including summer months, and are available in a PUMS-like format for use in estimating long-distance parameters.

- Canadian residents reported making 216.9 million person-trips annually (as defined above), of which 175.1 million were to destinations within Canada, 36 million were to the United States, and the remaining person-trips were to locations outside of North America.
- Of the 175.1 million trips to destinations within Canada, 86.4 million were same-day trips and 88.7 million were overnight trips.
- Of the 175.1 million trips to destinations within Canada, 153.5 million were made to a destination within the same province. Fifty-three percent of these intraprovincial trips were same-day trips, while 47 percent were overnight trips.
- Of the 175.1 million trips to destinations within Canada, 21.6 million were made to a destination outside the home province. As to be expected, the majority of these interprovincial trips were overnight trips (80 percent).
- In terms of trip purpose, of the 175.1 million person-trips to destinations within Canada, 39 percent were for pleasure, 36 percent were to visit friends or relatives, 14 percent were for personal or nondisclosed reasons, and the remaining 11 percent of trips were for business or to attend conventions.
- In terms of travel mode, 160.8 million of the 175.1 million person-trips were made by car. Seven million person-trips were made by plane, 4.6 million by bus, 1.3 million by train, and 0.5 million by boat. The remaining 0.9 million person-trips were either an "other" mode or not stated.
- Note: although trip distance is not recorded, the CTS documents the reported origins and destinations of travel at the city level. Thus, center city to center city distances could be estimated from the data. In addition, detailed tables provide person-trip numbers by various demographic and socioeconomic groupings.

B.5 Rural and Small Town Canada Analysis Bulletin

In 2002, Statistics Canada issued a Rural and Small Town Canada Analysis Bulletin. (Unless otherwise noted, the facts for this section come from http://www.statcan.gc.ca/pub/21-006-x/21-006-x2005005-eng.pdf). This document summarized details from the 2002 Canadian Travel Survey and its companion, the 2002 International Travel Survey (the CTS as described above focused on domestic travel, while the ITS documented statistics on travel to and from Canada). As with the other Canadian data sources, this bulletin was produced for the purpose of evaluating the tourism sector. The research was sponsored by the Agricultural Division of Statistics Canada, and "rural" regions were those with less than 150 persons per square kilometer.

The purpose of the bulletin was to examine the number and characteristics of travelers to rural Canada in 2002. Although the analysis is strictly focused on leisure travel, the relevant statistics can be useful to benchmark against parameters developed from other data sources. Relevant statistics include

- In 2002, there were 21 million leisure tourist visits to Canadian destinations. Of these, 83 percent were by Canadian travelers, 12 percent by U.S. residents, and the remainder from elsewhere in the world.
- About half of all Canadian tourist visits were to predominantly rural regions.
- About 39 percent of the 25.6 million visits by U.S. residents were to predominantly rural regions.
- Almost half (41 percent) of the U.S. visitors were age 55 or older.

Although not sufficient to develop parameters for this effort, the available statistics from the ITS can help to benchmark the parameters that are developed using other sources. Pertinent variables from the ITS that can help to inform both rural and long-distance analyses include (http://www.statcan.gc.ca/cgi-biN/Af-fdr.cgi?l=eng&loc=http://www.statcan.gc.ca/dli-ild/meta/its-evi/2002/its2002cdn-gid.doc):

- **Household—**Area of residence (province or tourism region);
- **Traveler—**Age and sex (a combined variable); and
- **Travel Details—**Canadian custom port of exit, date of exit, travel party size, main reason for trip, activities of travel party, mode of transportation for exit and entry, mode of transportation while used, total nights in place visited.

B.6 Canadian Tourism Surveys

As noted above with the TSRC and the CTS, the Canadian government invests significant resources into understanding the tourist market in Canada. This includes the 2006 Travel Activities and Motivations Survey, which documents all places traveled to in the past 2 years, activities undertaken, and general tourist details, as well as regional tourism surveys such as the 2006 Visitor Exit Survey of the Northwest Territories. The surveys are informative in terms of the residential location of visitors, which can be used to inform the development of attraction rates for specific tourist locations. The data from these surveys cannot, however, be used to estimate long-distance trip rates or other statistics of interest to this research.

Northwest Territories Visitor Surveys

The government of the Northwest Territories conducts visitor exit surveys on a regular basis to document baseline information on visitor numbers, spending patterns, and visitation characteristics (http://www.iti.gov.nt.ca/publications/2007/tourismparks/2006%20Exit%20Survey%20-%20Outdoor%20Adventure.pdf). The objectives of these surveys include the following:

- Obtain sufficient data to develop an estimate of total visitation to the Northwest Territories;
- Obtain sufficient data to develop estimates of total visitation and spending for six visitor segments;
- Obtain sufficient data to produce profiles for each visitor segment; and
- Obtain data on interest and participation in Aboriginal Tourism products.

A variety of survey instruments and methods are used to gather the data, including self-administered surveys, trip diaries, and tally count sheets. In the 2006 Visitor's Exit Survey, 10,674 surveys were completed. Data elements obtained in this survey that might be relevant to this study included the following:

- Primary destination;
- Mode of travel to the Northwest Territories and while in the Northwest Territories;
- Travel party size and composition (family, friends, etc.);
- Age and gender of those in the immediate travel party;
- Number of nights spent in the Northwest Territories, total, and by accommodation type;
- Home location;
- Trip purpose and activities undertaken while in the region; and
- Demographics (educational attainment, occupation, household income).

Through these surveys, Northwest Territories visitation for 2006/2007 was estimated at 63,461 total visitors, of which 38,819 were for leisure and 24,642 traveled for business. Details regarding home origin and distances traveled for all visitors were not published online.

B.7 International Studies on Long-Distance Travel

During the course of conducting literature scans for sources of long-distance travel data, several related studies conducted outside of North America were identified. Available studies are summarized in this section. The research team did not use data from outside North America, given differences in transportation options, development patterns, and other factors. However, it is important to note availability for future reference, as needed.

European Studies

Transportation researchers in Germany and France undertook a study to evaluate long-distance travel data from several European sources in order to develop harmonized results (Kuhnimhof et al. 2009). Their study considered data from the following eight different surveys:

1. Denmark National Travel Survey (2006)—Focus of this survey was on daily travel. There was not an explicit long-distance survey component.
2. French National Travel Survey (1993/1994)—The main survey was focused on daily travel. In addition, respondents were asked about long-distance travel (i.e., trips greater than 80 kilometers in "crow-fly" distance) during a 12-week period.
3. German National Travel Survey INVERMO (1999–2002)—Long-distance survey capturing trips more than 100 kilometers in length (network distance) over an 8-week period.
4. German National Mobility Panel (2006)—Panel survey of daily travel (no explicit long-distance survey component).
5. Swiss Microcensus (2005)—Daily travel survey that also obtained data on excursions more than 3 hours in length and/or overnight excursions over a 2- to 8-week period.

6. Swedish National Travel Survey RES (2006)—This was also a daily travel survey that asked about trips more than 100 kilometers (network distance) within a 4-week period and those over 300 kilometers in network distance within an 8-week period.
7. United Kingdom National Travel Survey (2005)—Daily travel survey that obtained details about long-distance trips of 50 miles or more over a 4-week period.
8. Design and Application of a Travel Survey for European Long-Distance Trips Based on an International Network of Experience (DATELINE)—A 2001/2002 survey of long-distance travel across 16 European counties. Long-distance trips were defined as those of more than 100 kilometers in length (crow-fly distance) for a 3-month period, with extended questions about holiday travel over a 12-month period.

Other Studies

The following articles investigated some aspect of long-distance travel that may inform the interpretation of other data sources, using data from outside North America:

- **International Mobility Biographies—**A Swedish (Frandberg, 2006) researcher surveyed 162 students about their international travel (i.e., all international trips made during their childhood and adolescence). Her theory was that the level of international travel was influenced by the educational level of the parents, their economic resources, and whether they lived in an urban or rural area. The 162 students reported almost 3,300 international trips, averaging 21 international trips per student. Almost half (44 percent) of the students reported regular travel abroad. The paper did not report on factors that influenced travel (i.e., did not directly address the research question). Instead, this paper offers interesting insights into retrospectively collecting long-distance travel, what results are more reliable, and why.
- **Destination Loyalty—**This study (McKercher and Guillet, 2011) investigated the research question of whether destination loyalty exists either at the tourist or market level. The research evaluated year-by-year and repeat-visitation intentions of Hong Kong residents to 11 popular destinations. The findings suggest, "low individual repeat visitation intention, but overall market stability" in terms of travel to specific destinations, with similar profiles identified for those who had traveled to a specific destination and those who intended to travel to that same destination. This information may help to inform distributions of leisure travel patterns in the United States.

APPENDIX C

Modal-Based Travel Data

This appendix discusses long-distance travel data for non-auto modes. Publicly available data on long-distance rail and bus travel is very limited at the present time to national statistics and major station/terminal traffic throughput volumes."

For the purposes of this report, the research team analyzed only readily available data on long-distance air travel, intercity bus, and intercity passenger rail. These databases did not permit the analysis of individual trip-makers as found in household or even roadside intercept surveys, which limited what transferable parameters could be gleaned from the data (e.g., no trip rates per household or person). Information was also limited to specific modes of travel so it was not directly useful in terms of mode choice either. The hope is that by summarizing average travel distance by travel mode in this appendix, conclusions can be drawn later about mileage break-points where certain modes become a more predominant choice.

C.1 Air Passenger Travel Data

The research team pulled together some data from BTS (Bureau of Transportation Statistics, 2011) related to air passenger travel. This database had about 20 million records from the past year so data were aggregated up to origin to destination airport data for the whole year. The individual records had details about layovers/stops along the way and were summarized by quarter of the year. Data were exported into a manageable spreadsheet that included fare and distance averaged over the O/D pairs. Data were also evaluated in terms of airport size as listed in an FAA report (Federal Aviation Administration, *Terminal Area Forecast Summary Fiscal Years 2009–2030*,http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/taf_reports/) by FAA region, intraregional/interregional (FAA regions) trips, and continental U.S. trips (excluding Alaska, Hawaii, Puerto Rico, Virgin Islands, Guam, American Samoa, and Northern Mariana Islands). "This table contains (directional) origin and destination markets from the Origin and Destination Survey (DB1B), which is a 10 percent sample of airline tickets from reporting carriers. It includes such items as passengers, fares, and distances for each directional market, as well as information about whether the market was domestic or international. The file also reports operating and ticketing carrier information for flight segments within the directional market. This table is related to both the Origin and Destination Segment and ticket files by the unique Market ID on each record. Market data are passenger, freight, and/or mail that enplane and deplane between two specific points, while the flight number remains the same. If the flight number changes, a new market begins."

Initial trip lengths appeared higher than expected so results were summarized using alternate calculation methodologies available in the database. The distances that were reported initially were based on median market distance. Market distance, in the context of this analysis, provides the distances that are likely traveled for a given airport pair, including ground transportation. Looking up the airport-to-airport distance provided results that were comparable with nonstop miles (another option also known as radian measure). For instance, someone flying between two smaller airports will probably not even have the option of flying a nonstop commercial flight and will likely make a few stops. The other two calculation options are market distance group (aggregates market distance into categories) and market miles flown (most often exactly equal to market distance or else a little shorter of a trip due to exclusion of ground transportation).

Market miles flown came out just between market distance and nonstop miles but very close to market distance. For the market distance group, the number of passengers was summed by the grouped categories (distance in 500-mile increments). About half the trips are under 1,000 miles and half above 1,000 miles. Distances recalculated using the radian measure had a minimal impact with slightly lower and more reasonable average trip lengths, potentially due to the exclusion of ground transportation mileage. Average trip lengths for air passenger trips, using radian mileage estimates, are summarized in Table C.1 by airport type and FAA region. These regions are depicted in Figure C.1.

As a point of reference, raw survey results for the California High-Speed Rail (CAHSR) Air Travel Survey were also summarized to get a sense of trip purpose for air passengers. Airline

Table C.1. Estimated 2010 air passenger travel distance, continental United States.

	Airport Type (Origin Airport)				Trip Type	
Annual Air Travel Statistics	All Airports	Large Hub	Medium Hub	Small Hub	Intraregional Trip	Interregional Trip
Total Number of Passengers (Millions)	40	24	10	6	7	33
Total Number of Passenger Miles (Millions)	45,248	28,248	10,764	6,236	2,933	42,315
Average Number of Miles Traveled per Passenger	1,137	1,198	1,035	1,071	433	1,281
Average Fare Paid per Mile Traveled	$0.18	$0.18	$0.18	$0.20	$0.37	$0.17

	FAA Region (by Origin Airport)							
	AEA	ASW	AGL	ASO	ANE	ACE	ANM	AWP
Annual Air Travel Statistics	Eastern Atlantic	Southwest	Great Lakes	South	New England	Central	Northwest/ Mountain	Western/ Pacific
Total Number of Passengers (Millions)	5	4	5	6	1	1	2	4
Total Number of Passenger Miles (Millions)	6,338	3,808	5,099	6,483	1,867	824	2,042	5,053
Average Number of Miles Traveled per Passenger	1,194	991	1,025	1,041	1,283	1,013	1,090	1,292
Average Fare Paid per Mile Traveled	$0.18	$0.21	$0.19	$0.19	$0.16	$0.19	$0.19	$0.16

Source: Bureau of Transportation Statistics. *U.S. Air Carrier Traffic Statistics Through December 2010* (http://www.bts.gov/data_and_statistics/), January 2011.

Source: Federal Aviation Administration (https://tpss.faa.gov/tpss/public/airports_regions.jsp).

Figure C.1. FAA regions.

passenger surveys were conducted at six key airports throughout California. The surveys were conducted on the following dates:

- **Sacramento Airport**—Conducted August 17–18, 2005;
- **San Jose Airport**—Conducted August 24–25, 2005;
- **San Francisco Airport**—Conducted September 20–22, 2005;
- **Fresno Airport**—Conducted October 13, 2005;
- **Oakland Airport**—Conducted November 1, 2005 (outside the security area); and
- **San Diego Airport**—Conducted November 9, 2005 (outside the security area).

The average trip distance from the California High-Speed Rail surveys (Corey, Canapary and Galanis Research, 2005) was 390 miles while the longest distance surveyed was 501 miles (San Diego to Sacramento). The resulting survey trip purposes are summarized in Table C.2.

Table C.2. Passenger air trip purpose from intrastate travel.

Trips by Purpose	Number of Passengers	Percent Share
Business	775	63
Work Commute	22	2
Vacation/Pleasure/Recreation	158	13
Visit Friends or Relatives	157	13
Personal or Family Matters	83	7
Go to or from School	17	1
Other (Specify)	7	1
Blank	14	1
Total	**1,233**	**100**

Source: California Air Travel Survey for High-Speed Rail Model.

C.2 Intercity Passenger Rail (Amtrak)

Amtrak (National Railroad Passenger Corporation) is the sole provider of long-distance intercity passenger rail in the United States. Ridership on Amtrak has been on a steady upward trend over the last decade, particularly since September 11, 2001. More recently, as the price and difficulty factor of air travel has risen, renewed growth has been observed. As of the end of April 2011, ridership has increased for 17 consecutive months. Amtrak service can be roughly divided into the following three categories.

Category 1 is the Northeast Corridor spine, centered on the former Pennsylvania Railroad Northeast Corridor line. This service represents the bulk of Amtrak ridership and is exemplified by the electric Boston to Washington, D.C. Acela Express and Northeast regional services. The corridor serves the most densely populated urban areas in the country with New York City's Pennsylvania Station being the focus and is the most naturally suited in the country for rail travel. Service in this corridor is fast and frequent and is time competitive with air and auto trips.

Category 2 is defined as state-supported corridor services and other short-distance corridor services. This service type is similar, in many respects, to Category 1, with relatively short distances but these are usually geographically limited to one state or neighboring states. They tend to be located away from the electrified Northeast Corridor and its branches and serve some less-dense urban areas that are less suited for rail travel. The intra-California services are the best examples. Service is less frequent than in the Northeast Corridor with somewhat lower speeds because routing generally relies on freight railroad infrastructure and uses diesel-powered equipment.

Category 3 is defined as traditional long-distance intracontinental service. These routes are very long and usually are operated over freight rail lines outside of the dense Amtrak-owned Northeast Corridor and Michigan lines. Several of these routes are in excess of 2,000 miles long, taking 2 to 3 days for complete traversal. Service is infrequent, sometimes being one train or less per day per direction. Like the corridor-supported trains outside of the Northeast Corridor, travel speeds are modest, usually being no faster than the national 79 mph speed limit on freight railroads, with a few exceptions. Many of these routes provide essential links in some of the most remote reaches of the country.

In FY 2010, Amtrak reported that it carried 28.7 million passengers, which represents an increase over the FY 2009 number of around 5 percent. An O/D table of routes was obtained from Amtrak and used to determine the trip totals by regions defined similarly to the FAA regions (excepting the rail-isolated areas of Hawaii, Alaska, and Puerto Rico). Table C.3 illustrates the breakdown of linked passenger trips by region using the O/D data. Please note, the differences between the total and Amtrak's reported total may be attributable to differences in reporting assumptions regarding data summation. Not surprisingly, the Northeast Region had the most trips, due primarily to the high-frequency Northeast Corridor. Somewhat more surprising is that the state-supported intra-California services and the Cascades Talgo services made the Western Region the second highest in number of intercity rail passenger trips. The regions serviced only by infrequent intercity long-distance service like the Southwest, Mountain, and Central Regions saw the lowest passenger volumes.

Table C.4 indicates key travel behavior characteristics such as revenue, average trip distance, passengers, and passenger miles traveled of Amtrak trains derived from Amtrak-published national and long-distance train fact sheets (Amtrak Media Relations, 2010.) As can be seen, the average passenger on an Amtrak long-distance train travels a distance of 622 miles. The system-wide average is 220 miles whereas the corridor services are 148 miles.

Table C.3. Passengers by FAA geographic region, federal FY 2010.

Region	Total
Western/Pacific	6,414,561
Southwest	410,163
Southern	1,343,867
Northwest/Mountain	208,693
Central	384,605
Eastern/Atlantic	12,365,838
Great Lakes	3,142,396
New England	2,750,222
Canada	161,539
Total	**27,181,884**

Source: Amtrak Incorporated (Station-to-Station O/D table).

Table C.4. Amtrak federal FY 2010 key travel characteristics.

	Passenger Miles (Millions)	Revenue (Dollars in Millions)	Passengers (Millions)	Fare per Passenger Mile (Dollars)	Average Trip Length
Long-Distance Trains	2,800	454	4.5	0.16	622
Corridor Services	3,563	2,056	24.2	0.58	148
Total	**6,363**	**2,510**	**28.7**	**0.39**	**222**

Sources: 1) Amtrak – National Fact Sheet 2010; 2) Amtrak – Long-Distance Train Facts; 3) www.Amtrak.com

An attempt was made to calculate the average trip length by region using the Amtrak-supplied O/D data via an alternate analytical process. This effort involved using a rail trip length matrix for counties along rail lines, matching the O/D data to the specific counties, and calculating averages using travel modeling software. The systemwide calculated value was 573 miles using this approach. It is surmised that the aggregation to county level is distorting the actual trip lengths, especially for the short corridor sectors. A better strategy may be to use the actual station locations and conduct a skim based on the passenger rail routes in the National Transportation Atlas Database (NTAD) rail file.

C.3 Intercity Passenger Bus (Greyhound, Trailways, Megabus, etc.)

The research team looked at a number of sources for intercity bus data. Among these was a recent study by DePaul University on intercity bus trips, conducted in December 2010. Unlike the case with air travel, there are no recent BTS data on intercity bus trips, hence raw numbers indicated are estimates derived using a combination of statistics found online at the sites of major intercity operators, the DePaul University numbers (which themselves are estimates), and clearly stated assumptions.

The intercity bus market has, in the last 4 to 5 years, been growing at a faster pace than growth in other travel modes. This represents a complete reversal of fortune when compared to the previous 25 years. This trend has been driven by the prevalence of a new class of intercity bus operation described as curbside operation. The basic premise of this type of operation is that the buses depart from designated curbside locations or general locations apart from traditional municipal bus depots. These operators additionally tend to use reservations systems and yield management techniques similar to airlines with fare purchases in the majority of cases being done in advance via the Internet. Curbside buses generally are equipped with additional legroom, power outlets for mobile devices and Wi-Fi access for mobile connectivity. Trips in many cases are express or very limited stops, and these services tend to cater to larger metropolitan areas. Curbside operators have started to attract a growing clientele who appreciate the ability to continue Internet connections, which facilitate online activities/work while in motion.

Another trend driving the renaissance of intercity bus travel has been the gradually increasing cost of operating private automobiles over the last 5 years. The price of gasoline has been on a steady upward trend since 2000, reaching an average of over $4 per gallon in July 2008 and consistently in the range of more than $3 per gallon in recent years. This price represents almost a tripling from the average price during the 1990s. While gas prices are likely impacting the use of intercity bus services, increasing gas costs have influenced travel on other modes, as well as the number of trips and trip lengths. Intercity coaches, among the most fuel-efficient motorized transportation modes, have been better able to adjust and hold fares at reasonable levels in comparison to low-occupancy auto travel and air, the two most energy-intensive modes of travel.

Intercity bus passenger trips can be roughly divided into three distinct services. As described above, there are the new curbside services, there is the traditional 100-year-old-style national operation by Greyhound, and there are traditional medium-distance intraregional operations. The Greyhound and intraregional operations are very similar except for size of service territory and are treated as one in the analysis. The traditional operators can be described as those primarily using bus terminals, fares usually being purchased at walk-up counters (not exclusively, however), and serving many smaller locations in rural towns and districts. They may be the only public transportation available to the areas served for large distances of up to several hundred miles. Some traditional operators now offer services that mimic curbside to stay competitive. The traditional sector is typified by the large and homogenous Greyhound Lines. Smaller regional lines like the Trailways association of companies, Jefferson Lines, and some statewide transit authorities round out traditional operations. Some of the smaller regional lines are the products of the disintegration of the original Trailways system over the years. Trailways still participates in a loose marketing and operating partnership and many of these services are still branded with the Trailways name. Examples include Trailways of New York and Burlington Trailways of Iowa, which still offer extensive intraregional scheduled service. In most cases, interline agreements are in place among the companies, which ensure that intercity bus transportation has the largest domestic geographic extent of any public transportation mode.

From the available data collected, it can be surmised that the average bus trip length per passenger is somewhere in the 200-mile range, as depicted in Table C.5. The passenger miles traveled are estimated at 10.5 billion per year with about 50 million passengers boarded. An attempt was made to determine regional breakdown, but such data were unavailable. A scan of various schedules in select regions was undertaken to get a rough idea of market size.

The regions looked at were the Northeast centered on New York City, the Midwest centered on Chicago, and the West Coast primarily looking at California. It is clear from this brief analysis that the Northeast is the largest market in the country based on sheer number of scheduled departures and destinations. A back-of-the-envelope estimate would be that it is at least 2 to 3 times the size of the next largest market, the Midwest. California comes in third behind the Midwest. It must be noted that there is also enhanced activity near the border regions (for Mexico-bound trips in particular).

Table C.5. Key bus travel characteristics.

2010 Annual Figures	Greyhound[a]	Curbside Operators[b]	Other Scheduled Operators (Jefferson Lines, Trailways, etc.)	All Scheduled	Amtrak Federal Fiscal Year 2010[e]
Total Passengers (Millions)[c]	25	6	19	50	29
Total Passenger Miles (Millions)[d]	5,800	1,216	3,466	10,482	6,363
Average Number of Miles Traveled per Passenger	232	205	187	214	222

Sources: Paul Bourquin – Economist and Industry Survey Analyst. *Motorcoach Census 2008: A Benchmarking Study of the Size and Activity of the Motorcoach Industry in the United States and Canada in 2007*. December 18, 2008.

Joseph P. Schwieterman and Lauren Fischer. Chaddick Institute for Metropolitan Development, DePaul University. *The Intercity Bus: America's Fastest Growing Transportation Mode, 2010 Update on Scheduled Bus Service*. December 20, 2010.

Notes:

[a] Greyhound numbers include subsidiary and Greyhound Canada travel and is not split out. An assumption that 20 percent represent the Canada operations gives about 20 million passengers.

[b] Curbside numbers represent estimates from the DePaul University report.

[c] Total passenger trip numbers derived by estimating total scheduled fleet size and then using ABA 2007 Census average trips per coach to get total.

[d] Passenger mile numbers for other operators is estimated based on ABA 2007 Census of motorcoach activity with the scheduled service percentage of 26.5 percent split out from total service miles, applying an average load of 30 per coach for all bus trips, and then removing Greyhound and Curbside numbers.

[e] Amtrak numbers include a small number of transborder Canada trips as well.

With an intercity bus market dominated by private service providers, it has proven difficult to gain access to operational data that would better pinpoint trip movements. It is anticipated that ATS and NHTS 2001 data on long-distance trips will show a strong income correlation with selecting intercity bus as a mode for long-distance travel.

APPENDIX D

Other Demographic and Origin-Destination Data

This appendix describes additional reviews of long-distance and rural travel O/D data sources that already are collected or could be effectively collected both with traditional and emerging intercept technologies. This appendix describes data limitations and the minimum amount of local data required to assess the reasonableness of travel parameters derived from data collected elsewhere with traditional roadside intercept and advanced technologies.

The advantage of employing traditional household survey methods for long-distance and rural trip data collection is that these surveys can gather most information required for travel analysis and modeling. But this approach also has obvious disadvantages, including very high costs (in order to have a sufficiently large sample), significant respondent burden, difficulty in gathering accurate longitudinal information, potential biases in the sampling frame, difficulty of data expansion, and data reporting and measurement errors. Several new and emerging technologies have been proposed and/or tested in recent studies, which have the potential of replacing or supplementing traditional household and intercept travel surveys, including the following:

- GPS-based longitudinal survey with in-vehicle data loggers or tracking systems installed by vehicle manufacturers (e.g., OnStar system);
- GPS-based longitudinal survey with on-person data loggers;
- Travel survey based on GPS-enabled smartphone technology;
- Automatic license-plate capture and re-identification technology;
- Bluetooth technology;
- Cell phone wireless network location technology;
- Other wireless locationing technologies such as Radio Frequency Identification (RFID) and Wireless Internet (Wi-Fi);
- Web-based surveys; and
- Web-based surveys integrated into social networking applications and using crowd sourcing.

D.1 Traditional Roadside Intercept Travel Surveys

An important category of supplemental survey data is those efforts where details can be gleaned through data mining and aggregation efforts using existing intercept surveys. It should be noted though that most intercept surveys are performed at model area boundary locations for the purposes of estimating external-internal and through travel. It also should be noted that in some states intercepting vehicles for survey purposes is illegal. At a minimum, where available, these secondary sources can help with reasonable tests of the results. For example, in Texas, the DOT has extensive documentation on travel patterns into and through metropolitan areas, obtained through external station surveys. TxDOT has also conducted border crossing surveys. Relevant statistics (as readily available in reports) are presented here.

Texas External Travel Surveys

Since 1990, TxDOT has funded travel surveys on a continuous, rotating basis across Texas MPO areas. These include household, commercial vehicle, workplace, special generator, and external station surveys. Since 2000, TxDOT has sponsored 56 surveys (http://www.travelsurveymethods.org/), including 17 household surveys, 8 workplace surveys (each of which includes several special generator surveys), 10 commercial vehicle surveys, and 21 external station surveys.

The external station surveys are straightforward in terms of the data elements collected: origin, destination, home location, trip purpose, travel party details, and vehicle details. From this, analysts estimate the volume of through versus local travel in a region. A summary of travel statistics obtained from across the state is shown in Table D.1. As indicated therein, there are significant variations in commercial and through trip traffic, based on multiple factors. Through trips are more likely to be long-distance or rural-generated trips than internal-external trips.

Texas Border Crossing Surveys

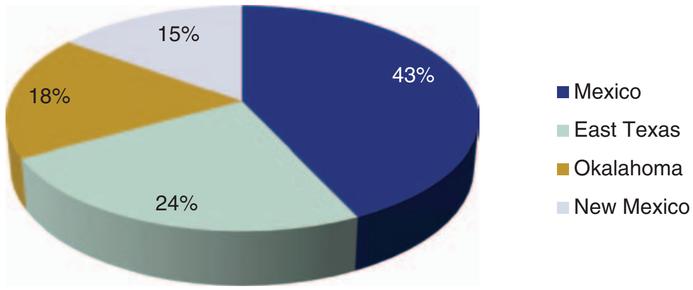
In 2001 and in 2007, TxDOT sponsored statewide surveys to document the level of traffic entering and leaving the state. The 2001 effort surveyed approximately 17,000 vehicles entering, exiting, and passing through Texas at 46 of the 115 highway border crossings in Texas (Texas Transportation Institute, 2001).

For the 2001 effort, the survey results were used to derive an estimate of 746,000 vehicles and 1.29 million persons in vehicles cross the Texas border on a daily basis. Of these, 43 percent of the noncommercial vehicles transported nonresidents across the state line. About 10 percent of these nonresidents remained overnight in Texas, with each person staying an average of three nights per trip. The geographic distribution of these trips is shown in Figure D.1.

Table D.1. Texas external station survey details.

Study Area	Year	Population	Daily Vehicles	Number of Persons	Percent Commercial	Percent Through Trips
Abilene	2005	116,000	80,000	86,300	83	16
Rio Grande Valley	2004	1,030,000	145,000	174,000	87	4
El Paso	2002	N/A	85,000	145,000[a]	67	7
Laredo	2002	193,117	70,000	82,400	68	7
Sherman-Denison	2005	117,000	118,600	135,000	82	17
Wichita Falls	2005	104,200	84,000	92,200	89	10
San Antonio	2005	1,145,000	290,000	313,000	82	11
Amarillo	2005	174,000	78,000	84,500	73	12
Killeen-Temple	2006	141,400	178,000	182,000	82	23
San Angelo	2004	88,000	49,000	55,400	85	9
Longview	2004	25,000	193,000	197,000	79	18

Source: Technical memos for the urban areas listed.
[a]Excludes pedestrian crossings.



Source: Texas Transportation Institute (2001), page 12.

Figure D.1. Texas border crossings, 2001.

Other relevant statistics from the 2001 effort include the following:

- An estimated 83 percent of the border crossing traffic was noncommercial vehicles;
- The average trip length for noncommercial vehicles was 60 miles, for commercial vehicles the average trip length increased to 101 miles; and
- The primary purpose of noncommercial vehicle trips was for work or work-related activities.

TxDOT repeated the effort in 2007. For that effort, 21,000 surveys were administered, including 17,900 surveys of noncommercial vehicles and 3,800 surveys of commercial vehicles (Texas Transportation Institute, 2008). These surveys were conducted at 54 of 115 highway or bridge border crossing locations around the state's perimeter.

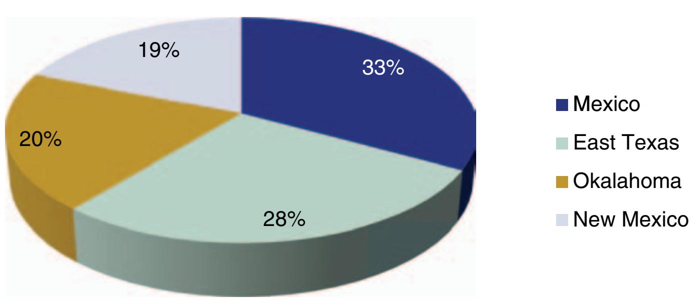
The 2007 survey results suggest that an estimated 787,000 vehicles and 1.13 million persons in vehicles cross the border on a typical weekday, which shows a slight increase from the 2001 survey results. The geographic distribution of border crossings is shown in Figure D.2.

Estimates suggest that 84 percent of vehicle traffic is noncommercial. Average trip length for noncommercial vehicles was 61 miles, and for commercial was 101 miles.

This study enhances our understanding of long-distance travel in several respects. First, it provides estimates of interstate travel based on direction of travel. It also shows the influence of the border crossings, useful for estimating long-distance travel in New Mexico, Arizona, and California. Finally, given the relative stability between 2001 and 2007, it supports the use of the older survey results in our estimations, particularly the Ohio statewide and long-distance survey efforts.

Other Origin-Destination Intercept Surveys

Origin-destination intercept surveys have traditionally been conducted largely to get a handle on the split between through and internal-external trips at a study area/model boundary. With

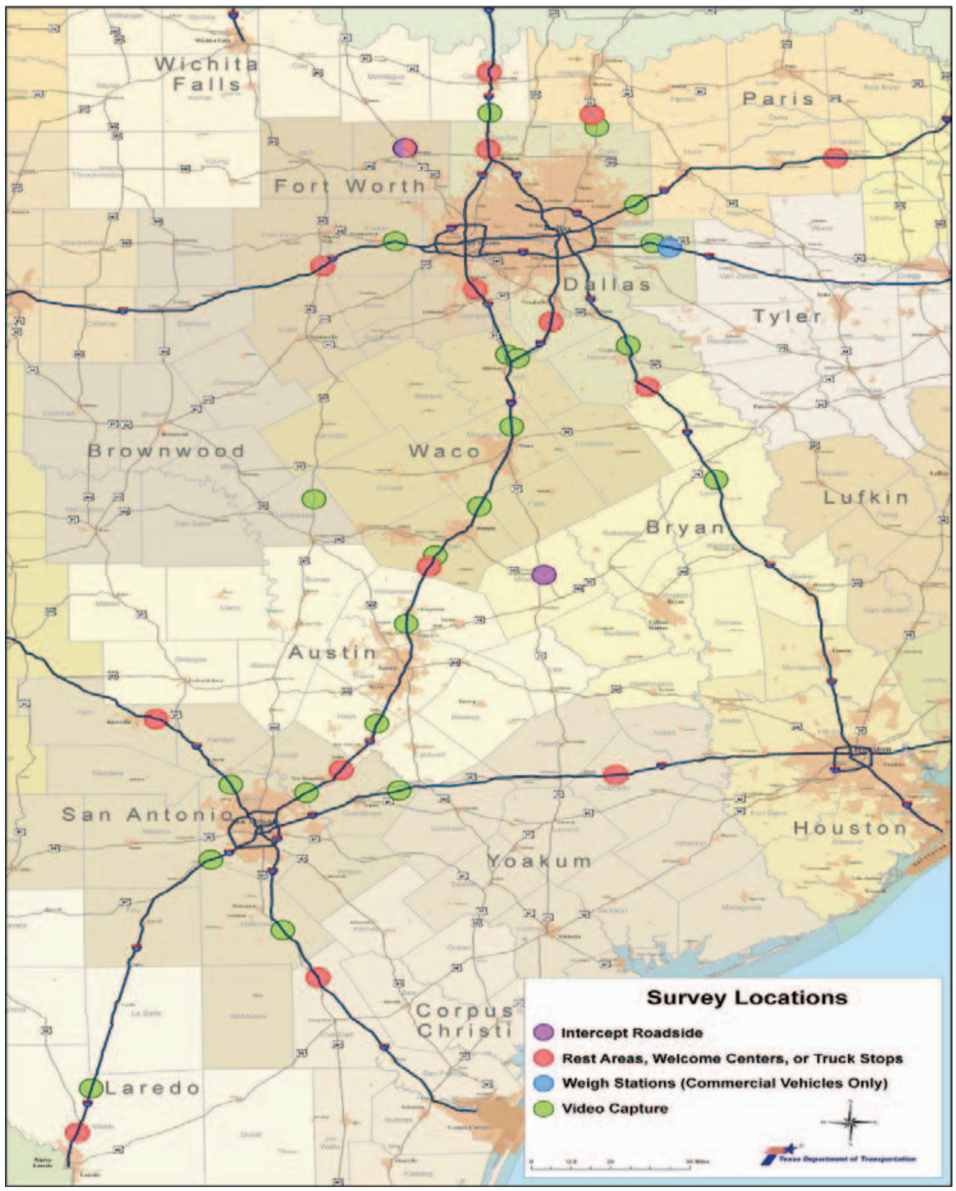


Source: Texas Transportation Institute (2008), page 15.

Figure D.2. Texas border crossings, 2007.

external splits being largely the focus of such surveys, minimal emphasis was placed on where trips were originating from, or destined to, on the outside of the study area boundary where the rural and long-distance characteristics could be tabulated. As such, few roadside intercept surveys provide information of benefit to understanding rural and long-distance trip-making.

In 2007–2008, TxDOT conducted a series of O/D intercept surveys along the I-35 corridor (Wilbur Smith Associates, Inc., 2008) for use in updating the Texas Statewide Analysis Model (SAM) for use in studying future needs along the proposed Trans-Texas Corridor. These surveys included a combination of roadside interviews, mailout/mailback, and license tag matching approaches, and addressed both passenger and commercial vehicle travel. With the focus of these studies largely on long-distance travel, there is some potential that these survey data could provide useful information, should the survey files be obtained. Figure D.3 depicts the survey intercept locations for this study.



Source: Wilbur Smith Associates, Inc.

Figure D.3. Texas Interstate 35 intercept survey locations.

Another, albeit older, roadside intercept survey with a focus on long-distance and rural trip-making was conducted by the Florida DOT in 1992 (Transportation Consulting Group, 1992) for the purposes of understanding the travel patterns of visitors to Florida traveling by automobile. Data collected using laptop computers at survey stations along the state line and several screenline locations crossing major highways in the Florida peninsula were later used to validate the statewide model. Unfortunately, documentation of the surveys is focused on data collection and processing rather than on survey findings.

Roadside intercept surveys were traditionally conducted by pulling over random platoons of vehicles to the roadside for a brief face-to-face survey about the current trip being made. Early data collection efforts were conducted using clipboards and paper surveys, which later gave way to the use of laptops and palm devices. As traffic congestion increased and privacy issues came to the forefront, use of high-speed video cameras became a common approach to locating survey respondents and asking questions about their trips. This high-speed video approach has led to other complications in linking tags to drivers, impacts of these delays on trip recall, and inability to reach travelers due to extensive use of rental cars. The next section describes the use of new and emerging technologies to enhance the collection of both O/D and household travel surveys.

D.2 Surveys Using New and Emerging Technologies

It is clear that no single technology can overcome all shortcomings of the traditional household-based survey method, as evidenced by a summary of technology capabilities depicted in Table D.2. Web-based surveys share the same advantages and disadvantages of traditional household-based surveys, including limitations of self-reporting, memory recall, and distance estimation (which is even more important when trying to identify long-distance and rural travel). GPS, smartphone, and license plate technologies, when used alone, can directly provide a wealth of information on long-distance and rural passenger travel, but not all the required information (such as travel purpose). Bluetooth technology does not allow re-identification of long-distance and rural travelers and is limited to instances where Bluetooth has been activated on devices within vehicles. Data-collection-based social networking sites have sampling bias issues at this time (which is expected to become a less limiting issue in the future) and limitations on data availability.

It appears that the most promising future research directions regarding these new/emerging technologies for the purpose of long-distance and rural travel analysis include the following:

- Testing of the feasibility of these technological options for long-distance and rural travel data collection, including estimating required sample sizes;
- Exploring software applications for event-prompted recall surveys and advanced data imputation algorithms to gather and/or generate information on trip purpose, mode, and traveler characteristics and to supplement data directly collected from GPS, smartphone, cell phone, license plate, and/or Bluetooth technologies, while considering the limitations that may be imposed to protect privacy of the users of those technologies; and
- Development of methods and procedures that employ advanced technologies to identify long-distance and rural trips, then re-identify the long-distance and rural travelers, and finally conduct follow-up household long-distance and rural travel surveys.

GPS-Based Travel Surveys

GPS technology has been used, to some extent, in household travel surveys for more than a decade. One of the main uses of GPS technology in travel surveys has been for logging second-by-second GPS point data that can be processed into a robust dataset that includes detailed trip information, such as start and end times and locations, route/link details, and travel speeds. Early

Table D.2. Capabilities of various new and emerging technologies.

Information Needs	Traditional Methods	GPS	Smartphone	License Plate	Bluetooth	Cell Phone	Web-Based	Social Media/ Networking
Origin-Destination	Y	Y	Y	Y	Y	Y	Y	Y
Mode: Main/Access/Egress	Y	M	Y	Y-auto	Y-auto	Y	Y	Y
Trip Purpose	Y	M	Y	M	N	M	Y	Y
Routes	Y	Y	Y	Y	Y	Y	M	M
Trip Frequency	Y	Y	Y	Y	Y	Y	Y	Y
Travel Season	Y	Y	Y	Y	Y	Y	Y	Y
Trip Duration	Y	Y	Y	Y	Y	Y	Y	Y
Itinerary and Side Tours	Y	Y	Y	M	M	M	Y	Y
Trip Cost and LOS	Y	M	M	M	M	M	Y	Y
Travel Party Size	Y	M	M	M	M	M	Y	Y
Traveler Characteristics	Y	M	M	M	N	M	Y	Y
Domestic or International	Y	M	M	N	N	N	Y	Y
Other Considerations								
Passive Data Collection	N	Y	M	M	Y	Y	N	M
Major Privacy Concern	M	M	M	N	N	M	Y	Y
High-Respondent Burden	Y	M	M	N	N	N	Y	Y
Sampling Bias	M	M	M	N	Y	M	Y	Y
Sufficient Sample Size	M	M	Y	Y	M	Y	Y	Y

Note: "M" (maybe) implies that although the information cannot be directly collected with a specific technology, it may be estimated based on other data sources and/or data post-processing algorithms.

studies used vehicle-based GPS data loggers that were deployed in tandem with travel diaries to collect 1 day of passive GPS data. These data were processed into trips and then compared to reported diary-based household vehicle trips. Over time, as GPS logger technology improved with respect to both power and storage capacity, and decreased in size, this method was modified to include person-based approaches. More than 20 GPS-enhanced travel surveys have been conducted in the United States to date, with a full complement of household travel survey data and GPS traces for a subsample of households (typically 5 to 10 percent of all households).

Since the intent of both the vehicle and person-based approach has been to compare diary-reported trips with GPS-measured trips for the same travel day, extended deployment periods for the GPS devices were not justified given the need to get the devices back quickly to redeploy to other households. Given this short deployment duration, the likelihood of capturing long-distance or rural travel in a single GPS day was limited to households that habitually made long-distance or rural trips. However, as GPS device costs continued to decline, more recent household travel surveys have deployed GPS devices for longer durations, sometimes up to 1 week. The advantage of longer duration GPS deployments is that it is more probable that less common or more infrequent long-distance and rural travel could be collected.

Currently in the United States, passenger vehicle GPS data are collected mainly for two purposes: supplementing/enhancing traditional paper-/telephone-based household travel surveys and providing data for research and pilot tests on VMT-based revenue collection systems. Several jurisdictions in the United States have recently collected GPS data on passenger travel, which are summarized in this appendix. In general, the sample sizes of these GPS-based surveys are not very large. In addition, most of the GPS surveys target urban travelers and the collected trip samples typically contain few long-distance and rural travel records. Nevertheless, these GPS data collection efforts may provide valuable lessons for possible future surveys that focus on long-distance and rural travel behavior.

In the previously mentioned Front Range Travel Counts Survey, conducted in four MPO regions in Colorado, more than 1,000 households were recruited into the GPS augment, which included both a 1-week vehicle GPS component and a 4-day wearable GPS component in two of the regions—Denver and Colorado Springs. The preliminary GPS datasets for this study reveal 176 trips out of 27,515 (0.6 percent) with distances greater than 50 miles (made by 61 households), 214 external-external trips (0.8 percent), and 15 external-internal or internal-external trips (0.01 percent). These percentages confirm the rarity of these behaviors, especially in small samples.

The latest trend in GPS-enhanced travel surveys is a 100-percent GPS approach, in which households are recruited and report traditional sociodemographic information and then receive person-based GPS devices for 3 or more days. The GPS devices are then retrieved, and the GPS data downloaded and processed into trips and trip details. Sophisticated algorithms are applied to impute travel details such as travel mode, trip purpose, and household travel companions (Wolf, Guensler, and Bachman, 2001). GPS-based prompted recall techniques are applied to a subsample of these households to validate and/or calibrate imputation algorithms (Schuessler and Axhausen, 2009).

The appeal of this approach is that other than carrying and charging a GPS data logger for a few days, there is minimal respondent burden once the recruit interview is over. Both long-distance and rural travel can be easily identified within the GPS dataset, with highly accurate trip lengths and travel routes/locations readily available. The benefit of 100-percent GPS travel surveys is that much larger GPS sample sizes (and datasets) are available for data mining. The Greater Cincinnati Household Travel Survey (2009–2011) is the first of its kind and size to adopt a 100-percent GPS sampling methodology (http://www.oki.org/departments/dataservices/faq.html).

GPS-Enabled Smartphone Travel Surveys

Many smartphones, such as iPhone, Droid, Windows Mobile, and Blackberry phones, have embedded GPS tracking capabilities. It is feasible to collect GPS location data at very frequent time intervals (e.g., several seconds) from smartphone users with or without them being aware of the data collection efforts. For long-distance and rural travel analysis, the value of smartphones relies, most likely, on third-party applications (i.e., apps) that users choose to install onto their devices either voluntarily for information provided by the apps or based on financial and other incentives.

Members of this research team from the University of Maryland have tested several apps that enable researchers to collect GPS location information from smartphone users. Figure D.4 shows these apps running in the foreground of an iPhone and a Droid phone, respectively, and the collected GPS location data of a trip originating from Frederick, Maryland, in the early afternoon of March 24, 2011. It is certainly feasible to conduct travel surveys with third-party applications like the one tested by the research team. At this time, there could be sampling biases among smartphone users who are likely to be younger and more affluent than the average traveler. However, this issue is expected to become less serious with smartphones almost becoming must-haves for younger generations. Compared to traditional GPS-based surveys, major advantages of travel surveys based on smartphones include zero device cost (users have already purchased

Figure D.4. GPS location data collected from smartphones.

the phones), zero or very low data transmission/collection cost (users' own data plans may cover the location data transmission especially when the data logging frequency is set at a low level), and potentially large sample sizes.

There has been recent interest in, and discussion about, GPS-enabled smartphone travel surveys among members of the travel survey research community. The technology certainly offers promise in the sense of convenience to study participants in that an application could be downloaded onto a GPS-enabled smartphone that logs GPS data while the user travels and then prompts the user for details about the trips made. However, there are several key issues to be addressed before this approach is feasible in a large-scale survey effort. These issues include the following:

- **Technology Support—**There currently exist several different types of smartphone platforms with varying levels of functionality. Any solution attempting a large sample size would need to support these different models and systems. At present five platforms control over 99 percent of the market.
- **Incomplete Information—**Some smartphones will require the user to start the survey/GPS logging application at the start of each trip and to close it at the end of each trip. Some older smartphone models (e.g., iPhone 3G or versions of iOS that are older than 4) do not support GPS logging while the phone is in use for other purposes (such as when used for a phone call or to play music).
- **Power Consumption—**Continuous GPS data logging significantly increases power draw and may require some users to recharge more frequently than once a day.
- **Data Plans/Costs—**Many smartphone data plans are limited; unless only basic trips details are transferred (rather than complete GPS traces), users are likely to get hit with extra cell phone costs, which could be significant. Users may also not understand this clearly when volunteering for surveys.
- **Travel Surveys are Typically Conducted at the Household Level—**Not all members (even all adult members) of sampled households are likely to have GPS-enabled smartphones. This would result in incomplete household information. More importantly, many households may not have any GPS-enabled smartphones, causing significant biases in the survey results.

Web-Based Surveys

Surveys implemented on the Web have become prevalent across many industries and topics; travel surveys are no exception. Most household travel surveys conducted today include an option for survey participants to report sociodemographic and travel information on-line. Web-based mapping interfaces, implemented using toolkits such as the Google Maps API, allow for real-time geocoding of trip ends by participants as well as provision of actual route traveled. These two features, in turn, enable the automatic identification of both long-distance and rural travel. Limitations of this approach include Internet access to all targeted survey populations and technology expertise in using interactive maps (the latter of which could be circumvented if participants are asked to provide address information only, with geocoding occurring in a post-processing step).

Web-Based Surveys Integrated with Social Networking

Social networks can be used to increase the reach of traditional Web-survey recruitment efforts by exposing them to a wider audience. For example, one could add social-network-like features to existing Web-survey efforts through integration with platforms such as Twitter for notifying participants of changes or updates to the survey and Facebook for allowing participants to invite friends and family to complete the survey ("snowball sampling"). The resulting bias from such an approach must be addressed in analyzing survey response. Location-based features built into social networks can also be leveraged to facilitate the collection of origin and destination information.

Bluetooth Technology

Bluetooth Traffic Monitoring (BTM) has emerged since 2007 as an anonymous vehicle re-identification technology that has proved to be an effective tool for collecting travel time and trip O/D information. Bluetooth subsystems in consumer electronic devices utilize a unique identifier known as a MAC address to facilitate communications. This unique identifier can be used similarly to toll tags or license plates to identify vehicles at different locations and to assess travel time as well as the O/D distribution of trips through the network.

In the past 2 years, several studies have used Bluetooth to sample O/D movements on a small scale to determine turning movements within a freeway or arterial corridor or for distribution of traffic around a major attractor such as a subway stop. The University of Maryland has also recently deployed Bluetooth sensors along the I-95 corridor for travel time, traffic diversion under real-time traveler information, and O/D studies. Theoretically, nothing prevents the use of BTM on long-distance and rural travel O/D data collection, though no such attempt is known to have occurred. The unique electronic IDs are just as applicable to long distances as they are to short or medium distances. The primary limiting factor is the BTM sampling rate, which is known to be generally in the 5-percent range for most areas in the United States. For travel surveys and O/D analysis, the anonymous nature of BTM (i.e., no way to retrieve user information from MAC addresses) is both an advantage in that there should be no privacy concerns and a disadvantage in that it is impossible to conduct any follow-up surveys.

In summary, Bluetooth Traffic Monitoring

- Can anonymously re-identify consumer electronic devices emitting Bluetooth signals (e.g., Bluetooth calling devices installed as vehicle parts, Bluetooth devices such as cell phones carried by drivers and/or passengers in vehicles);
- Can be deployed in a temporary, portable format for short-term studies, or permanently for long-term continuous travel time and O/D pattern monitoring;
- Can achieve approximately a 5-percent sampling rate;

- Is an emerging technology with ongoing parallel experiments for various transportation operations and planning purposes; and
- Does not allow the retrieval of any user information and, therefore, any follow-up surveys.

Automatic License-Plate Capture

When applied for travel surveys and O/D analysis, automatic license-plate capture (ALC) technology is very similar to Bluetooth technology because both enable re-identification of vehicles at multiple sensor locations, which makes it possible to easily single out long-distance and rural trips from other trips. ALC usually is based on high-definition video sensors and machine vision technologies for post-processing video streams. The advantage of ALC, compared to Bluetooth, is that ALC at least theoretically allows the retrieval of vehicle ownership information. In practice, obtaining vehicle owner information from license plate readings for applications other than law enforcement can be very challenging. On the other hand, Bluetooth is more anonymous, and Bluetooth sensors can be encased in a protective box and locked to various roadside features. ALC sensors typically require human monitoring for sensor security, unless they are permanently installed above ground.

D.3 Emerging Sources of Data from Private Companies

There are a variety of new technologies that are being refined and marketed that may have value in the passive collection of long-distance and/or rural travel data. Most of these approaches have not been publicly marketed for these uses, but have been leveraged for passive measurement of similar O/D or travel information. In general, these technologies rely on the fact that the majority of the travelers leave "breadcrumbs" wherever they go due to their use of mobile electronic devices or credit cards. Privacy concerns and existing regulations have prevented any significant development of this capability in the past.

Recently, however, smartphones and personal navigation devices (PND) have circumvented privacy issues through the use of license agreements of software or data services. When a user agrees to the licensing terms of an application or device, there can be clauses in that agreement that allow the licensing organization to access these data for other purposes. These data can then be used as a source of traffic data for real-time or historical traffic data applications and as a source for exploring location-based services.

In other cases where there is no relevant license agreement, or existing agreements preclude such derived uses, there are attempts to use detailed information while still protecting personal data. This is usually handled through data aggregation and anonymization techniques that separate the useful data from anything that can be directly linked to an individual or individual device.

Selected examples of these emerging technologies that could be used for long-distance travel or rural travel identification follow, although all of these are missing key household- and person-level sociodemographic information as well as household-level travel details.

AirSage Cell Phone Data (www.airsage.com) (Airsage Inc., 2011). Private-sector companies routinely accumulate, anonymize, and analyze cell phone signal data from individual handsets and determine accurate location information and convert it into real-time anonymous location data. AirSage markets cell phone data as a source of real-time traffic information and is now providing their data as a source of O/D data for public agencies. The data generated by their technology comes from the triangulation or translation of phone signals from cell phone towers that have known fixed locations. A device location is not polled at regular intervals, but is generated by some action (an active phone call and the switching between different towers). The resulting dataset may be a little spotty for retracing entire trip details, but it can be significant for reviewing overall long-distance travel patterns. This information does come from a biased sample (users of certain cell phone companies), but has a very large sample of continuous data. Detection of repetitive patterns, in conjunction with land use and demographic data, can be used to classify trips as work, shop, school, etc.

TomTom Personal Navigation Device (PND) Data (trafficstats.tomtom.com). TomTom sells PND devices and supporting software. They are now marketing processed results derived from GPS data collected by these devices to transportation planners and engineers that are interested in detailed traffic data. Their marketed solution offers travel time and speed data for almost any route in the United States and Europe. Although the details of their capabilities and methods are not known publicly, it can be assumed that they have access to full data traces from their users, resulting in massive amounts of detailed travel data. Origin-destination products derived from these data have not been marketed to date.

GPS-Tracking Systems Installed by Vehicle Manufacturers. GPS-tracking systems installed by vehicle manufacturers to protect the safety and security of vehicles and their owners (e.g., the OnStar system) also have the capability of tracking vehicle locations over time. The GPS data collected from these systems are from a very large sample for long periods of time and include long-distance and rural trips, which make them desirable for long-distance and rural travel analysis. However, these data products are usually proprietary and may be subject to privacy-related scrutiny. A major issue with GPS travel surveys is attributed to the lack of trip purpose and travel mode information in the collected data. However, it is possible to develop statistical and artificial intelligence algorithms (Stopher, Clifford, Zhang, and FitzGerald) to estimate trip purpose and travel mode information with GPS location data, GIS land-use data, and—if available—sociodemographic information.

Smartphone Track Logs via User-Installed Applications. There have been a range of studies around the world that involve GPS-enabled smartphone users installing a GPS logging application that transfers the GPS point information to a central location for other uses. For example, the Mobile Millennium Project (traffic.berkeley.edu) was a cooperative research endeavor between UC Berkeley, Nokia Research Center, and NAVTEQ to investigate the provision of a traffic monitoring application that was based on GPS data provided by the users of the application. These databases could be mined for long-distance and rural trips but would face the same limitations as other datasets in this group; namely, lack of information about the travel characteristics, lack of household-level information and trips, and bias in available samples.

Wireless Network Locationing Technologies. Compared to GPS-tracking, person/vehicle tracking based on wireless network locationing technologies provides distinct advantages. A very large percentage of U.S. residents already owns cell phones and/or other devices (e.g., RFID, Wi-Fi) that can be tracked by wireless network towers/receivers. This can provide a huge sampling frame for long-distance and rural travel studies. Recently, cell phone tracking for traffic monitoring/management and O/D information gathering has become a common practice in other countries. Wireless networks also tend to function much better than GPS underground, inside buildings, and in areas with high-rise/dense structures. The anonymity of trip information collected via wireless network locationing technology is a major advantage. Since location information from this technology also comes with time stamps, it is relatively straightforward to impute travel modes based on how fast the cell phones move from location to location. Trip purpose information, which is also important for long-distance and rural travel analysis, may be estimated based on collected information such as land use, trip duration, etc.

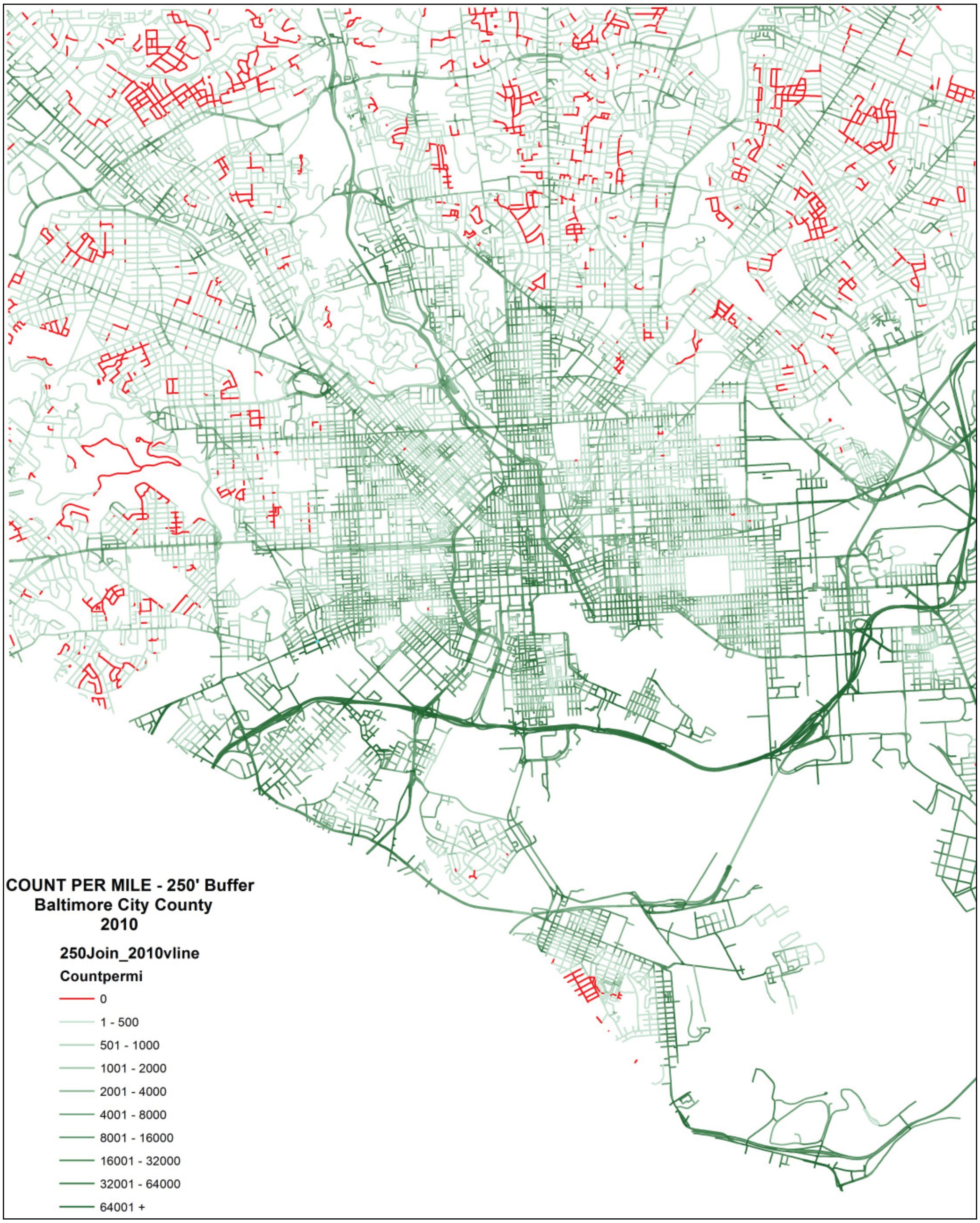
Social Network-Based Location Tracking. Emerging online social network services and features, such as Foursquare and Facebook's Check In, allow users to publish their active location information to their network; they also allow users to know who else is at the same place. Participating merchants can use this information for marketing purposes such as tracking customer loyalty and implementing advertising campaigns. In the context of O/D surveys, this technology could be used to recruit participants to participate in a visitor survey and also assist in the collection of personal movement. However, it is very likely that existing end-user agreements would limit how previously collected data can be used to derive travel.

D.4 Emerging Sources of Data from Research Organizations

Since 2002, the American Transportation Research Institute (ATRI) has assembled and maintained a substantial database of truck GPS position data, with information coming from more than 600,000 trucks in North America. The interval of GPS reads can be as frequent as 1 to 3 minutes or as long as 60 minutes depending on location and individual trucks. Each GPS track position data point is also assigned a unique truck ID and time stamp, which theoretically enables the tracking of the positions of any individual truck and its total vehicle miles traveled. The trucks included in the ATRI GPS database are primarily multi-unit semitrailers owned by large trucking companies, which would not be representative of the entire truck fleet in the nation.

Between January and March 2011, ATRI and University of Maryland researchers, who are also part of the NCHRP Project 8-36 team, worked together to develop a preliminary methodology for linking GPS truck position data to TIGER GIS transportation network data. A 250-foot buffer distance was selected, and any truck GPS position points located within this buffer distance of a transportation network polyline were considered points on that polyline. Figure D.5 shows the number of recorded truck position points per mile on individual roadway segments in the City of Baltimore for the whole year of 2010. Overall, the recorded truck travel patterns show higher truck counts on higher-level roads such as Interstate highway and arterial streets. This type of volume graph can be plotted for all regions of the United States with the ATRI data. More detailed analysis taking advantage of the trucking ID and time stamp information can also be conducted.

While certain sampling and methodological issues with the ATRI truck position data must be addressed before it can be widely used for long-distance and rural truck travel behavior/performance analysis, its continuous national coverage is impressive and appealing for national, regional, and state-level analysis.



Source: FHWA Office of Freight Management, American Transportation Research Institute and University of Maryland.

Figure D.5. Geocoded 2010 ATRI truck GPS data for City of Baltimore.

APPENDIX E

Urban Versus Rural Truck Trips

The documentation for NCHRP Project 8-36-B Task 91, Validation and Sensitivity Considerations for Statewide Models (Cambridge Systematics, Inc., 2010d) noted that a primary issue for statewide modeling of trucks is the consideration of freight. The Task 91 Final Report suggested using the Freight Analysis Framework (FAF), the national policy tool for freight analysis maintained by FHWA, as the most comprehensive tool for considering freight issues. Version 3 of the FAF was released in July of 2010 and includes flows for a base year of 2007.

The FAF3 highway network is available for download from the FHWA Website (FAF3 Network Database and Flow Assignment: 2007 and 2040, http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/faf3/netwkdbflow/index.htm, accessed on July 20, 2011) as both a TransCAD network (FAF3 Network ESRI Format: faf3_1_1_esri.zip, http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/faf3/netwkdbflow/network/esri/faf3_1_1_esri.zip, accessed on July 20, 2011) and as an ESRI shapefile (FAF3 Network TransCAD Format:faf3_1_1_TransCAD.zip, http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/faf3/netwkdbflow/network/TransCAD/faf3_1_1_TransCAD.zip, accessed on July 20, 2011), with the actual loaded network volumes, congested speeds, and performances stored as a DBF file (FAF3 network Output:faf3_1_1_data.dbf, http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/faf3/netwkdbflow/database/faf3_1_1_data.dbf, accessed on July 20, 2011), which can be joined to the network in either software format. The FAF3 network was examined to determine patterns of truck usage that could be reported for this project.

E.1 Freight Analysis Framework Version 3.0

The FAF3 network includes all of the major highways in the United States. As shown in Table E.1, the FAF3 highway network includes virtually all of the center line miles in the three highest functional classifications for rural and urban areas, shown in the shaded rows. While differences do exist, characterizations by the authors of this report will be made at a system level and these minor differences between the FAF3 and official mileages are not considered to be important.

It is inappropriate to load the FAF3 origin and destination flows of trucks with only the 123 domestic U.S. zones reported in FAF3. Doing so without disaggregating to smaller zones would incorrectly load only the principal highway routes connecting the centers of these regions. The FAF3 highway assignment, which was prepared for FHWA, first converted annual flows by truck into daily truck flows, using relationships between tonnage and truck and body type by commodity. Then, the origin-destination matrix was disaggregated from the 123 domestic zones to 4,609 network-specific zones consisting of county centroids, border crossings, major ports, intermodal terminals, and other significant truck generators. FAF3 used impedances on highway links that include preloaded auto and nonfreight truck volumes, developed in cooperation with

Table E.1. Highway mileages—FAF3 versus highway statistics.

Functional Classification		Center Line Miles	
		FAF3	2007 Highway Statistics
Rural			
Interstate	1	32,892	30,360
Other Principal Arterial	2	100,385	94,766
Minor Arterial	6	142,884	135,296
Major Collector	7	754	419,437
Minor Collector	8	34	262,899
Local	9	10	2,045,000
Urban			
Interstate	11	13,537	16,312
Other Freeways and Expressways	12	9,428	10,913
Other Principal Arterial	14	57,598	63,282
Minor Arterial	16	2,270	104,033
Collector	17	232	109,555
Local	19	56	740,273

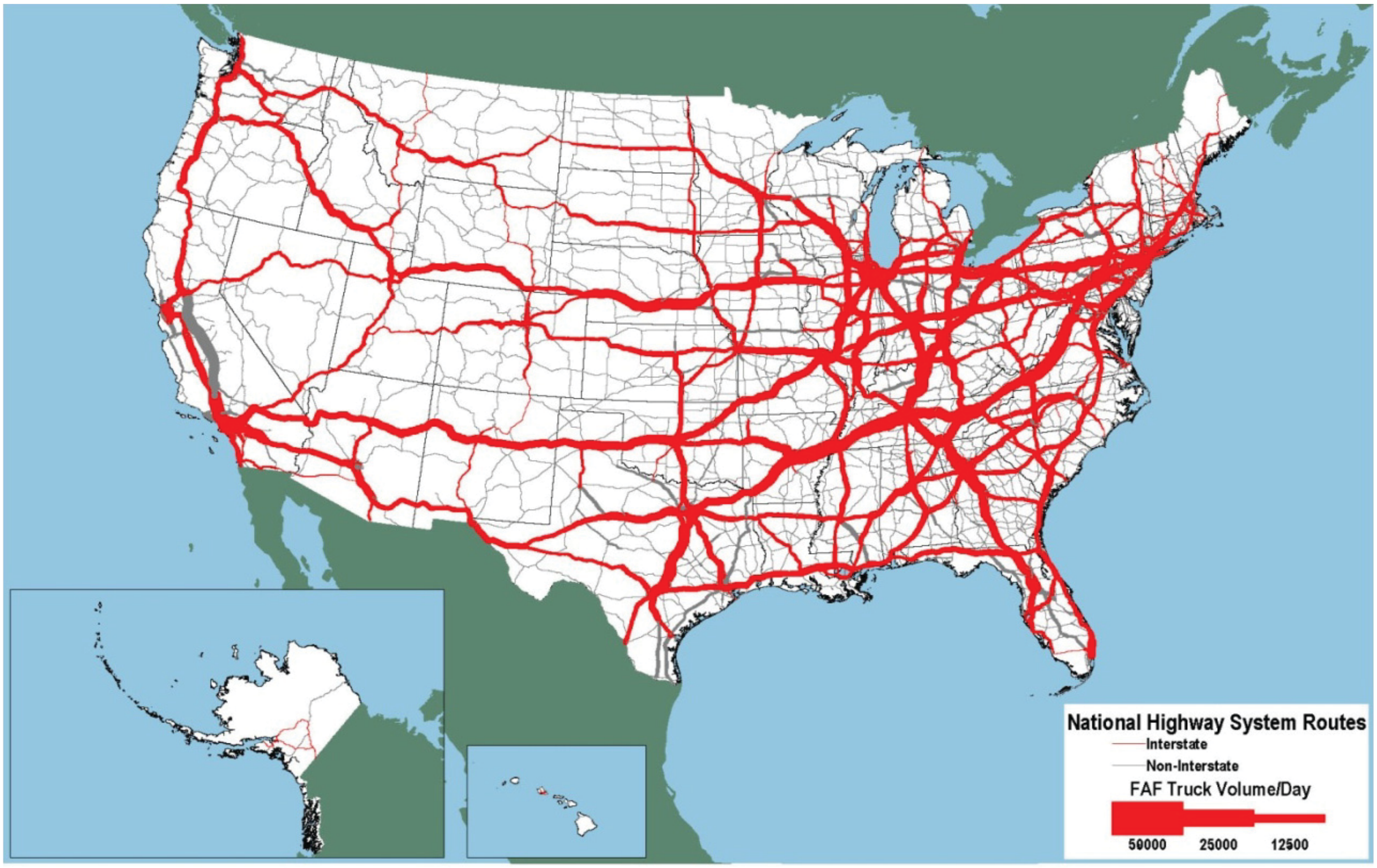
state DOTs, and assigned FAF truck flows using these impedances in a stochastic user equilibrium traffic assignment. The resulting network flow, which includes calibration and validation against known truck volumes, is shown in Figure E.1.

The FAF3 network consists of more than 170,994 links. Of these links, 150,344 had complete Functional Classification System and state identification information that could be used to sort and characterize the network volumes.

The reported daily link volumes for total vehicles, FAF3 trucks, and non-FAF3 trucks were weighted by link length, aggregated by Census region, and reported separately for Interstates and other expressways and other arterials and local roads, for urban and rural areas. (FAF3 trucks report major commodity movements by trucks. It does not report movements of trucks that are the empty movement of trucks in support of freight, local delivery of freight, service trucks, construction trucks, utility trucks, etc. These trucks do contribute to road congestion and must be considered in any assignment of FAF3 trucks. They collectively are called non-FAF trucks in the FAF3 assignment.) The results of that analysis are shown in Table E.2.

This analysis suggests that, on average, non-FAF truck usage is similar for urban and rural areas across all functional systems. The usage is slightly lower on Urban Interstates (5.5 percent) and is even lower on Rural Interstates (3.7 percent) but this is to be expected since these roads have widely spaced interchanges, particularly in rural areas, and would be less suitable for serving local truck trips. If the percentage of non-FAF truck flows is expressed as a percentage of total flows excluding FAF trucks, the similarity becomes much more evident. Excluding FAF trucks, non-FAF truck flows in rural areas, on average, on the Interstates and expressways would be 4.9 percent of the revised total in rural areas and 5.8 percent in urban areas; and on other roadway types would be 7.4 percent in rural areas and 6.2 percent in urban areas.

It is also noted that non-FAF trucks on rural highways constitute approximately one-third of the volumes of those average volumes in urban areas both for Interstates (900 rural versus 4,000 urban) and for other roadways (400 rural versus 1,200 urban). This likely reflects the



Note: Long-haul freight trucks serve locations at least 50 miles apart, excluding trucks that are used in intermodal movements.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.1, 2010.

Source: Battelle Memorial Institute, Network Assignment of Highway Truck Traffic in FAF3, PowerPoint presentation, FHWA Talking Freight Seminar, Freight Analysis Framework, Version 3, October 20, 2010.

Figure E.1. Average daily long-haul volume on the National Highway System, 2007.

Table E.2. Average truck usage by functional system.

		Weighted AADT						Coefficient of Variation		
Geography	Miles	Total	Trucks	FAF Trucks	Percent FAF Trucks	Non-FAF Trucks	Percent Non-FAF Trucks	Total	FAF Trucks	Non-FAF Trucks
Rural Interstates (FC=01)	32,892	24,500	7,000	6,100	24.9	900	3.7	4.77	5.44	8.45
Urban Interstates and Freeways (FC=11 and =12)	22,965	73,000	7,800	3,800	5.2	4,000	5.5	1.23	1.64	1.74
Other Rural Roads (FC 02 through 09)	244,067	5,700	700	300	5.3	400	7.0	8.34	15.79	10.86
Other Urban Roads (FC 14 through 19)	60,156	19,700	1,400	200	1.0	1,200	6.1	1.60	4.01	1.95

combination of two conflicting effects, where the activities that generate truck traffic are more numerous in urban areas, driving down the ratio, while the density of the road system is lower in rural areas, driving up the ratio.

Table E.2 shows that, on average, FAF3 truck volumes on arterials and other local roadways are approximately equal: 200 trucks per day on these roadways in urban areas and 300 trucks per day on these roads in rural areas. While the volumes are considerably higher on Interstates and expressways, these numbers are also more divergent, on average, at 3,800 trucks per day on these roads in urban areas and 6,100 trucks per day on these roads in rural areas. It is suggested that the order of magnitude is similar if it is recognized that there are typically more paths utilizing Interstate highways between FAF regions through urban areas than through rural areas. The FAF volumes in Table E.2 suggest that there are approximately twice (6,100 versus 3,800) as many effective paths through urban areas, than through rural areas, using Interstates and other freeways. This seems like a reasonable relationship.

Table E.2 also shows the coefficient of variation for the reported values. The coefficient of variation is the ratio of the standard deviation of the records, divided by the mean value. As shown, the variation as expected is higher in rural areas than in urban areas, but the values for the variation are similar for the three reported quantities (total volume, FAF trucks, and non-FAF trucks). This suggests that the reported averages, while informative, should only be considered generally applicable. Specific forecasts for individual roads would be preferable to averages.

Table E.2 highlights that it would be preferable for any travel-demand forecasting model to include separate matrices of freight and nonfreight trucks. It is suggested that a commodity flow database at a disaggregated level be used to develop the freight truck table, or be used as a calibration database to develop the parameters for freight truck trip tables. This is consistent with the approach outlined in Chapter 4 of *NCFRP Report 8* (Cambridge Systematics, Inc., 2010b).

Table E.2 also suggests that the relationship between total vehicles and nonfreight trucks is similar in urban and rural areas. On average, the nonfreight truck volume is 6.1 percent of total AADT in urban areas and it is 7.0 percent of total AADT in rural areas. It is therefore reasonable to expect that whatever relationship exists between auto trips and activity generation in urban and rural areas will also exist for nonfreight truck generation in urban and rural areas. Thus if auto trips are found to be generated by households, and the auto trips per household in rural areas are 70 percent of the value of auto trips per household in urban areas, it is reasonable to expect that however the activity is generated for nonfreight truck trips in urban areas, that same indicator of activity should be used in rural areas, but the rate of truck trips per activity in rural areas should be 70 percent of the value found in urban areas.

Table E.3 shows the same values as in Table E.2 reported by U.S. Census divisions, which are aggregations of states as shown in Figure E.2. The behavior among those Census divisions along both U.S. coasts as well as metropolitan areas along the Great Lakes, as shaded in light grey, would be expected to be similar and this is the case. The remaining Census divisions, which have substantially more rural area, are shaded in dark grey, and their behavior is similar. It is suggested that the differences in percentage of FAF traffic versus total traffic is largely a function of the larger values of non-FAF trucks and passenger cars in these denser, more metropolitan divisions. However, the variation between these Census divisions and the U.S. averages is not substantial. One notable exception is the average value for FAF trucks on rural Interstates in the New England Division. It is suggested that this is a function of geography where the travel between FAF regions does not have to pass through significantly rural sections of New England.

Canadian traffic is assigned to New England counties on the border. Although the results of these intermediate steps are not shown, the assumption has to be that the low New England

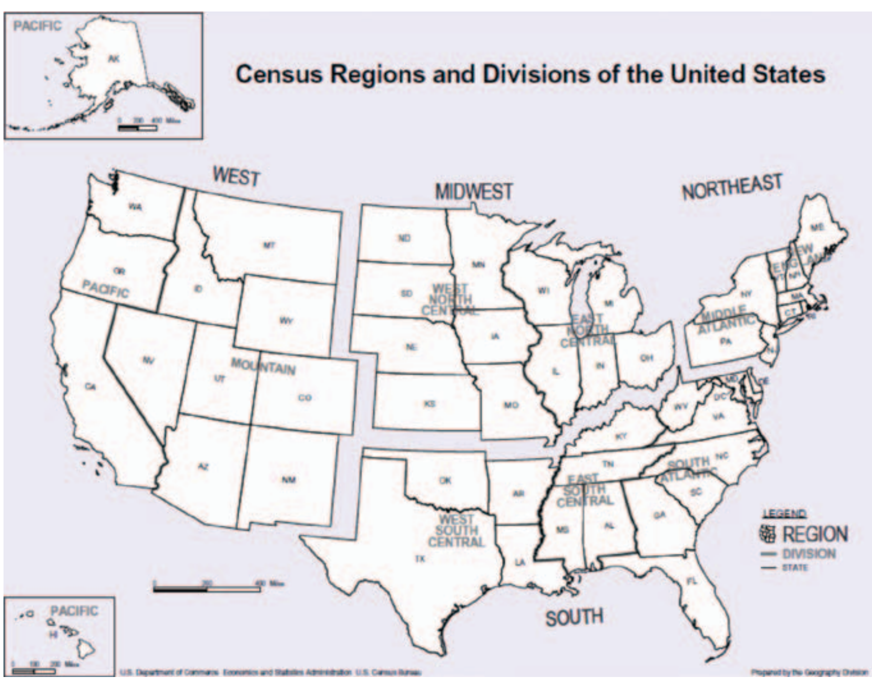
Table E.3. Average truck usage by functional system by Census divisions.

Geography	Miles	Weighted AADT Total	Weighted AADT Trucks	Weighted AADT FAF Trucks	Weighted AADT Percent FAF Trucks	Weighted AADT Non-FAF Trucks	Weighted AADT Percent Non-FAF Trucks	Coefficient of Variation Total	Coefficient of Variation FAF Trucks	Coefficient of Variation Non-FAF Trucks
Rural Interstates (FC=01)										
New England Division	993	25,400	2,900	1,800	7.1%	1,100	4.3%	3.30	3.50	3.87
Middle Atlantic Division	2,260	28,600	7,000	6,000	21.0%	1,000	3.5%	3.48	4.21	5.28
East North Central Division	4,524	26,900	8,000	6,900	25.7%	1,100	4.1%	3.56	3.98	6.50
West North Central Division	4,395	16,700	6,200	6,100	36.5%	100	0.6%	5.00	5.44	14.72
South Atlantic Division	4,430	39,000	8,200	6,400	16.4%	1,800	4.6%	3.22	3.60	4.62
East South Central Division	2,406	31,700	9,800	8,600	27.1%	1,200	3.8%	3.63	4.17	8.47
West South Central Division	4,003	24,500	8,500	7,600	31.0%	900	3.7%	5.03	5.41	9.13
Mountain Division	6,404	13,700	4,900	4,500	32.8%	400	2.9%	7.97	9.16	15.66
Pacific Division	3,477	24,300	5,900	5,000	20.6%	900	3.7%	7.69	8.37	12.36
Total	**32,892**	**24,500**	**7,000**	**6,100**	**24.9%**	**900**	**3.7%**	**4.77**	**5.44**	**8.45**
Urban Interstates and Freeways (FC=11 and =12)										
New England Division	1,512	65,500	5,500	2,100	3.2%	3,400	5.2%	1.22	1.39	1.95
Middle Atlantic Division	3,185	62,900	7,000	2,900	4.6%	4,100	6.5%	1.31	2.11	2.15
East North Central Division	3,463	62,700	8,400	4,700	7.5%	3,700	5.9%	1.13	1.55	1.55
West North Central Division	1,706	55,400	5,800	3,300	6.0%	2,500	4.5%	1.36	1.64	1.83
South Atlantic Division	3,814	75,800	8,000	3,700	4.9%	4,300	5.7%	1.40	1.67	1.87
East South Central Division	1,306	58,300	9,200	6,400	11.0%	2,800	4.8%	1.43	1.79	1.77
West South Central Division	3,190	69,700	8,000	3,900	5.6%	4,100	5.9%	1.19	1.36	1.65
Mountain Division	1,345	67,500	7,600	3,600	5.3%	4,000	5.9%	1.35	2.20	1.59
Pacific Division	3,443	112,500	8,700	3,700	3.3%	5,000	4.4%	0.94	1.19	1.31
Total	**22,965**	**73,000**	**7,800**	**3,800**	**5.2%**	**4,000**	**5.5%**	**1.23**	**1.64**	**1.74**
Other Rural Roads (FC 02 through 09)										
New England Division	5,698	7,700	500	100	1.3%	400	5.2%	5.93	35.26	12.20
Middle Atlantic Division	16,253	7,100	700	200	2.8%	500	7.0%	5.12	23.90	10.39
East North Central Division	32,213	6,300	800	300	4.8%	500	7.9%	6.07	15.62	9.04
West North Central Division	50,264	3,200	500	300	9.4%	200	6.3%	10.03	15.44	26.39
South Atlantic Division	35,955	8,300	900	300	3.6%	600	7.2%	6.22	16.16	8.11

(continued on next page)

Table E.3. (Continued).

Geography	Miles	Weighted AADT: Total	Weighted AADT: Trucks	Weighted AADT: FAF Trucks	Weighted AADT: Percent FAF Trucks	Weighted AADT: Non-FAF Trucks	Weighted AADT: Percent Non-FAF Trucks	Coefficient of Variation: Total	Coefficient of Variation: FAF Trucks	Coefficient of Variation: Non-FAF Trucks
Other Rural Roads (FC 02 through 09) (continued)										
East South Central Division	21,684	6,300	800	300	4.8%	500	7.9%	6.88	13.85	9.90
West South Central Division	30,149	6,000	1,000	400	6.7%	600	10.0%	8.28	10.76	8.00
Mountain Division	29,094	3,500	500	200	5.7%	300	8.6%	16.69	25.92	14.83
Pacific Division	22,756	6,700	800	300	4.5%	500	7.5%	11.03	14.43	8.71
Total	**244,067**	**5,700**	**700**	**300**	**5.3%**	**400**	**7.0%**	**8.34**	**15.79**	**10.86**
Other Urban Roads (FC=14 through 19)										
New England Division	3,288	16,800	800	100	0.6%	700	4.2%	1.41	3.34	1.68
Middle Atlantic Division	7,610	19,000	1,200	200	1.1%	1,000	5.3%	1.55	3.32	1.88
East North Central Division	10,375	18,600	1,400	200	1.1%	1,200	6.5%	1.56	3.62	1.88
West North Central Division	4,006	14,600	1,000	300	2.1%	700	4.8%	1.64	2.90	1.90
South Atlantic Division	10,077	23,900	1,600	300	1.3%	1,300	5.4%	1.84	4.68	1.88
East South Central Division	4,352	17,100	1,400	300	1.8%	1,100	6.4%	2.14	4.14	2.70
West South Central Division	8,156	18,200	1,500	300	1.6%	1,200	6.6%	1.67	4.19	2.33



Source: http://www.census.gov/geo/www/us_regdiv.pdf

Figure E.2. U.S. Census divisions.

volumes are primarily a reflection of geography based on the following statement found in FAF3 documentation:

> For international O-D pairs, the process is static where an adjacent network "node" of each border crossing or port geo-location is a virtual O-D zone. The virtual O-D zone for international movement was further divided into cross-border movements (U.S.-Canada and U.S.-Mexico) and port movements. Cross-border movements were defined as O-D pairs originating from FAF zone adjacent to Canada or Mexico and destined to other FAF zone and vice versa. Similarly, for ports, the O-D pairs originated from or were headed toward a FAF zone containing one or more ports or gateways (http://faf.ornl.gov/fafweb/Data/FAF_3_network_assignment_executive_summary.pdf).

E.2 Conclusions

It is recommended that any travel-demand forecasting model, particularly statewide models, include separate matrices of freight and nonfreight trucks. It is suggested that a commodity flow database at a disaggregated level be used to develop the freight truck table, or be used as a calibration database to develop the parameters for freight truck trip tables.

It is recommended that the relationship between the coefficients and parameters for passenger trips in urban and rural areas should guide the development of coefficients and parameters for nonfreight truck generation and distribution in urban and rural portions of travel demand models. The assumption is that if the shopping passenger trips per retail employee are 50 percent higher in urban models, compared to rural models, that the truck trips per retail employee would also show the same relationship. It is recommended that further research be undertaken to determine these parameters, making the effort to distinguish freight (FAF) truck trip generation and distribution from nonfreight truck generation and distribution for the customary treatment of total truck generation and distribution.

It is suggested that the differences in percentage of FAF total traffic are largely a function of the larger values of non-FAF trucks and passenger cars in these denser, more metropolitan U.S. Census divisions and that the values found in Table E.3 be used as a reasonableness check. One notable exception is the average value for FAF trucks on rural Interstates in the New England Division. It is suggested that this is a function of geography where the travel between FAF regions does not have to pass through significantly rural sections of New England and that lower values for FAF trucks in New England should be expected.

It is suggested that there is no value in developing transferable freight rates, from public commodity sources such as the Commodity Flow Survey (CFS) (Research and Innovative Technology Administration, Bureau of Transportation Statistics, Commodity Flow Survey, http://www.bts.gov/publications/commodity_flow_survey/index.html) or FAF3, because freight traffic to, from, and through jurisdictions differ geographically, as shown in Table E.3. Hence, this appendix of the report includes no transferable parameters or rates for that reason.

Even though freight truck traffic is different enough not to be transferable, nonfreight truck traffic does show consistent behavior. Although models have not yet been developed to make such distinctions, it is hoped that over time the process shown in Figure E.2 of the aforementioned *NCFRP Report 8* will become more widely developed, making distinctions between freight and nonfreight trucks. At that time, the rates for nonfreight trucks should be tested for transferability. At this time, almost all truck models combine freight and nonfreight trucks, which means since freight truck rates are nontransferable, the combined rates are nontransferable.

APPENDIX F

Review of Statewide Models

This appendix covers the following topics related to each statewide model:

- **Likely Ranges of Parameter Values—**Describes sources used for model parameters in existing models, those that are transferable and those that are unique to certain states, and describes the rationale (e.g., geography, population density, available transportation modes, proximity to primary tourist destinations, etc.);
- **Age of Models—**Includes information about when the model was developed, base and forecast years available, and current status of the model;
- **Purposes for Which Models are Applied—**This discussion goes beyond the rationale for statewide models to identify how, when, and why each statewide model is used; and
- **Frequency of Application—**It is also important to understand how frequently each model is used and updated, and what level of coordination is done to keep the model current with new assumptions found in urban and regional MPO models.

This appendix continues with a state-by-state assessment of rural and long-distance travel from available technical documentation, largely focused on the likely ranges of parameter values. This is followed by a discussion of model applications and uses derived from informal telephone and e-mail contact with state departments of transportation (DOTs) focused on age of models, purposes for which models are applied, and frequency of application. This appendix ends with a summary of conclusions and limitations gleaned from this statewide model document and DOT state review and assessment.

F.1 Likely Ranges of Rural and Long-Distance Parameter Values in Statewide, Multistate, and National Models

In many cases, states have incorporated methods for forecasting long-distance trips along with shorter regional trips in their statewide models. In most cases, statewide models incorporate truck and auto long-distance trips; however, in some cases, additional modes are incorporated such as air and intercity transit. The threshold for defining long-distance trips also varies among statewide models, with some states considering trips over 100 miles to be long distance and others considering 50 miles or 75 minutes as long distance.

The following discussion is a state-by-state rundown of how long-distance and rural trips are incorporated into their respective statewide models. States without long-distance or rural trip purposes are not included in this discussion. It should be noted that statewide model documentation for Arizona, Maryland, and Ohio includes coefficients and constants used in long-distance trip modules; however, it was not believed that these parameters would be transferable in the absence of additional background information on the structure of these models.

Arizona

The Arizona statewide model (SWM) estimates both long-distance (LD) personal trips and long-distance truck trips. LD personal trips are defined as those trips 50 miles and greater, while the LD truck trips are defined as regional truck flows made between metropolitan areas. The 2009 NHTS/Arizona Add-On was used as a primary data source for model parameters. Although the 2009 NHTS does not include a long-distance survey, it does provide some data on trips longer than 50 miles. As part of the Arizona SWM, long-distance trip data to and from Arizona for all 50 states were included. According to model documentation (Parsons Brinckerhoff, 2011), when the NHTS was conducted, 15 states (including neighboring New Mexico) and Washington, D.C., were left out of the survey. The report states that the NHTS reports origin state for states with a population of 2 million or more and the missing records for smaller states needed to be generated. Due to this omission, records were synthesized by Arizona DOT consultants for each of the missing states based on the records from neighboring states with survey data. Once records were synthesized for the missing states, a regression analysis was performed to obtain nationwide totals for long-distance trips, and three independent variables were tested: population; percent of employment in the service sector; and gross domestic product per capita. The population variable had the strongest correlation, and therefore the other two variables were not used. Special generators were also used for major tourist attractions such as the Grand Canyon and other national parks in the state. NHTS data were deemed insufficient for these areas, and instead, data from the parks on visitor travel were developed and used in the long- and short-distance models.

California

The California High-Speed Rail model is a combination of intraregional and interregional models (Cambridge Systematics, Inc., and Mark Bradley Research and Consulting, 2007). The interregional model is further segmented into short trips (less than 100 miles) and long trips (greater than 100 miles). The 1995 ATS was used to validate the long-distance trips, CTPP was used for short and long commute trips, and the California Statewide Travel Survey was used for short-distance trips. The ATS was used to determine intra-California trips over 100 miles in length. Since the ATS data were from 1995, a 6.9 percent compounded annual growth factor was applied to estimate base year 2000 figures. Applying the growth factor to ATS trips resulted in an estimate of about 350,000 long-distance daily trips in the year 2000 for California. The auto occupancies for short and long trips were about the same, at 1.35 and 1.34, respectively. No average trip lengths were provided.

Florida

The Florida statewide model is primarily used to forecast long-distance truck trips and intercity automobile travel. Although freight is modeled outside Florida, passenger trips are only modeled within the state. The average long-distance business trip length is 127.2 minutes in the latest base year 2005 model (BCC Engineering, 2011). Matrix estimation was used to generate long-distance tourist trip tables, for which average trip lengths were not documented.

Georgia

The Georgia statewide model has the ability to generate external through trips and internal-external trips (Atkins, 2011). The freight model relies on TRANSEARCH data and the passenger model is based on the 2009 NHTS and the Georgia NHTS Add-On. Passenger model trips were separated into two categories, short-distance and long-distance trips. The short-distance trips are considered to be less than 75 minutes and within urbanized areas, and the long-distance trips are greater than 75 minutes and interurban. The Georgia passenger model estimated 183,000 internal long-distance trips and 235,000 internal-external long-distance trips for a total of 418,000 average daily base year 2006 trips or 1.34 percent of all trips in the model. The average long-distance trip length is 131.67 minutes. Home-based other long-distance trips are longest at 140 minutes, followed by nonhome-based LD at 135 minutes, and home-based work LD at 120 minutes.

Indiana

The statewide model network used was a refinement of the I-69 Indiana Statewide Travel Demand Model network (Bernardin, Lochmueller & Associates, Inc., and Cambridge Systematics, Inc., 2004). Data from the 2001 NHTS and the 1995 Indiana Household Travel Survey were used. Long-distance trips were generated as a separate purpose during trip generation. Truck trips were generated separately. There was no indication of the threshold used to classify the trips as long-distance; however, the documentation stated that "long-purpose trips included internal zones in border states."

Louisiana

The Louisiana statewide model uses a different approach from most other models. The Louisiana model focuses mainly on urban versus rural trips using micro and macro submodels (Wilbur Smith Associates, 2004). The micro model focuses on mainly urban trips that are shorter distances and the macro model estimates long-distance intercity trips on rural highways. According to the 1995 ATS, 45 percent of long-distance auto trips in Louisiana were intrastate and the rest were interstate.

Maryland

The Maryland Statewide Travel Model (STM) was developed with a three-tier geographical approach: regional, statewide, and urban (Parsons Brinckerhoff, 2009). The regional model network covers the full United States, Canada, and Mexico. The statewide model includes Maryland and its border states, and the urban submodel focuses on the major urban areas within the state and is comprised of the Baltimore and metro D.C. models. The regional submodel includes a visitor model and long-distance person module to simulate long-distance trips. The long-distance person submodel handles trips that originate in Maryland. The long-distance trip model is different from traditional models in that it uses microsimulation. Initially, long-distance travelers are individually generated and then trip information is applied to get the final long-distance trip estimated. The trips are based on data from the 2005 NHTS and use origin, destination, mode, party size, income, and time of day to simulate trips. Destinations are provided by state, not zone; therefore, if the destination is within one of the surrounding states in the statewide model, the model randomly assigns the resulting trips to a zone based on population and employment factors. Train, bus, and air travel modes are simulated for long-distance travel. The model apportions non-auto trips to either a station or airport, but does not include the egress travel to the final destination. Departure times are assigned a time of day (a.m. or midday, peak or off-peak). No nighttime long-distance trips are simulated due to the small percentage of these trips. The visitor travel submodel simulates trips that have an origin outside of Maryland and a destination within Maryland. The visitor submodel works similarly to the person long-distance submodel, but in the reverse travel direction. In 2000 there were 49,355 daily long-distance travelers exiting the state and 46,733 daily visitors entering the state as estimated in the Maryland statewide model.

Mississippi

The Mississippi statewide model operates in a similar manner as the Louisiana statewide model (Wilbur Smith Associates, 2002). It was created to complement the urban models that already existed and focus on interurban travel. The main sources of data were the 1995 ATS and 2001 NHTS. The long-distance trips were considered to be 100 miles and greater. Friction factors were calibrated to observed trip lengths in the NHTS.

Ohio

The Ohio statewide model uses a tour-based approach with separate short-distance and long-distance models that are later combined (Parsons Brinckerhoff, date unknown). The long-distance model is based on a long-distance travel survey that was administered by the state and only looked at trips greater than 50 miles. The Ohio model is a tour-based model and since most long-distance trips occur over multiple days, the Ohio model uses a 2-week window instead of a single day, meaning the trips either started and/or ended within this window of time. The beginning tours were given a departure time, ending tours received an arrival time, and complete tours had both departure and arrival times. Although the model does indeed predict the incidence of travel over a 2-week period (in its first step), later, the amount of that travel occurring on the "model day" is predicted as either starting, ending, traveling, or "not on this date," with "not on this date" occurring close to 80 percent of the time (i.e., the person did a long-distance trip at some time in the 2-week window, but not on the "model day"), hence comparable daily travel statistics can be generated.

Utah

The Utah Statewide Travel Model (USTM) does not include a separate model for long-distance trips but does estimate LD trips by two purposes: work and other (Wilbur Smith Associates, 2009). The data source used for these trips was the 2001 NHTS. Daily long-distance trip generation rates were estimated at 0.0310 per household for LD home-based work trips and 0.0532 per household for LD home-based other trips. When calibrating LD trips, an average trip length of 120 minutes was used for long work trips and 80 percent of the 120 minutes was used for nonwork long trips. The 120 minutes was used because it is assumed that any urban area in the state can be reached within 120 minutes. The validated LD trip lengths were 89.54 minutes for work and 81.73 minutes for other long-purpose trips. The average auto occupancy rates were 1.33 and 2.06 for work and other, respectively.

Virginia

The Virginia model was developed similarly to the Louisiana and Mississippi models (Wilbur Smith Associates, 2004). The 1995 ATS was the primary data source for long-distance trip tables. Long-distance trips were defined as those trips longer than 100 minutes, which is assumed equivalent to 75 miles, and differs from the ATS 100-mile definition. The average trip lengths reported were 303.73 minutes for interstate trips and 126.13 minutes for intrastate trips. The long-distance auto occupancy rate was 1.82 for business trips and 2.69 for tourist and other long-distance purposes.

Wisconsin

The Wisconsin statewide model focuses on long-distance trips in and through the state that are 50 miles and greater (Cambridge Systematics, Inc. and HNTB, 2006). The purpose was to get a handle on intercity travel for different travel modes. The model focuses on trips that originate or end in Wisconsin or its surrounding states. Trip rates were estimated from the 2001 NHTS

Daily Trip File and the 2001 NHTS Long-Distance Trip File, and transit travel characteristics were gathered from various transit authorities. When modeling the trips, the initial focus was on understanding the difference between recurring trips and nonrecurring trips. These trips included all internal-internal and internal-external trips. The external-external trips were more difficult to model due to a lack of available data. The state was divided into five regions with different trip generation rates to reflect each region. A destination choice model was used to distribute intercity flows and, from this, the mode choice model was applied. The modes included auto, bus, and rail. Overall, 97.69 percent of the long-distance trips estimated were auto, with 1.95 percent and 0.35 percent for bus and rail, respectively.

F.2 Age, Frequency, and Purpose of Statewide Model Use and Assumptions for Rural and Long-Distance Travel

Table F.1 depicts information obtained by e-mail request from several state DOTs regarding their statewide models. This information is intended to supplement what is described in available technical reports and includes the age of models and assumptions, purposes for which statewide models are applied, and frequency of statewide model application and model updates.

If the nine responses provided in Table F.1 are considered as representative of the full range of statewide travel demand models, there is considerable range in the age of models and supporting data, model applications, and frequency of model use and updating. In terms of common findings from this dialogue, it does appear that most state DOTs plan on continuing the process of updating their statewide models every 5 to 10 years. Oldest data assumptions include reliance on the 1995 ATS and Census 2000.

This informal survey found a wide range of uses for statewide models and indicates that state DOTs are making regular use of their statewide models. Not surprisingly, the most common uses of statewide models include statewide transportation plans, corridor studies, air quality conformity, freight planning, and providing performance statistics for other reporting purposes.

Perhaps the most significant conclusion from this analysis is that statewide models will continue to be updated and will clearly need new and updated data sources that help quantify trip generation and distribution parameters. States still largely rely on 1995 ATS and 2001 NHTS data to identify characteristics of long-distance trips, although several states have conducted their own surveys of long-distance and rural trip-makers or participated in the 2009 NHTS Add-On. The types of studies being conducted through use of statewide models should also help focus on the most important components and related parameter needs and accuracy levels.

F.3 Conclusions

A review of statewide models, discussions with state DOT staff, and available BTS analysis of long-distance trips from the 2001 NHTS provide a few common findings with respect to long-distance travel, as follows:

- **Long-distance travel thresholds** vary considerably by model, ranging from 50 to 100 miles and sometimes using minutes of travel as the breakpoint instead of miles traveled; however, it is fair to say that most statewide models distinguish long-distance trips from short-distance trip purposes found in urban area models.
- **Transferable parameters and statistics** for long-distance travel were sparsely documented based on this review of statewide model technical reports.

Table F.1. State department of transportations' use of statewide models.

State	Age of Statewide Model and Assumptions	Statewide Model Applications	Frequency of Statewide Model Applications and Updates
Arizona	• 1st generation (2009) • 2nd generation (2011) • 3rd generation (just started) • Oldest assumption – 1995 ATS	• Statewide Framework Visioning Studies • Phoenix-Tucson Intercity Rail Study (3rd generation) • Central Arizona Association of Governments (CAAG) Long-Range Transportation Plan (3rd generation)	• Model still in its infancy but will identify more uses when done • Anticipate annual routine updates, as new data available
Florida	• 1988 base year model (1989-1993) • 1990/2020 (1995-1998) • 2000/2030 (2003-2007) • 2005/2035 (2007-2011) • Oldest assumption – 2000 era tourist data	• Corridor studies • Corridor master plans • New corridor initiative • Freight flows • Subarea extraction • Input to decision tool • Strategic Intermodal System	• Model is applied for internal purposes on a regular basis • Routine annual updates and major updates every 5 years
Iowa	• 2005/2035 (2009), socioeconomic (SE) data available in 5-year increments • Oldest assumption – 2005 population, employment, and traffic counts	• Bypass analyses • Passenger rail demand • Airport drive time • Detour analyses • Statewide regional corridor scenario analysis • Supplemental traffic forecasts • MPO external forecasts • Rest area analysis • Snow plow optimization • River crossing closures • Rural Interstate Interchange Justification	• Model applications: one significant project every 3 months • Minor projects several times per week • Model updates planned for every 5 years
Michigan	• 1990/2020 (1996) • 2000/2030 (undocumented) • 2005/2035 (2010) • 2008/2035, 2040 (2012) • 2010/2040, 2045 (2014) • Above model SE data typically available in 5-year increments between base and horizon years	• Statewide VMT Forecast • Corridor Studies • Air quality conformity • Work Zone Safety and Mobility Analysis • Detour Evaluation • Small Area Models • Environmental Justice Analysis • Economic Impact Analysis • Project Alternatives and Project Selection • Select Link Analysis • Deficiency Analysis • Congested speeds and travel times	• Economic analysis of 5-year plan – annually • Air quality conformity – a few times a year • Work zone analysis – 6 to 10 requests per year • Growth rates – 5 to 10 requests per year • Proximity analysis – annually • Growth rates – < 10 per year • Detour evaluation – approximately 1 per year • Select link analysis – approximately 2 per year • Small area models – approximately 1 every 3 years

Table F.1. (Continued).

State	Age of Statewide Model and Assumptions	Statewide Model Applications	Frequency of Statewide Model Applications and Updates
Ohio	• Final V1 "model" 2003 • Updated to V1.1 2007 • Final V2 model 2009 • V3 anticipated by 2013	• Corridor/bypass studies • Tolling studies • Project design traffic • Project ranking process • Economic impact analysis • Long-range planning • Strategic planning • Freight planning • Grant applications • Air quality conformity	• Model is applied on a regular basis • Major updates every 3 to 5 years
Oregon	• First: 1990 base year model (1999) • 1998 recalibration • Newest: 2000 (2009) • Underway: 2009 base	• Oregon Transportation Plan • Oregon Freight Plan • Oregon Bridge Study • Willamette Valley Alternative Futures • Newberg-Dundee Bypass • New freeway in central Oregon • Land use – transportation	• Model is applied on a regular basis • Routine annual updates and major updates every 5 years
Tennessee	• 2003/2030 (2005) • Planned update (2011-2012)	• State Long-Range Transportation Plan • I-40/I-81 corridor study • I-75 corridor study • Rural Planning Organizations • Subarea analysis	• Only updated as needed to conduct model applications (e.g., network corrections, etc.)
Utah	• 2007 base year (July 2009) • 2010 base year (2013-2014)	• UDOT Long-Range Transportation Plan • External model refinement for urban models/studies • 2008 Baseline data for Envision Utah Study	• Model is applied on an as-needed basis • Plan to update in 2013-2014 timeframe using statewide household survey just started
Virginia	• Base year 2000 model (2005) • Forecast year of 2025 • Model update initiated in 2008 but effort shelved due to staff reductions	• I-81 corridor study	• Dependent on funding and staffing availability

- **Statewide model updates** are being planned by most state DOTs, showing the need for more updated data sources for calculation of model parameters, especially with continued reliance on 1995 ATS and 2001 NHTS for assumptions on long-distance trips.
- The vast majority of long-distance trips are **less than 500 miles** on average.
- **Long-distance mode of travel** is impacted by type/purpose of trip, income, and geography, with business trips, higher incomes, and urban geographies showing a greater likelihood of air travel than their counterparts.

Relatively little information was available from these same sources on rural trips, perhaps in part due to rural trips not being an isolated set of trip purposes (as with long-distance trips) and the treatment of rural trips being largely the same as urban trips and purposes in most statewide models.

Abbreviations and acronyms used without definitions in TRB publications:

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