IDAHO STATEWIDE TRIP GENERATION RATES AND FRICTION FACTORS

FINAL REPORT

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EXECUTIVE SUMMARY

In June 1999, the Idaho Transportation Department (ITD) in collaboration with the Department of Commerce and other agencies participated in a statewide travel survey, "1999-2000 Idaho Resident and Nonresident Motor Vehicle Travel Survey." Using the highway intercept method and a mail-back questionnaire, the survey collected data on traveler characteristics, trip characteristics, and many other variables from resident and nonresident travelers in Idaho. This report describes the activities that have been completed for the Idaho Statewide Trip Generation Rates and Friction Factors project, the purpose of which was to use the survey data to develop Idaho-specific trip generation rates and friction factors.

The Idaho statewide travel survey was conducted between October 1999 and October 2000 at 56 sites based on a stratified random sampling method to make sure that nearly everyone who traveled in the state had an equal chance of being sampled. A total of 7284 questionnaires were returned. Because many returned questionnaires did not provide complete household and trip information, only 4285 questionnaires were useable for this project. An additional problem with the returned questionnaires was discovered in spring 2000: many respondents filled out the trip diary section of the questionnaire only for one person, instead of every household member. A one-page addendum was therefore developed and inserted in the questionnaire for the summer and part of the fall of 2000. A much simpler survey instrument, the addendum only asked for trip destinations and trip sequence made by other members of the household (i.e., besides the one who filled out the questionnaire). A total of 874 addendums were returned. In addition to the survey data, this project compiled a base year 1999 socioeconomic database using data from the U.S. Census Bureau, and the Idaho Division of Finance Management.

Cross-classification was the method for deriving trip production rates. Trip data from the questionnaire and the addendum were grouped by trip purpose into home-based work (HBW), home-based recreation (HBR), and home-based other (HBO). Household data were classified by income, household size, and number of vehicles owned. Three income brackets were used: low (less than $20,000), medium ($20,000-$50,000), and high (greater than $50,000). Both household size and number of vehicles owned were grouped into 1, 2, 3, and 4+. Trip production rates based on the questionnaire data appeared substantially lower than trip generation rates published in reports by NCHRP and other states. Trip production rates based on the addendum data were more reliable and could be used for Idaho statewide traffic demand modeling.

The development of trip attraction models was based on the trip purposes of HBW, HBO, HBR, and NHB (non-home-based). An initial experiment with regression models showed unsatisfactory results because of low R-Square values, collinearity between the independent variables, and negative regression coefficients. This project then developed a method, in which the model for each trip purpose was based on a set of activity indicators and the rates were calculated using the state-level data. These attraction models were later adjusted for unclassifiable trips in the survey data and persons under 14 years of age.

The ratios of attractions to productions by trip purpose ranged from 0.45 to 0.88 using rates derived from this project. These ratios fell outside the range of 0.90 to 1.10 recommended by FHWA. The imbalance could be the result of inadequate socioeconomic estimates, trip rates, or both. Because production rates are generally considered more trustworthy than attraction rates,

attractions are usually adjusted to match productions by trip purpose at the end of the trip generation step in statewide travel demand modeling, thus resolving the problem of imbalance.

This project used travel time data from the survey and the Gamma impedance function recommended by the FHWA to develop the Idaho statewide friction factors. The Gamma function parameters were calibrated for each trip purpose of HBW, HBO, HBR, and NHB. Two time intervals, 15 and 30 minutes, were used to characterize the trip length frequency. The Gamma function was fit by log-linear transformation and linear regression, and the two time intervals were evaluated by comparing the respective root-mean-square errors. The curve with the lowest root-mean-square error was then chosen to represent the full trip length frequency distribution for each trip purpose.

The multi-purpose statewide travel survey did not entirely fulfill the data needs for this project. The questionnaire was too long and complicated for many respondents. This resulted in less reliable data and a lower response rate. Fortunately, some useful information was extracted from the questionnaire for determining friction factors and attraction rates. The addendum, although used only for part of the project, provided more useful data for estimating trip production rates and would be a desirable means for collecting trip data in future surveys.

This project has been beneficial to transportation planners in Idaho in several ways. First, experience from this project can certainly be used to improve the future survey process and its reliability and applicability to statewide transportation modeling. Second, the trip rates and friction factors derived from the project have provided for the first time Idaho-specific data that can be compared to data published by NCHRP and other states as well as data to be available from the 2001 National Household Travel Survey (NHTS) and the Census 2000 Journey to Work Survey (JTW). Third, the trip rates and friction factors derived from the project, combined with published data sources, can be used for calibrating the Idaho statewide travel demand model.

1. BACKGROUND

The building of a statewide travel demand model requires use of trip production and attraction rates for trip generation and friction factors for trip distribution. The development of trip generation rates and friction factors requires use of data based on the demographic and socioeconomic characteristics of households and the travel habits of household members. Because surveys are instruments typically used to collect data at the household level, surveys are an integral part of a statewide model project.

A pilot household survey using the mail-out/mail-in method was conducted in Latah County in 1998-99 (Khatib et al. 1999). Following the design of a household travel survey in Vermont, the Latah survey package included a form for soliciting household information and trip diary forms for information on trips made by household members on a Friday and a Saturday. A random sample of 800 households was selected throughout Latah County. Only 59 surveys, at a response rate of less than 8%, were returned. Although trip generation rates were derived from the pilot study, the small sample size rendered them useless.

In June 1999, the Idaho Transportation Department (ITD) in collaboration with the Department of Commerce and other agencies participated in a statewide travel survey, "1999-2000 Idaho Resident and Nonresident Motor Vehicle Travel Survey." The main purpose of the survey was the collection and analysis of data on the primary market/user group: the resident and nonresident personal motor vehicle traveler in Idaho. Appendix A contains the goals and methods of the statewide travel survey. The project web site (http://www.uidaho.edu/cfwr/rrt/travelerstudy/) provides information on the progress of the project. (A copy of the final project document including a series of reports and a computer database will be delivered to ITD when it is completed at the end of May 2001.)

The statewide travel survey was conducted between October 1999 and October 2000. Figure 1 shows the 56 sites for the survey. (Site maps by travel region are available at http://www.uidaho.edu/cfwr/rrt/travelerstudy/sitemaps/.) Each site was sampled several times a month for each direction of traffic. Each sampling period lasted for about 2½ hours. After a vehicle was waved into the survey site, a brief front-end interview was conducted to gather information on purpose of trip, trip destination(s), party size, place of residence, etc. Once the front-end interview was complete, a randomly selected occupant of each vehicle was given a mail-back diary questionnaire (questionnaire hereafter) to take with them and complete as they traveled through Idaho. The questionnaire included questions regarding traveler characteristics, trip characteristics, opinions on Idaho's tourism and recreation services, opinions on highway rest areas, travel mode, evaluations of traveler facilities and services, travel behavior and psychographics (marketing) information, and a trip diary section designed for the traveler to keep a log of their travel expenditures and activities while in Idaho. The questionnaire contained a total of 244 blanks to be checked or filled out.

A total of 7284 questionnaires were returned, at a response rate of about 50%. But many of these questionnaires did not provide complete household and trip information for modeling trip rates. About 60% of the returned questionnaires (4285 out of 7284) were useable for this project. We

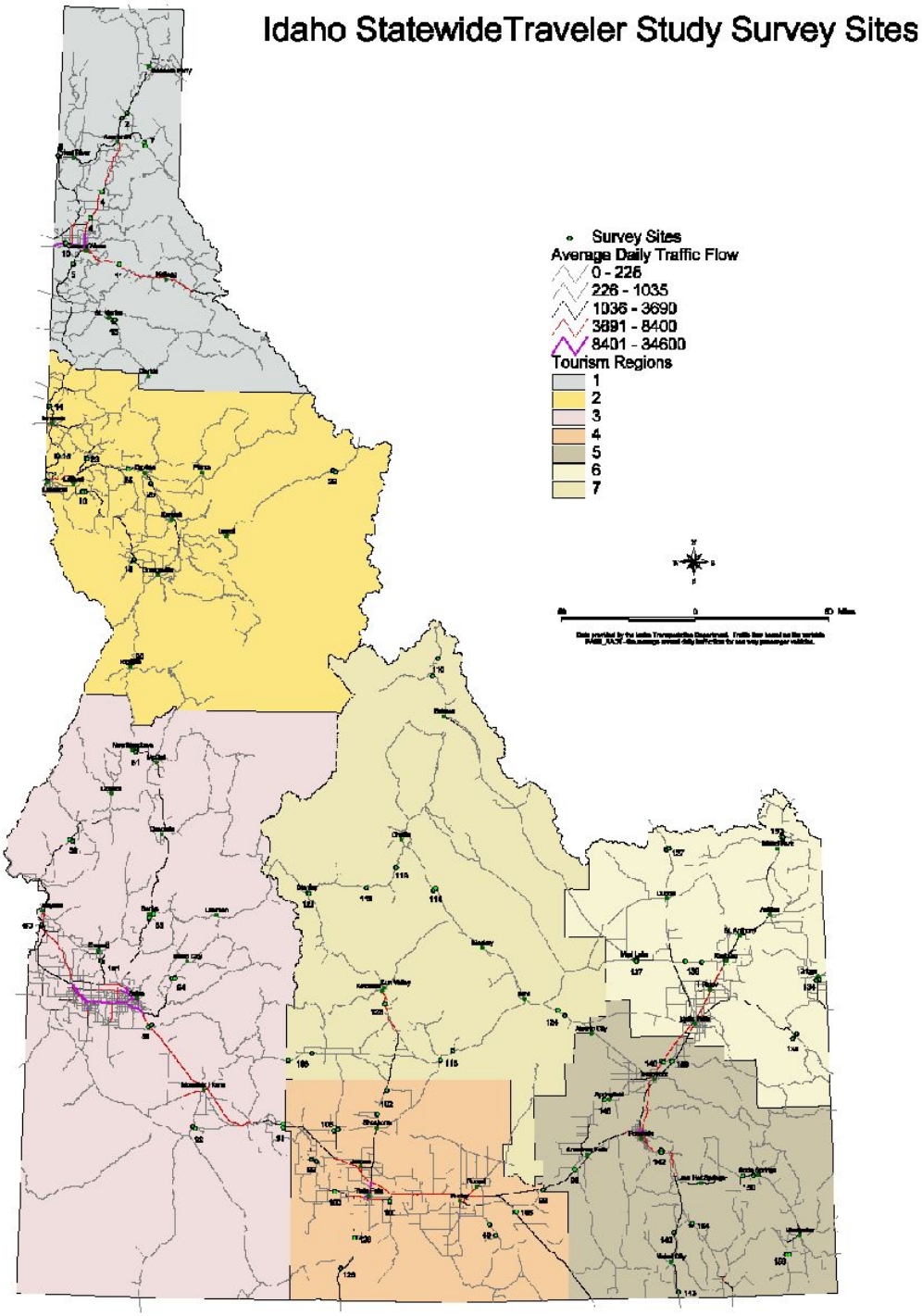

Figure 1 Statewide Travel Survey Sites

discovered an additional problem with the returned questionnaires after we analyzed the winter 1999 data. Many respondents filled out the trip diary section of the questionnaire only for one member of the household, i.e., the one who filled out the questionnaire, instead of every household member. A one-page addendum (addendum hereafter) was developed and inserted in the questionnaire for the summer and part of the fall of 2000. The addendum was used to record trip destinations (i.e., home, work, school, store, park, fishing, etc.) and trip sequence made by other members of the household (i.e., besides the one who filled out the survey).

This report describes the activities that have been completed for the Idaho Statewide Trip Generation Rates and Friction Factors project. The primary goal of this project was to use the household data collected from the statewide travel survey to develop Idaho-specific trip generation rates and friction factors. These rates and factors will then be used for the Idaho Statewide Transportation Planning Model (Research Project #135). Appendix B contains the proposal describing the intent of this project.

This report is organized into six sections. Section 2 describes data compilation. Section 3 explains the base year socioeconomic database. Section 4 covers trip production rates. Section 5 discusses trip attraction models. Section 6 covers trip length friction factors. Conclusion and recommendations are included in Section 7.

2. DATA COMPILATION

The following shows the steps we used in compiling data from the statewide travel survey for this project:

1. Data from the returned questionnaires were coded in an Excel spreadsheet. Many of the 244 variables were irrelevant to this project. We filtered through the data and re-formatted the useable data in terms of income, household size, number of autos owned, and trip details.

2. Data from the returned addendums were sorted and coded in Excel.

3. Data from the returned questionnaires and addendums were separated into useable and not-useable categories.

4. Trips from the useable questionnaires were divided into intra-state and inter-state categories. Intra-state represented household trip within Idaho. Inter-state included trips through Idaho and trips with one end in Idaho and the other end outside of Idaho.

5. The households were aggregated by income, household size, and number of vehicles owned. Following NCHRP reports and other states' experience, the household size was aggregated into 1-person, 2- person, 3-person, and 4^{+}-person categories. Number of available autos was also aggregated into four categories: 1-auto, 2-auto, 3-auto, and 4^{+}-auto. To best represent Idaho, three income brackets were used: low (less than $20,000), medium ($20,000 to $50,000), and high (greater than $50,000).

Many respondents apparently had difficulty in filling out the long and complicated questionnaire. We noticed the following problems while compiling data from the returned questionnaires:

- Approximately 25% of the respondents made only one trip. For example, a person would make a trip from home to work but would not make the return trip. Almost all of these trips should have a return trip. The only exception would be trips to hotels or motels.

- Approximately 20% of the respondents who filled out at least two trips in the questionnaire had an origin of the second trip different from the destination of the first trip. For example, trip one would be from home to the store and trip two would be from home to work. Again the return trips were not logged.

- A small percentage of the respondents would list multiple destinations for a single trip. For example, a person would list work as the origin of the trip and store, post office, then home as the destination. They listed all these activities as one trip, instead of logging the three trips individually.

3. BASE YEAR 1999 SOCIOECONOMIC DATABASE

We used data from the Census Bureau, the Idaho Division of Finance Management, and the statewide travel survey to develop the base year database. This database contains variables at the county and block group levels necessary for inputs to the statewide travel demand model. These inputs include:

- Population
- Household
- Household distribution by income, household size, and auto ownership
- Total employment
- Retail employment
- Service employment
- Other employment
- Total land area (acre)
- Total water area (acre)

3.1 Data Sources

The following describes each of the data sources and how the data were used in this project.

3.1.1 Census Bureau

The U.S. Census Bureau has the latest socioeconomic estimates for 1997 and 2002. These estimates include total population, household, and employment at county, tract, and block group levels. Only the total population and household estimates at the county and block group levels were used in this project. These estimates were derived from existing symptomatic data from various sources and used by other agencies for Federal funding allocations (http://www.census.gov/population/www/estimates/concepts.html, January 2001). Employment estimates were not used in this project because they corresponded to the number of employees (labor force), instead of the actual number of jobs available. The total land area and water area at the block group level were also taken from the Census Bureau web site for this project.

3.1.2 Idaho Division of Finance Management

The Idaho Division of Finance Management has county-level employment data from 1969 to 1997. Unlike data from the Census Bureau, the employment data from the Idaho Division of Finance Management represent the full- and part-time jobs by place of work (http://www2.state.id.us/dfm/othereconinfo.htm**,** March 2001). Employment data cover the following industries:

- Food Product
- Lumber & Wood Products
- Chemicals
- Metals
- Machinery (exc. elect)
- Electronics & Elec. Equip.
- Other Manufacturing
- Construction
- Mining

- Transportation/Communication/Utililities
- Wholesale & Retail Trade
- Finance, Insur. & Real Est.
- Services & Misc.
- Government
- Farm employment

For this project, employment data were grouped into three major categories: retail, service, and other employment. Retail employment included wholesale and retail trades. Service employment included services and miscellaneous, finance, insurance, and real estate. And other employment included the rest of the industries.

3.1.3 Statewide Travel Survey

The statewide travel survey provided data on household and household trip characteristics. Data from the returned questionnaires were aggregated by income, household size, and auto ownership.

3.2 Methodology

3.2.1 TAZ Population and Household Data

1999 was chosen as the base year for this project. The base year TAZs' population and household data were estimated by linearly interpolating between two data estimates for 1997 and 2002 from the Census Bureau. The equation for estimating year 1999 TAZ total population was

$$POP_{1999} = POP_{1997} + \left(\frac{POP_{2002} - POP_{1997}}{5} \right) x2 \qquad (1)$$

where
POP_{1999} = 1999 Population
POP_{1997} = Population estimate at year 1997
POP_{2002} = Population estimate at year 2002

The base year TAZ total household was estimated using the same equation. The household distribution by income, household size, and auto ownership for each TAZ was calculated by multiplying the total number of households by the percentage for each household category. The TAZ household distribution was used in calculating trip productions.

3.2.2 TAZ Employment Data

The base year (1999) employment data were estimated by extrapolating from 1990 to 1999. The 1999 county-level employment data were then allocated to the TAZ level by population proportion using the following equation:

$$EMP_{TAZ} = EMP_{cnty} * (POP_{TAZ} / POP_{cnty}) \qquad (2)$$

where
EMP_{TAZ} = TAZ employment

EMP_{cnty} = County employment
POP_{TAZ} = TAZ population
POP_{cnty} = County population

The TAZ employment data were used in calculating trip attractions. So were the county-level land and water area data.

4. TRIP PRODUCTION

Two common methods for estimating trip generation are cross-classification and multiple regression. Both use survey data. Cross-classification estimates home-based trip productions in a table stratified by household size and some measure of mobility such as number of autos per household. Multiple regression estimates home-based-other productions, non-home-based productions, and trip attractions in a traffic analysis zone (TAZ) against independent variables such as number of household, population, employment, and income.

After analyzing the data, cross-classification was chosen as the best method for developing trip production rates. We developed two variations of cross-classification by using data collected from the survey instruments of the questionnaire and the addendum. The two variations are called hereafter the questionnaire method and the addendum method.

4.1 Questionnaire Method

A total of 7284 surveys were collected, but only 4285 were useable for calculating trip generation rates. The break down of the survey returns by season is as follow:

- Fall 99: 413 collected and 272 useable
- Winter 99: 1305 collected and 800 useable
- Spring 00: 2034 collected and 1058 useable
- Summer 00: 2253 collected and 1335 useable
- Fall 00: 1279 collected and 820 useable

The first step in data analysis was to go through the diary data and label each trip as home-based work (HBW), home-based recreation (HBR), home-based other (HBO), or non-home based (NHB). In this study the attraction rates were used in lieu of the production rates for NHB (see Section 5.2, Table 14). NHB trip rates are typically estimated using regression models, instead of the cross-classification method, so that NHB trips can be assigned to the TAZs.

Next the data were classified by income, household size, and number of vehicles owned. Three income brackets were used: low (less than $20,000), medium ($20,000-$50,000), and high (greater than $50,000). Both household size and number of vehicles owned were grouped into 1, 2, 3, and 4+.

One of the major problems with the questionnaire method was that the data were only representative of one family member, i.e., the one who filled out the survey. To calculate the trip rate for the entire family, a few assumptions had to be made:

- Only the surveys filled out by the actual driver were analyzed. This made it possible to calculate the vehicle trip rate for the individual.

- To calculate the number of vehicle trips made per household, we assumed that each licensed driver in a household would make the same trips as the person who was surveyed. This assumption then allowed us to estimate the total vehicle trips made by a household by multiplying the number of trips filled out in a survey by the average number of licensed drivers for each classification. Obviously the teenage members of a household would not be

making the same number and type of trips as a working parent, but no other method of calculating the number of vehicle trips made per household could be found.

- To calculate the person trips per household, we needed to multiply the vehicle trip by an occupancy factor. Table 1 shows the average occupancy factors by trip purpose derived from the returned questionnaires. Perhaps because many returned questionnaires did not fill out the "Group by Size" question, these factors in Table 1 were higher than the NCHRP 187 occupancy values, which had 1.1 persons per vehicle for HBW trips and 1.6 persons per vehicle for HBO and HBR trips. We used the NCHRP 187 occupancy values in the analysis.

Table 1 Average Occupancy Factors Derived From the Returned Questionnaires

Occupancy	Trip Purpose		
	HBW	HBO	HBR
1	972	928	381
2	158	708	393
3	42	168	131
4	22	107	71
5	8	34	31
6	5	11	12
7	0	5	3
8	0	2	2
9	0	1	2
10	0	0	0
11	0	0	1
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	4
17	0	0	0
18	0	0	0
19	0	0	1
Average Occupancy	1.30	1.82	2.15

Table 2 shows the results from the full diary method, where the grayed-out blocks indicate rates that were calculated based on a number of households less than 10. The rates seem quite low compared to trip production rates published in NCHRP 187 Update for rural area and small urban area (Table 3 and Table 4) and trip production rates published in NCHRP Report 365 for small urban area (Table 5 and Table 6). The low rates may be due to (1) many respondents had a hard time understanding the survey and didn't fill out the survey correctly, and (2) the adjustment factors used to get the vehicle trips of one person and the person trips made by the entire family reduced the data accuracy.

Table 2 Trip Rates per Household: Questionnaire Method

LOW

HBW Trip Rate

HH Size	# Autos 1	2	3+
1	0.34	0.63	0.367
2	0.30	0.64	0.92
3+	1.41	0.79	1.48

HBR Trip Rate

HH Size	# Autos 1	2	3+
1	0.48	0.46	0.933
2	1.56	1.25	0.82
3+	1.25	1.71	1.03

HBO Trip Rate

HH Size	# Autos 1	2	3+
1	1.36	0.82	1.333
2	2.55	2.34	1.75
3+	5.13	4.27	2.76

Total Trip Rate

HH Size	# Autos 1	2	3+
1	2.18	1.91	2.633
2	4.41	4.23	3.50
3+	7.79	6.78	5.27

MED

HBW Trip Rate

HH Size	# Autos 1	2	3+
1	0.51	0.65	0.66
2	0.86	0.98	1.01
3+	0.70	1.69	1.93

HBR Trip Rate

HH Size	# Autos 1	2	3+
1	0.50	0.67	0.88
2	0.40	1.20	1.11
3+	1.17	1.95	1.61

HBO Trip Rate

HH Size	# Autos 1	2	3+
1	0.91	1.78	1.60
2	2.99	2.33	2.43
3+	3.79	3.29	2.82

Total Trip Rate

HH Size	# Autos 1	2	3+
1	1.91	3.11	3.14
2	4.25	4.51	4.54
3+	5.65	6.93	6.36

HIGH

HBW Trip Rate

HH Size	# Autos 1	2	3+
1	0.29	0.50	0.37
2	0.33	0.97	1.02
3+	0.28	1.70	1.81

HBR Trip Rate

HH Size	# Autos 1	2	3+
1	1.04	0.24	0.00
2	1.05	0.94	0.87
3+	0.83	1.66	1.87

HBO Trip Rate

HH Size	# Autos 1	2	3+
1	1.04	0.92	1.07
2	2.27	2.06	2.14
3+	3.31	2.09	2.88

Total Trip Rate

HH Size	# Autos 1	2	3+
1	2.36	1.66	1.43
2	3.66	3.97	4.03
3+	4.42	5.45	6.56

Table 3 Total Motorized Person Trips per Household by Persons per Household and Income for Rural Area

HH Size	Income		
	1	2	3
1	3.7	4.8	5.7
2	6.8	7.5	10.3
3	8.2	8.8	12.1
4	10.7	11.8	14.2
5+	11.0	17.6	21.2

Income 1 = less than $20,000, income 2 = $20,000-40,000, income 3 = greater than $40,000
Source: NCHRP 187 Update, quoted in *Michigan Statewide Travel Demand Model Update and Calibration Phase II*

Table 4 Total Motorized Person Trips per Household by Persons per Household and Income for Small Urban Area (50,000-200,000)

HH Size	Income		
	1	2	3
1	3.7	4.6	5.1
2	6.8	8.0	9.2
3	8.7	10.4	12.1
4	11.4	14.3	16.0
5+	13.0	17.6	20.2

Source: NCHRP 187 Update, quoted in *Michigan Statewide Travel Demand Model Update and Calibration Phase II*

Table 5 Average Daily Person Trips per Household by Persons per Household and Auto Ownership for Small Urban Area (50,000-199,999)

HH Size	# Autos			
	0	1	2	3+
1	2.6	4.0	4.0	4.0
2	4.8	6.7	8.1	8.4
3	7.4	9.2	10.6	11.9
4	9.2	11.5	13.3	15.1
5+	11.2	13.7	16.7	18.0

Source: NCHRP Report 365, *Travel Estimation Techniques for Urban Planning*

Table 6 Average Daily Person Trips by Income and Auto Owned for Small Urban Area (50,000-199,999)

Income	# Autos			
	0	1	2	3+
Low	3.4	5.3	8.7	10.6
Medium	5.4	7.0	10.1	12.1
High	7.1	8.9	12.4	14.6

In actual 1990 dollars: Low = less than $20,000, Medium = $20,000 to 39,999, and High = $40,000 and up.
Source: NCHRP Report 365, *Travel Estimation Techniques for Urban Planning*

4.2 Addendum Method

This method used the single-sheet trip diary, the addendum, as the data source. The addendum was added to the survey conducted during the summer months and part of the fall of 2000. Most respondents seemed to understand this addendum much better than the initial survey questionnaire. The number of trips reported increased substantially, and we were also able to get the number of trips made by everyone in the household as opposed to just one person who filled out the survey.

The total number of usable single-sheet diaries was 874. Besides having a smaller sample to begin with (only the summer months and part of the fall of 2000), the additional constraint was the number of single-sheet trip diaries that were actually returned and useable.

The first step in analyzing data from the single-sheet addendum was to go through the data and label each trip as HBW, HBR, HBO, or NHB. Again, NHB trips were not included in the following analysis.

Next, the data were classified by income, household size, and number of vehicles owned. Each of these household characteristics was further classified in the same way as for the questionnaire method.

The single-sheet addendum only recorded trips made by household members who were 14 years and older. This age limit on trips recorded reduced the effort needed to complete the addendum and thus increased the likelihood of it being filled out correctly and/or returned. To include all members under the age of 14, we had to adjust the number of person trips made per household. Published population data do not have a separate category for 14 and under: both the Census Bureau and the Idaho Division of Finance Management use under 18 as a category in their reports. Using linear interpolation, we estimated about 25% of Idaho's population to be under 14. We therefore increased the numbers of HBR and HBO trips made by households with two or more members by 25%. We did not adjust the number of HBW trips because we assumed that no person under the age of 14 worked. One problem with the adjustment of HBR and HBO trips was that it assumed that all people under the age of 14 were distributed uniformly among households with two or more members. Obviously the households with larger numbers would have a higher probability of having members under the age of 14. But no useful data could be found on this subject.

The trip rates were then calculated for each classification by dividing the number of trips made by the number of households in that classification. Table 7 shows person trips per household per day. Because the addendum was only handed out during the summer session and half of the fall session, many cells in Table 7 did not have enough observations to get accurate rates (i.e., less than 10 households), as indicated by the grayed-out blocks. To increase the sample size in the classifications, the household sizes and number of vehicles owned were each re-grouped to 1, 2, and 3+. Results from the re-grouping are shown in Table 8.

Table 7 Person Trips per Household per Day: Addendum Method No Consolidation

LOW

HBW Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.75	1.18	0.00	2.00
2	1.29	1.90	2.29	4.00
3	0.00	2.00	5.25	6.00
4+	2.00	1.00	2.17	3.50

HBR Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.53	0.36	0.00	1.50
2	4.82	2.44	2.32	0.00
3	0.00	5.63	5.63	2.92
4+	1.88	3.50	4.79	3.75

HBO Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.41	0.55	1.33	2.00
2	3.39	3.63	1.79	3.75
3	0.00	5.00	2.81	2.08
4+	1.67	3.50	2.29	5.00

Total Trip Rate

HH Size	# Autos 1	2	3	4+
1	2.69	2.09	1.33	5.50
2	9.50	7.96	6.39	7.75
3	0.00	12.63	13.69	11.00
4+	5.54	8.00	9.25	12.25

MED

HBW Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.67	0.53	0.40	0.00
2	0.92	1.72	1.37	1.60
3	0.00	2.81	1.95	3.33
4+	0.00	2.50	3.61	3.79

HBR Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.42	0.80	1.00	5.00
2	1.15	2.90	2.34	1.25
3	5.00	3.58	3.95	2.22
4+	0.00	3.59	3.89	5.06

HBO Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.61	0.97	1.20	5.00
2	2.50	2.24	2.57	2.58
3	2.50	3.68	3.82	1.39
4+	0.00	4.56	3.53	4.42

Total Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.69	2.30	2.60	10.00
2	4.56	6.86	6.28	5.43
3	7.50	10.06	9.71	6.94
4+	0.00	10.66	11.03	13.28

HIGH

HBW Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.29	0.82	0.00	0.00
2	0.25	1.57	2.62	2.65
3	0.00	2.50	2.23	2.53
4+	0.00	2.07	2.70	3.52

HBR Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.18	0.00	0.00	0.00
2	2.19	2.00	2.06	1.59
3	0.00	2.14	3.08	4.28
4+	5.00	3.58	3.51	5.52

HBO Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.06	0.64	3.00	0.00
2	1.56	2.83	2.56	2.21
3	0.00	3.30	2.75	2.30
4+	5.00	3.33	5.10	4.64

Total Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.53	1.45	3.00	0.00
2	4.00	6.40	7.23	6.45
3	0.00	7.95	8.07	9.11
4+	10.00	8.98	11.32	13.68

Table 8 Person Trips per Household per Day: Addendum Method with Consolidation of 1, 2, and 3+ for Household size and Vehicle Ownership

LOW

HBW Trip Rate

HH Size	# Autos 1	2	3+
1	0.75	1.18	0.80
2	1.29	1.90	2.67
3+	2.00	1.44	3.93

HBR Trip Rate

HH Size	# Autos 1	2	3+
1	0.53	0.36	0.60
2	4.82	2.44	1.81
3+	1.88	4.44	4.50

HBO Trip Rate

HH Size	# Autos 1	2	3+
1	1.41	0.55	1.60
2	3.39	3.63	2.22
3+	1.67	4.17	2.75

Total Trip Rate

HH Size	# Autos 1	2	3+
1	2.69	2.09	3.00
2	9.50	7.96	6.69
3+	5.54	10.06	11.18

MED

HBW Trip Rate

HH Size	# Autos 1	2	3+
1	0.67	0.53	0.33
2	0.92	1.72	0.12
3+	0.00	2.64	3.37

HBR Trip Rate

HH Size	# Autos 1	2	3+
1	0.42	0.80	1.67
2	1.15	2.90	2.10
3+	5.00	3.59	4.17

HBO Trip Rate

HH Size	# Autos 1	2	3+
1	0.61	0.97	1.83
2	2.50	2.24	2.57
3+	2.50	4.14	3.72

Total Trip Rate

HH Size	# Autos 1	2	3+
1	1.69	2.30	3.83
2	4.56	6.86	4.79
3+	7.50	10.38	11.26

HIGH

HBW Trip Rate

HH Size	# Autos 1	2	3+
1	0.29	0.82	0.00
2	0.25	1.57	2.63
3+	0.00	2.28	2.77

HBR Trip Rate

HH Size	# Autos 1	2	3+
1	0.18	0.00	0.00
2	2.19	2.00	1.88
3+	5.00	2.89	4.06

HBO Trip Rate

HH Size	# Autos 1	2	3+
1	1.06	0.64	3.00
2	1.56	2.83	2.43
3+	5.00	3.32	3.92

Total Trip Rate

HH Size	# Autos 1	2	3+
1	1.53	1.45	3.00
2	4.00	6.40	6.95
3+	10.00	8.48	10.75

Although difficult to directly compare the trip production rates from this project to the NCHRP 187 rates, it is clear that results from the addendum method are closer to the NCHRP 187 rates than the questionnaire method.

Because data for the addendum method were collected during the summer and the first part of the fall, a seasonal adjustment could be made to the trip production rates. We found that the average person made about 10% more trips during the summer and fall months than the annual average according to the questionnaire results (Table 9). Therefore, a seasonal adjustment factor by trip purpose could be calculated by taking the average number of trips made per survey for the entire year and dividing it by the average number of trips made per survey for the summer and fall seasons.

Table 9 Seasonal Adjustment Factors by Trip Purpose

	Trips per Survey		
	HBW	HBR	HBO
Fall	0.57	0.39	0.86
Winter	0.42	0.32	0.69
Spring	0.45	0.34	0.56
Summer	0.56	0.41	0.76
Adjustment Factor	0.88	0.91	0.89

Note: Adjustment Factor = [(Fall + Winter + Spring + Summer) / 4] / [(Summer + Fall) / 2]

Table 10 and Table 11 show the trip production rates developed from the addendum data with seasonal adjustment.

Table 10 Person Trips per Household Per Day with Seasonal Adjustment

LOW

HBW Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.66	1.04	0.00	1.76
2	1.13	1.67	2.01	3.52
3	0.00	1.76	4.62	5.28
4+	1.76	0.88	1.91	3.08

HBR Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.48	0.33	0.00	1.37
2	4.39	2.22	2.11	0.00
3	0.00	5.12	5.12	2.65
4+	1.71	3.19	4.36	3.41

HBO Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.25	0.49	1.19	1.78
2	3.02	3.23	1.59	3.34
3	0.00	4.45	2.50	1.85
4+	1.48	3.12	2.04	4.45

Total Trip Rate

HH Size	# Autos 1	2	3	4+
1	2.40	1.86	1.19	4.91
2	8.54	7.12	5.71	6.86
3	0.00	11.33	12.24	9.79
4+	4.95	7.18	8.31	10.94

MED

HBW Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.59	0.47	0.35	0.00
2	0.81	1.51	1.21	1.41
3	0.00	2.47	1.71	2.93
4+	0.00	2.20	3.18	3.34

HBR Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.38	0.73	0.91	4.55
2	1.04	2.64	2.13	1.14
3	4.55	3.25	3.59	2.02
4+	0.00	3.27	3.54	4.61

HBO Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.54	0.86	1.07	4.45
2	2.23	1.99	2.29	2.30
3	2.23	3.28	3.40	1.24
4+	0.00	4.06	3.14	3.94

Total Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.51	2.06	2.33	9.00
2	4.07	6.14	5.62	4.84
3	6.78	9.00	8.70	6.19
4+	0.00	9.53	9.86	11.88

HIGH

HBW Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.26	0.72	0.00	0.00
2	0.22	1.38	2.31	2.34
3	0.00	2.20	1.97	2.22
4+	0.00	1.82	2.38	3.09

HBR Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.16	0.00	0.00	0.00
2	1.99	1.82	1.87	1.44
3	0.00	1.95	2.81	3.89
4+	4.55	3.26	3.20	5.03

HBO Trip Rate

HH Size	# Autos 1	2	3	4+
1	0.94	0.57	2.67	0.00
2	1.39	2.52	2.27	1.97
3	0.00	2.94	2.45	2.05
4+	4.45	2.97	4.54	4.13

Total Trip Rate

HH Size	# Autos 1	2	3	4+
1	1.36	1.29	2.67	0.00
2	3.60	5.72	6.45	5.75
3	0.00	7.09	7.22	8.16
4+	9.00	8.05	10.12	12.25

Table 11 Person Trips per Household Per Day with Data Consolidation and Seasonal Adjustment

LOW

HBW Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.66	1.04	0.70
2	1.13	1.67	2.35
3+	1.76	1.27	3.46

HBR Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.48	0.33	0.55
2	4.39	2.22	1.64
3+	1.71	4.04	4.10

HBO Trip Rate

	# Autos		
HH Size	1	2	3+
1	1.25	0.49	1.42
2	3.02	3.23	1.98
3+	1.48	3.71	2.45

Total Trip Rate

	# Autos		
HH Size	1	2	3+
1	2.40	1.86	2.67
2	8.54	7.12	5.97
3+	4.95	9.02	10.00

MED

HBW Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.59	0.47	0.29
2	0.81	1.51	0.10
3+	0.00	2.33	2.97

HBR Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.38	0.73	1.52
2	1.04	2.64	1.91
3+	4.55	3.26	3.80

HBO Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.54	0.86	1.63
2	2.23	1.99	2.29
3+	2.23	3.69	3.31

Total Trip Rate

	# Autos		
HH Size	1	2	3+
1	1.51	2.06	3.44
2	4.07	6.14	4.30
3+	6.78	9.28	10.07

HIGH

HBW Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.26	0.72	0.00
2	0.22	1.38	2.32
3+	0.00	2.00	2.44

HBR Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.16	0.00	0.00
2	1.99	1.82	1.71
3+	4.55	2.63	3.69

HBO Trip Rate

	# Autos		
HH Size	1	2	3+
1	0.94	0.57	2.67
2	1.39	2.52	2.16
3+	4.45	2.95	3.49

Total Trip Rate

	# Autos		
HH Size	1	2	3+
1	1.36	1.29	2.67
2	3.60	5.72	6.19
3+	9.00	7.58	9.62

5. TRIP ATTRACTION MODELS

The trip attraction models generate the trips attracted to non-residential and residential land uses for each TAZ. This project used the employment types, land area, and water area to measure the intensity of non-residential land uses, and total households to measure the intensity of residential land use. The primary data sources for developing the attraction models were data collected from the statewide travel survey and the base-year socioeconomic database discussed in Section 3. We first experimented with regression analysis for developing trip attraction models (Appendix C). But the regression models proved inadequate because of low R-Square values, collinearity between the independent variables, and negative coefficients. We therefore developed the attraction models based on state-level data.

5.1 Trip Purposes

Similar to trip productions, trip attraction models were developed for the trip purposes of HBW, HBO, HBR, and NHB. HBO, HBR, and NHB trips were further categorized into sub-purposes by trip activities. HBW trips were trips with one end at home and the other end at work. HBO trips included trips with one end at home and the other end at retail (e.g., store, restaurant, and eating and drinking places) or service related activities (e.g., motel, school, medical facilities, post office, and bank). HBR trips were trips with one end at home and the other end at land or water related recreational activities, social activities, and service related activities. NHB trips included trips with both ends at retail or service related activities. Table 12 is a summary of trip purposes and their respective activity indicators.

Table 12 A Summary of Trip Purposes and Activity Indicators

Trip Purpose	Example	Activity Indicator
HBW	home to work work to home	total employment (TE) total employment
HBO	home to store restaurant to home home to school bank to home	retail employment (RE) retail employment service employment (SE) service employment
HBR	home to grandma's home home to fishing home to hunting home to gym	household (HH) water area (0.001 acre) land area (0.001 acre) service employment
NHB	bank to store work to bank	total employment total employment

5.2 Model Development

A total of 5193 returns were useable from the statewide travel survey for developing the attraction models. This total was larger than the total for developing trip production rates because returns with incomplete household information were useable. A total of 13,134 internal attraction trips were counted but only 11,451 trips were useable. Internal attraction trips are trips that have both ends within Idaho and trips with at least one end within Idaho. The useable internal survey trips were tabulated by trip purpose, sub-purpose, and trip activity. The total surveyed trips for each activity was multiplied by a factor of 182 to represent the statewide population which was

the inverse of the survey's sampling rate for the state of Idaho. This factor was computed as follows:

$$FACTOR = POP_{Idaho} / POP_{survey} \quad (3)$$
$$= 943700 / 5193$$
$$= 182$$

where
FACTOR = expansion factor
POP_{Idaho} = estimated number of persons 14 and older in Idaho in 1999
POP_{survey} = number of respondents from the useable surveys

Table 13 summarizes the tabulated trip and activity indicator for each trip sub-purpose at the state level. The attraction trip rates were calculated by dividing the total expanded trips by the activity indicators (i.e., number of households, total employment, etc.). The sub-purpose attraction trip rates were then included within their corresponding trip purposes to get the attraction models. Table 14 presents the attraction trip rates for different sub-purposes by trip purpose and Table 15 presents the internal person trip attraction models by purpose.

Table 13 Survey Trips, Expanded Trips, and Activity Indicators by Trip Purpose

Purpose	Survey Trip	Expanded Trip	Activity Indicator
HBW	2774	504868	TE = 767645
HBO-Retail	1638	298116	RE = 176542
HBO-Service	1620	294840	SE = 242467
HBR-Visiting	1175	213850	HH = 463925
HBR-Land	467	84994	LAND= 52961971 acres
HBR-Water	199	36218	WATER= 526628 acres
HBR-Service	381	69342	SE = 242467
NHB	3157	574574	TE = 767645

Table 14 Attraction Trip Rates by Trip Purpose

Purpose	Rate	Unit
HBW	0.66	per employment (TE)
HBO-Retail	1.69	per retail employment (RE)
HBO-Service	1.22	per service employment (SE)
HBR-Visiting	0.46	per household (HH)
HBR-Land	0.16	per 100 acres of land area
HBR-Water	6.88	per 100 acres of water area
HBR-Service	0.29	per service employment (SE)
NHB	0.75	per employment (TE)

Table 15 Trip Attraction Models

HBW = 0.66 TE
HBO = 1.69 RE + 1.22 SE
HBR = 0.46 HH + 0.16 LAND + 6.88 WATER + 0.29 SE
NHB = 0.75TE

5.3 Model Calibration

The total internal trip productions should be similar to internal trip attractions. To determine this, total statewide productions and attractions were calculated using the production and attraction models and the TAZ data. Table 15 shows the total productions and attractions for each trip purpose. The ratios of attractions to productions range from 0.32 to 0.62, which fall outside the range of 0.90 to 1.10 recommended by FHWA (1990). Causes for the imbalance include the socioeconomic estimates, the trip rates, or both. Figure 2 shows the imbalance graphically. No imbalance exists for the NHB trip purpose because the productions and attractions were calculated using the same model shown in Table 15.

Table 16 Comparisons of Productions and Attractions

Purpose	Productions	Attractions	Attractions/Productions	Diff (%)
HBW	813022	505901	0.62	38
HBO	1197516	594511	0.50	50
HBR	1169391	376348	0.32	68
NHB	575679	575679	NA	NA

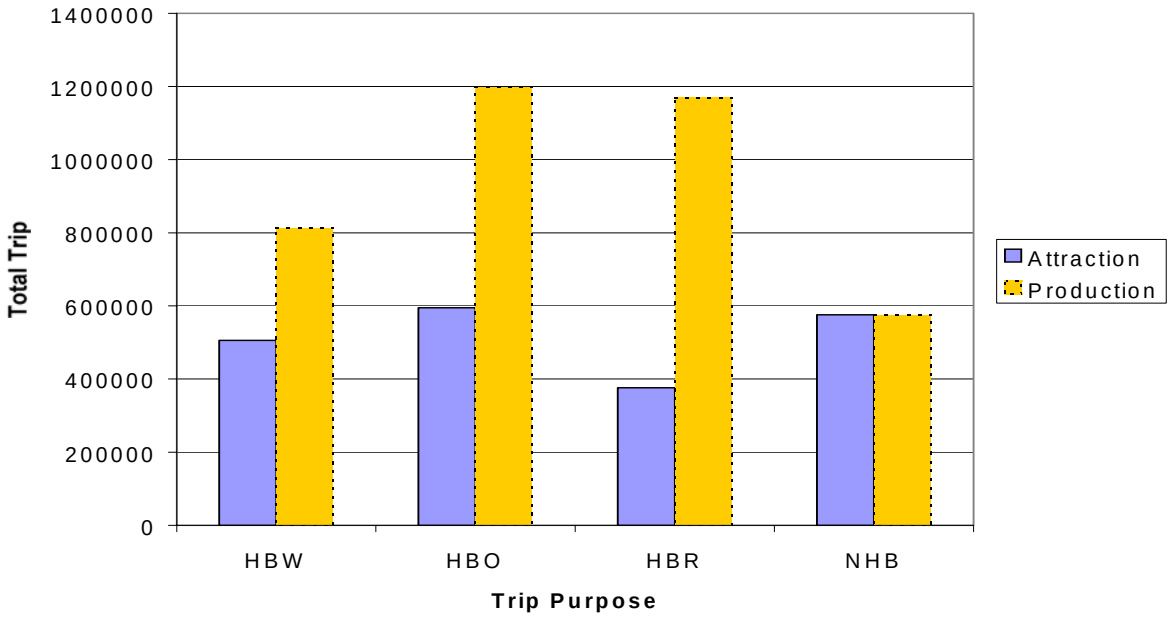

Figure 2 Productions—Attractions Comparison Before Calibration

However, we found that an acceptance factor was needed for the attraction models to account for the trips that were reported on the questionnaire but were discarded because of lack of classifiable trip activity for a surveyed household. This adjustment was not needed for trip production rates based on the addendum method, in which all trip information was useable. This acceptance factor for HBO and HBR trip purposes was calculated by

Acceptance factor = (total trips by purpose) / (useable trips by purpose).

Because all HBW and NHB trips were used, both trip purposes had an acceptance factor of 1. Table 17 shows the acceptance factor for each trip purpose.

Table 17 Acceptance Factor

Purpose	Acceptance Factor
HBW	1.00
HBO	1.42
HBR	1.14
NHB	1.00

Because respondents to the survey questionnaire were 14 years old or older, another factor was needed to account for trips made by persons less than 14 years old. These factors, taken from the trip production analysis, were 1.23, 1.24, and 1.24 for HBO, HBR, and NHB, respectively. These factors were calculated by first increasing trips made by households of two or larger by 25% to account for trips made by persons less than 14 years of age, and then dividing the adjusted number of trips by the original number of trips made by households of all sizes. A HBW factor was not needed because we assumed that persons under 14 do not make work trips. This adjustment is shown mathematically below.

$$FACTOR_{age<14} = [(TRIPS_{HH\ SIZE\ 2+}*1.25)+TRIPS_{HH\ SIZE\ 1}]/TRIPS_{HH\ SIZE\ 1+}$$

where
$FACTOR_{age<14}$ = adjustment for trips made by those of ages less than 14 years
$TRIPS_{HH\ SIZE\ 2+}$ = trips of households of two or larger
$TRIPS_{HH\ SIZE\ 1}$ = trips of households of one
$TRIPS_{HH\ SIZE\ 1+}$ = trips of households of all sizes

Both factors—unclassified trips and persons under 14—were then applied to the attraction models. Table 18 shows the final attraction models, and Table 19 shows the comparison between the total productions and attractions for each trip purpose.

Table 18 Final Attraction Models

HBW = 0.66 TE
HBO = 2.98 RE + 2.15 SE
HBR = 0.65 HH + 0.23 LAND + 9.68 WATER + 0.40 SE
NHB = 0.93 TE

Table 19 Comparisons of Final Productions and Attractions

Purpose	Productions	Attractions	Attractions/Productions	Diff (%)
HBW	813022	505901	0.62	38
HBO	1197516	1049692	0.88	12
HBR	1169391	529439	0.45	55
NHB	713699	713699	NA	NA

After adjusting the attraction rates, imbalance still exists between total productions and attractions for each purpose (Table 19). The ratios of attractions to productions range from 45 to 88 percent, which still fall outside the range recommended by FHWA. Figure 3 shows the

imbalance graphically. This imbalance suggests a problem with the socioeconomic estimates, trip rates, or both.

The difference between productions and attractions will be corrected by forcing the attractions to equal the productions. Attractions are usually adjusted to match productions by trip purpose at the end of the trip generation step in statewide traffic demand modeling. This is because production rates are generally considered more trustworthy than attraction rates (FHWA 1999).

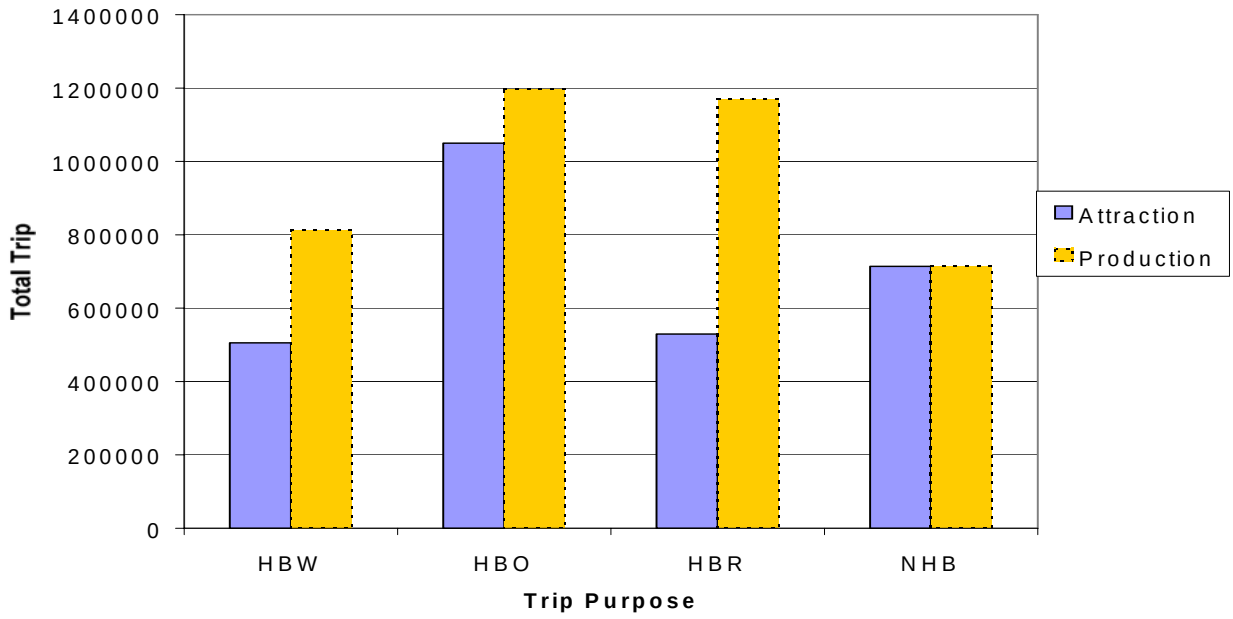

Figure 3 Production—Attraction Comparison (After Adjustment Factors)

6. FRICTION FACTOR

A basic input to the trip distribution gravity model, friction factors express the area wide effect of zone separation on trip frequency. Typical forms of impedance are travel time, travel cost, or travel distance between zones. This study used travel time and the Gamma impedance function recommended by the FHWA to develop the Idaho statewide friction factors. The following describes the data source and steps in developing the Idaho statewide friction factors for intra-state trips. Data from the Idaho statewide travel survey were the primary data source, and the Gamma function was calibrated for each of the trip purposes of HBW, HBO, HBR, and NHB.

6.1 Data Source

A total of 4704 returns from the questionnaire portion of the statewide travel survey were used to develop the friction factors. Each survey return was inspected for completeness. Returns with incomplete trip information were discarded. Examples of incomplete trip information are shown below.

- missing departure time
- missing arrival time
- missing origin city
- missing destination city
- unreasonable trip length

A total of 8575 intra-state trips were useable. Intra-state trips are trips that have both ends within Idaho. The reported times for all intra-state motorized trips were categorized by trip purpose. Figure 4 through Figure 7 show the observed trip length frequency distributions (TLFD) for each purpose and the average trip length.

The average trip lengths appear to be longer than national averages. For example, the 1995 Nationwide Personal Transportation Survey (NPTS) reported an average work travel time of 20.7 minutes (http://www.bts.gov/), compared to 44 minutes in Figure 4. This difference may be explained by the fact that the trip lengths reported here were based on the recorded time (recorded departure time minus recorded arrival time), rather than the actual travel time. Many respondents might have included stops within the trip in the recorded time or simply have forgotten the actual departure and/or arrival time. For example, a trip from Mountain Home to Boise—a 50-mile trip—was recorded to have a trip length of three hours in one questionnaire.

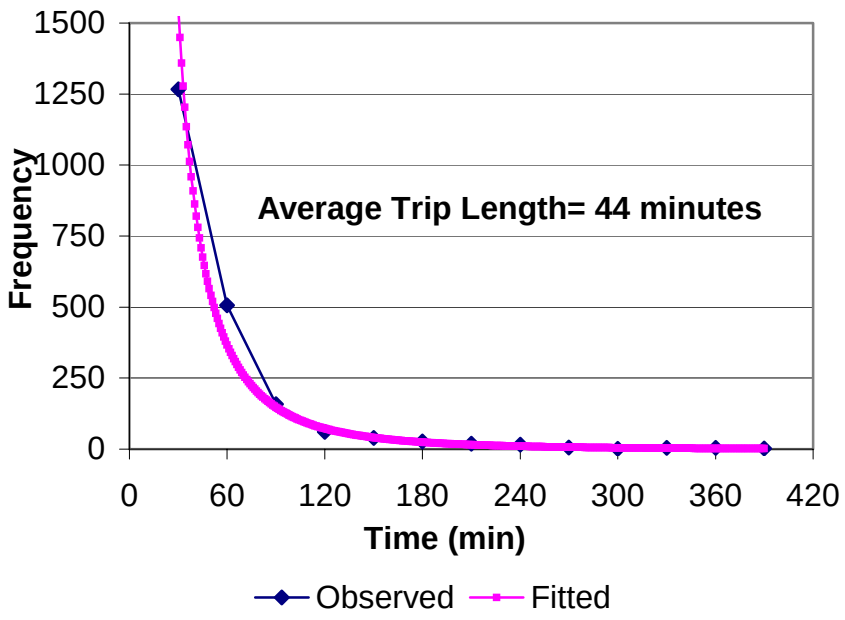

Figure 4 HBW TLFD

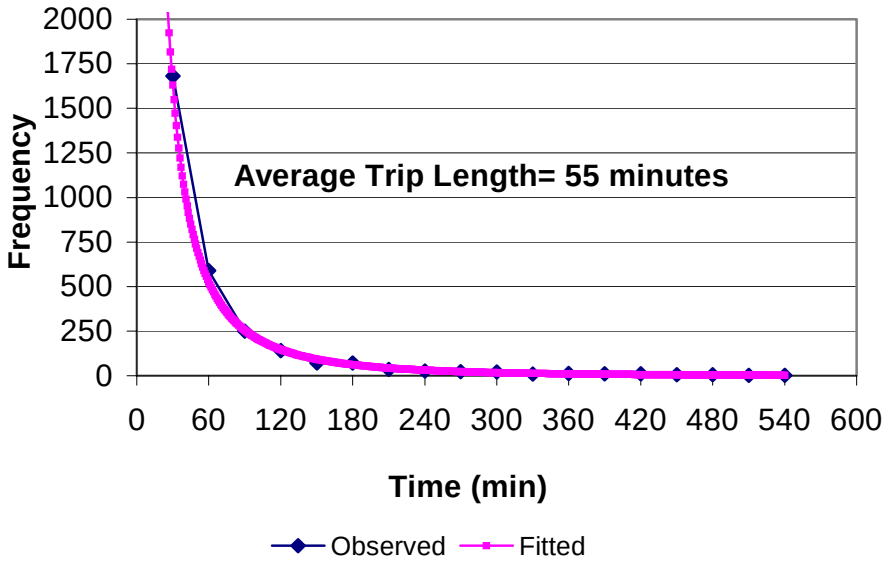

Figure 5 HBO TLFD

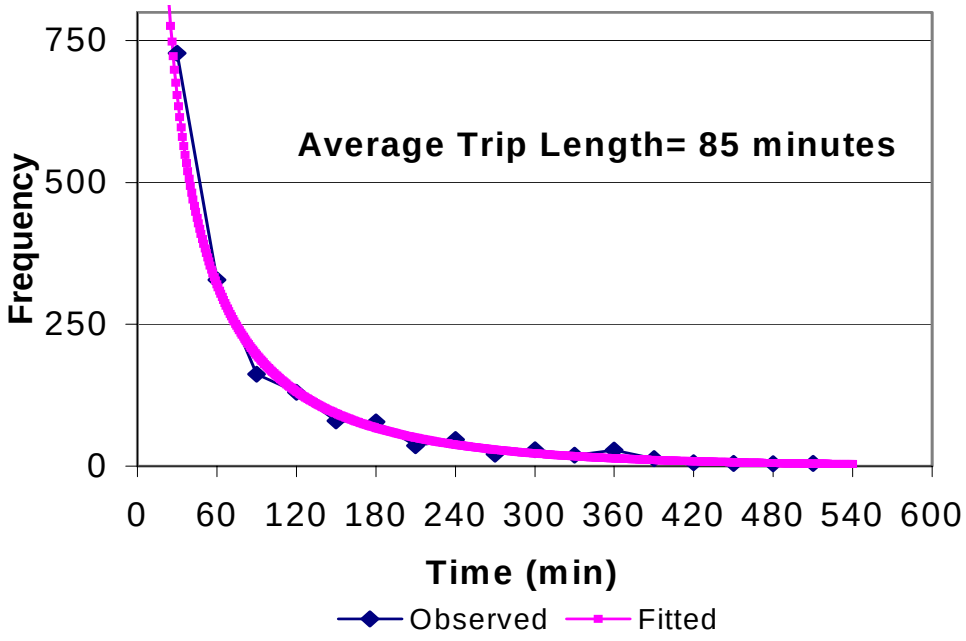

Figure 6 HBR TLFD

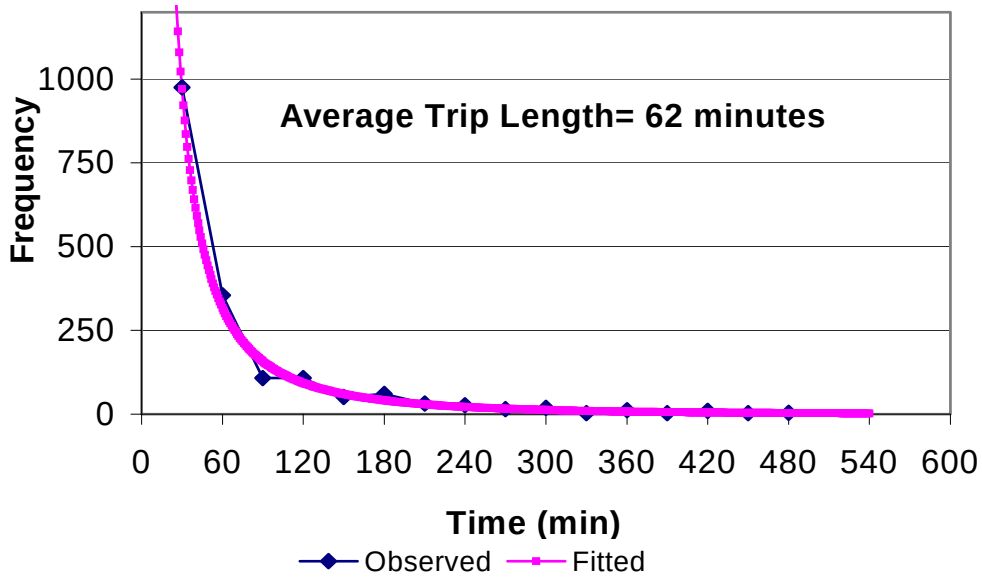

Figure 7 NHB TLFD

6.2 Gamma Function

Using a combination of the exponential and power functions, the Gamma impedance function equates travel time to a friction factor. This friction factor is a relative weight, where an

increased friction factor for a given travel time, relative to other travel times, is equivalent to a increased probability of a trip, with that travel time, occurring:

$$F=a*T^{b}*e^{c*T} \quad (4)$$

where
F = Friction factor
T = Travel time
a,b,c = calibration parameters

Pertaining to trip distribution application, the Gamma function parameters have the following characteristics:

- The parameter “a” is always positive and is a scaling factor controlling the overall range of function values. It can be varied without changing the relative distribution.
- The parameter “b” can be positive or negative and can affect the distribution of shorter trips.
- The parameter “c” is always negative and can affect the distribution of longer trips.

With three parameters and a combination of the power and exponential functions, the Gamma function is flexible in fitting distributions and is suitable for the statewide model where the trip length distributions vary over a great range.

6.3 Methodology

The Gamma function parameters were calibrated for each trip purpose. Two time interval sizes, 15 and 30 minutes, were used to characterize the trip length frequency. The parameters were calibrated by fitting the Gamma function to the observed trip length frequency distribution. The Gamma function was fit by log-linear transformation and linear regression and the two time interval sizes were evaluated by comparing the respective root-mean-square errors. The best-fit curve should reflect the full trip length frequency distribution and have the lowest mean-root-square error.

6.4 Results

Table 20 presents the calibrated Gamma function parameters, which can be used to calculate the friction factors used as input for trip distribution in the transportation planning model.

Table 20 Calibrated Gamma Function Parameters

Trip Purpose	a	b	c
HBW	924517	-1.829	-0.006
HBO	242024	-1.428	-0.005
HBR	10789	-0.772	-0.006
NHB	148868	-1.449	-0.004

7. CONCLUSION

The statewide travel survey was designed for multiple purposes. As a result, the survey did not entirely fulfill the data needs for this project. Because of the large amount of information being collected to satisfy the multiple purposes of the survey, the questionnaire was too long and complicated for many respondents. This resulted in less reliable data and a lower response rate. Fortunately, some useful information was extracted from the questionnaire for determining friction factors and attraction rates. The addendum provided more useful data for estimating trip production rates and would be a desirable means for collecting trip data in future surveys. Unfortunately, for this survey, the addendum only covered the summer months and part of the fall season resulting in an incomplete picture of annual travel behavior.

We developed the trip attraction models for four trip purposes from the statewide travel survey data and the base year socioeconomic database. The attraction models were developed by matching each trip purpose with trip activities and by using the state-level data. The models were adjusted for unclassifiable trips and persons under 14-years old. A comparison between productions and attractions revealed a difference of 38% for HBW, 12% for HBO, and 55% for HBR. These differences can be due to socioeconomic estimates, trip rates, or both. Attractions are usually adjusted to match productions by trip purpose at the end of the trip generation step in statewide traffic demand modeling, thus resolving the imbalance problem.

A friction factor function, based on the Gamma function, was calibrated for each trip purpose and for 30-minute and 15-minute time intervals. We found that 15-minute time intervals provided the best fit and that the Gamma function fit the observed data quite well.

We recognize that the trip rates and friction factors derived from this project must be used with caution because of the sample size, socioeconomic estimates, and the imbalance between productions and attractions. The project, however, has been beneficial to transportation planners in Idaho in at least three ways:

1. Experience from this project can certainly be used to improve the future survey process and its reliability and applicability to statewide transportation modeling. The travel diary used in the 2001 National Household Travel Survey (NHTS, formerly NPTS or National Personal Transportation Survey) (http://www.bts.gov/) can probably be used as a model to further improve the design of the addendum used in this project. The NHTS trip diary, however, is designed for one person to fill out and the recorded data in the diary are verified through phone interviews. A copy of the NHTS travel diary is included in Appendix D.
2. The trip rates and friction factors derived from the project have provided for the first time Idaho-specific data that can be compared to data published by NCHRP and other states as well as data to be available from the Census 2000 Journey to Work Survey (JTW) and the 2001 NHTS.
3. The trip rates and friction factors derived from the project, combined with published data sources, can be used for calibrating the Idaho statewide traffic demand model. This is an approach used in statewide traffic demand modeling projects in Michigan, Kentucky, and other states.

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APPENDIX A: THE GOALS AND METHODS OF THE STATEWIDE TRAVEL SURVEY

GOALS

The purpose of the 1999 Idaho Resident and Nonresident Motor Vehicle Travel Study is to continue the collection and analysis of data on the primary market/user group: the resident and nonresident personal motor vehicle traveler in Idaho.

The goals of this cooperative research are:

1. To provide practical data on nonresident motor vehicle travelers in Idaho, including: party characteristics, trip characteristics, recreation activity characteristics, location data, economic data, psychographics profile, traveler opinions and preferences on Idaho tourism and recreation services, needs and assessment of traveler signage, facility and safety.

2. To provide practical tourism information for use in transportation planning—motor vehicle, bicycle and pedestrian tourist travel—(Idaho Transportation Department and local governments), development of local comprehensive plans (city and county governments), development of scenic byway corridor management plans (ITD and the Idaho Scenic Byways Advisory Committee and partners), rural tourism development planing (Idaho Department of Commerce and local governments), and Comprehensive Outdoor Recreation and Tourism Plans (Idaho Department of Parks and Recreation).

3. To continue trend analysis capabilities through periodic data collection over multiple travel quarters every five to seven years.

4. To create a database that is compatible with the 1987 and 1993 studies and future studies of the other primary market/user groups.

5. To disseminate the findings, share the statistical databases, and communicate the implications of the study by electronic and other means so that the widest possible array of users can benefit from these data in a timely and efficient manner.

6. To provide scientifically defensible data at a state and tourism region levels. The intent is to have as many of the variables as feasible reportable at the regional level and wherever possible, as per limits of sampling, report information at a destination level.

METHODS

Population

All resident and nonresident motor vehicle travelers in Idaho for a 12 month period June or July 1999 until May or June of 2000. Starting date is dependent upon the approval of the contract and creation of necessary materials. Examples of likely quarters to be used are as follows:

Summer	June, July, August
Fall	September, October, November
Winter	December, January, February
Spring	March, April, May

Approach

The most efficient method of studying resident and nonresident motor vehicle travel to and within Idaho is to treat the state as a model, or closed unit, and using a methodology by which information can be obtained on every traveler (or sample of travelers) in the state. To assure a minimum of bias, it is critical that nearly everyone who travels in the state has an equal (or known) chance of being sampled.

In the case of motor vehicle travelers, the contact locations should be on roads/highways where the traveler enters or traverses the state. The highway intercept method is used at two types of locations: 1) a sample of highways entering the state, and 2) a sample of highways internal to each travel region in Idaho. The first will provide an opportunity to sample primarily nonresidents entering or leaving the state, and the second will allow a sampling of intra-state travel, predominantly by residents.

Sampling

Each site will be sampled several times a month for a three-hour period. These sampling periods will be randomly assigned so as to cover time periods throughout the daylight hours. A flag person will direct all commercial (e.g., semi-trailer trucks, delivery vehicles, government vehicles) around the survey site. All other motor vehicles (or a sample of motor vehicles, when traffic volumes are high) will be waved into the survey site. Due to the size of some of the highway pullouts used as survey sites, no more than 3 or 4 vehicles can be accommodated at any given time. In these cases, the flag person would wave on motor vehicles until more space is available at the survey site. In this way, random selection can be maintained when conditions do not allow for sampling all motor vehicle travelers. At these sites, a count of all traffic and of all motor vehicle traffic will be kept for the three-hour sample period. These counts will later be used, in conjunction with monthly average daily traffic flow data, to weight returned surveys for analysis and to determine the total number of nonresident and resident motor vehicle travelers in Idaho each season.

A second approach to stopping motor vehicles may be necessary for some Interstate highway sites where the traffic volume is too large to be controlled by a flag person. In these cases extra road signs will be used to inform the motor vehicle travelers that a tourism survey was ahead, that all vehicles should keep in the right lane, a second reminder that a tourism survey was

ahead, and a request for them to pull into the rest area where the survey site will be located. The ratio of nonresident to resident traffic can be calculated from the counts. Those ratios coupled with the Idaho Transportation Department's ADT counts will permit estimates of the total number of nonresident travel parties that visit Idaho during each quarter.

Target sample size

Our target is to contact approximately 1000-1500 persons per region (7 regions) per season (4 seasons) or approximately 28,000- 42,000 vehicles total over the year. Of these, we are estimating 50% will return their dairies. Therefore we will have approximately 2000-3000 completed interviews per region or approximately 500-750 per season. These targets are used to guide the estimation of interview costs and materials. Should additional funds be identified these numbers would be adapted. The total numbers are likely to impact our ability to talk about destinations within regions. Based upon the 1993 nonresident travel study it is likely that approximately twice as much time will need to be spent sampling in Travel Regions 2 and 7 and about 1/2 as much time in Region 1 as will need to be spent in Regions 3, 4, 5, and 6.

The Survey Instruments

Once a traveler is pulled into the survey site, the study will be briefly introduced and the traveler asked a series of short questions regarding their destination(s), purpose of trip, familiarity with the area in which they were traveling, party size, vehicle type, place of residence, places that they were going to visit in Idaho, and their anticipated total number of nights in Idaho. This information comprises the front-end Interview and will be administered to occupants of all vehicles that are stopped.

Once the front-end Interview is complete, a randomly selected occupant of each vehicle will given a Mail-back Diary Questionnaire to take with them and complete as they traveled through Idaho. The Mail-back Questionnaire asks some of the same questions as the front-end Interview, as well as questions regarding traveler characteristics, trip characteristics, opinions on Idaho's tourism and recreation services, opinions on highway rest areas, travel mode, evaluations of traveler facilities and services, travel behavior and psychographics (marketing) information, and a trip diary section designed for the traveler to keep a log of their travel expenditures and activities while in Idaho.

The interview and questionnaire are designed to be easily modified from quarter to quarter, or even for each region of the state. This allows additional questions to be added or removed to address specific issues as they come up throughout the course of this study.

Data Analysis

Data from the questionnaire will be entered at the office of the Department of Resource Recreation and Tourism in the University of Idaho. SPSS-DE will be used as the data entry tool. Data entry will be checked for accuracy by the principal investigators of this project. Corrections will be made where errors were found. Data files will be maintained in ASCII and SPSS format on IBM PC compatible hard drives and on floppy disks. In order to avoid bias that could result because we are not able to interview all potential respondents that pass by our sample point during the sample period, variables will be weighted to make the responses representative of the proportions of the traffic actually flowing through the sampling sites.

Analysis will be performed on the interview and questionnaire data using SPSS for Windows. Basic descriptive statistics, frequency distributions and cross tabulations will be computed for all variables of interest.

APPENDIX B: IDAHO STATEWIDE TRIP GENERATION RATES AND FRICTION FACTORS PROJECT

The Idaho Transportation Department, in collaboration with Department of Commerce and other agencies, is participating in a statewide travel survey, "1999-2000 Idaho Resident and Nonresident Motor Vehicle Travel Survey." ITD's participation in this survey is using Division of Planning funds, not research funds. This survey will provide household data needed to develop the trip generation rates and friction factors for the Idaho Statewide Transportation Planning Model, Research Project #135.

The building of a statewide travel demand model requires use of data based on the demographic, social, and economic characteristics of households and the travel habits of household members. These household data are used in trip generation and trip distribution of the modeling process. Because surveys are instruments typically used to collect data at the household level, surveys are an integral part of a statewide model project.

Two common methods for estimating trip generation are cross-classification and multiple regression. Both use survey data. Cross-classification estimates home-based trip productions in a table stratified by household size and some measure of mobility such as number of autos per household. Multiple regression estimates home-based-other productions, non-home-based productions, and trip attractions in a traffic analysis zone (TAZ) against independent variables such as number of household, population, employment, and income.

Survey data are needed for estimating friction factors, also called travel time factors. In trip distribution, friction factors represent the effect of travel time on trips between TAZs. Friction factors are also useful for model calibration by comparing trip length distributions and average trip lengths from the model output to survey data. Ideally, friction factors should vary by trip purpose and by the regional characteristics, e.g., urban vs. rural, within a state.

The lack of Idaho statewide, up-to-date survey data has been a constant problem for the research team at the University of Idaho in developing an Idaho statewide traffic demand model. As reported in the progress report, we used trip generation rates and friction factors from different sources. Thus, it is not surprising at all that the difference between the estimated traffic volumes from our model and the ground counts was larger than we expected.

The purpose of this proposed project is to make sure that data collected from the statewide travel survey will satisfy the needs of the traffic demand model project. Periodically, as survey data are made available, the UI research team will check the data for validity and produce trip generation rates and friction factors to ensure their applicability.

The proposed study is crucial to building a reliable statewide traffic demand model and model calibration. An Idaho statewide model should reflect the demographic and socioeconomic characteristics of travelers in the state and their travel habits. This can only be achieved by conducting a well-designed, statewide travel survey.

This project has several important benefits to Idaho Transportation Department and other state agencies:

Trip generation rates developed from the travel survey data will better represent motorists' travel behavior in Idaho.
Friction factors developed from the travel survey data can measure more accurately the effect of travel time on trips in Idaho.
A valid statewide travel demand model can provide future traffic volumes on all segments of the statewide road network.

APPENDIX C: REGRESSION MODELS FOR TRIP ATTRACTION

To derive trip attraction models using regression analysis, trips from the statewide travel survey were grouped at the city level and regressed against socioeconomic data at the city level. The predictor variables included total employment (TE), retail employment (RE), service employment (SE), other employment (OE), and number of households (HH). The predictor variables were chosen subjectively based on the definitions of trip purposes. The regression models had problems such as multi-collinearity, outliers, and negative coefficients.

Purpose	Without Intercept	With Intercept
HBW	0.492*TE $R_{adj}^2 = 0.5468$	2207 + 0.431*TE $R_{adj}^2 = 0.5428$
HBO	10.07*RE – 5.60*RE $R_{adj}^2 = 0.6418$	2646 + 7.73*RE – 3.99*RE $R_{adj}^2 = 0.6354$
HBR	0.69*HH + 2.91*RE – 2.48*SE $R_{adj}^2 = 0.6878$	1570 + 0.23*HH + 3.49*RE – 2.11*SE $R_{adj}^2 = 0.6916$
NHB	7.49*RE – 3.84*SE + 0.21*OE $R_{adj}^2 = 0.7207$	2049 + 6.69*RE – 2.59*SE – 0.36*OE $R_{adj}^2 = 0.7161$

APPENDIX D: NATIONAL HOUSEHOLD TRAVEL SURVEY TRAVEL DIARY AND INSTRUCTIONS

Respondent Label with Name
Travel day and date

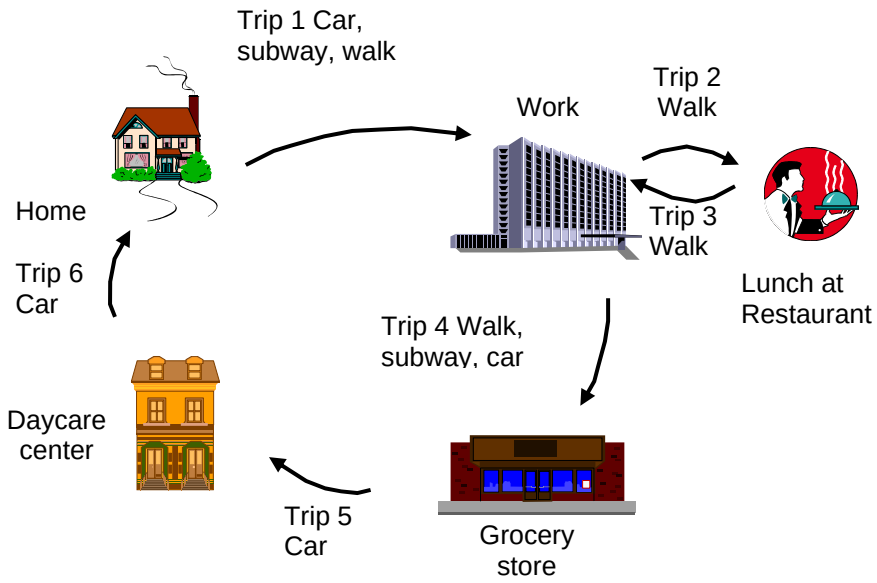
At the beginning of my travel day (4:00 a.m.) I was:
☐ Home ☐ Some other place

WHERE did you go? (Name of place)	What **TIME** did you start and end each trip?		**WHY** did you go there?
	Started at:	**Arrived at:**	
EXAMPLE: *West Park Theater*	*2:00 p.m.*	*2:55 p.m.*	*To see a movie*
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Instructions for completing your Travel Diary

- Use this diary on your **assigned travel day,** shown on the front.
- The travel day starts at 4:00 a.m. and ends at 4:00 a.m. the next day.
- A **trip** is whenever you travel **from one address to another**. Use one line to record each trip. **Include:**
  - All trips you made for a specific reason, such as to go to work or school, buy gas, or drop someone off.
  - Return trips, such as coming home from work or school.
  - Walks, jogs, bike rides, and short drives. If you started and ended in the same place, list the farthest point you reached and record a return trip.
  - **Do not** include stops just to change the type of transportation.
  - Record all of your child's trips on the child's diary, including trips that were not taken with an adult member of your household, such as riding the school bus.
- If you made more than ten trips as part of your job (examples: a cab driver, delivery person, police officer):
  - **Don't** record the trips that were made as part of your job.
  - **Do** record the trips that got you to and from your work place.
  - **Do** record all other trips that **were not** part of your job.
- If you made more trips than will fit on the diary, record the rest on a blank sheet of paper.

Example of Trips on a Travel Day



Filled Out Example of Travel Diary matching pictorial example, with car and bus and walk to work, walk to lunch and back, walk and bus and car to grocery store, car to day care to pick up someone, and car to home.