



Baltimore Metropolitan Council

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# **2001 HOUSEHOLD TRAVEL SURVEY: BALTIMORE REGION ANALYSIS**

**Task Report 06-2**

**August 2005**

**Baltimore Metropolitan Council ■ 2700 Lighthouse Point East, Suite 310 ■  
Baltimore, Maryland 21224-4774**

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## Introduction and Background

Approximately every 5 years, the United States Department of Transportation (USDOT) conducts a national household survey that is used to measure demographic and household travel characteristics used to evaluate national policies and assist researches in understanding emerging travel trends. The USDOT allows states, local jurisdictions and Metropolitan Planning Organizations (MPOs) to purchase additional local samples. The additional local samples can be used by local planning agencies in evaluating and understanding community transportation issues and increase the national sample.

The Baltimore Regional Transportation Board (BRTB), the designated MPO for the Baltimore metropolitan area, agreed to participate in the 2001 National Household Travel Survey (NHTS) as an add-on. The BRTB felt the survey was a unique opportunity to collect household travel observations that could assist in developing travel models used in policy analysis and development of long range transportation plans. The travel survey also coincided with the 2000 decennial Census, another large database used by local planners. The NHTS would also allow the household travel within the Baltimore region to be compared to similar urban areas across the country, since all survey data and add-ons are collected in a similar fashion. These types of comparisons are useful in evaluating the transferability of successful transportation policies in other communities.

The Baltimore Metropolitan Council (BMC), staff to the BRTB, managed the project. Staff worked with federal representatives and contractors to estimate number of desired weekday and weekend household participants in order to have a valid database to use in regional planning. BMC staff also served as first point of contact for recruited households with concerns.

The household survey was mainly focused on weekday travel, collecting a one day travel itinerary from 3,131 Baltimore region households. A smaller survey of 325 households was also sampled to obtain weekend travel behavior. Traditionally, travel activity has been focused on weekday travel associated with commuting as a primary concern. Recently, non-work related travel has rivaled commuting with some locations in the Baltimore region having the greatest one hour peak volume on weekends. A smaller weekend sample was selected to start the process of understanding the travel choices being made and to establish a baseline to measure change.

The year long travel survey began data collection in June of 2001. Participating households reported demographic data and recorded one day of travel for all household members. The survey contractor organized the collected household information into four databases as follows:

1. Household – containing demographic data common to all household members, such as number of household members, number of motorized vehicles available, and household income. Characteristics such as type of household and tenure of housing unit were also collected.
2. Person – containing demographic data on the individual persons within the household, such as age, sex, and employment status.
3. Vehicle – characteristics of the available motor vehicles within the household, such as make, model, year, and annual mileage from odometer readings.

4. Travel Day – reported daily trips for all household members. Information on type of trip (work, shopping, church, etc.), mode used (walk, car, transit), time of day and location of the trip destination were collected.

## Survey Sample Size

BMC staff gained experience in understanding travel behavior and survey principles from the Household Travel Survey completed in 1993.<sup>1</sup> Using the *Travel Survey Manual, Travel Model Improvement Program*, (July 1996), BMC staff estimated regionwide sample sizes for various trip categories and confidence levels using the mean, standard deviation and coefficient of variation (standard deviation/mean) calculated from the 1993 Household Travel Survey. Table 1 lists the estimated sample sizes for a regionwide survey. A greater confidence level demands more surveys be conducted.

A relatively small number of samples are needed to estimate total person trips at a regionwide level. Evaluating the 1993 Survey, BMC staff measured differences in total person trips for a household based on number of persons, motorized vehicle availability, and Transportation Analysis Zone (TAZ) density (city center, urban, suburban, rural). It is believed that household density acts as an indicator of the extent and availability of the pedestrian friendly environment as density increases. Density helps explain differences in number of trips, motorized trips, and duration. Using the 1993 Survey indexing the households on household size (1-4+), number of motorized vehicles (0-3+) and TAZ density, and the number of desired households for 13 cells (cells with more motor vehicles than persons were combined) for the four densities were estimated. This generated a sample size greater than 4,100, which was greater than the proposed budget. Testing the difference between the mean trip rates (t-test) for all households within each density, there was no significant difference between the mean rate for the urban and suburban total trip rate. For this reason, these two density areas were combined yielding a total sample size of 3,200 households for the three density areas (city center, suburban/urban and rural).

In negotiations with the contractor, the final desired number of surveys was modified due to concerns mainly over the number of zero car households. The final desired number of weekday surveys is shown in Table 2 and the number of weekday households that participated is shown in Table 3.

For the weekend survey, the number of samples was calculated using the previous methodology from the 1995 National Personal Travel Survey for the State of Maryland. No stratification was performed for the weekend survey. The effort collected 325 observations.

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<sup>1</sup> Task Report 97-3, June 1997, *Baltimore Regional Household Travel Survey: Findings* by Gene Bandy & Charles Baber

**TABLE 1**  
**Estimated Baltimore Region Sample Size**

| Variable        | Mean Trip Rate | Standard Deviation | Coefficient of Variation | Sample Size (95% Confidence,+- 5%) | Sample Size (90% Confidence,+- 10%) |
|-----------------|----------------|--------------------|--------------------------|------------------------------------|-------------------------------------|
| Total Trips     | 9.37           | 6.56               | 0.70                     | 753                                | 132                                 |
| Motorized Trips | 8.32           | 6.27               | 0.75                     | 874                                | 153                                 |
| Transit Trips   | 0.72           | 1.48               | 2.07                     | 6,569                              | 1,150                               |
| HBW             | 1.64           | 1.68               | 1.03                     | 1,615                              | 283                                 |
| HBSshop         | 0.98           | 1.44               | 1.47                     | 3,305                              | 578                                 |
| HBOther         | 1.07           | 1.57               | 1.46                     | 3,287                              | 575                                 |
| HBSchool        | 2.80           | 3.17               | 1.13                     | 1,962                              | 343                                 |
| WBO             | 1.85           | 2.69               | 1.45                     | 3,251                              | 569                                 |
| OBO             | 1.08           | 1.81               | 1.68                     | 4,343                              | 760                                 |

**TABLE 2**  
**Estimated Sample Size: Weekday**

| Sample Area    | Number of Household Vehicles | Number of Persons in the Household |     |     |           | Total |
|----------------|------------------------------|------------------------------------|-----|-----|-----------|-------|
|                |                              | 1                                  | 2   | 3   | 4 or More |       |
| Rural          | 0                            | 50                                 |     |     |           |       |
|                | 1                            | 84                                 | 109 | 83  | 118       |       |
|                | 2                            |                                    | 102 | 77  | 84        |       |
|                | 3 or More                    |                                    |     | 102 | 79        |       |
|                | Total                        |                                    |     |     |           | 888   |
| Suburban/Urban | 0                            | 70                                 |     |     |           |       |
|                | 1                            | 100                                | 132 | 132 | 155       |       |
|                | 2                            |                                    | 102 | 109 | 112       |       |
|                | 3 or More                    |                                    |     | 79  | 103       |       |
|                | Total                        |                                    |     |     |           | 1,094 |
| City Center    | 0                            | 50                                 | 100 |     |           |       |
|                | 1                            | 146                                | 108 | 103 | 71        |       |
|                | 2                            |                                    | 44  | 133 | 96        |       |
|                | 3 or More                    |                                    |     | 98  | 190       |       |
|                | Total                        |                                    |     |     |           | 1,139 |
| Grand Total    |                              |                                    |     |     |           | 3,121 |



**TABLE 3**  
**Observed Households: Weekday**

| Sample Area    | Number of Household Vehicles | Number of Persons in the Household |     |    |           | Total |
|----------------|------------------------------|------------------------------------|-----|----|-----------|-------|
|                |                              | 1                                  | 2   | 3  | 4 or More |       |
| Rural          | 0                            | 10                                 |     |    |           |       |
|                | 1                            | 166                                | 60  | 12 | 7         |       |
|                | 2                            |                                    | 316 | 55 | 107       |       |
|                | 3 or More                    |                                    |     | 70 | 91        |       |
|                | Total                        |                                    |     |    |           | 894   |
| Suburban/Urban | 0                            | 78                                 |     |    |           |       |
|                | 1                            | 236                                | 104 | 20 | 20        |       |
|                | 2                            |                                    | 319 | 81 | 114       |       |
|                | 3 or More                    |                                    |     | 50 | 62        |       |
|                | Total                        |                                    |     |    |           | 1,084 |
| City Center    | 0                            | 251                                | 143 |    |           |       |
|                | 1                            | 315                                | 131 | 41 | 28        |       |
|                | 2                            |                                    | 162 | 33 | 27        |       |
|                | 3 or More                    |                                    |     | 9  | 13        |       |
|                | Total                        |                                    |     |    |           | 1,153 |
| Grand Total    |                              |                                    |     |    |           | 3,131 |

## Survey Methodology and Weighting

The survey contractor obtained a list-assisted, random-digit-dialing (LA-RDD) list of telephone numbers to increase the likelihood of dialing household residences. Household telephone numbers were then matched to street address in order to mail a pre-contact letter. Each selected household was contacted twice. The first contact was used to recruit the household, collect household level information and assign a travel day. The household was later contacted after the assigned travel day to obtain trip information for each person in the household.

The contractor also assigned weights to the survey records. Weighting the survey data enables the data to be representative of the Baltimore region adjusting for circumstances that may introduce a bias into the resulting analyses. Separate weights are assigned at the household level, person level, and trip level using known Census 2000 population distributions.

Greater detail describing the methodology and procedures used can be found in *Travel Survey Add-On Program: Baltimore Regional Transportation Board Final Report and Data Codebook*, Battelle and MORPACE International, (October 2002).

## **Survey Clean UP**

Upon receiving the survey data, BMC staff began the process of reviewing the data looking for inconsistencies. The geocoded location (the contractor performed geocoding of all addresses) of the 3,464 captured households was mapped checking for general coverage and verification of location. During this review, 37 households were found to be geocoded incorrectly and/or assigned to the wrong jurisdiction based on geocoded location. The problem of Baltimore City and Baltimore County being interchanged and also Howard and Harford, which either sound similar or coded incorrectly were observed. These records were corrected by BMC staff and forwarded to the contractor to be considered in developing new weights. Exhibit 1 displays a geographic distribution of the surveyed households within the Baltimore region.

The contractor re-weighted the entire dataset and provided, at the request of BMC staff, a new set of estimated weights considering only the weekday observations for further analysis. An average weekday calculation for the Baltimore region will be useful in getting benchmark data on total number of trips and miles traveled.

## **Allocation for Destinations**

Being satisfied with a reasonable distribution of households, BMC staff began the process of reviewing the captured travel days. The NHTS methodology captured the destination of the reported trips. For transportation purposes, the previous destination becomes the next trip's origin. For the first reported trip, the origin would be the household, unless the trip started from some other location other than home, which was identified on the survey record.

In the Baltimore sample, 346 persons began their travel day from some other location other than home. For these persons, the survey did ask and categorized why the trip began somewhere else, but did not capture the address of this location. These records were reviewed in hopes of identifying that location. For some records the process was straight forward, since the respondent reported traveling home from work as the response "why start somewhere else." The work location, which was captured during the person interview, was used as the origin for these trips. The first trip location was also identified using the entire day's travel and reported times between trip interchanges, hoping the location of the first trip was visited later in the day. Reviewing the activity of other household members also was used in the identification of the first trip location. This technique seems to work best when adult members in the household picked up younger members at the non-home location.

Finally, the reported travel time of the first trip was used. When the travel time exceeded that of a possible trip within the region, the location was presumed to be outside the region. This worked best when the first destination within the region was BWI airport.

The next step was to review the individual geocoding of destinations. Geocoding was categorized into four groupings: 1) street level, 2) intersection, 3) ZIP code, and 4) non-geocodable. Locations that were categorized as non-geocodable and ZIP code were reviewed first. Using captured information on the trip record of address, cross street, zip, trip name (sometimes containing the name of the business such as Home Depot or McDonalds or generic

terms such as mall or shopping center), local knowledge was used to identify these locations. For specific business names, the internet was a valuable resource.

The final test for the accuracy of geocoding was reviewing records that have a large difference in absolute and percent difference between reported time and travel model skim time (computer estimate of elapsed time between origin and destination TAZ) between interchanges. To determine the extent of further geocoding clean up activities, the first 100 records, where simulated time differed from reported time, were reviewed. In almost all cases, the geocoding appeared to be accurate and either an error in reported time or perception was believed to be the problem. Since only a few records required a revised geocoded location and the amount of time required to review each flagged record, staff decided to proceed with the geocoded records as is.

During some initial tabulation of trips by purpose using the captured field of "why trip," staff observed a larger than expected number of school trips. A quick investigation into this purpose identified several school trips reported by household members above the age of 18. Reviewing the entire household record with a greater than 18 years of age school trip, it was determined that many of these older age school trips were dropping off or picking up a school age child within the household. It was also observed that "why trip" was categorized into groupings of "general" and "specific." An example is: shopping/errands are generally reported with a code "040," but also, more specifically, reported with code "041" (buy goods), or "042" (buy services), or "043" (buy gas). In discussions with the survey consultant, it appeared that probing for specific trip purposes was not accomplished and respondents' purposes were developed from characterizing what was reported. A destination of school got recorded as a school trip. Another example is: several persons responded that their destination was a bank; they were generally characterized as "060" (family personal business/obligations), but, potentially, they were making banking trips to deposit or withdraw money and should be categorized at "042" (buy services).

It was felt that correct classification of the trip was important. As reported previously, the name of the destination was captured. Using this information along with the age of the respondent, time of the trip, and records from all members within a household, the classification of the trip purposes was reviewed, updated, and ready for analysis.

## Trip Linking

Travel surveys can capture numerous segments of a respondent's daily travel activity that are not traditionally considered as travel demand analysis. Trip legs of serving passenger, stopping for gas, and changing means of travel were considered a potential portion of overall trips that should be linked together. For travel demand analysis, the final destination is considered the main reason for the trip and intervening stops along the way for these specific purposes should be linked together. For example, traveling from home to work, stopping for gas is converted from two reported trips (home-gas, gas-work) to one trip of home to work.

Linking stopping for gas was the simplest of the three types. A Visual Basic (VB) script was developed that linked the two trips into one. Various fields associated with the origin of the first reported trip were maintained for the origin of the linked trip and likewise fields associated with the destination of the second trip were maintained for the destination of the linked trip. The only

exception to linking the trip of stop for gas was for the few trips that started at home, went to the gas station and returned home. Linking of this type of activity would result in a trip from home to home, so the two trips were maintained and classified as buy goods.

The purpose of serving passenger required a few more criteria in the linking process. Some serve passenger is treated similarly to stop for gas. Traveling from home to pick up someone and continuing to work was linked. For trips that served passenger and started and ended at the same place (i.e., traveling from home to the airport and back home) were not linked. Serving the passenger was the purpose and not a leg in the overall trip. There are also serve passenger trips where a household member reported taking and waiting. This type of serve passenger was not linked. Trips that were made to serve a passenger where someone was picked up and dropped off before the trip traveler's final destination was maintained. The best example of this was a reported trip from home to pick up their mother who was dropped off at the beauty salon before the final destination of work. This complex trip was maintained.

Change means of transportation was also evaluated for potential linking. In the region's previous travel survey, the various legs completed by different modes were captured as individual trips. For example, traveling from home to the bus stop was a trip and traveling from the bus stop by transit to work was a separate trip. In the 2001 survey, most of the trip linking for change means of travel has been accomplished and noted. Each respondent was asked first if transit was used during any portion of their travel day. If transit had been used during the course of the day, the respondent was asked if transit was used during each reported trip. When the answer was "yes," up to five different access and egress modes were recorded for that particular trip. The trip linking for change means of transportation that used transit had already been accomplished. Change means of travel where transit was not used (i.e., traveling to a park and ride lot and car pooling to work) was linked. A similar process was used as stop for gas. The only difference being a hierarchy (mass transit (rail, express bus, local bus)), auto (driver, passenger), non-motorized was used in selecting the final mode for the linked trip. A handful of the change means of transportation trips were linked together not using the VB script. These trips were linked individually with some investigating since an unusual mode was involved, usually a boat or airplane.

The original database contained 28,881 individual trips and after linking for serving passengers, stopping for gas, and changing means of travel, the travel day database was reduced to 27,364 person trips. Reporting of trip behavior in the remainder of this document will consider the linked reported database.

**EXHIBIT 1**  
**General Location of Surveyed Households**





## **Analysis of Collected Data**

The collected information from participating households is divided into four separate databases as follows:

- Person – consisting of information such as age, sex, and occupation of individuals within sampled households.
- Household – data such as type of unit, number of persons, and employed persons.
- Vehicle – information on the make, model, and annual miles driven of each motorized vehicle available in the household.
- Travel day – details on the trip activities of the various members of the household and information on the mode, purpose, and time of the reported trips.

Analysis of these datasets will be used to understand travel characteristics of individuals within the Baltimore region. It is hoped that relationships between person and household characteristics can be developed to explain travel choices. Developed statistically established relationships will then be applied to projections of potential future person and household characteristics in order to plan for transportation needs.

The reported analysis of the existing database will proceed using person and household characteristics already established and emerging relationships reported previously in the Baltimore region and other urban areas.

### ***Household Characteristics***

Characteristics of individual households can help determine transportation choices, number of trips, travel patterns and time of day available to individuals within the household. Location of the household might influence the modes available to the household or the availability of the non-motorized network and the proximity to shopping or other activities. The family structure of the household of having a presence of children or workers can determine the type, number, and when trips are made. The household income and availability of motorized vehicles also helps understand the choice made by the individuals in the household.

### ***Household Size***

The number of individuals in the household has been used previously to estimate average household generated motorized person/person trips. Larger households tend to make greater number of motorized person/person trips on average per household than smaller households. However, smaller households tend to generate greater number of trips per person on average. This difference is most likely due to difference in family structure with larger households potentially having the presence of additional workers or children. The average household size in the Baltimore region has been decreasing as captured in previous surveys and the Decennial Census. Table 4 contains the average household size captured in the 2001 NHTS survey compared to the 2000 Census. The average household size for the Baltimore region from 1980 to present is also displayed.

**TABLE 4**  
**Baltimore Region Persons per Household**  
**(Persons per Household)**

|  |                        | 2001<br>NHTS | 2000<br>Census |
|--|------------------------|--------------|----------------|
|  | Baltimore City         | 2.50         | 2.43           |
|  | Anne Arundel County    | 2.81         | 2.65           |
|  | Baltimore County       | 2.54         | 2.41           |
|  | Carroll County         | 2.79         | 2.82           |
|  | Harford County         | 2.64         | 2.71           |
|  | Howard County          | 2.73         | 2.71           |
|  |                        |              |                |
|  | Baltimore Region       | 2.62         | 2.54           |
|  |                        |              |                |
|  | Inside Baltimore City  | 2.50         | 2.43           |
|  | Outside Baltimore City | 2.66         | 2.59           |

|  |                  | 1970<br>Census | 1980<br>Census | 1990<br>Census | 1993<br>HTS | 2000<br>Census | 2001<br>NHTS |
|--|------------------|----------------|----------------|----------------|-------------|----------------|--------------|
|  | Baltimore Region | 3.22           | 2.80           | 2.64           | 2.64        | 2.54           | 2.62         |

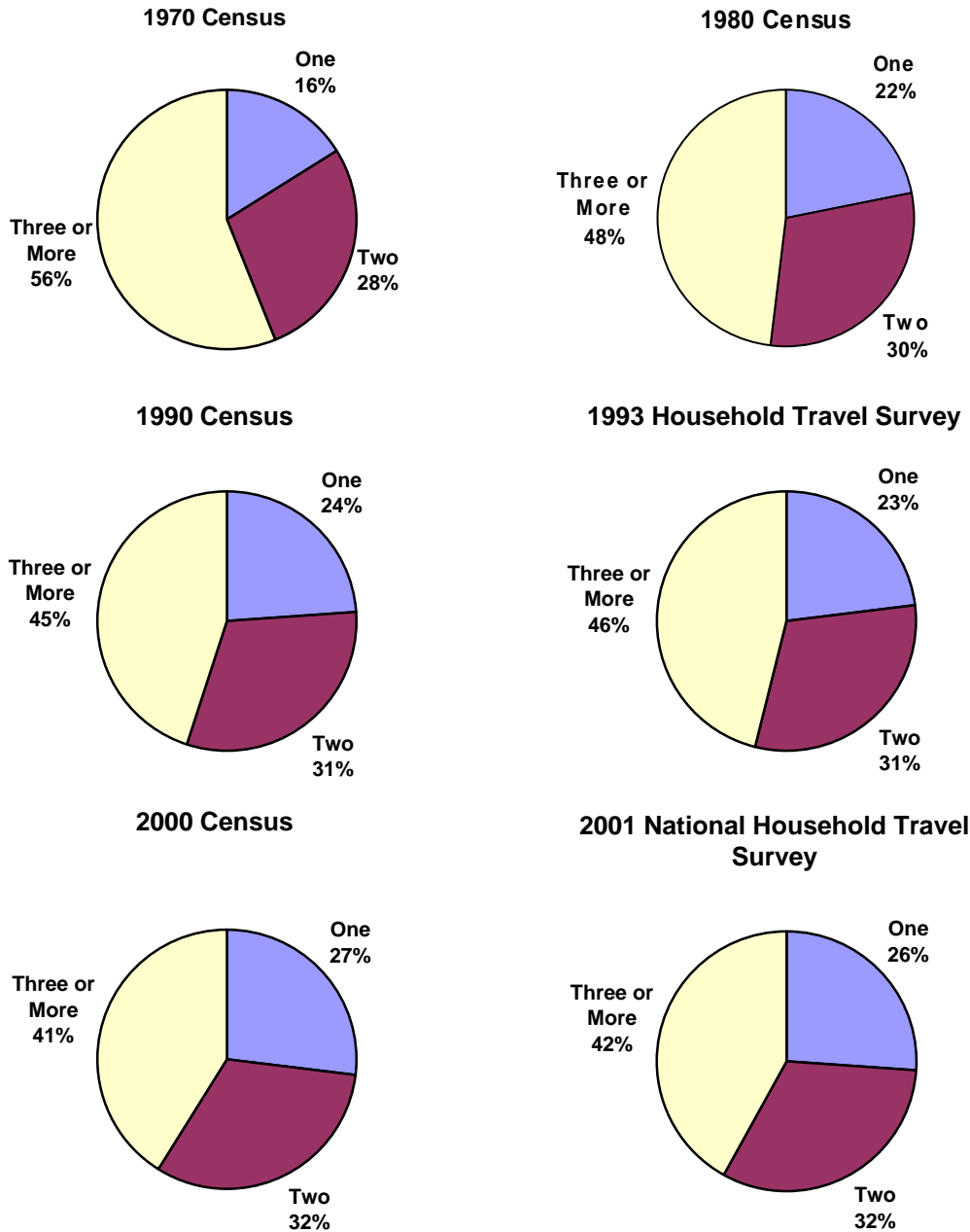
The 2001 NHTS approximates the estimates from the 2000 Census. The difference at the jurisdiction level is due to the small sample size in suburban jurisdictions (the post-stratification weighted households inside/outside Baltimore City) and the representation of larger households grouped in the four plus household category.

The share of households by size from 1970 to present using Census and household survey data is displayed in Exhibit 2. The share of single household members is increasing, which is reflected in the average persons per household displayed in the previous table. According to Census information, single person households from 1970 through 2000 are growing the fastest. By the year 2000, slightly greater than 40 percent of the households have three or more persons.

Using the linked reported trips, discussed above, average trip rates by household size were estimated and are contained in Table 5. Due to sample size, household rates at the jurisdiction level outside the City of Baltimore should be used with caution. The average trip rate per household for these is more accurately displayed on the row "Outside the City." The first group of rates shown in Table 5 is for linked motorized person trips and the second group is the average trip rate considering adding motorized and non-motorized modes (walking, bicycle).



## EXHIBIT 2 Share of Households by Size



Households with a greater number of persons generate a greater number of trips on average. There is also a difference between the number of motorized trips per household between households located inside/outside the City. Other household characteristics, such as vehicles available, could help explain the difference. Households shown as “Inside City” are also generating a greater number of non-motorized trips ( $6.72 - 5.32 = 1.39$ ) compared to households

“Outside City” (9.09-8.42=0.67). Once again, other household characteristics or the environment of the household location could help explain these differences.

**TABLE 5**  
**Household Trip Rates\***

|                     | Vehicle Trips (Motorized)                  |      |       |              |       |
|---------------------|--|------|-------|--------------|-------|
|                     | One  | Two  | Three | Four or More | Total |
| Baltimore City      | 2.41                                       | 5.45 | 6.82  | 10.02        | 5.32  |
| Anne Arundel County | 3.13                                       | 6.84 | 10.40 | 14.65        | 8.88  |
| Baltimore County    | 2.92                                       | 6.63 | 9.23  | 13.56        | 7.83  |
| Carroll County      | 3.05                                       | 6.66 | 10.91 | 14.67        | 9.23  |
| Harford County      | 3.07                                       | 6.72 | 10.74 | 12.57        | 8.39  |
| Howard County       | 4.38                                       | 7.40 | 9.16  | 15.43        | 9.07  |
|                     |  |      |       |              |       |
| Inside City         | 2.41                                       | 5.45 | 6.82  | 10.02        | 5.32  |
| Outside City        | 3.17                                       | 6.77 | 9.78  | 14.03        | 8.42  |
|                     |  |      |       |              |       |
| Baltimore Region    | 2.88                                       | 6.45 | 9.14  | 13.19        | 7.59  |
|                     |  |      |       |              |       |
|                     |  |      |       |              |       |
|                     | Person Trips (Motorized and Non-Motorized) |      |       |              |       |
|                     | One  | Two  | Three | Four or More | Total |
| Baltimore City      | 3.04                                       | 6.64 | 8.15  | 13.36        | 6.72  |
| Anne Arundel County | 3.43                                       | 7.48 | 10.81 | 16.53        | 9.77  |
| Baltimore County    | 3.26                                       | 6.98 | 10.42 | 14.51        | 8.48  |
| Carroll County      | 3.16                                       | 6.86 | 11.52 | 15.53        | 9.70  |
| Harford County      | 3.29                                       | 7.05 | 11.35 | 13.60        | 8.94  |
| Howard County       | 4.42                                       | 7.75 | 9.73  | 16.52        | 9.58  |
|                     |  |      |       |              |       |
| Inside City         | 3.04                                       | 6.64 | 8.15  | 13.36        | 6.72  |
| Outside City        | 3.44                                       | 7.18 | 10.60 | 15.26        | 9.09  |
|                     |  |      |       |              |       |
| Baltimore Region    | 3.28                                       | 7.05 | 10.07 | 14.87        | 8.45  |

\*Data are not significant, given the sample size, at the jurisdictional level.

### ***Vehicle Availability and Licensed Drivers***

Vehicle availability has in the past influenced the number of trips generated and the mode of travel within a household. In previous decades, the region has seen dramatic changes in number of vehicles available. The average number of vehicles available per household located inside and outside Baltimore City for the 1990 and 2000 Census along with the 2001 survey is contained in Table 6. Census data show a slight increase on average within Baltimore City and a slight decrease in suburban jurisdictions. The regionwide survey data match that which was observed in the 2000 Census. However, it should be noted that the survey data do have a limited

number of observations for households with zero vehicles available. Also, a high number of vehicles available, especially in the suburban jurisdictions, might explain the difference.

The share of households located inside Baltimore City and outside Baltimore City with zero, one, two, and three or more vehicles available from 1990 and 2000 Census along with the 2001 survey is displayed in Exhibit 3. The decennial Census shows a slight decrease in the share of zero vehicle households located within Baltimore City and a slight decrease in the share of multi-vehicle households located in suburban jurisdictions. The 2001 survey does show a similar distribution of households with vehicles available compared to that observed in the 2000 Census for inside and outside Baltimore City.

The reduction in suburban jurisdiction totals in the average number of vehicles available and the share of multi-vehicle households may be a result of decreasing household size.

**TABLE 6**  
**Vehicle Availability per Household**

|                        | 1990 Census | 2000 Census | 2001 NHTS |
|------------------------|-------------|-------------|-----------|
| Inside Baltimore City  | 0.93        | 0.95        | 0.89      |
|                        |             |             |           |
| Outside Baltimore City | 1.87        | 1.82        | 1.86      |
|                        |             |             |           |
| Baltimore Region       | 1.57        | 1.59        | 1.60      |

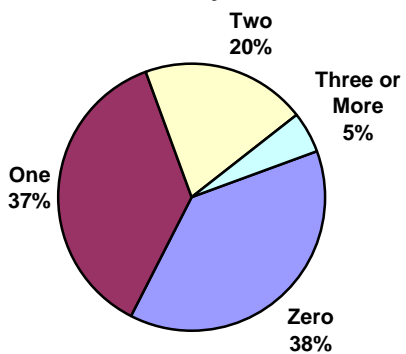
Average trip rates were estimated for inside Baltimore City and the suburban jurisdictions stratified by household vehicle availability and displayed in Table 7. As expected, trip rates increase with a greater number of household vehicle availability.

In addition to the number of vehicles available, the number of licensed drivers within a household can influence the amount of motorized person trip making. Table 8 contains the average number of observed licensed drivers within a household. The 2001 NHTS recorded more vehicles per household (1.60) than licensed drivers per household (1.57). A greater number of vehicles per licensed driver is predominant in the suburban jurisdictions, but not within Baltimore City.

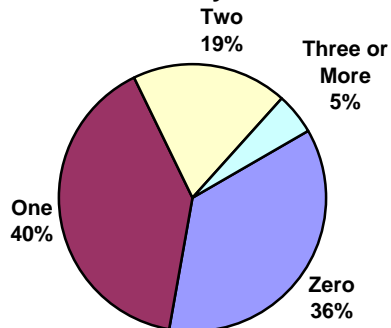
### EXHIBIT 3

#### Share of Households by Vehicle Availability

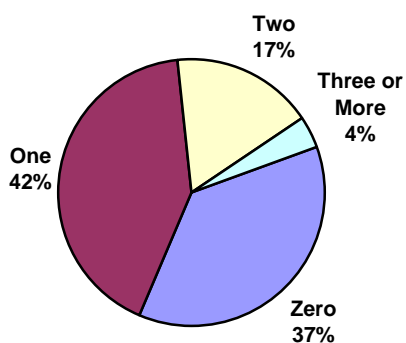
**Inside Baltimore City 1990 Census**



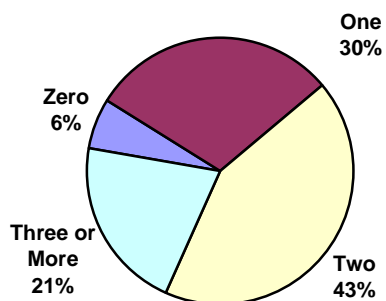
**Inside Baltimore City 2000 Census**



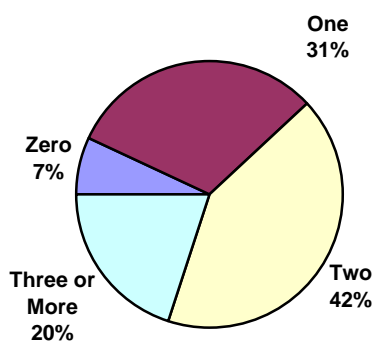
**Inside Baltimore City 2001 NHTS**



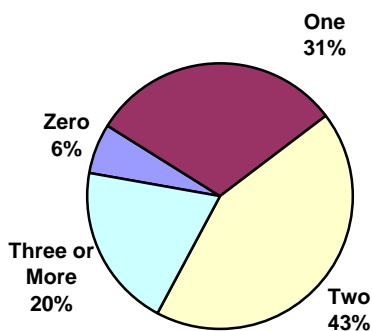
**Outside Baltimore City 1990 Census**



**Outside Baltimore City 2000 Census**



**Outside Baltimore City 2001 NHTS**



**TABLE 7**  
**Household Trip Rates by Vehicle Availability**

|                        | Vehicle Trips (Motorized)                  |      |       |               |       |
|------------------------|--|------|-------|---------------|-------|
|                        | Zero                                       | One  | Two   | Three or More | Total |
| Inside Baltimore City  | 3.31                                       | 5.20 | 8.73  | 10.64         | 5.32  |
| Outside Baltimore City | 3.43                                       | 5.50 | 10.04 | 10.93         | 8.42  |
|                        |  |      |       |               |       |
| Baltimore Region       | 3.35                                       | 5.40 | 9.87  | 10.91         | 7.59  |
|                        |  |      |       |               |       |
|                        | Person Trips (Motorized and Non-Motorized) |      |       |               |       |
|                        | Zero                                       | One  | Two   | Three or More | Total |
| Inside Baltimore City  | 5.01                                       | 6.39 | 9.88  | 12.38         | 6.72  |
| Outside Baltimore City | 5.13                                       | 5.88 | 10.77 | 11.60         | 9.09  |
|                        |  |      |       |               |       |
| Baltimore Region       | 5.05                                       | 6.05 | 10.66 | 11.65         | 8.45  |

**TABLE 8**  
**Licensed Drivers per Household**

|                        | Licensed Drivers |
|------------------------|------------------|
| Inside Baltimore City  | 1.03             |
| Outside Baltimore City | 1.76             |
|                        |                  |
| Baltimore Region       | 1.57             |

The relationship between licensed drivers and vehicle availability within a household could help explain the difference in the number of trips and also the mode. Four categories of households were created from the 2001 NHTS as follows:

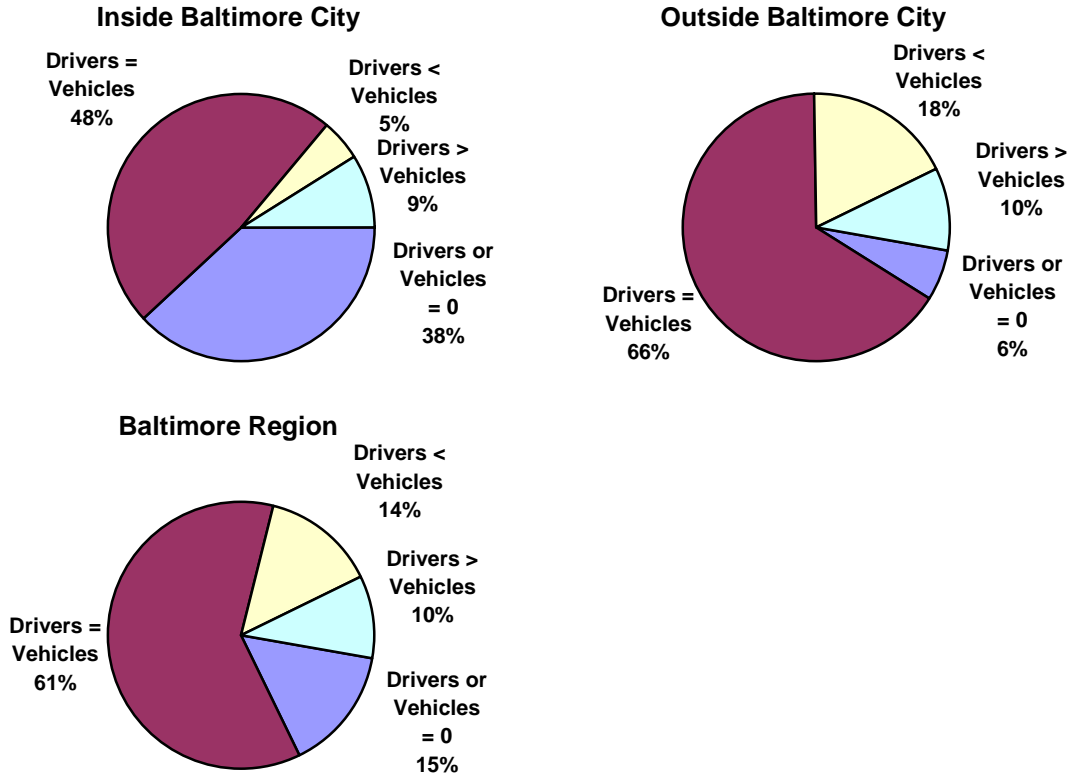
- Households where licensed drivers or vehicles equal zero
- Households where licensed drivers equal vehicles
- Households where licensed drivers were less than vehicles
- Households where licensed drivers were greater than vehicles

The share of households inside Baltimore City, outside Baltimore City, and the Baltimore region within the above categories is displayed on Exhibit 4. Households with zero vehicles or zero licensed drivers are estimated greater than a third of all households in Baltimore City. In the suburban jurisdictions, 84 percent of the households have at least one vehicle for every eligible driver.

Average person and vehicle household trip rates were estimated for vehicle and licensed driver ratio for the geographic area of inside and outside Baltimore City, which is contained in Table 9. Households where vehicles are greater than licensed drivers generate the greatest number of trips. In the previous survey in 1993, it was believed that households with equal number of drivers and vehicles along with households with greater number of vehicles than drivers would behave similarly, since household members can only use one vehicle at a time.

## EXHIBIT 4

### Vehicle Availability and Licensed Drivers Relationship per Household



Potentially, households with a greater number of vehicles have specialized vehicles to perform specific duties (example: a household might have a small vehicle in which to commute, a large SUV to carry all household members, a pickup vehicle to haul goods, and another purpose vehicle), which increases the number of trips generated. Household size could also be influencing the average trip rates and will be explored later.

### ***Household Life Cycle***

Over the course of time, households move from formation, to family, and finally retirement. During the various stages household size changes with the presence of children and household members are a part of the labor force and eventually retire. It is believed that household trip making changes in the number, type, duration, and time period that travel occurs and this changes with life cycle.

The share of households inside and outside Baltimore City with the presence of children, workers and the combination of both is displayed in Table 10. In Baltimore City, households with workers and no children is the plurality with 42.6 percent of all households. Single person

**TABLE 9**  
**Household Trip Rates by Vehicle Availability**

| Inside Baltimore City          | Motorized Trips | Person Trips |
|--------------------------------|-----------------|--------------|
| Vehicles or Drivers Equal Zero | 3.28            | 4.95         |
| Vehicles Equal Drivers         | 6.14            | 7.20         |
| Vehicles Greater Than Drivers  | 8.67            | 9.68         |
| Vehicles Less Than Drivers     | 7.76            | 9.96         |
|                                | 5.32            | 6.72         |
| Outside Baltimore City         |                 |              |
| Vehicles or Drivers Equal Zero | 3.41            | 5.09         |
| Vehicles Equal Drivers         | 8.37            | 8.99         |
| Vehicles Greater Than Drivers  | 9.71            | 10.25        |
| Vehicles Less Than Drivers     | 9.59            | 10.19        |
|                                | 8.42            | 9.09         |
| Baltimore Region               |                 |              |
| Vehicles or Drivers Equal Zero | 3.32            | 4.99         |
| Vehicles Equal Drivers         | 7.91            | 8.62         |
| Vehicles Greater Than Drivers  | 9.62            | 10.20        |
| Vehicles Less Than Drivers     | 9.11            | 10.13        |
|                                | 7.59            | 8.45         |

households inside Baltimore City are 38.1 percent of Table 9 households compared to 22.2 percent in suburban jurisdictions, which explains the high number of childless households. Almost 40 percent of households outside Baltimore City have a presence of a worker and a child, which is slightly greater than households with a worker and no children with 38 percent of all households. Slightly greater than a quarter of households inside Baltimore City have no worker and no child present.

**TABLE 10**  
**Household Life Cycle**

|                        |             |       |           |       |           | no children | children |
|------------------------|-------------|-------|-----------|-------|-----------|-------------|----------|
| Inside Baltimore City  | no children | 69.4% | no worker | 30.7% | no worker | 26.1%       | 4.6%     |
|                        | children    | 30.6% | worker    | 69.3% | worker    | 43.3%       | 26.0%    |
|                        |             |       |           |       |           |             |          |
| Outside Baltimore City | no children | 58.9% | no worker | 22.1% | no worker | 20.7%       | 1.5%     |
|                        | children    | 41.1% | worker    | 77.9% | worker    | 38.2%       | 39.7%    |
|                        |             |       |           |       |           |             |          |
| Baltimore Region       | no children | 61.7% | no worker | 24.5% | no worker | 22.1%       | 2.3%     |
|                        | children    | 38.3% | worker    | 75.5% | worker    | 39.6%       | 36.0%    |

The difference in household life cycle effects on average household trip rate is displayed in Table 11 for motorized person and person trips. The trip rate is almost doubled for households

with a child compared to households without a child and also when household with and without a worker is present. When combining both variables, average trip rate is nearly three times greater when comparing households with a child and worker present with that of households without a child and worker present.

**TABLE 11**  
**Household Life Cycle Trip Rates**

|                           |           | Motorized person |          |       |           | person      |          |       |
|---------------------------|-----------|------------------|----------|-------|-----------|-------------|----------|-------|
|                           |           | no children      | children | total |           | no children | children | total |
| Inside<br>Baltimore City  | no worker | 3.05             | 4.64     | 3.34  | no worker | 3.66        | 5.78     | 4.38  |
|                           | worker    | 4.97             | 8.82     | 6.20  | worker    | 8.41        | 11.06    | 7.75  |
|                           | total     | 4.04             | 8.23     | 5.32  | total     | 4.98        | 10.65    | 6.72  |
| Outside<br>Baltimore City | no worker | 4.68             | 9.07     | 4.97  | no worker | 4.94        | 9.72     | 5.27  |
|                           | worker    | 6.39             | 12.31    | 9.40  | worker    | 6.76        | 13.47    | 10.18 |
|                           | total     | 5.79             | 12.19    | 8.42  | total     | 6.12        | 13.34    | 9.09  |
| Baltimore<br>Region       | no worker | 4.16             | 6.87     | 4.42  | no worker | 4.55        | 9.02     | 4.97  |
|                           | worker    | 5.87             | 11.63    | 8.61  | worker    | 6.47        | 13.00    | 9.58  |
|                           | total     | 5.26             | 11.34    | 7.59  | total     | 5.78        | 12.76    | 8.45  |

## ***Gender and Age***

The gender and age of individuals can influence number of trips. The influence of gender and age has been captured in prior analysis, but has not specifically been studied. Average motorized person and person trip rates are estimated using the linked survey data and displayed in Table 12 for the Baltimore region. On average, females generate slightly greater number of trips than males. Females, ages 40 to 54, generate the greatest number of trips on average, while males, ages 65 to 75, have the highest person trip rate. As expected, the cohort under the age of 16 has the greatest difference between total motorized person and person trips.

## ***Household Size and Vehicle Availability***

The 2001 survey was stratified using household characteristics of size and vehicle availability and land type (City Center, Urban/Suburban, and Rural). These characteristics were chosen based on findings from the 1993 Household Travel Survey and other research linking these variables to household trip generation variation. Table 13 shows the average household linked motorized person and person trip rate for this stratification. Overall, the average rates move in a logical direction of increasing with larger household size and greater vehicle availability. The greatest difference between vehicle and non-motorized average trip rates (person trip minus motorized person trips) is households located in City Center. The land type classifications were developed in 1996 while updating the travel demand model by calculating the number of



**TABLE 12**  
**Baltimore Region Person Trip Generation Rate**  
**by Gender and Age**

| Age      | Motorized Person |        |       | Person |        |       |
|----------|------------------|--------|-------|--------|--------|-------|
|          | Male             | Female | Total | Male   | Female | Total |
| <16      | 2.54             | 2.51   | 2.53  | 3.00   | 2.98   | 2.99  |
| 16 to 24 | 2.62             | 2.84   | 2.73  | 3.01   | 3.08   | 3.04  |
| 25 to 39 | 3.34             | 3.56   | 3.46  | 3.67   | 4.01   | 3.85  |
| 40 to 54 | 3.20             | 3.59   | 3.41  | 3.49   | 4.02   | 3.77  |
| 55 to 64 | 3.36             | 3.28   | 3.31  | 3.60   | 3.47   | 3.52  |
| 65 to 74 | 3.80             | 3.01   | 3.35  | 4.07   | 3.23   | 3.60  |
| 75+      | 2.75             | 1.80   | 2.14  | 2.98   | 1.95   | 2.31  |
| Total    | 3.10             | 3.12   | 3.02  | 3.45   | 3.48   | 3.37  |

dwelling units per acre within a one-mile radius of the TAZ of interest and the classification is being used as a surrogate to obtain TAZs pedestrian friendliness. City Center has the highest number of dwelling units per acre and is believed to have a concentration of characteristics related to non-motorized travel.

**TABLE 13**  
**Baltimore Region Motorized Person and Person Trip Generation Rates**  
**by Household Size and Vehicle Availability**

|                  | HHSIZE/Vehicles | 0            | 1             | 2             | 3+            | Total       |
|------------------|-----------------|--------------|---------------|---------------|---------------|-------------|
| City Center      | 1               | 1.71 / 2.68  | 3.04 / 4.09   | 4.11 / 5.09   | 3.00 / 3.00   |             |
|                  | 2               | 2.84 / 5.16  | 5.41 / 7.02   | 6.12 / 7.98   | 7.39 / 9.35   |             |
|                  | 3               | 4.50 / 7.15  | 8.16 / 10.15  | 9.15 / 12.01  | 9.50 / 10.75  |             |
|                  | 4+              | 5.09 / 11.19 | 8.15 / 12.23  | 10.58 / 13.08 | 10.12 / 12.19 | 4.21 / 6.20 |
| Suburban/Urban   | HHSIZE/Vehicles | 0            | 1             | 2             | 3+            | Total       |
|                  | 1               | 1.36 / 2.07  | 3.39 / 3.58   | 4.37 / 4.64   | 3.49 / 3.72   |             |
|                  | 2               | 3.54 / 5.01  | 6.65 / 7.12   | 7.22 / 7.66   | 7.68 / 7.97   |             |
|                  | 3               | 7.02 / 9.68  | 7.99 / 8.53   | 9.14 / 9.70   | 9.57 / 10.59  |             |
|                  | 4+              | 8.56 / 11.15 | 10.28 / 13.14 | 13.93 / 15.32 | 14.58 / 15.85 | 7.56 / 8.37 |
| Rural            | HHSIZE/Vehicles | 0            | 1             | 2             | 3+            | Total       |
|                  | 1               | 1.31 / 1.72  | 3.38 / 3.55   | 3.24 / 3.28   | 4.60 / 4.68   |             |
|                  | 2               | 1.00 / 1.33  | 5.24 / 5.86   | 6.83 / 7.17   | 6.04 / 6.35   |             |
|                  | 3               | 4.00 / 18.00 | 10.43 / 10.96 | 10.33 / 10.86 | 11.45 / 11.73 |             |
|                  | 4+              | NA / NA      | 14.86 / 16.29 | 15.30 / 16.44 | 14.31 / 14.98 | 9.01 / 9.59 |
| Baltimore Region | HHSIZE/Vehicles | 0            | 1             | 2             | 3+            | Total       |
|                  | 1               | 1.47 / 2.25  | 3.36 / 3.62   | 4.01 / 4.26   | 3.80 / 3.99   |             |
|                  | 2               | 3.25 / 4.89  | 6.30 / 6.90   | 7.08 / 7.54   | 7.07 / 7.39   |             |
|                  | 3               | 6.15 / 9.38  | 8.46 / 9.17   | 9.40 / 10.02  | 10.23 / 11.00 |             |
|                  | 4+              | 7.53 / 11.16 | 10.61 / 13.43 | 14.25 / 15.60 | 14.43 / 15.48 | 7.59 / 8.45 |

## **Travel Characteristics**

The captured travel information can be analyzed looking at the reasons for travel (work, shopping, recreation), choice of mode (vehicle, transit, walk), distance, and time period of travel.

### ***Trip Purpose***

Using the definitions used in travel demand modeling, captured trip information was categorized into six trip purposes as follows:

1. Home-Based Work (HBW)
2. Home-Based Shop (HBSh)
3. Home-Based Other (HBO)
4. Home-Based School (HBSch)
5. Work Based Other (WBO)
6. Other Based Other (OBO)

The trip purpose classification was determined looking at the origin and destination reported reason for travel. For example, traveling from home to buy goods was classified as Home-Based Shop (HBSh). Totals for linked person motorized and person trips with at least one end within the Baltimore model region are displayed in Exhibit 5 and Exhibit 6, respectfully. For households inside and outside Baltimore City, around 20 percent of household motorized person trips are for the purpose of work (HBW) and motorized person trips traveling to other locations (recreation, visiting family/friends) and shopping are around 50 percent of household trips. Considering motorized and non-motorized modes of travel, households within Baltimore City have 19 percent of their travel related to work (HBW), while outside Baltimore City, households have 18 percent of their travel for the purpose of work (HBW). Shopping and other home-based person trips again make up around half of the reasons for traveling for both households inside and outside Baltimore City.

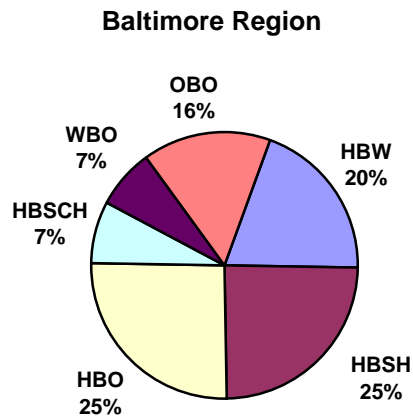
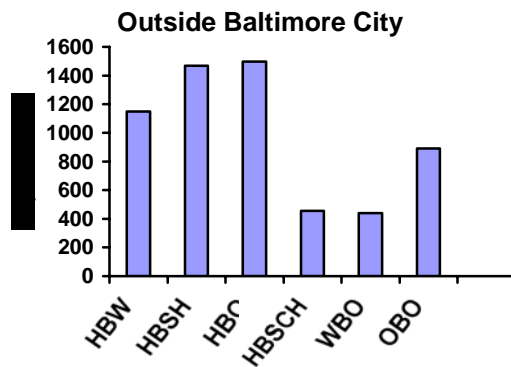
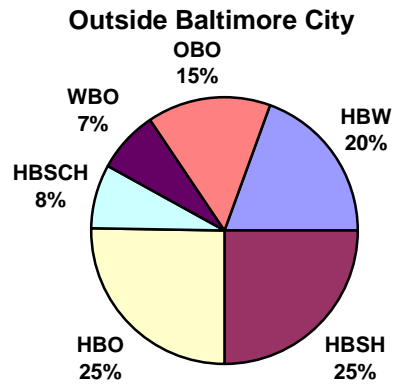
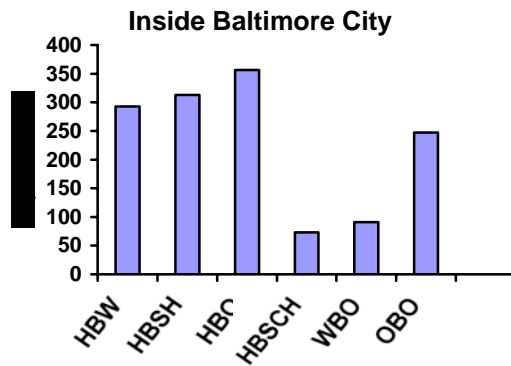
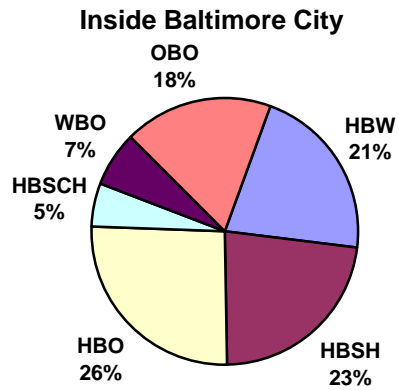
The decrease in share of HBW trips has been a phenomenon observed in the previous Baltimore and other regional/national databases. Some of the decreasing share of HBW trips is a result of the definitions adopted in the 1960's with the development of travel demand forecasting. Shares are also decreasing as non-work related activities have grown (video stores, gyms, specialty shops) and travelers link/chain trip activities together.

### ***Vehicle Miles of Travel and Travel Time***

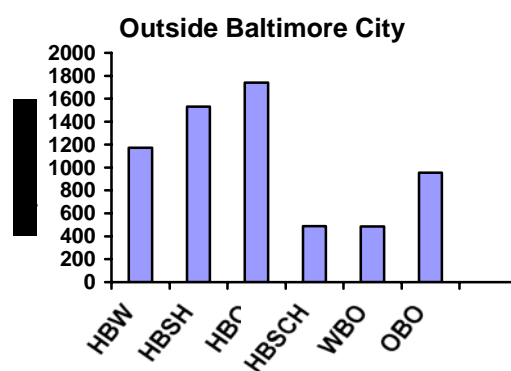
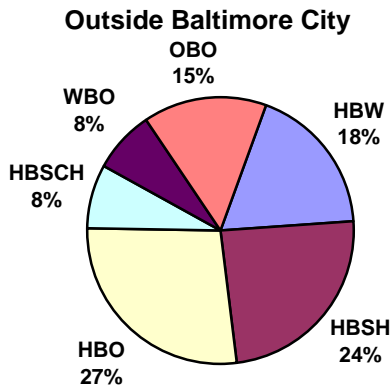
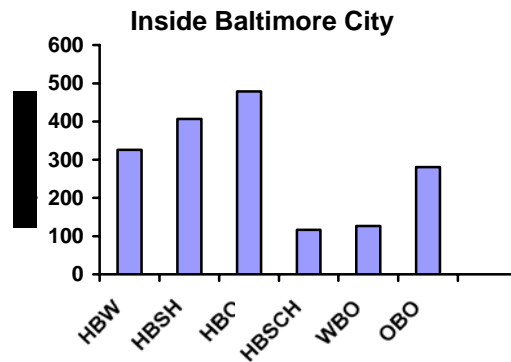
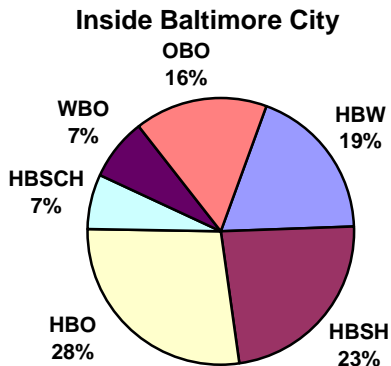
Combining information from the travel survey using the geocoded origin and destination with simulated travel time and distance from the 2000 travel demand model, estimates of Vehicle Miles of Travel (VMT) and travel time can be made for households, persons and purpose. The estimated highway travel time was calculated using the initial skim of an unassigned highway network including terminal and intrazonal times. The estimated distance is the accumulation of link distance over the minimum path (time). Trips either ending or starting outside the model region were assigned from a range of the most probable external station based on the shortest in travel time from either the origin or destination within the region. For example, if a trip was reported to start in Towson and destined to somewhere in Pennsylvania, the external

## EXHIBIT 5

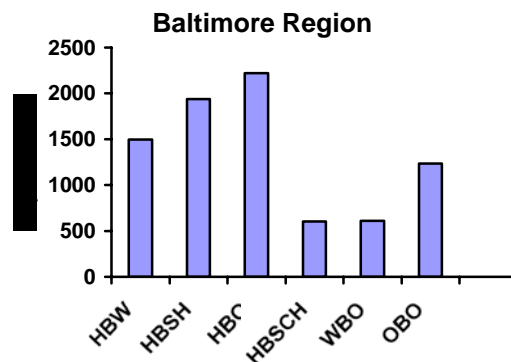
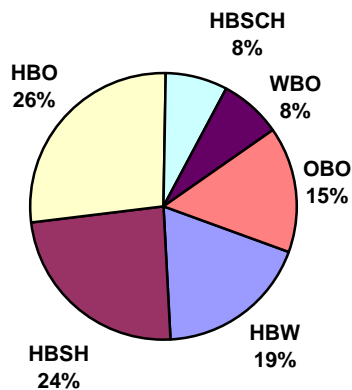
### Motorized Person Trips by Purpose



## EXHIBIT 6 Person Trips by Purpose



### Baltimore Region



station with the shortest travel time from Towson among the external stations along the Maryland/Pennsylvania boarder was chosen.

Because trip lengths vary based on trip purpose, the share of household trip miles and time by purpose can be different from shares by purpose only. As an example, the average trip length for motorized person HBW trips with at least one end within the model region has an estimated trip length of 13.71 miles. The average trip length of all motorized trips is estimated at 8.16 miles.

The average trip length for households inside/outside Baltimore City for motorized person trips by purpose per household, person, and trip is displayed on Table 14. Households outside Baltimore City travel over 2 times more miles during a weekday than households inside Baltimore City. Around a third of all motorized person miles is attributed to traveling for the purpose of work to/from home. A little less than 50 percent of the travel in miles is for shopping or other purposes. On average, HBW travel is 13.71 miles. The next highest average trip length is for WBO with an average of 9.36 miles. This apparently long distance could be the result of chaining of trip purposes with the traditional home to work commute. For example, stopping at the video rental on the way home from work is captured as a WBO trip to the video rental store and a HBSH for the remaining portion to home.

Adding the non motorized modes of travel and accumulating the miles for person trips by purpose, per household, person, and trip is displayed on Table 15. At the jurisdiction level, households located inside Baltimore City travel over 2 miles for non-motorized travel compared to households located outside Baltimore City that only travel 1 mile on average. As may be expected, shopping and traveling by households inside Baltimore City have the greatest amount of miles for non-motorized travel. Shopping trips are one mile on average longer for person trips compared to motorized person trips for households inside Baltimore City.

The average amount of travel time can also be estimated using initial highway skim including terminal and intra zonal travel times (Tables 16 and 17). As with VMT, total average travel time can be accumulated by purpose, for households, persons, and trips. Comparing accumulated travel time with miles, little difference exists in the portions by purpose. Slightly less than 30 percent of a households travel is for the purpose of HBW. Households inside Baltimore City spend one hour and 10 minutes on average for motorized person trips, while households outside Baltimore City spend 2 hours and 4 minutes on average. Comparing motorized person trips with that of total person trips, households inside Baltimore City have almost 10 minutes of non-motorized travel on average, while outside Baltimore City the non-motorized travel is not quite 4 minutes.

Average travel speed can be calculated with the estimated average travel distances and time. Average miles per hour (MPH) are displayed on Table 18 for households inside and outside Baltimore City. As expected, travel related to work activity have a longer travel distance. Households in Baltimore City have lower speeds on average about 8 MPH per trip.

**TABLE 14**  
**Baltimore Region Motorized Person Vehicle Miles of Travel (VMT)**  
**Per Household, Person, and Trip**

| Per Household          | HBW   | HBSH  | HBO   | HBSCH | WBO  | OBO  | All Trips |
|------------------------|-------|-------|-------|-------|------|------|-----------|
| Inside Baltimore City  | 10.87 | 5.64  | 6.66  | 1.10  | 2.91 | 5.22 | 32.39     |
| Outside Baltimore City | 24.20 | 12.89 | 18.22 | 3.61  | 6.01 | 7.84 | 72.76     |
| Baltimore Region       | 20.62 | 10.94 | 15.11 | 2.93  | 5.17 | 7.13 | 61.90     |
|                        |       |       |       |       |      |      |           |
| Per Person             | HBW   | HBSH  | HBO   | HBSCH | WBO  | OBO  | All Trips |
| Inside Baltimore City  | 4.90  | 2.54  | 3.00  | 0.49  | 1.31 | 2.35 | 14.60     |
| Outside Baltimore City | 9.34  | 4.98  | 7.03  | 1.39  | 2.32 | 3.03 | 28.09     |
| Baltimore Region       | 8.28  | 4.39  | 6.07  | 1.18  | 2.08 | 2.86 | 24.86     |
|                        |       |       |       |       |      |      |           |
| Per Trip               | HBW   | HBSH  | HBO   | HBSCH | WBO  | OBO  | All Trips |
| Inside Baltimore City  | 9.58  | 4.65  | 4.82  | 3.86  | 8.24 | 5.45 | 6.08      |
| Outside Baltimore City | 14.77 | 6.15  | 8.52  | 5.54  | 9.60 | 6.16 | 8.64      |
| Baltimore Region       | 13.71 | 5.89  | 7.81  | 5.31  | 9.36 | 6.01 | 8.16      |

**TABLE 15**  
**Baltimore Region Person Vehicle Miles of Travel (VMT)**  
**Per Household, Person, and Trip**

| Per Household          | HBW   | HBSH  | HBO   | HBSCH | WBO  | OBO  | All Trips |
|------------------------|-------|-------|-------|-------|------|------|-----------|
| Inside Baltimore City  | 11.05 | 6.66  | 7.20  | 1.26  | 3.03 | 5.35 | 34.55     |
| Outside Baltimore City | 24.47 | 13.02 | 18.65 | 3.67  | 6.10 | 7.96 | 73.87     |
| Baltimore Region       | 20.86 | 11.31 | 15.57 | 3.02  | 5.27 | 7.25 | 63.29     |
|                        |       |       |       |       |      |      |           |
| Per Person             | HBW   | HBSH  | HBO   | HBSCH | WBO  | OBO  | All Trips |
| Inside Baltimore City  | 4.98  | 3.00  | 3.24  | 0.57  | 1.36 | 2.41 | 15.57     |
| Outside Baltimore City | 9.45  | 5.03  | 7.20  | 1.42  | 2.35 | 3.07 | 28.52     |
| Baltimore Region       | 8.38  | 4.54  | 6.25  | 1.21  | 2.12 | 2.91 | 25.41     |
|                        |       |       |       |       |      |      |           |
| Per Trip               | HBW   | HBSH  | HBO   | HBSCH | WBO  | OBO  | All Trips |
| Inside Baltimore City  | 8.76  | 4.23  | 3.88  | 2.80  | 6.19 | 4.93 | 5.14      |
| Outside Baltimore City | 14.63 | 5.96  | 7.50  | 5.27  | 8.83 | 5.84 | 8.12      |
| Baltimore Region       | 13.36 | 5.60  | 6.72  | 4.80  | 8.28 | 5.63 | 7.49      |

**TABLE 16**  
**Baltimore Region Motorized Person Travel Time (Minutes)**  
**Per Household, Person, and Trip**

| Per Household          | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
|------------------------|-------|-------|-------|-------|-------|-------|-----------|
| Inside Baltimore City  | 20.80 | 13.73 | 16.60 | 2.96  | 5.54  | 11.66 | 71.28     |
| Outside Baltimore City | 36.47 | 24.55 | 31.61 | 7.17  | 9.83  | 14.60 | 124.24    |
| Baltimore Region       | 32.26 | 21.64 | 27.57 | 6.04  | 8.68  | 13.81 | 109.99    |
|                        |       |       |       |       |       |       |           |
| Per Person             | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
| Inside Baltimore City  | 9.38  | 6.19  | 7.48  | 1.34  | 2.50  | 5.26  | 32.14     |
| Outside Baltimore City | 14.08 | 9.48  | 12.20 | 2.77  | 3.80  | 5.64  | 47.96     |
| Baltimore Region       | 12.95 | 8.69  | 11.07 | 2.42  | 3.48  | 5.55  | 44.17     |
|                        |       |       |       |       |       |       |           |
| Per Trip               | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
| Inside Baltimore City  | 18.33 | 11.32 | 12.01 | 10.43 | 15.70 | 12.18 | 13.39     |
| Outside Baltimore City | 22.25 | 11.71 | 14.79 | 11.01 | 15.71 | 11.48 | 14.75     |
| Baltimore Region       | 21.46 | 11.64 | 14.26 | 10.93 | 15.71 | 11.63 | 14.49     |

**TABLE 17**  
**Baltimore Region Person Travel Time (Minutes)**  
**Per Household, Person, and Trip**

| Per Household          | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
|------------------------|-------|-------|-------|-------|-------|-------|-----------|
| Inside Baltimore City  | 21.74 | 16.57 | 19.41 | 3.90  | 6.91  | 12.68 | 81.21     |
| Outside Baltimore City | 36.90 | 25.01 | 33.40 | 7.42  | 10.37 | 15.10 | 128.21    |
| Baltimore Region       | 32.82 | 22.74 | 29.64 | 6.47  | 9.44  | 14.45 | 115.56    |
|                        |       |       |       |       |       |       |           |
| Per Person             | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
| Inside Baltimore City  | 9.80  | 7.47  | 8.75  | 1.76  | 3.11  | 5.72  | 36.61     |
| Outside Baltimore City | 14.24 | 9.66  | 12.89 | 2.86  | 4.01  | 5.83  | 49.50     |
| Baltimore Region       | 13.18 | 9.13  | 11.90 | 2.60  | 3.79  | 5.80  | 46.41     |
|                        |       |       |       |       |       |       |           |
| Per Trip               | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
| Inside Baltimore City  | 17.25 | 10.51 | 10.47 | 8.64  | 14.12 | 11.69 | 12.09     |
| Outside Baltimore City | 22.06 | 11.45 | 13.44 | 10.66 | 15.02 | 11.08 | 14.10     |
| Baltimore Region       | 21.02 | 11.26 | 12.80 | 10.27 | 14.84 | 11.22 | 13.67     |

**TABLE 18**  
**Baltimore Region Motorized Person Miles Per Hour**  
**Per Trip**

| MPH                    | HBW   | HBSH  | HBO   | HBSCH | WBO   | OBO   | All Trips |
|------------------------|-------|-------|-------|-------|-------|-------|-----------|
| Inside Baltimore City  | 31.35 | 24.66 | 24.08 | 22.23 | 31.50 | 26.87 | 27.27     |
| Outside Baltimore City | 39.82 | 31.51 | 34.57 | 30.20 | 36.65 | 32.20 | 35.14     |
| Baltimore Region       | 38.35 | 30.34 | 32.87 | 29.15 | 35.77 | 30.99 | 33.77     |

### ***Trip Tours***

The previous analysis categorized person trips into one of 6 purposes based on the traditional definition used in travel demand forecasting. In response to observations of chaining trips together due to increases in non-work activity, household travel is being analyzed using tours. Tours are defined as the activity that a household makes in a round trip that starts/ends at home. Person tours are defined as follows:

1. Non-Work Tour – one/series of person trips where no work location (including business related) was visited.
2. Work Tour – one/series of person trips where a work location (including business related) was visited.

For each tour, the number of stops within the tour was evaluated. If the trips simply went from home to school and back, this was classified as a simple non-work tour. Chaining several locations (example home to work, work to lunch, lunch to work, and finally work to home) was classified as a complex tour. Identified work tours were evaluated looking for a sub tour. Reported trips that started and ended at the work location were identified as sub work tours.

Three additional categories of tours were identified as partial work and non-work tours, where either the starting location or the destination was not a home location for the day's activity. The majority of this type of tour was associated with traveling to/out of the region, but there are several persons that begin/end their daily activity within the region at a non-home location. Finally, person tours were identified where the person did not start nor end at home.

The analysis of classifying the reported trips into tours is contained on Tables 19 and 20 showing motorized person and person trips. Household trip tours that have a work location are slightly greater than a quarter of all trip tours. There are small differences between simple and complex non-work and work tours. Within Baltimore City for motorized person non-work tours, there is a greater share of complex tours. Adding non-motorized modes increases the share of simple tours over that of complex for all households. This would indicate that non-motorized tours are more simple than complex. The work sub tour is dominated by the simple sub work tour, most likely traveling from work to lunch and back. Non-motorized travel is evident in the sub work tour especially for households within Baltimore City with 14.9% of work tours having a sub work tour for person trips compared to only 9.8% for motorized person trips.



**TABLE 19**  
**Baltimore Region Motorized Person Trip Tours (Trips)**

|                        | Non-Work Tours |         | Work Tours |         | Sub tour Work |         | Partial Tours |      |          |
|------------------------|----------------|---------|------------|---------|---------------|---------|---------------|------|----------|
|                        | simple         | complex | Simple     | complex | simple        | complex | Non-Work      | Work | Non-Home |
| Inside Baltimore City  | 68.3%          |         | 28.4%      |         | 9.8%          |         | 1.8%          | 0.9% | 0.7%     |
|                        | 44.9%          | 55.1%   | 49.2%      | 50.8%   | 78.4%         | 21.6%   |               |      |          |
| Outside Baltimore City | 68.6%          |         | 28.7%      |         | 10.8%         |         | 2.0%          | 0.5% | 0.2%     |
|                        | 53.9%          | 46.1%   | 45.9%      | 54.1%   | 83.2%         | 16.8%   |               |      |          |
| Baltimore Region       | 68.6%          |         | 28.7%      |         | 5.3%          |         | 1.9%          | 0.5% | 0.3%     |
|                        | 52.2%          | 47.8%   | 46.5%      | 53.5%   | 79.3%         | 20.7%   |               |      |          |

**TABLE 20**  
**Baltimore Region Person Trip Tours (Trips)**

|                        | Non-Work Tours |         | Work Tours |         | Sub tour Work |         | Partial Tours |      |          |
|------------------------|----------------|---------|------------|---------|---------------|---------|---------------|------|----------|
|                        | simple         | complex | Simple     | complex | simple        | complex | Non-Work      | Work | Non-Home |
| Inside Baltimore City  | 70.5%          |         | 26.8%      |         | 14.9%         |         | 1.5%          | 0.7% | 0.5%     |
|                        | 53.0%          | 47.0%   | 47.2%      | 52.8%   | 78.5%         | 21.5%   |               |      |          |
| Outside Baltimore City | 69.5%          |         | 27.7%      |         | 12.5%         |         | 2.1%          | 0.5% | 0.2%     |
|                        | 56.1%          | 43.9%   | 45.3%      | 54.7%   | 83.0%         | 17.0%   |               |      |          |
| Baltimore Region       | 69.7%          |         | 27.5%      |         | 12.3%         |         | 2.0%          | 0.5% | 0.3%     |
|                        | 55.4%          | 44.6%   | 45.7%      | 54.3%   | 80.2%         | 19.8%   |               |      |          |

**TABLE 21**  
**Baltimore Region Motorized Person Trip Tours VMT (Miles)**

|                        | Non-Work Tours |         | Work Tours |         | Sub tour Work |         | Partial Tours |      |          |
|------------------------|----------------|---------|------------|---------|---------------|---------|---------------|------|----------|
|                        | simple         | complex | simple     | Complex | simple        | complex | Non-Work      | Work | Non-Home |
| Inside Baltimore City  | 41.6%          |         | 52.0%      |         | 5.8%          |         | 3.8%          | 2.1% | 0.4%     |
|                        | 52.6%          | 47.4%   | 62.8%      | 37.2%   | 75.8%         | 24.2%   |               |      |          |
| Outside Baltimore City | 49.3%          |         | 45.3%      |         | 5.5%          |         | 4.4%          | 0.8% | 0.3%     |
|                        | 55.8%          | 44.2%   | 55.3%      | 44.7%   | 83.2%         | 16.8%   |               |      |          |
| Baltimore Region       | 48.2%          |         | 46.3%      |         | 5.0%          |         | 4.3%          | 1.0% | 0.3%     |
|                        | 55.4%          | 44.6%   | 56.5%      | 43.5%   | 76.9%         | 23.1%   |               |      |          |

**TABLE 22**  
**Baltimore Region Person Trip Tours VMT (Miles)**

|                        | Non-Work Tours |         | Work Tours |         | Sub tour Work |         | Partial Tours |      |          |
|------------------------|----------------|---------|------------|---------|---------------|---------|---------------|------|----------|
|                        | simple         | complex | simple     | Complex | simple        | complex | Non-Work      | Work | Non-Home |
| Inside Baltimore City  | 42.6%          |         | 51.2%      |         | 6.1%          |         | 3.7%          | 2.1% | 0.4%     |
|                        | 54.5%          | 45.5%   | 62.5%      | 37.5%   | 76.8%         | 23.2%   |               |      |          |
| Outside Baltimore City | 49.6%          |         | 45.1%      |         | 5.5%          |         | 4.3%          | 0.8% | 0.2%     |
|                        | 56.2%          | 43.8%   | 55.4%      | 44.6%   | 83.0%         | 17.0%   |               |      |          |
| Baltimore Region       | 48.6%          |         | 46.0%      |         | 5.0%          |         | 4.2%          | 1.0% | 0.3%     |
|                        | 56.0%          | 44.0%   | 56.5%      | 43.5%   | 76.7%         | 23.3%   |               |      |          |

The travel demand model estimated distance (miles) was accumulated for each segment of these tours. Tables 21 and 22 contain the share of distances traveled for each household tour. The accumulated travel distance for tours is approximately equal between work and non-work except for households inside Baltimore City where work tours contain 11% more household travel distance than non-work tours. About 5% of the work tour travel distance is attributed to the sub work tour for both motorized person and person trips.

Comparing simple versus complex tours where distance traveled is considered, simple tours have a larger share of household travel. This is more evident evaluating the work tour. It would appear that households with longer distance trips do not chain other activities to the trip.

Average trip length can be estimated knowing the number of trips and distance traveled. Table 23 shows the average motorized person trip length for non-work and work tours along with the sub work tour. Tours with a work destination are more than twice as long as tours with no work location. As seen in total mileage accumulated, simple tours on average are longer than complex, especially for work tours.

**TABLE 23**  
**Baltimore Region Average Trip Length (Miles)**  
**Motorized Person Trip Tours**

|                        | Non-Work Tours |         | Work Tours |         | Sub Tours |         |
|------------------------|----------------|---------|------------|---------|-----------|---------|
|                        | Simple         | Complex | Simple     | Complex | Simple    | Complex |
| Inside Baltimore City  | 3.71           |         | 11.13      |         | 6.59      |         |
|                        | 4.34           | 3.19    | 14.21      | 8.14    | 6.37      | 7.37    |
| Outside Baltimore City | 6.20           |         | 13.60      |         | 6.91      |         |
|                        | 6.41           | 5.95    | 16.42      | 11.22   | 6.91      | 6.93    |
| Baltimore Region       | 5.73           |         | 13.14      |         | 6.85      |         |
|                        | 6.08           | 5.35    | 15.98      | 10.67   | 6.82      | 7.03    |

Evaluating only the households that make complex motorized person trip tours, the average number of segments in a non-work tour is 6.1 trips. The work tour has 5 segments on average. Households on average chain more non-work related tasks together than chaining activity with work. This may have something to do with the time it takes to travel and/or the duration of the activities.

## ***Mode of Travel***

The travel survey recorded one of 37 potentially different travel modes used during the survey day. These modes include non-motorized and motorized options, passenger car and various forms of mass transit divided among bus and rail, and air/water transportation. The estimated mode share, grouped into seven generic categories, for the travel survey data is found in Table 24 for person trips traveling within the modeled region. Households within Baltimore City rely less on the personal vehicle, which makes up almost 61% of the mode of travel outside of Baltimore

City. A significant amount of travel for households within Baltimore City use the transit bus (14.4%) and non-motorized (20.7%) modes. Over 88% of suburban household travel is associated with the auto. The use of school bus outside Baltimore City is estimated at 3.3% and at 1.0% within the City. Differences in the modeling of travel between a household located inside or outside Baltimore City are being influenced by auto availability (reported earlier with Baltimore City households having fewer than 1 auto per household on average) and potentially land use configuration.

**TABLE 24**  
**Baltimore Region Mode Share**  
**Person Trips**

|                        | Auto Driver | Auto Passenger | Transit Bus | Transit Rail | School Bus | Other | Non Motorized |
|------------------------|-------------|----------------|-------------|--------------|------------|-------|---------------|
| Inside Baltimore City  | 39.8%       | 20.8%          | 14.4%       | 1.9%         | 1.0%       | 1.4%  | 20.7%         |
| Outside Baltimore City | 61.0%       | 27.1%          | 0.7%        | 0.5%         | 3.3%       | 0.1%  | 7.4%          |
|                        |             |                |             |              |            |       |               |
| Baltimore Region       | 56.4%       | 25.7%          | 3.6%        | 0.8%         | 2.8%       | 0.4%  | 10.2%         |

The purpose of the trip also influences the mode chosen, due to differences in starting time, duration (time and distance), and location. Table 25 displays the trip purpose mode share for households inside/outside Baltimore City. As expected, travel to work has the highest share of transit trips (8.4% Transit Bus and Rail) due to peaking characteristics and the concentration of high quality transit service in the peak periods. There is a significant share of Transit Bus and Rail (27.3%) for households inside Baltimore City for the purpose of school. The Mass Transit Administration (MTA) operates additional school bus trips and provides for a school fare discount inside Baltimore City.

Average trip purpose auto occupancy was calculated from reported trips that drove or were passengers and is found in Table 26. Work trip purposes (HBW and WBO) have the lowest vehicle occupancy with a regional average of 1.08. The non-work related travel varies from a high of 4.51 for school trips to 1.49 for shopping trips. For all trip purposes, the Baltimore region average auto occupancy is 1.46.

**TABLE 25**  
**Baltimore Region Trip Purpose Mode Share**  
**Person Trips**

|       |                        | Auto Driver | Auto Passenger | Transit Bus | Transit Rail | School Bus | Other | Non Motorized |
|-------|------------------------|-------------|----------------|-------------|--------------|------------|-------|---------------|
| HBW   | Inside Baltimore City  | 53.8%       | 8.4%           | 20.8%       | 6.9%         | 0.1%       | 9.6%  | 0.3%          |
|       | Outside Baltimore City | 88.7%       | 6.1%           | 0.8%        | 2.3%         | 0.0%       | 2.0%  | 0.2%          |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 81.1%       | 6.6%           | 5.1%        | 3.3%         | 0.0%       | 3.6%  | 0.2%          |
| HBO   | Inside Baltimore City  | 32.6%       | 26.5%          | 13.2%       | 0.8%         | 0.1%       | 25.3% | 1.5%          |
|       | Outside Baltimore City | 51.2%       | 33.4%          | 1.0%        | 0.1%         | 0.1%       | 14.0% | 0.2%          |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 47.2%       | 31.9%          | 3.6%        | 0.2%         | 0.1%       | 16.4% | 0.5%          |
| HBShp | Inside Baltimore City  | 41.6%       | 21.0%          | 11.3%       | 0.5%         | 0.0%       | 23.0% | 2.6%          |
|       | Outside Baltimore City | 64.5%       | 31.1%          | 0.3%        | 0.0%         | 0.0%       | 4.0%  | 0.1%          |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 59.7%       | 30.0%          | 2.6%        | 0.1%         | 0.0%       | 8.0%  | 0.6%          |
| HBSCh | Inside Baltimore City  | 7.3%        | 21.3%          | 26.4%       | 0.9%         | 7.3%       | 36.6% | 0.2%          |
|       | Outside Baltimore City | 11.7%       | 42.0%          | 1.7%        | 0.0%         | 38.2%      | 6.4%  | 0.0%          |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 10.8%       | 38.0%          | 6.4%        | 0.2%         | 32.3%      | 12.3% | 0.0%          |
| OBO   | Inside Baltimore City  | 57.8%       | 5.4%           | 6.1%        | 1.6%         | 0.9%       | 27.9% | 0.3%          |
|       | Outside Baltimore City | 83.3%       | 6.7%           | 0.1%        | 0.3%         | 0.3%       | 9.4%  | 0.0%          |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 78.0%       | 6.40%          | 1.4%        | 0.5%         | 0.4%       | 13.2% | 0.1%          |
| WBO   | Inside Baltimore City  | 38.6%       | 31.7%          | 12.9%       | 0.7%         | 2.5%       | 11.5% | 2.1%          |
|       | Outside Baltimore City | 52.7%       | 37.8%          | 0.1%        | 0.0%         | 2.5%       | 6.6%  | 0.2%          |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 49.5%       | 36.4%          | 3.0%        | 0.2%         | 2.5%       | 7.8%  | 0.6%          |

### ***Trip Length by Mode of Travel***

The reported person trips from the survey have been geocoded and assigned a Transportation Analysis Zone (TAZ). Combining the information from survey records with impedances from the travel demand model, average trip length in time and distances can be analyzed. Two impedances (times), initial highway skim and minimum transit path, including in and out of vehicle (terminal and intra zonal times for highway and wait, walk, and transfer times for transit) were used. The highway impedance is the shortest elapsed time from zone to zone over the highway network and the transit skim is the minimum elapsed time from one of six possible skims (walk/drive to bus, rail, or MARC). The distance calculation is based on the accumulated highway link distances over the initial minimum path. For trips entering or exiting the region, a logical external station was chosen for each interchange based on the minimum travel time. For example, trip traveling to/from Pennsylvania were assigned to the external station with the minimum travel time from all external stations along the Pennsylvania/Maryland border. This way trips to/from Carroll County will have a different external station than the trips traveling to/

**TABLE 26**  
**Baltimore Region Vehicle Occupancy by Trip Purpose**

| Purpose   | Household Location     | Occupancy |
|-----------|------------------------|-----------|
| HBW       | Inside Baltimore City  | 1.16      |
|           | Outside Baltimore City | 1.07      |
|           | Baltimore Region       | 1.08      |
| HBO       | Inside Baltimore City  | 1.81      |
|           | Outside Baltimore City | 1.65      |
|           | Baltimore Region       | 1.68      |
| HBShp     | Inside Baltimore City  | 1.50      |
|           | Outside Baltimore City | 1.48      |
|           | Baltimore Region       | 1.49      |
| HBShc     | Inside Baltimore City  | 3.92      |
|           | Outside Baltimore City | 4.60      |
|           | Baltimore Region       | 4.51      |
| OBO       | Inside Baltimore City  | 1.82      |
|           | Outside Baltimore City | 1.72      |
|           | Baltimore Region       | 1.74      |
| WBO       | Inside Baltimore City  | 1.09      |
|           | Outside Baltimore City | 1.08      |
|           | Baltimore Region       | 1.08      |
| All Trips | Inside Baltimore City  | 1.52      |
|           | Outside Baltimore City | 1.44      |
|           | Baltimore Region       | 1.46      |

from Harford County. For intrazonal distance, the straight line distance between the geocoded origin and destination was used.

Average trip distance is contained on Table 27. For the work related purposes, HBW and WBO rail transit contains the largest trip length of 23.0 and 36.9, respectfully. The longer distance is attributed to commuter rail operating between Baltimore and Washington. The non-motorized trip distance for HBW for households located outside Baltimore City is 1.9 miles in length, which is the longest average non-motorized trip length.

Average trip travel times (minutes) are contained in Table 28. Initial transit skims (in vehicle and out of vehicle) from model simulated impedances are used for bus and rail transit. All other purposes use the initial highway skim, including terminal and intrazonal travel times. Travel time using mass transit has the greatest average travel times, with rail being the greatest.

**TABLE 27**  
**Baltimore Region Average Trip Length - Miles**  
**by Trip Purpose and Travel Mode**

|       |                        | Auto Driver | Auto Passenger | Transit Bus | Transit Rail | School Bus | Other | Non Motorized |
|-------|------------------------|-------------|----------------|-------------|--------------|------------|-------|---------------|
| HBW   | Inside Baltimore City  | 10.8        | 6.5            | 5.5         | 16.3         | 2.0        | 3.1   | 1.3           |
|       | Outside Baltimore City | 14.5        | 13.3           | 11.2        | 28.6         |            | 4.7   | 1.9           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 14.0        | 11.4           | 6.2         | 23.0         | 2.0        | 4.3   | 1.6           |
| HBO   | Inside Baltimore City  | 4.5         | 5.7            | 3.7         | 5.7          |            | 3.7   | 0.9           |
|       | Outside Baltimore City | 5.7         | 6.9            | 5.1         |              |            | 71.6  | 1.4           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 5.5         | 6.7            | 3.8         | 5.7          |            | 9.4   | 1.1           |
| HBShp | Inside Baltimore City  | 5.4         | 4.8            | 3.3         | 12.2         | 2.3        | 2.2   | 0.7           |
|       | Outside Baltimore City | 8.1         | 9.0            | 8.9         | 12.1         | 9.1        | 3.8   | 0.9           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 7.7         | 8.3            | 4.5         | 12.2         | 7.7        | 2.6   | 0.8           |
| HBSch | Inside Baltimore City  | 7.3         | 3.3            | 3.6         | 4.7          | 2.8        | 0.8   | 0.7           |
|       | Outside Baltimore City | 10.9        | 5.2            | 4.2         |              | 4.3        |       | 1.4           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 10.4        | 5.0            | 3.7         | 4.7          | 4.3        | 0.8   | 1.0           |
| OBO   | Inside Baltimore City  | 5.3         | 6.2            | 4.7         | 11.5         | 2.4        | 3.3   | 0.5           |
|       | Outside Baltimore City | 6.1         | 6.2            | 3.3         | 1.3          | 8.0        | 4.6   | 0.8           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 5.9         | 6.2            | 4.6         | 10.7         | 6.8        | 3.6   | 0.7           |
| WBO   | Inside Baltimore City  | 8.6         | 4.5            | 2.0         | 33.5         | 7.9        | 2.4   | 0.7           |
|       | Outside Baltimore City | 9.4         | 10.9           | 7.4         | 42.3         | 2.7        |       | 0.6           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 9.3         | 9.8            | 2.4         | 36.9         | 5.2        | 2.4   | 0.6           |

### ***Trip Distribution***

The location of households, employment, and other activities influences the distribution of travel activities. Using the location of reported trips, trip distribution can be analyzed by mode and trip purpose. Over the past decades, both households and employment have decentralized moving to the outer counties. Understanding travel patterns and the interaction between concentrations of households and employment for different trip purposes assists in understanding of travel demands on the existing transportation system.

A conversion of home-based trips was first performed converting reported origins and destinations to productions and attractions. Home-based trips were analyzed identifying the origin or destination that was from/to the home and the non-home location. The home end of the trip was classified as the production and the non-home was classified as the attraction. For a simple trip of an origin from home to work and back was classified as two HBW productions at the home TAZ and two HBW attractions at the work location TAZ.

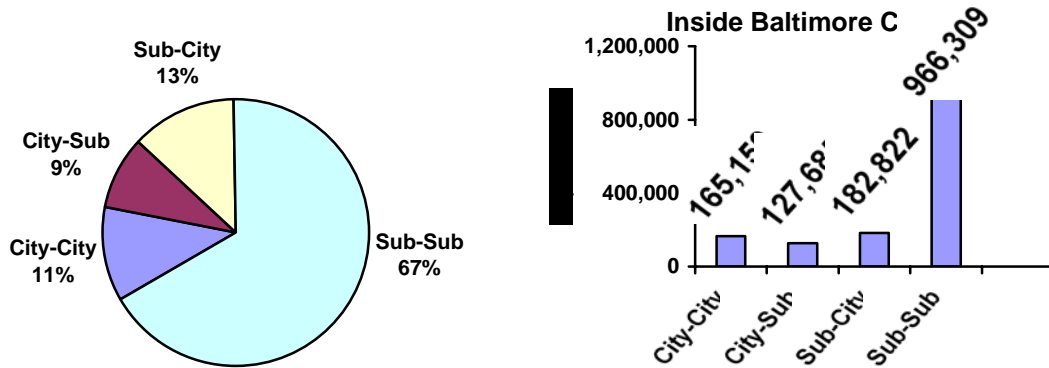
The HBW motorized surface trip purpose productions and attractions have been classified into two areas, City and Suburban, for further analysis. Productions/attractions within Baltimore City are classified as City and all other locations (including locations within the Washington Region) are classified as suburban. Exhibit 7 contains the share and absolute number of motorized surface HBW trips traveling to/from City/Suburban locations. Almost 1 million or 67% reported motorized surface HBW trips reported traveling from a suburban location to another suburban location. Suburban to City is the the next highest with 183,000 or 13% of the trips. Traveling from City to suburban locations contains the fewest number of motorized surface trips.

**TABLE 28**  
**Baltimore Region Average Trip Length - Minutes**  
**by Trip Purpose and Travel Mode**

|       |                        | Auto Driver | Auto Passenger | Transit Bus | Transit Rail | School Bus | Other | Non Motorized |
|-------|------------------------|-------------|----------------|-------------|--------------|------------|-------|---------------|
| HBW   | Inside Baltimore City  | 19.4        | 15.1           | 28.4        | 52.9         | 11.0       | 13.2  | 7.3           |
|       | Outside Baltimore City | 21.9        | 20.6           | 43.6        | 81.7         |            | 14.9  | 5.9           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 21.5        | 19.1           | 30.2        | 68.7         | 11.0       | 14.5  | 6.7           |
| HBO   | Inside Baltimore City  | 10.6        | 12.4           | 21.7        | 22.4         |            | 10.2  | 5.5           |
|       | Outside Baltimore City | 11.2        | 12.7           | 31.1        |              |            | 78.0  | 5.1           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 11.1        | 12.6           | 22.6        | 22.4         |            | 160   | 5.3           |
| HBShp | Inside Baltimore City  | 12.5        | 11.9           | 20.7        | 44.9         | 9.9        | 8.    | 5.2           |
|       | Outside Baltimore City | 14.2        | 15.5           | 76.9        | 49.1         | 16.3       | 9.0   | 4.9           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 14.0        | 14.8           | 32.8        | 46.3         | 14.9       | 8.3   | 50            |
| HBSch | Inside Baltimore City  | 15.2        | 9.2            | 20.3        | 26.7         | 9.         | 5.2   | 5.2           |
|       | Outside Baltimore City | 17.5        | 10.5           | 25.8        |              | 9.6        |       | 5.6           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 17.2        | 10.4           | 21.4        | 26.7         | 9.5        | 5.2   | 5.4           |
| OBO   | Inside Baltimore City  | 11.2        | 13.1           | 30.9        | 42.1         | 8.2        | 8.5   | 7.4           |
|       | Outside Baltimore City | 11.3        | 11.5           | 14.5        | 12.0         | 14.5       | 9.7   | 5.6           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 11.3        | 11.8           | 30.4        | 39.7         | 13.1       | 8.8   | 6.2           |
| WBO   | Inside Baltimore City  | 15.8        | 10.4           | 14.6        | 125.6        | 20.0       | 12.2  | 9.8           |
|       | Outside Baltimore City | 15.4        | 17.0           | 130.6       | 101.7        | 8.0        |       | 7.5           |
|       |                        |             |                |             |              |            |       |               |
|       | Baltimore Region       | 15.5        | 15.8           | 23.8        | 116.3        | 13.6       | 12.2  | 8.5           |



**EXHIBIT 7**  
**Motorized Surface HBW Trip Distribution**



Analyzing the data on a jurisdiction-to-jurisdiction basis can be found in Table 29 for motorized surface HBW reported trips in production/attraction format. All jurisdictions have at least a plurality of HBW productions staying within their jurisdiction. Carroll County has the least with 40.8% of the HBW trips produced and Anne Arundel County has the greatest. The Washington region is a significant destination for the jurisdiction of Carroll (10.7%), Anne Arundel (20.8%), and Howard County (23.2%). Baltimore City is a major destination for the jurisdictions of Baltimore County (27.7%), Carroll County (12.0%), and Harford County (12.1%). Carroll and Harford Counties also send a large share of work trips to Baltimore County.

**TABLE 29**  
**Baltimore Region Motorized Surface HBW**  
**Trip Distribution**

|                     | Baltimore City | Anne Arundel County | Baltimore County | Carroll County | Harford County | Howard County | Washington Jurisdictions | External Stations |
|---------------------|----------------|---------------------|------------------|----------------|----------------|---------------|--------------------------|-------------------|
| Baltimore City      | 56.4%          | 7.4%                | 24.2%            | 1.1%           | 0.5%           | 5.1%          | 3.6%                     | 1.8%              |
| Anne Arundel County | 7.4%           | 57.8%               | 4.4%             | 0.0%           | 0.5%           | 5.3%          | 20.8%                    | 3.9%              |
| Baltimore County    | 27.7%          | 6.8%                | 52.3%            | 1.0%           | 2.6%           | 4.4%          | 3.2%                     | 2.2%              |
| Carroll County      | 12.0%          | 5.3%                | 17.9%            | 40.8%          | 0.8%           | 9.1%          | 10.7%                    | 3.4%              |
| Harford County      | 12.1%          | 4.7%                | 18.8%            | 2.0%           | 55.0%          | 0.0%          | 1.1%                     | 6.2%              |
| Howard County       | 6.3%           | 11.2%               | 11.6%            | 0.0%           | 0.0%           | 43.6%         | 23.2%                    | 4.2%              |

The other non-work related home-based trips have a majority of trips staying within jurisdiction of production, due to shorter trip lengths. The distribution for motorized surface HBO productions can be seen on Table 30. The exception is Howard County for the purpose of HBO, which has 66% staying within jurisdiction and 8.2% traveling to Baltimore County and 10.6% traveling to the Washington region. There is a significant movement of motorized surface trips between Baltimore County and Baltimore City.

**TABLE 30**  
**Baltimore Region Motorized Surface HBO**  
**Trip Distribution**

|                     | Baltimore City | Anne Arundel County | Baltimore County | Carroll County | Harford County | Howard County | Washington Jurisdictions | External Stations |
|---------------------|----------------|---------------------|------------------|----------------|----------------|---------------|--------------------------|-------------------|
| Baltimore City      | 73.8%          | 4.4%                | 20.5%            | 0.1%           | 0.1%           | 0.2%          | 0.3%                     | 0.6%              |
| Anne Arundel County | 2.5%           | 86.7%               | 1.3%             | 0.8%           | 0.2%           | 0.5%          | 4.3%                     | 3.8%              |
| Baltimore County    | 14.8%          | 2.1%                | 74.9%            | 0.6%           | 2.7%           | 1.9%          | 2.0%                     | 1.0%              |
| Carroll County      | 0.3%           | 0.2%                | 9.5%             | 72.8%          | 2.4%           | 3.1%          | 7.4%                     | 4.2%              |
| Harford County      | 2.5%           | 0.2%                | 10.2%            | 0.0%           | 82.3%          | 0.0%          | 0.0%                     | 4.9%              |
| Howard County       | 3.4%           | 6.8%                | 8.2%             | 0.4%           | 0.0%           | 66.1%         | 10.6%                    | 4.5%              |

### ***Travel Period***

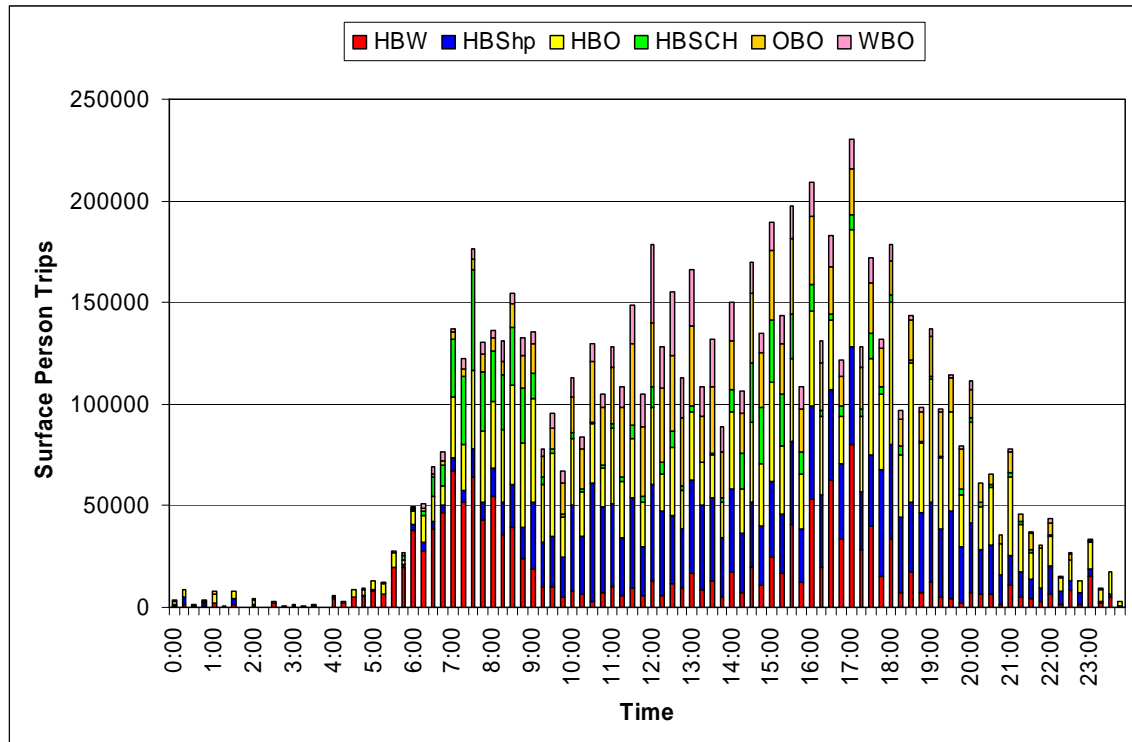
Participants in the travel survey provide the starting time and ending time for each reported trip. Information on time period travel behavior can be determined analyzing the starting time, ending time, and perceived trip duration grouped by trip purpose, mode or other household characteristics. Some caution is needed in analyzing reported times. Most respondents round starting and ending times in 5 or 10 minute increments. The starting time and ending time for the work location can also affect the reported times. An example of this would be if work ends at 4:00 pm and it takes 35 minutes to travel to home, the trip home should have ended at 4:35. Most likely the trip did not start at 4:00 pm and the travel time was more/less than 35 minutes.

The reported starting and ending times within the travel database was converted to 15 minute increments throughout the day. A trip that reported starting at 7:50 and ending at 8:18 was identified as traveling in the 7:45 and 8:00 time period. The starting time for this trip would also be recorded with a 7:45 start time.

The starting time of reported surface person trips with at least one end within the modeling region is displayed in Exhibit 8 for an average weekday grouped into 15 minute increments. The morning peak period is well defined. Surface person trips starts drop off for a short period of time around 9:00 am, before the mid-day period builds until noon. Trip starts drop off slightly

before the beginning of the afternoon peak period, which is much more spread throughout the evening period compared to the morning peak.

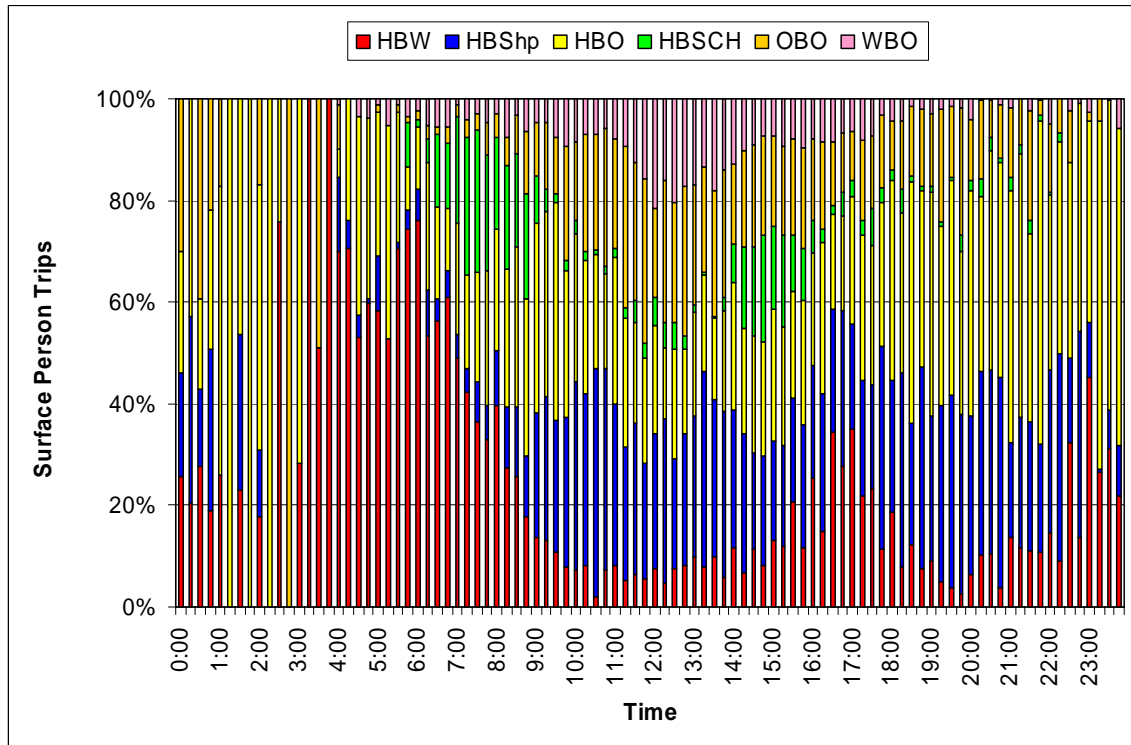
**EXHIBIT 8**  
**Surface Person Trip Starts – Time of Day**  
**Absolute Number of Trips by Trip Purpose**



The share of surface starts by trip purpose can also be analyzed for a day in 15 minute increments, displayed in Exhibit 9. A significant share of the morning am peak period starts was reported as HBW. The mid-day period has large shares of WBO and OBO trip activities. The evening time period contains a large share of home-based trips related to shopping and other activities. Different travel purposes dominate the peak periods making it possible for a mixture of strategies to ease peak congestion or air quality concerns.

Travel can also be analyzed using all the time periods of travel for the reported person surface trips. Analysis of person surface trips in motion shows the total amount of travel by purpose for each 15 minute time period based on reported start and end times. Exhibit 10 shows the time of day travel for an average weekday. As with trip starts, a morning, mid-day and evening peak period are well defined. The morning period is also more concentrated compared to evening peak period.

**EXHIBIT 9**  
**Surface Person Trip Starts – Time of Day**  
**Share of Number of Trips by Trip Purpose**

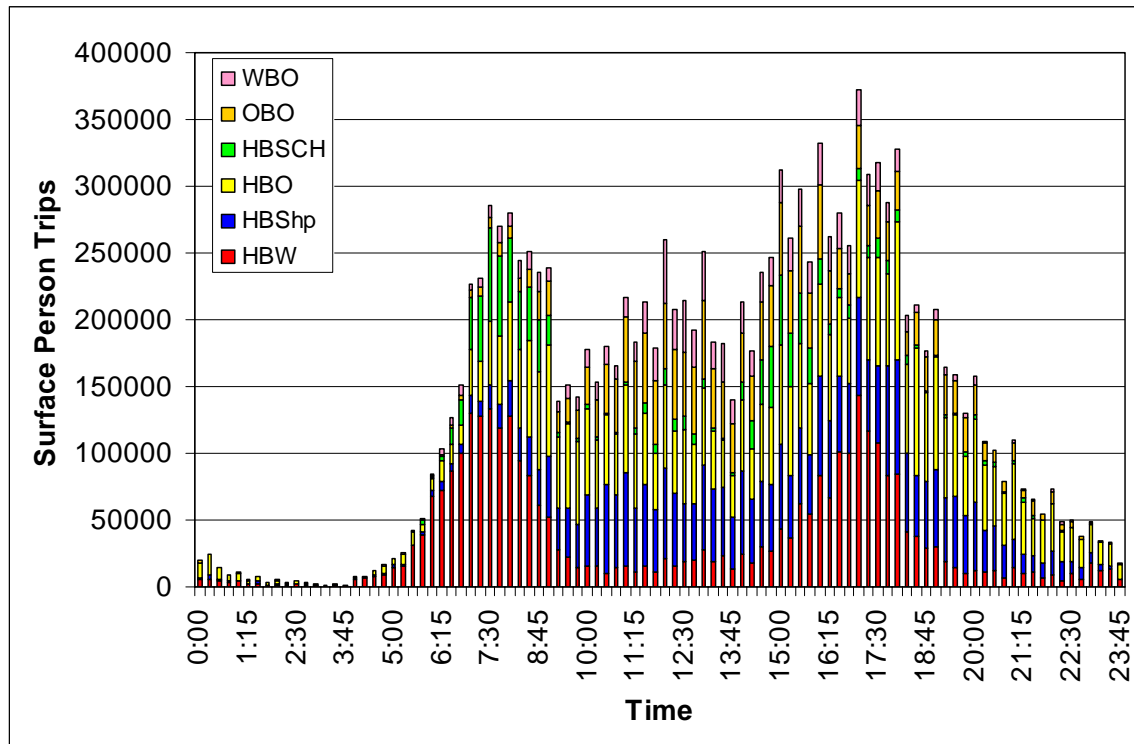


***Trip Tours -Travel Period***

As previously defined, household travel can be chained together in tours of work and non-work. Exhibit 11 shows the share of daily surface person trip tours in motion for work and non-work divided into simple and complex tours along with partial tours for an average weekday.

Trip tours involving work activity of both simple and complex tours make up the majority of surface person trips in motion during the am peak period. During this period, simple work tours (traveling from home to work and back) have the highest share. Non-work activity dominates the mid-day time period with complex trip activity having the highest share. There is a slight mid-day work tour peak (20%) with the majority being complex. These complex work tours are not necessarily traveling to a work location, but are just a leg within the over all work tour. During the evening peak period, non-work activity is the larger share. Simple work tours are around a quarter of travel during the pm peak period.

**EXHIBIT 10**  
**Surface Person Trip in Motion – Time of Day**  
**Absolute Number of Trips by Trip Purpose**



# **EXHIBIT 11** **Surface Person Trip Tours in Motion – Time of Day** **Share of Number of Trips by Trip Tours**

