

EXECUTIVE SUMMARY



2006 • 2007 • 2008 • 2009 • 2010

**Killeen-Temple Urban  
Transportation Study Travel Survey**

Portions of Bell, Coryell, and Lampasas County

## **DISCLAIMER**

The contents of this report reflect the views of the authors who are responsible for the data, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration, the Texas Department of Transportation (TxDOT), or the Killeen-Temple Metropolitan Planning Organization. This report does not constitute a standard, specification, or regulation. Additionally, this report is not intended for construction, bidding, or permits.

## **ACKNOWLEDGEMENTS**

This report provides a summary of the travel surveys conducted during the period between 2006 and 2010 in the Killeen-Temple Urban Transportation Study Metropolitan Planning Organization (KTUTS MPO) Area. Details of these surveys are provided in the following separate technical reports, which are available for viewing through the KTUTS MPO and the TxDOT Transportation Planning and Programming Division.

- Farnsworth, Stephen P. *2006 Killeen-Temple External Survey Technical Summary*. Texas Transportation Institute, The Texas A&M University System, College Station, TX, August 2008.
- GRAM Traffic Counting, Inc. *Waco MPO and KTUTS MPO External Station Travel Surveys*. October 2006.
- Larsen, Lisa K., David F. Pearson and Edwin N. Hard. *2007-2008 Killeen-Temple Metropolitan Planning Organization Household Travel Survey Technical Summary*. Texas Transportation Institute, The Texas A&M University System, College Station, TX, December 2011.
- Nepal, Stella Amor F., and David F. Pearson. *2010 Killeen-Temple Work Place Travel Survey Technical Summary*. Texas Transportation Institute, The Texas A&M University System, College Station, TX, August 2011.
- Nepal, Stella Amor F., and David F. Pearson. *2008/2009 Killeen-Temple Commercial Vehicle Survey Technical Summary*. Texas Transportation Institute, The Texas A&M University System, College Station, TX, December 2010.

The factual contents of this report were taken from the above summary reports and the contributions of the authors of these reports are acknowledged. Other factual sources are referenced in the report. The authors are responsible for the opinions, findings, and conclusions. There were a number of individuals who extended technical support and assistance during the preparation of this report. Special thanks are due to Gary Lobaugh, Debbie Spillane, and David Pearson of the Texas A&M Transportation Institute for their help in this report. The authors would like to thank Charlie Hall, TxDOT Travel Survey Program Manager, for his advisement and guidance and the Department for its continuing program to collect and analyze urban travel data to support travel demand modeling.

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# Killeen-Temple Urban Transportation Study Travel Survey

*Portions of Bell, Coryell, and Lampasas County*

## **EXECUTIVE SUMMARY**

Sponsored by the Killeen-Temple Urban Transportation Study Metropolitan Planning Organization (KTUTS MPO) in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA)

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Main Street, downtown Temple, Texas

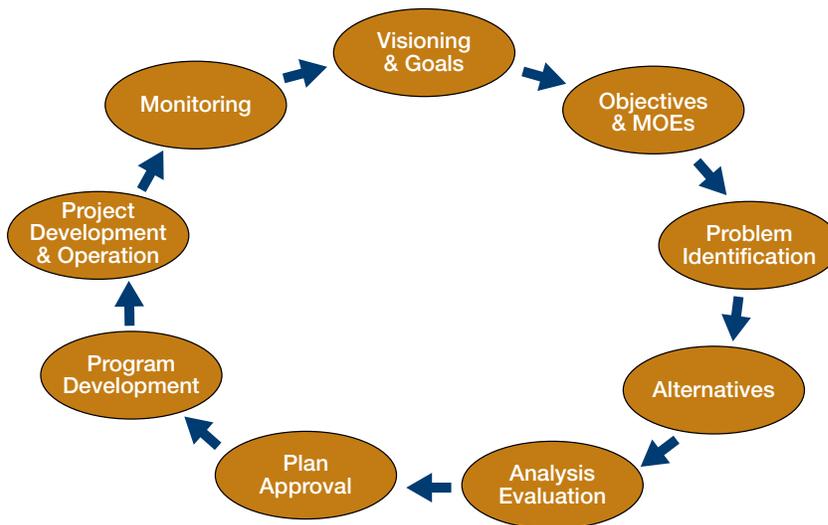
## INTRODUCTION

The metropolitan transportation planning process is based on the Federal-Aid Highway Acts of 1962 and 1973. These acts established the cooperative, continuing, and comprehensive (3C) transportation planning process and created the metropolitan planning organization (MPO) to assist in conducting the process. Subsequent federal acts strengthened the transportation planning process and the role of MPOs. Figure 1 shows the key elements of the metropolitan transportation planning process.

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**The metropolitan transportation planning process is based on the Federal-Aid Highway Acts of 1962 and 1973.**

Figure 1. Key Elements of the Planning Process.



Source: National Highway Institute Course No. 152069, Metropolitan Transportation Planning.

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Where do travel surveys fit into this process? Data collected from travel surveys serve as vital input to travel demand models. Most MPOs use a travel demand model to forecast the demand for transportation and capacity needs and to evaluate how proposed alternative transportation systems will perform. MPOs use this analysis to support the development of a long-range transportation plan and short-range transportation improvement program that are adopted by an MPO's policy board. These plans are approved at a minimum of once every five years for metropolitan areas that are in attainment of National Ambient Air Quality Standards (NAAQS) and once every four years for metropolitan areas that are not in attainment of the NAAQS.

Modelers require travel surveys to support travel demand model estimation, calibration, and validation for the model's base year. After the travel demand model is validated, it is used as an evaluation tool to determine how well or how poorly the proposed urban transportation system will perform in the future given the land use forecast of where people will live and work. Travel surveys are the essential first step for travel model estimation, calibration, and validation. The Texas Department of Transportation (TxDOT) has supported, and continues to support, the timely conduct of urban travel surveys that are essential for the development of travel demand models to support the metropolitan transportation planning process.

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**Travel surveys are required to support travel demand model estimation, calibration, and validation for the model's base year.**

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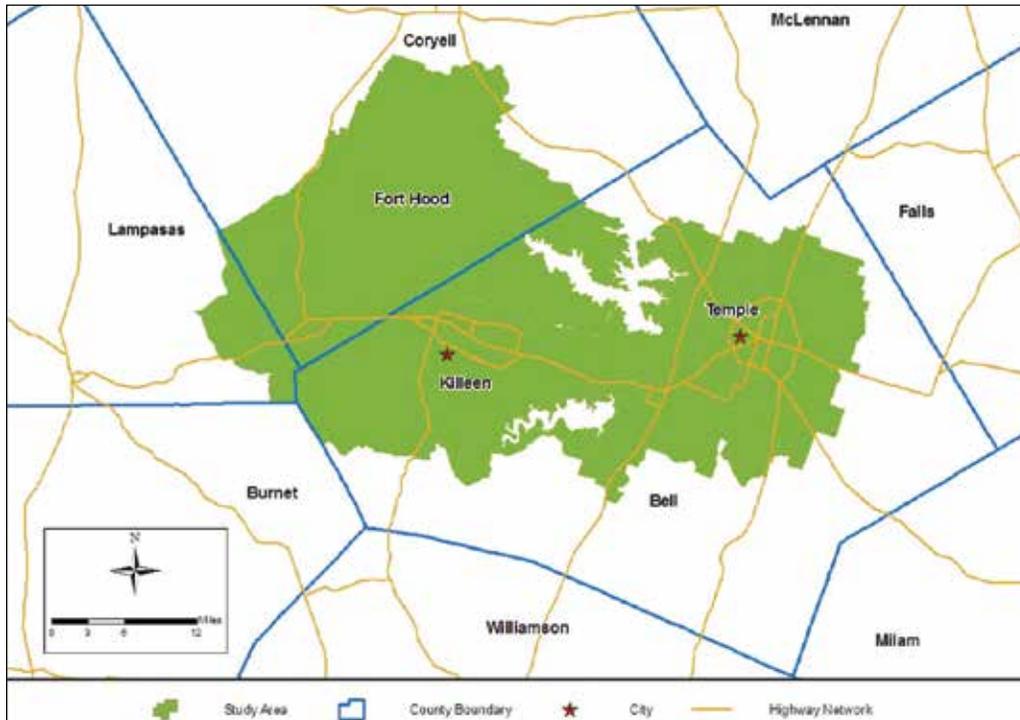
During the period between 2006 and 2010, the Transportation Planning and Programming Division (TPP) of TxDOT funded a comprehensive set of travel surveys in the Killeen-Temple Urban Transportation Study Metropolitan Planning Organization (KTUTS MPO) area. Four types of travel surveys were conducted to collect information on different aspects of travel and trip making in the KTUTS area. These four types included the following:

- A *household travel survey* to collect information on amounts, origins, and destinations of resident travel within the area.
- A *work place survey* (including special generators) to collect information on the number and types of trips attracted to basic, retail, service, and education establishments.
- An *external survey* to collect information on travel coming into, going out of, or passing through the study area.
- A *commercial vehicle survey* to collect information on travel made by commercial vehicles operating within the study area.

The KTUTS MPO is the organization responsible for transportation planning for the Killeen-Temple metropolitan area. This report presents a summary of the travel surveys conducted in portions of Bell, Coryell, and Lampasas Counties. Figure 2 shows the location map for the KTUTS area.

This section presents selected demographic and transportation statistics to provide a frame of reference for the KTUTS MPO study area compared to the state of Texas. Improved transportation planning and analysis tools are needed to plan for the future needs of Bell, Coryell and Lampasas counties. The travel surveys, summarized in the remainder of this report, provide the travel-related data needed to continue to improve these analysis tools.

**Figure 2. Killeen-Temple Urban Transportation Study Area.**



### Population Growth

The KTUTS area’s population is forecasted to increase by about 208,471 people or 59.4 percent between 2007 and 2035 (Texas State Data Center, Texas Population Projections Program). The population of the state of Texas as a whole is projected to increase from 23,837,701 in 2007 to 34,962,746 in 2035—an increase of about 46.7 percent. Thus, in 2035, the combined population of Bell County and Coryell County is projected to make up 1.60 percent of the Texas population, a slight increase from the 1.47 percent it contained in 2007 (Table 1). For the population estimation, only values from Bell and Coryell Counties were used, given their relatively small portion of Lampasas County included in the study area.

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**Improved transportation  
planning and analysis  
tools are needed to plan  
for the future needs of the  
Killeen-Temple area.**

**Table 1. Population Estimates.**

Geography	Year	
	2007	2035
Bell County	278,342	461,794
Coryell County	72,605	97,624
Bell and Coryell Counties	350,947	559,418
Texas	23,837,701	34,962,746

Source: Census Bureau Pop Estimates 2000-09 Texas Counties and Texas Data Center 2012 Projections (0.5 migration scenario).



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**Persons commuting to work in the KTUTS area primarily drive alone or use carpools.**

### Transportation Statistics

Persons commuting to work in the KTUTS area primarily drive alone or use carpools (Table 2). There is a higher percentage of carpooling occurring in Coryell County than in Bell County (16.9 percent compared to 11.2 percent), as well as a higher percentage of walking trips in Coryell County than in Bell County (6.1 percent compared to 2.7 percent). In both Bell County and Coryell County, there is limited use of public transportation. Part of the reason for this modest use of public transportation is that the percentage of households with a vehicle available in the KTUTS area is high (over 97 percent).

**Table 2. Mode of Commuting to Work, 2007.**

Mode of Commuting to Work	Bell County	Coryell County	Texas
Drive Alone	80.82	72.04	78.88
Carpool	11.17	16.90	12.19
Public Transportation	0.35	0.49	1.69
Walk	2.68	6.09	1.76
Work at Home	3.17	2.38	3.61
Other	1.81	2.10	1.87
Total	100.00	100.00	100.00

Source: U.S. Census Bureau, 2007 American Community Survey (ACS).

Table 3 shows the population and daily vehicle miles of travel (VMT) estimates and projections for the KTUTS area. With the population forecast to increase by 59.4 percent from 2007 to 2035, and with daily VMT projected to increase by around 41.3 percent, the average daily VMT per person is estimated to be 22.32 miles by 2035.

**Table 3. Population and Vehicle Miles Traveled Data.**

Year	Population of Bell and Coryell Counties	Daily Vehicle Miles of Travel (1,000)	Daily Vehicle Miles of Travel per Person
2007	350,947	8,839.27	25.19
2030	523,491	11,938.72	22.81
2035	559,418	12,488.22	22.32

To estimate future travel, the studies consider the travel between trips made within the study area (internal trips), trips made into or out of the study area (external-local trips), and trips made through the study area (external-through trips). The household survey collected information and data on internal trips.

## **HOUSEHOLD SURVEY**

The primary purpose of the household survey is to understand the travel patterns of households as a function of their characteristics, such as household size, number of persons employed, income, vehicles available, and trip purpose. The data obtained from the survey are used in the trip generation step of the travel demand model to estimate trip production rates by trip purpose. The average travel distances and trip length frequency distributions for each trip purpose are then estimated, and, along with the number of productions and attractions, are used in the trip distribution step of the travel demand model to estimate the attraction end for each trip produced (see the Glossary and Terminology section of this report for an explanation of terms).

### ***Household Characteristics***

Households that participated in the survey were randomly selected and were asked to record in a diary the trips made by each person in the household during a 24-hour period. For each trip, participants were asked to record the time and place the trip began and ended, mode of travel, number of passengers, purpose of the trip, and other descriptive information. In addition to the trip diary, households were asked to provide information on household characteristics that are closely correlated with household travel, such as the number and age of persons in the household, number of members employed, income, and the number of vehicles available to the household.

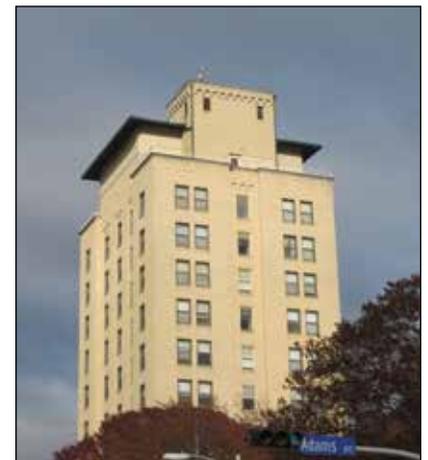
The KTUTS Area Household Travel Survey included 1,444 randomly selected households from within the study area. The joint distribution of household size and income characteristics from the 2000 U.S. Census and the Texas State Data Center (TSDC) population projections for the study area, with the estimated distribution of persons by age cohort and gender, were used to expand the household survey data. The results presented in this section are based on expanded survey data.

### ***Household Size and Income***

Household size and income are used in the travel demand model for estimating and forecasting travel. In general, as household size increases, daily household travel increases. In the same manner, when household income increases, daily household travel increases. By controlling for these two household characteristics, future travel demand can be estimated with greater accuracy. The average household size in the KTUTS area in 2007/2008 was 2.67 persons. Figures 3 and 4 show the distributions of households by household size and household income in the study area, respectively. Nearly a quarter of the households have a household size of one, and roughly 30 percent have a household size of two. Nearly 43 percent of households have an annual household income greater than \$50,000.

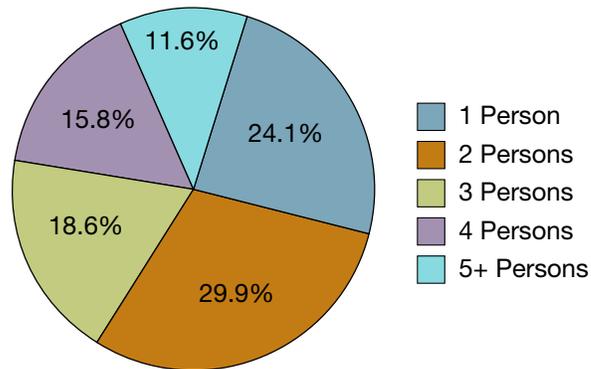


**Households that participated in the survey were randomly selected and were asked to record in a diary the travel made by each person in the household during a 24-hour period.**



Former Kyle Hotel in Temple, TX

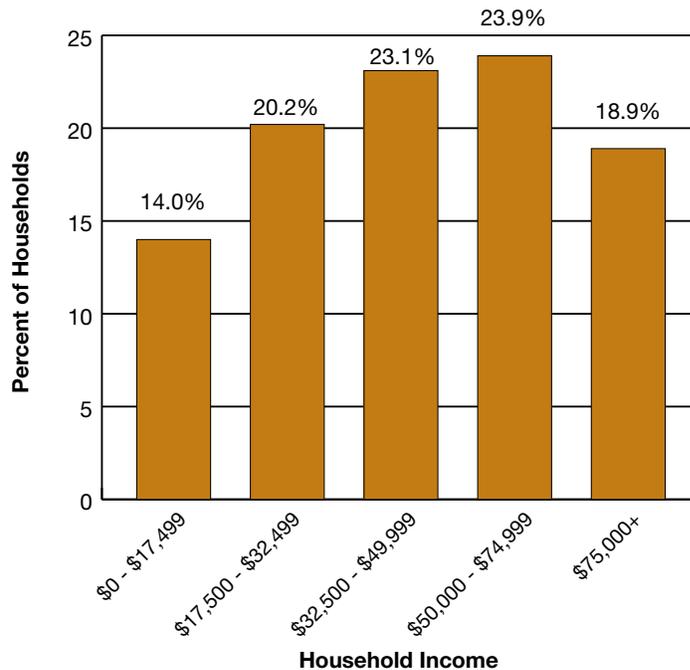
**Figure 3. Distribution of Households by Household Size.**



Generally, household travel increases as the number of vehicles available to the household increases.



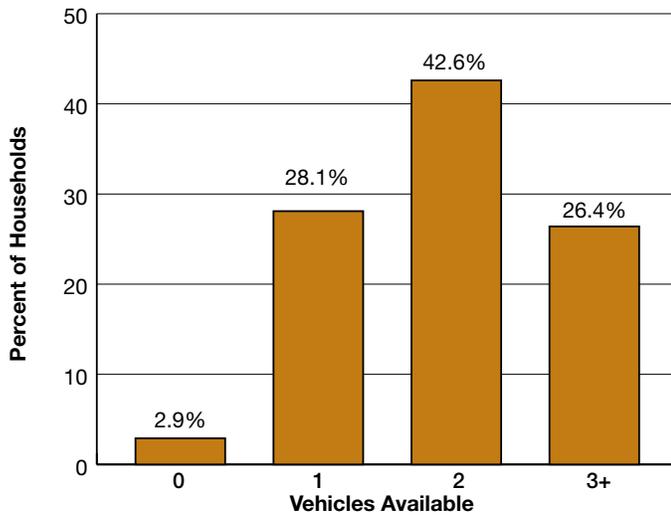
**Figure 4. Distribution of Households by Household Income.**



**Vehicles Available**

Generally, daily household travel increases as the number of vehicles available to the household increases. Household demand for public transportation tends to decrease as vehicle availability to the household increases. Figure 5 shows the distribution of households by number of vehicles available. Nearly 3 percent of households in the study area do not have a vehicle available, and slightly more than 28 percent of the households have only one vehicle available. Over a quarter of households in the study area have three or more vehicles.

**Figure 5. Distribution of Households by Vehicles Available.**



**Age Cohort**

The impact of age on daily travel of household members is more complex than the other household characteristics shown and is not being used directly in the travel demand model. However, age cohort can be used to characterize household life cycle. Figure 6 shows the distribution of persons by age cohort and the percentage of persons not making any internal trips on their survey day. As expected, older persons are less likely to travel than younger persons, but the older population is mobile and contributes significantly to the amount of household travel. The percentage of 65+ age cohorts not making internal trips ranged from 36.6 percent to 51.0 percent.

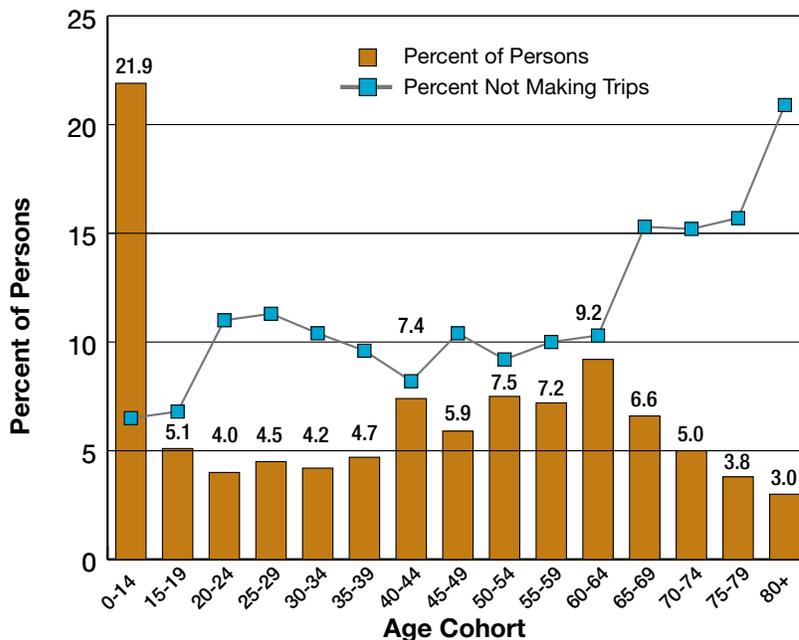
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**Older persons are less likely to travel than younger persons, but the older population is mobile and contributes significantly to the amount of household travel.**

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**Figure 6. Distribution of Persons by Age Cohort.**



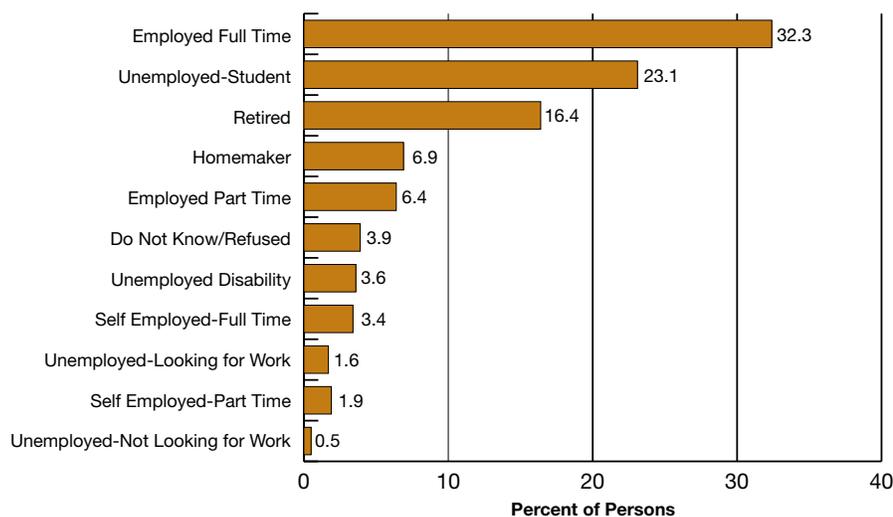
### Employment Status

Employment status is used to characterize household life cycle. Life cycle can be an excellent household characteristic to help forecast future travel demand. It can be defined by a combination of the ages of the head of household and the ages of the children in the household, if any. A young couple of working age with no children will have different daily trip-making characteristics than will a retired couple with no children at home.

Figure 7 provides the distribution of all persons by employment status, regardless of age, in the study area. Nearly one-third of the population is employed full time, and over 23 percent of the population is students.

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Employment status is used to characterize household life cycle.

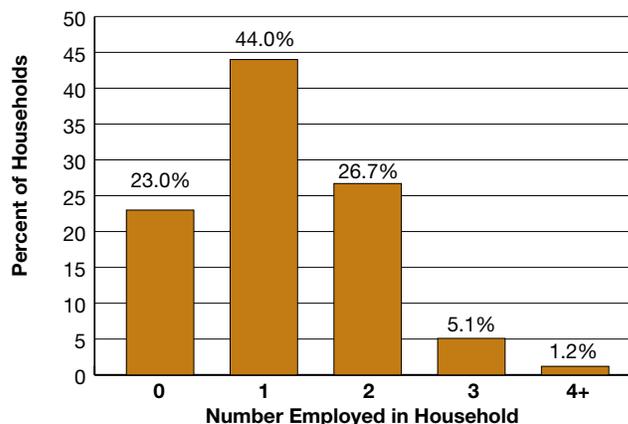
Figure 7. Distribution of Persons by Employment Status.



Source: 2007–2008 Waco MPO Household Travel Survey and TTI Analysis.

Daily household travel also increases as the number of persons employed in the household increases. Figure 8 shows the distribution of households by number of persons employed in the study area. Interestingly, 23 percent of the households do not have an employed household member. This number may stem partially from unemployment and partially from households with retired household members.

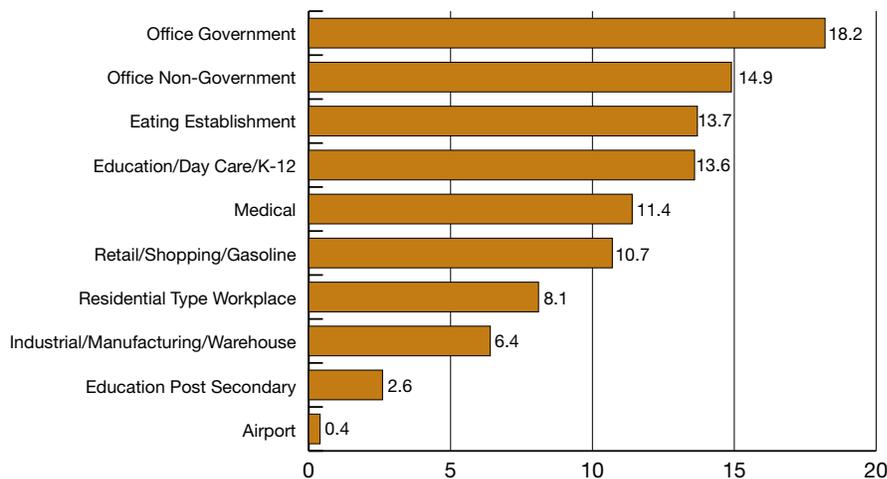
Figure 8. Distribution of Employed Household Members.



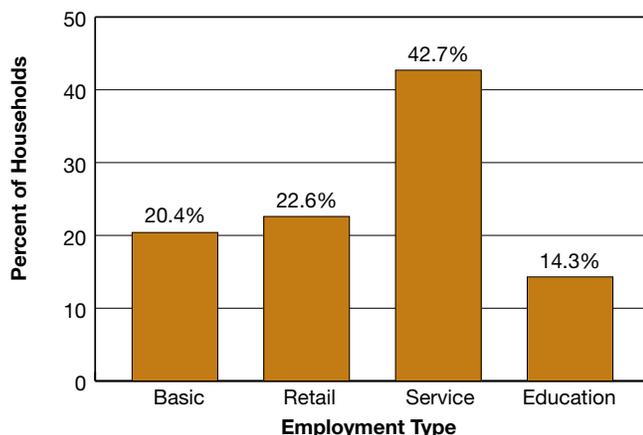
## Employment Type

The household characteristics described previously are used to help estimate the demand (trip productions) for travel. Workplace characteristics are used to help estimate where people are attracted (trip attractions). In the travel demand model, the type of employment is summarized into four employment types—basic, retail, service, and education. While the latter three employment types are fairly self-explanatory, note that the “basic” category includes a variety of industries such as agriculture; forestry; fishing; hunting; quarrying; oil and gas extraction; utilities; manufacturing; wholesale trade; and transportation and warehousing. Each of these employment types has a different attracting power or attraction rate. Figure 9 shows the data on the type of work place for employed persons from the household survey. Over 18 percent of employed persons in the study area work at government offices, nearly 15 percent work at non-government offices, and roughly 14 percent work at eating establishments. Figure 10 shows the data summarized into basic, retail, service, and education work place types by employment, which are used in travel demand modeling (Figure 10).

**Figure 9. Type of Work Place.**



**Figure 10. Distribution of Employed Persons by Basic, Retail, Service, and Education Employment.**



Source: 2010 Killeen-Temple Work Place Travel Survey Technical Summary and TTI Analysis.



**In the travel demand model, the type of employment is summarized into four employment types—basic, retail, service, and education.**



Mary Alice Marshall Performing Arts Building at Temple College

## HOUSEHOLD TRAVEL CHARACTERISTICS

The travel characteristics of households are determined by the purpose for each trip being made at certain locations. In travel demand modeling, trip purposes are defined as home-based work trips (HBW), home-based non-work trips (HBNW), and non-home-based trips (NHB). HBW trips are those trips with one end at home and the other at work. HBNW trips are those trips with one end at home and the other not at work. NHB trips are those trips with neither end at home. Trips are divided into these purposes to account for the different trip length characteristics of each purpose. HBW trips generally have the longest average trip length, while HBNW trips and NHB trips tend to have shorter average trip lengths.



**Person trips include walk, bicycle, and vehicle trips, while vehicle driver trips are those trips made by an individual driving a vehicle.**

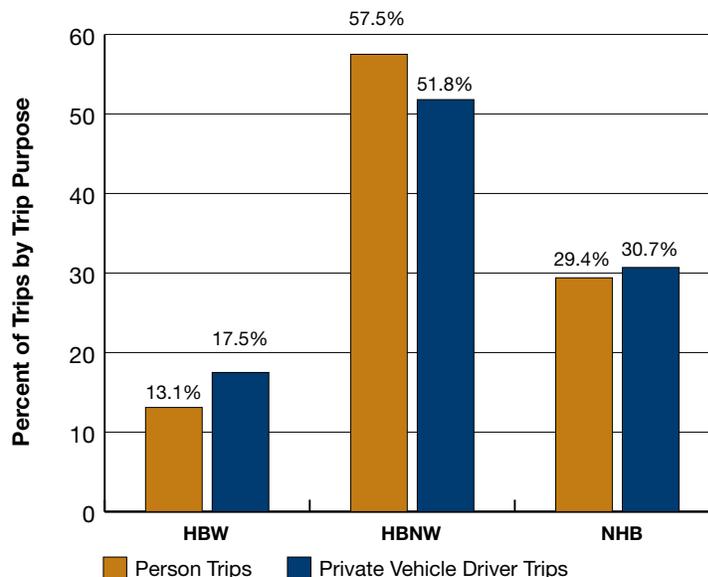
For travel demand model application, the HBNW trip purpose may be further divided among trips to school, trips to shopping centers, and trips to other locations. The trip purposes are also classified in terms of person trips or vehicle driver trips, depending on the mode of travel used. Person trips include walk, bicycle, and vehicle trips, while vehicle driver trips are those trips made by an individual driving a vehicle.

### ***Trip Productions***

Trip ends are divided between trip productions (the home end of the trip) and trip attractions (the non-home end of the trip). If neither end of the trip is at home (NHB), the production end of the trip is defined as the origin end of the trip. These distinctions are important as the number of trip productions is a function of the number of households and the household characteristics, and the number of trip attractions is a function of the number of work places, the number of employees, and the types of employment.

Figure 11 shows the distribution of trip productions by trip purpose in the study area. HBNW trips account for more than half of person trips (57.5 percent), as well as over half of household vehicle trips (51.8 percent).

**Figure 11. Distribution of Trip Productions by Trip Purpose.**



### Trip Production Rates

Among the important products of the household survey are the trip production rates for use in the trip generation step of the travel demand model. Table 4 shows the person trip rates (trips per household) cross-classified by household size and household income for all internal trip purposes combined, that is, trips that begin and end inside the KTUTS MPO area. These trip rates are for all trips by all modes including transit, bicycle, and walk trips. For travel forecasting applications, the cross-classified trip rates are disaggregated by trip purpose into HBW trips, HBNW trips, and NHB trips. As part of the travel forecasting process, the person trips are divided among the modes during the mode split step. The average daily person trip rate for all households, internal to the study area, is around 9.6 trips per household.

**Table 4. Trips per Household Cross-Classified by Household Size and Household Income.**

Household Income Range	Household Size				
	1	2	3	4	5+
\$0-\$17,499	3.7	4.9	8.2	9.8	18.5
\$17,500-\$32,499	3.8	6.1	9.1	11.5	20.7
\$32,500-\$49,999	3.3	7.5	9.4	13.4	20.4
\$50,000-\$74,999	3.9	8.1	12.2	15.6	21.1
\$75,000+	2.2	7.6	11.2	16.9	23.4

### Trip Length

Travel distances vary by trip purpose with the HBW trip purpose having the longest average trip length. The average travel distance and trip length frequency distribution by trip purpose are estimated from the household survey. These measures are used to calibrate the trip distribution step of the travel demand model. The trip distribution model is calibrated so that the modeled average travel distance and trip length frequency distribution by trip purpose agree with the values estimated from the travel surveys.

Over time, the average trip length for HBW trip purposes tends to increase along with urban growth, and the average trip length for HBNW trip purpose tends to remain stable. For HBNW trip purposes, which are largely shopping and school trips, the marketplace provides attraction opportunities such as new retail stores and new schools, as the urban area grows.

Figure 12 shows the distribution of person trips by the length of the trip in miles by trip purpose, while Figure 13 shows the distribution of person trips by trip duration in minutes by trip purpose. The distribution is for internal person trips, which are those trips beginning and ending within the KTUTS area. The average person trip length is 6.9 miles for HBW trips, 4.9 miles for HBNW trips, and 4.4 miles for NHB trips. The average person trip duration is 12.4 minutes for HBW trips, 9.5 minutes for HBNW trips, and 9.2 minutes for NHB trips.



**Travel distances vary by trip purpose with the HBW trip purpose having the longest average trip length.**

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The time-of-day that people travel is generally dictated by the scheduled start times of their activities.

Figure 12. Distribution of Person Trips by Trip Distance in Miles by Trip Purpose.

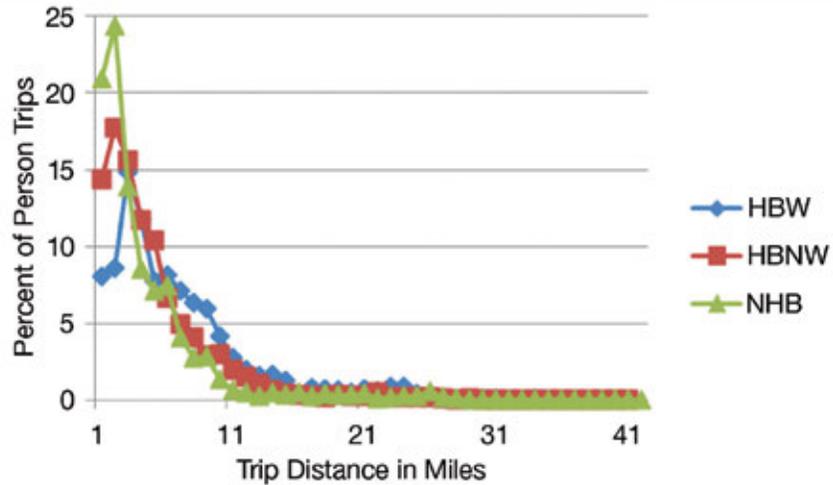
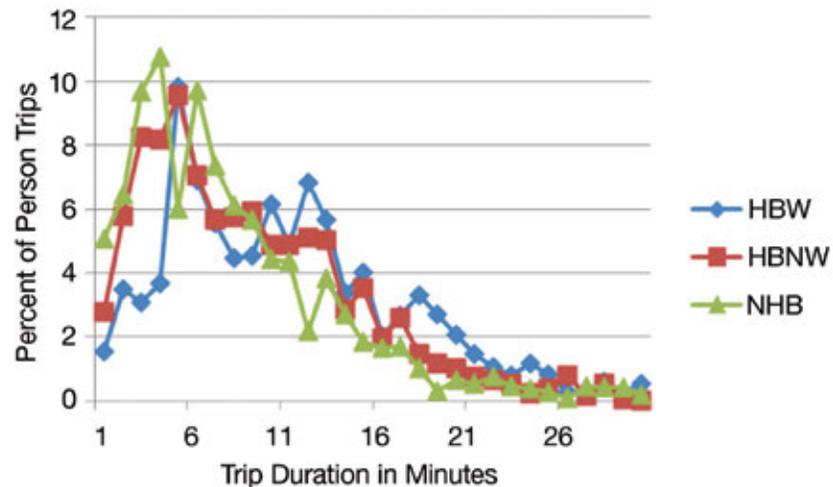


Figure 13. Distribution of Person Trips by Trip Duration in Minutes by Trip Purpose.



Overall, the average person trip length is 5.1 miles, and the average person trip duration is 10.1 minutes.

**Time-of-Day Travel**

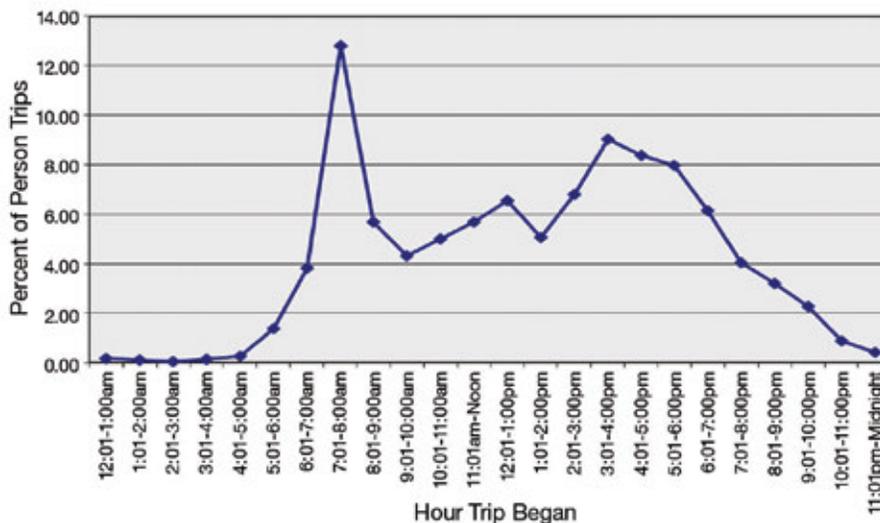
The time of day that people travel is generally dictated by the scheduled start times of their activities (i.e., home to work/home to school). For other trips, the start times are flexible and the decision as to when to make these trips may partially depend on the amount of traffic congestion that the trip maker expects to experience. As the amount of peak-period traffic increases, the trip maker may choose to make discretionary trips during a less congested time of day.

Figure 14 shows the distribution of daily person trips by time of day. The highest percentage of daily person trips occurs during the morning peak, as both home-to-work and home-to-school trips are occurring during this time period. The modest noon peak, the school-to-home peak, and the work-to-home peak are all evident. As the amount of travel in an urban area increases,



the duration of the morning and afternoon peak periods increases in time as people choose to travel just prior to or just after the morning and afternoon peaks. This phenomenon is referred to as peak spreading. Time-of-day travel information may also be used to estimate air quality emissions inventories that are used for air quality photochemical analysis models.

**Figure 14. Distribution of Person Trip Start Times by Hour of the Day.**



**Trip Purpose**

As a part of their travel diary, each household member in the KTUTS Area Household Travel Survey was asked to identify from a list of choices what they did at each trip destination. The information about the trip destination was used to categorize the trip according to trip purpose. In travel demand modeling, typically there are three internal trip purposes—HBW, HBNW, and NHB trips—that are used for forecasting future travel. For each of these trip purposes, trip rates and trip length frequency distributions are estimated from the household survey

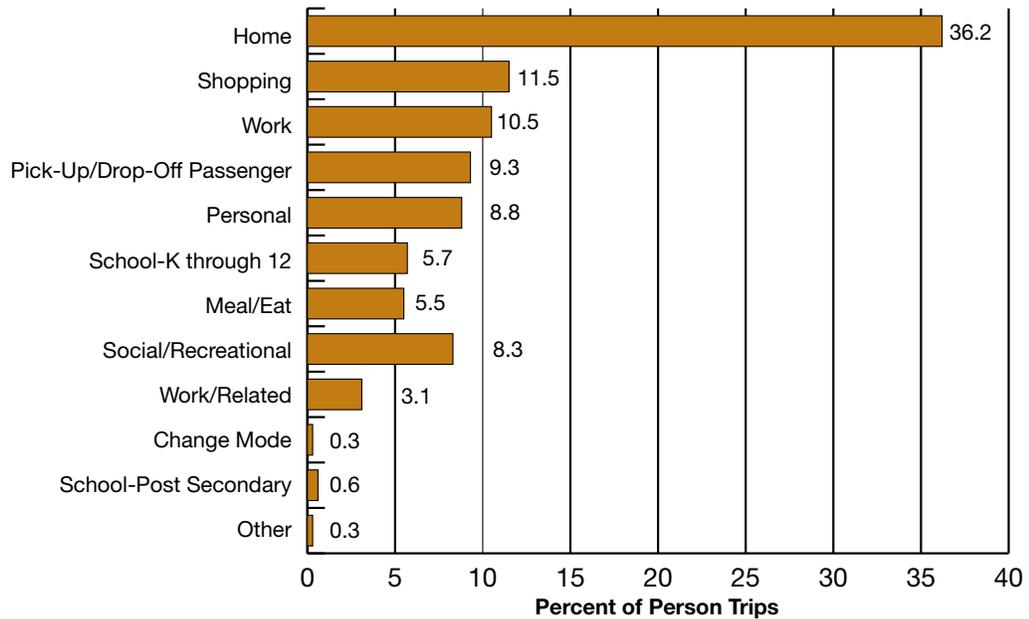
Figure 15 shows the distribution of person trips by the trip destination purposes used in the survey. As would be expected, the most frequent trip destination is the return to home trip, which accounts for 36.2 percent of the person trips on the destination side.

★

**The modest noon peak, the school-to-home peak, and the work-to-home peak are all evident.**



**Figure 15. Distribution of Person Trips by Destination Purpose.**



The household survey provides a representative sampling of trip origins and destinations within the study area. This information is then used in a gravity model formula to estimate trip volumes between distinct geographical areas used in modeling, termed traffic analysis zones (TAZs). Using the results from the household survey, the relative amounts of travel between subregions in the KTUTS area are shown in the *2007 – 2008 Killeen-Temple Metropolitan Planning Organization Household Travel Survey Technical Summary*.

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**The primary purpose of a work place survey is to understand the trip attraction characteristics of basic, retail, service, and education establishments.**

### **WORK PLACE SURVEY**

The primary purpose of a work place survey is to understand the trip attraction characteristics of basic, retail, service, and education establishments. While the household survey collects information on the travel characteristics of persons living in the study area at the household level, the work place survey collects similar information at the destination end of travel. The KTUTS Work Place Travel Survey, like other work place surveys across the U.S., consisted of a combination of survey instruments and data collection efforts, which included:

- A *general survey* of the work place.
- A *travel survey* of employees and visitors at the work place.
- *Counts* of either persons or vehicles traveling to and from the work place.

Data collected from these efforts were used to develop trip attraction rates by purpose, stratified by area type and employment type.

For analysis purposes, TAZs in the work place survey are grouped according to the level of activity within the zone as measured by the density of population and employment within the zone. There were five area types identified in the KTUTS area—the central business district (CBD), the central business district fringe (CBD fringe), urban, suburban, and rural.

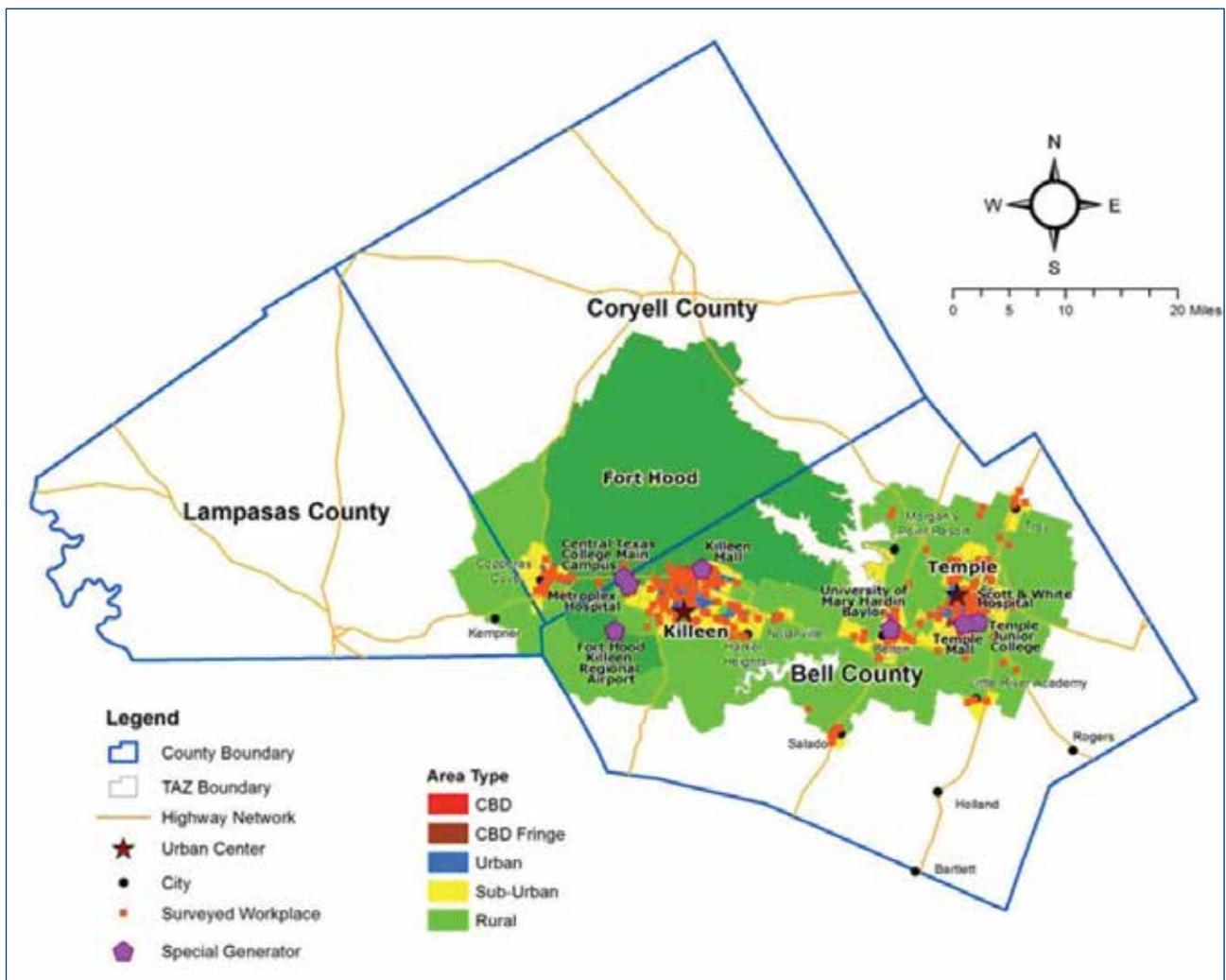
The 2010 KTUTS Work Place Travel Survey included 298 randomly selected business establishments, of which 100 had complete full surveys and 198 had partial surveys. The full surveys consisted of surveys of 1,096 employees and 1,947 visitors or non-employees. The full surveys also included surveys of vehicles owned and leased by the establishments and used for business purposes, and counts of persons or vehicles arriving and departing the establishments. The partial survey mainly included a general survey of the establishment, such as the type, location, total employment, and number of employees at work on the day of the survey.

Figure 16 shows the locations of the establishments that participated in the work place survey. The data presented in this section are based on survey data and are not expanded, unless otherwise noted.

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**The full surveys consisted of surveys of 1,096 employees and 1,947 visitors or non-employees.**

**Figure 16. Killeen-Temple Study Area Surveyed Work Place Locations.**

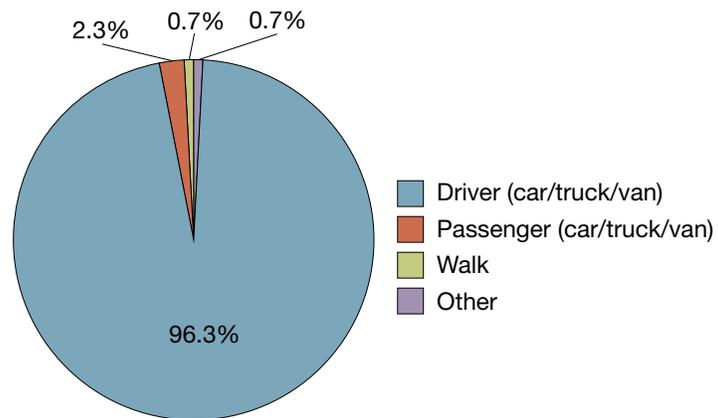


Trip purposes to the work place are categorized to include not only internal home-based (HBW and HBNW) trips and non-home-based (NHB-O and NHB-D) trips at origin and destination locations, but also external trips from and to the study area. The external trips include external origin trips (EXT-O), which are trips whose destinations are outside the study area when leaving the

establishment, and non-resident trips (NON-RES), which are those internal trips to the establishment made by persons who live outside the study area. Attraction rates are then developed for each trip purpose, area type, and employment type for use in travel demand models.

Figure 17 provides the distribution of reported trips to the work place by mode of travel. The majority of trips are by drivers. Over 96 percent are drivers of a vehicle, with less than 3 percent of trips made as a passenger of a vehicle. Less than 1 percent (0.69 percent) of trips was made by walking, with only a few trips made by other modes.

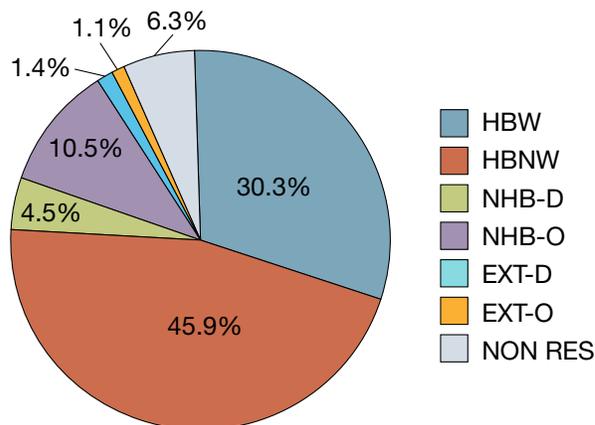
**Figure 17. Distribution of Reported Trips to the Work Place by Mode of Travel.**



Source: 2010 Waco Work Place Travel Survey and TTI Analysis.

Figure 18 shows the distribution of reported trips by trip purpose. Approximately 91.2 percent of the trips are internal trips, with 45.9 percent being HBNW trips, 30.3 percent as HBW trips, and 15.0 percent as NHB trips. The remaining 8.8 percent are external trips, with 1.4 percent being EXT-D trips, another 1.1 percent being EXT-O trips, and 6.3 percent being NON-RES trips.

**Figure 18. Distribution of Reported Trips by Trip Purpose.**



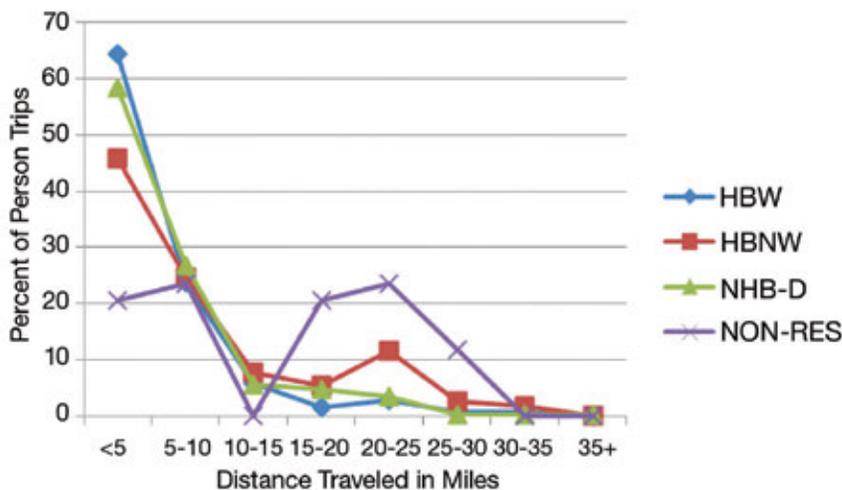
The reported trips for both employees and visitors were geocoded to the study area's TAZs to compute the travel distance by trip purpose. Table 5 shows the average trip lengths by trip purpose for person trips and vehicle trips, while Figure 19 shows the trip length frequency distributions for person trips by travel distance. The average trip lengths and trip length frequency distributions are only for HBW, HBNW, NHB and NON-RES travel.

**Table 5. Average Trip Lengths by Trip Purpose for Person Trips and Vehicle Trips to the Work Place (does not reflect intra-zonal trips).**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	6.1	6.1
HBNW	9.5	9.5
NHB	6.5	6.6
NON-RES	15.8	14.4

Source: 2010 Waco Work Place Travel Survey and TTI Analysis.

**Figure 19. Distribution of Person Trips by Travel Distance.**



As Table 5 shows, the surveyed NON-RES person trips have the highest average length when compared against the average person trip length of HBW, HBNW, and NHB-D. This result is not surprising, as non-residents, by definition, do not live within the study area. This opens up the possibility for longer trips by non-residents because there is no limit on the distance from the origin of their trip to the KTUTS area border. Although normally HBW trip length averages would be anticipated to have a higher average trip length than HBNW trips, note that the average trip lengths shown in Table 5 only include inter-zonal trips, or non-intra-zonal trips. Thus, short HBNW trips that are intra-zonal trips would normally be considered in calculating the HBNW average trip length, but are not included in this analysis. The surveyed average trip lengths and the trip length frequency distribution are used to calibrate the trip distribution step of the travel demand model. The trip distribution model is calibrated so that the modeled average trip length and trip length frequency distributions closely match the average trip length and trip length frequency distribution estimated from the travel surveys.

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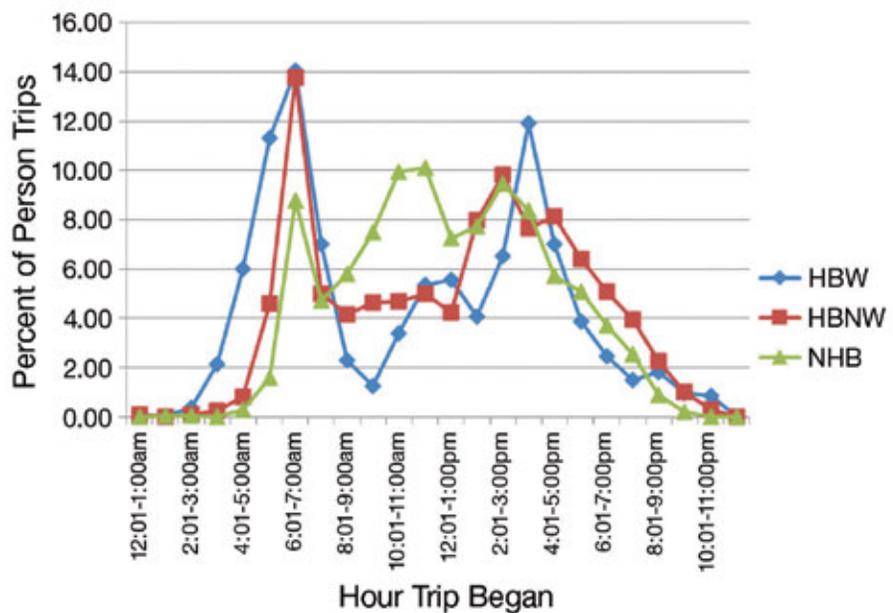
**Trips with a distance between 1 and 5 miles are the most common trip length.**

Trips by purpose type typically have distinct characteristics by time of day that are consistent for nearly all urban areas. Figure 20 shows the distribution of trips by purpose by the time the trip began, based on expanded data. The results indicate that the characteristics for travel in the KTUTS area are similar to those for other urban areas. HBW trips exhibit two time periods when those types of trips are most likely to occur, in the morning and afternoon. The morning peak is between 6:01 a.m. and 7:00 a.m., and the afternoon peak is between 3:01 p.m. and 4:00 p.m. Typically, HBNW and NHB trips are more spread throughout the day—though peaks in NHB trips can be seen in the morning between, during lunch, and in the early afternoon. The HBNW lunch peak is not nearly as pronounced as the peaks experienced in HBW and NHB trips around lunch.



**Trips by purpose typically have distinct characteristics by time of day that are consistent for nearly all urban areas.**

**Figure 20. Distribution of Person Trips by Time of Day.**



### SPECIAL GENERATORS

Eight important work places surveyed were treated as special generators. These special generators included one university (University of Mary Hardin Baylor), two colleges (Central Texas College Main Campus and Temple Junior College), one airport (Fort Hood Killeen Regional Airport), two shopping centers (Killeen Mall and Temple Mall), and two hospitals (Metroplex Hospital and Scott & White Hospital). Special generators are those types of employment locations that are considered unique and subject to modeling outside the typical modeling framework. The methodology used to survey special generators is the same as that used for a full work place survey, except to a much larger scale.



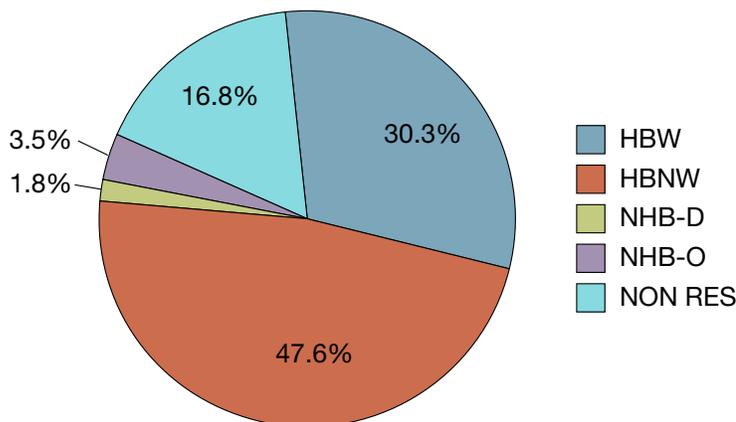
Parker Academic Center at the UMHB

**Mary Hardin Baylor (UMHB)**

Vehicle counts at the University of Mary Hardin Baylor were conducted at 11 locations and totaled 11,644, with approximately 0.8 percent (91 trips) being commercial vehicle trips. A total of 149 employees and 285 non-employees (255 students and 30 visitors) participated in the survey. It was estimated that all 350 employees were at work on the travel survey day.

Figure 21 shows the surveyed trips by trip purpose at UMHB. Nearly half of the surveyed trips were HBNW, which makes sense because this location is a college setting with students traveling from home to school or school to home. Over 30 percent of the surveyed trips were HBW, which may have consisted of professors, staff, and student workers.

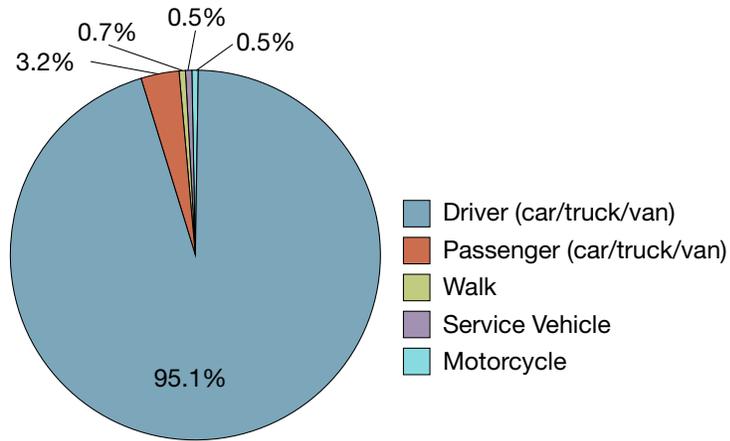
**Figure 21. Surveyed Trips by Trip Purpose at UMHB.**



**Special generators are those types of development that are considered unique and subject to modeling outside the typical modeling framework.**

Figure 22 shows the distribution of mode of travel to UMHB. Over 95 percent of trips were made by vehicle drivers, with passenger, walk, service vehicle, and motorcycle combining to comprise the remaining 5 percent of travel mode for those surveyed.

**Figure 22. Distribution of Mode of Travel to UMHB.**



★

**The data for all Special Generators was processed separately and average trip length was calculated for travel distance by trip purpose for each location.**

The internal survey trips were geocoded for both employees and visitors to the TAZs in the KTUTS area. The data were processed and average trip length computed for travel distance by trip purpose. These data are based on a small number of observations, but they do provide a reference of comparison with the average trip lengths found for the full work place survey. Table 6 shows the average trip lengths for the UMHB trips and Table 7 shows the expanded survey results for UMHB.

**Table 6. Average Trip Length for Surveyed Trips to UMHB.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	5.40	5.40
HBNW	10.06	9.31
NHB-D	5.36	5.75
NON-RES	13.00	13.00
ALL	8.00	7.89

**Table 7. UMHB Person and Auto-Driver Trips and Attraction Rates.**

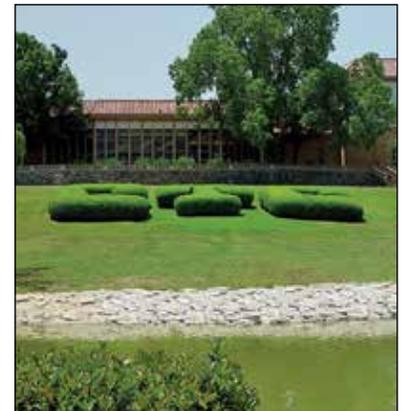
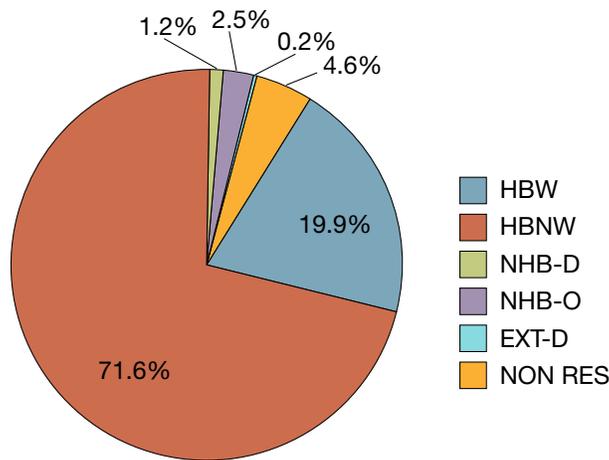
Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	1,119	3.20	1,102	3.15
HBNW	8,029	22.94	7,764	22.18
NHB	332	0.95	321	0.92
Non-Resident Trips	2,106	6.02	2,045	5.84
Commercial Vehicle Trips	91	0.26	91	0.26
<b>Total</b>	<b>11,677</b>	<b>33.37</b>	<b>11,323</b>	<b>32.35</b>

**Central Texas College (CTC), Central Campus**

At CTC’s central campus in Killeen, vehicle counts were conducted at six locations and totaled 16,551, with nearly 2 percent (327 trips) being commercial vehicle trips. A total of 147 employees and 543 non-employees (458 students and 85 visitors) participated in the survey. It was estimated that 520 of the 600 employees were at work during the travel survey day.

Figure 23 shows the surveyed trips by trip purpose at CTC. Over 70 percent were HBNW, which makes sense because this is a college setting with students traveling from home to school or school to home. Nearly 20 percent were HBW. This group of trips largely stems from professors, staff, and student workers.

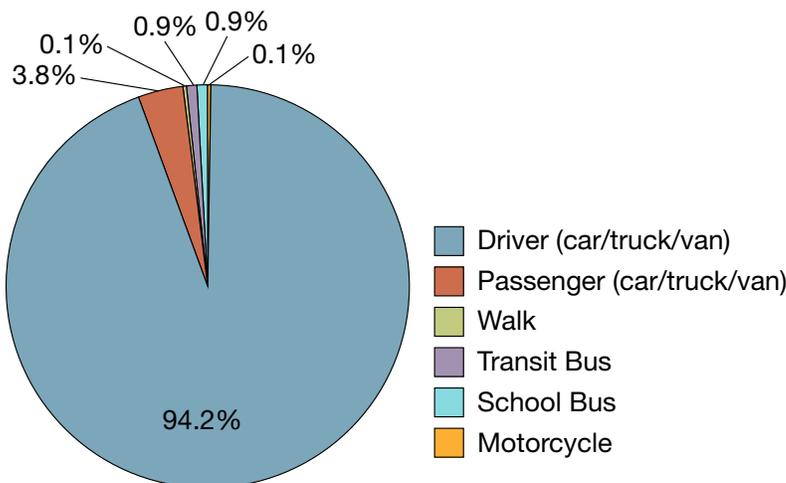
**Figure 23. Surveyed Trips by Trip Purpose at CTC.**



Central Texas College

Figure 24 shows the distribution of mode of travel to CTC. Over 94 percent of trips were made by vehicle drivers, nearly 4 percent of trips were made as passengers, and the remaining trips consisted of the modes of walk, transit bus, school bus, and motorcycle.

**Figure 24. Distribution of Mode of Travel to CTC.**



The internal survey trips were geocoded for both employees and visitors to the TAZs in the KTUTS area. Similar to those calculated for UMHB previously, Table 8 shows the average trip lengths for the CTC trips. Table 9 shows the expanded survey results for CTC.

**Table 8. Average Trip Length for Surveyed Trips to CTC.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	4.89	4.89
HBNW	8.00	8.24
NHB-D	10.22	9.62
NON-RES	-	-
ALL	8.07	7.92

**Table 9. CTC Person and Auto-Driver Trips and Attraction Rates.**

Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	1,262	2.10	1,234	2.06
HBNW	14,827	24.71	13,688	22.81
NHB	317	0.53	294	0.49
Non-Resident Trips	742	1.24	686	1.14
Commercial Vehicle Trips	327	0.55	327	0.55
<b>Total</b>	<b>17,425</b>	<b>29.13</b>	<b>16,229</b>	<b>27.05</b>



The CTC internal survey trips were geocoded for both employees and visitors to the TAZs in the KTUTS area.



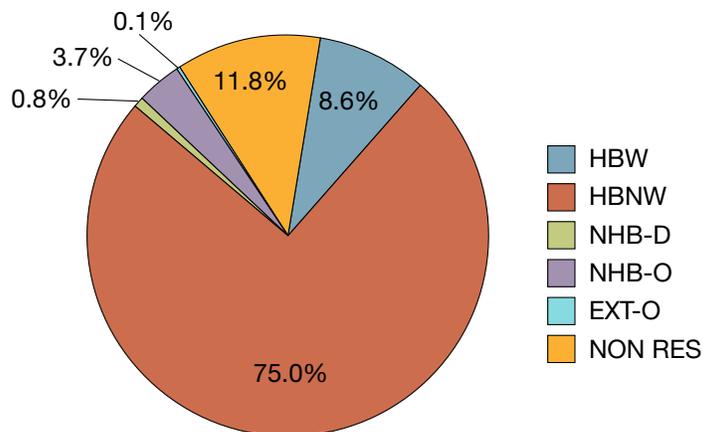
Marc A. Nigliazzo Administration Building, Temple Junior College.

**Temple Junior College (TJC)**

Vehicle counts at TJC were conducted at eight locations and totaled 9,469 vehicles, with approximately 0.9 percent (84 trips) being commercial vehicle trips. A total of 59 employees and 561 non-employees (548 students and 13 visitors) participated in the survey. It was estimated that 475 of the 517 employees were at work during the travel survey day.

Figure 25 shows the surveyed trips by trip purpose at TJC. Approximately 75 percent of the surveyed trips were HBNW, which makes sense again because this is a college setting with students traveling from home to school or school to home. Less than 9 percent (8.63 percent) were HBW, which is a noticeably smaller percentage than that observed for UMHB or CTC. Interestingly, there was a higher percentage of NON-RES trips observed (11.77 percent) at TJC, than the percentage of HBW trips observed.

**Figure 25. Surveyed Trips by Trip Purpose at TJC.**




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**Vehicle counts at TJC were conducted at eight locations and totaled 9,469 vehicles.**

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Figure 26 shows the distribution of mode of travel to TJC. Over 94 percent of trips were made by vehicle drivers, nearly 4 percent of trips were made as passengers, and the remaining trips consisted of the modes of walk, bicycle, and transit bus.

**Figure 26. Distribution of Mode of Travel to TJC.**

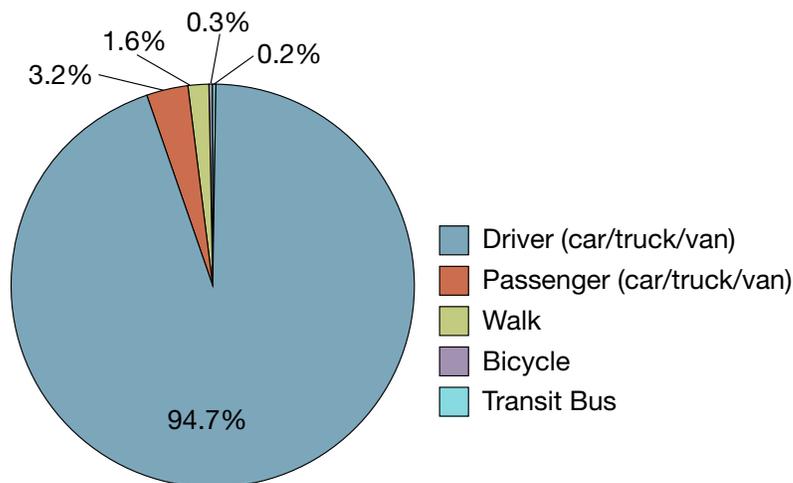


Table 10 provides the average trip lengths for the TJC trips and Table 11 shows the expanded survey results for TJC.

**Table 10. Average Trip Length for Surveyed Trips to TJC.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	5.33	5.25
HBNW	6.16	6.26
NHB-D	6.15	6.62
NON-RES	16.00	13.40
ALL	6.53	6.52

**Table 11. TJC Person and Auto-Driver Trips and Attraction Rates.**

Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	863	1.67	855	1.65
HBNW	7,653	14.80	6,994	13.53
NHB	230	0.45	211	0.41
Non-Resident Trips	1,208	2.34	1,106	2.14
Commercial Vehicle Trips	84	0.16	84	0.16
<b>Total</b>	<b>10,038</b>	<b>19.42</b>	<b>9,250</b>	<b>17.89</b>

★

**Vehicle counts at FHK Regional Airport were conducted at two locations and totaled 1,759 vehicles.**



Fort Hood Main Gate

**Fort Hood Killeen (FHK) Regional Airport**

Vehicle counts at FHK Regional Airport were conducted at two locations and totaled 1,759 vehicles, with approximately 7.6 percent (133 trips) being commercial vehicle trips. A total of 24 employees and 134 non-employees participated in the survey. It was estimated that 150 of the 250 total employees were at work on the travel survey day.

Figure 27 shows the surveyed trips by trip purpose at FHK Regional Airport. Nearly half of the surveyed trips (48.1 percent) were HBNW. Nearly a quarter of the trips were NON-RES, over 17 percent were HBW trips, and the remaining 10 percent of the trips were EXT-O, NHB O, or NHB-D.

**Figure 27. Surveyed Trips by Trip Purpose at FHK Regional Airport.**

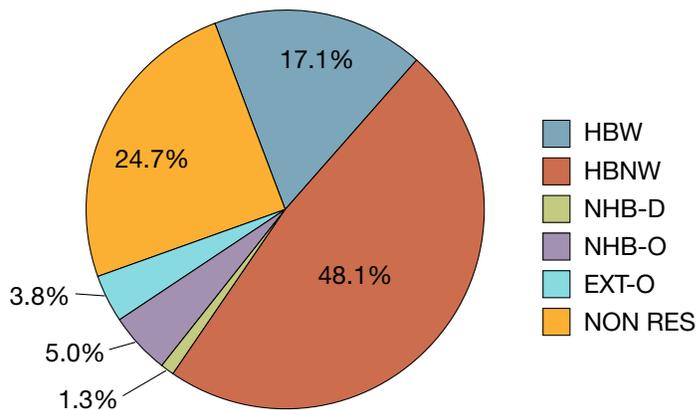


Figure 28 provides the distribution of mode of travel to FHK Regional Airport. Nearly 70 percent of the trips were made by vehicle drivers, approximately a quarter of the trips were made by airplane, and the remaining trips, approximately 6 percent, were made as either a vehicle passenger, by taking a taxi/limousine, or via a service vehicle.

**Figure 28. Distribution of Mode of Travel to FHK Regional Airport.**

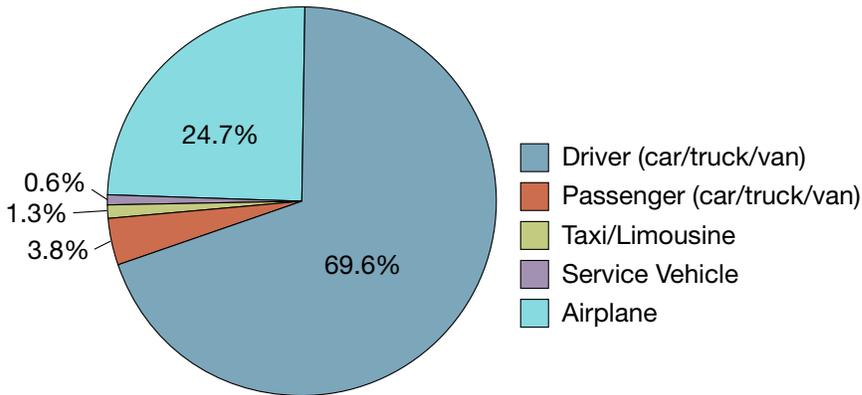


Table 12 shows the average trip lengths for the FHK Regional Airport trips and Table 13 shows the expanded survey results for the FHK Regional Airport.

★

**Nearly half of the surveyed trips at FHK were HBNW and about half were trips made by non-residents.**

**Table 12. Average Trip Length for Surveyed Trips to FHK Regional Airport.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	5.00	5.00
HBNW	7.21	7.31
NHB-D	5.75	5.50
NON-RES	10.00	7.50
ALL	7.43	7.00

**Table 13. FHK Regional Airport Person and Auto-Driver Trips and Attraction Rates.**

Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	351	1.40	328	1.31
HBNW	1,350	5.40	752	3.01
NHB	83	0.33	51	0.20
Non-Resident Trips	641	2.56	386	1.54
Commercial Vehicle Trips	133	0.53	133	0.53
<b>Total</b>	<b>2,558</b>	<b>10.22</b>	<b>1,650</b>	<b>6.59</b>

### Killeen Mall

At the Killeen Mall, vehicle counts were conducted at five locations and totaled 26,308 vehicles, with 0.9 percent (237 trips) being commercial vehicle trips. A total of 123 employees and 569 non-employees participated in the survey. It was estimated that 250 of the total 600 employees were at work during the travel survey day.

Figure 29 shows the surveyed trips by trip purpose at the Killeen Mall. Approximately two-thirds of the surveyed trips were HBNW. Over 15 percent of the surveyed trips were HBW trips, with over 9 percent of the surveyed trips being NHB-O. Both NHB-D and NON-RES each encompassed approximately 4 percent of the surveyed trips. Only one of the surveyed trips (0.07 percent) was EXT-O.

**Figure 29. Surveyed Trips by Trip Purpose at the Killeen Mall.**

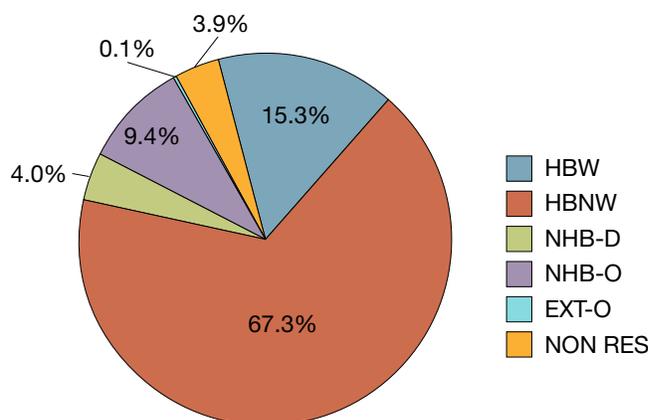
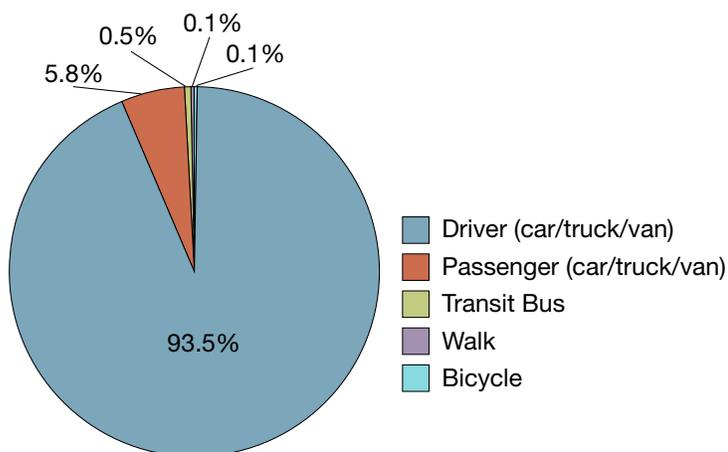


Figure 30 provides the distribution of mode of travel to the Killeen Mall. The vast majority (93.5 percent) of surveyed trips were made as a driver. Nearly 6 percent of the surveyed trips were made as a passenger. Transit bus trips, walk trips, and bicycle trips combined accounted for less than 1 percent of all surveyed trips.

**Figure 30. Distribution of Mode of Travel to the Killeen Mall.**



★  
**Vehicle counts at the Killeen Mall were conducted at five locations and totaled 26,308 vehicles.**



★

**Nearly two-thirds of the survey trips at Killeen Mall were HBNW and about 4 percent were from non-residents.**

Table 14 shows the average trip lengths for the Killeen Mall trips and Table 15 shows the expanded survey results for the Killeen Mall.

**Table 14. Average Trip Length for Surveyed Trips to the Killeen Mall.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	7.17	7.10
HBNW	5.52	5.40
NHB-D	6.38	6.50
NON-RES	8.00	8.00
ALL	5.82	5.82

**Table 15. Killeen Mall Person and Auto-Driver Trips and Attraction Rates.**

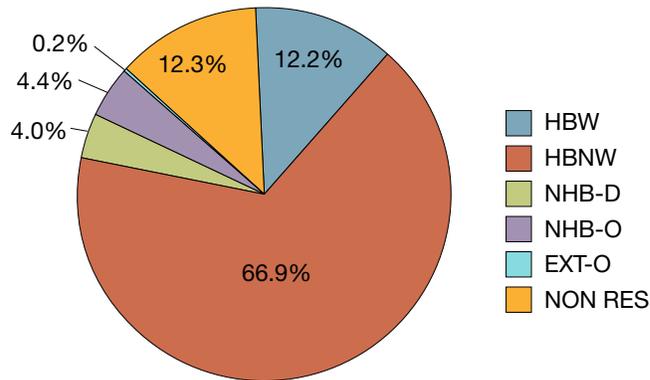
Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	610	1.02	554	0.92
HBNW	29,481	49.13	20,736	34.56
NHB	2,775	4.63	1,957	3.26
Non-Resident Trips	1,190	1.98	845	1.41
Commercial Vehicle Trips	237	0.40	237	0.40
<b>Total</b>	<b>34,056</b>	<b>57.16</b>	<b>24,329</b>	<b>40.55</b>

### Temple Mall

Vehicle counts at the Temple Mall were conducted at six locations and totaled 9,065 vehicles, with 1.2 percent (107 trips) being commercial vehicle trips. A total of 93 employees and 583 non-employees participated in the survey. It was estimated that 200 of the total 375 employees were at work during the travel survey day.

Figure 31 shows the surveyed trips by trip purpose at the Temple Mall. Similar to the Killeen Mall, approximately two-thirds of the surveyed trips (66.9 percent) at the Temple Mall were HBNW. NON-RES surveyed trips and HBW trips each comprised approximately 12 percent of the surveyed trips; while NHB-D and NHB-O each comprised approximately 4 percent of the surveyed trips. Also similar to the Killeen Mall, the Temple Mall had a very small percentage of trips (0.15 percent) classified as EXT-O.

**Figure 31. Surveyed Trips by Trip Purpose at the Temple Mall.**

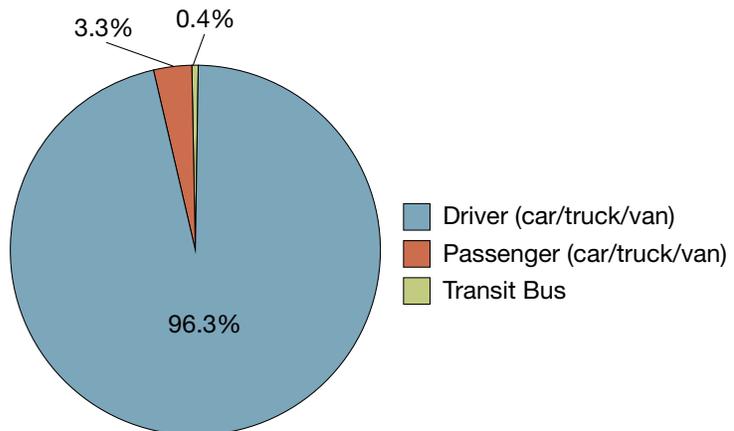


★  
**Vehicle counts at the Temple Mall were conducted at six locations and totaled 9,065 vehicles**



Figure 32 presents the distribution of mode of travel to the Temple Mall. An even higher percentage of surveyed trips (96.3 percent) than the trips recorded at the Killeen Mall (93.5 percent) were made as drivers of vehicles. Over 3 percent of the trips were made as a passenger, and less than half of a percent of the trips (0.4 percent) were made via transit bus.

**Figure 32. Distribution of Mode of Travel to the Temple Mall.**





The internal survey trips were geocoded for both employees and visitors to the TAZs in the KTUTS area. Table 16 shows the average trip lengths for the Temple Mall trips and Table 17 shows the expanded survey results for the Temple Mall.

★

**Two-thirds of the surveyed trips to the Temple Mall were HBNW and about 12 percent were non-resident.**

**Table 16. Average Trip Length for Surveyed Trips to the Temple Mall.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	3.00	3.00
HBNW	5.80	6.05
NHB-D	5.64	5.58
NON-RES	10.08	9.57
ALL	6.11	6.10

**Table 17. Temple Mall Person and Auto-Driver Trips and Attraction Rates.**

Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	411	1.10	390	1.04
HBNW	9,274	24.73	6,539	17.44
NHB	919	2.45	652	1.74
Non-Resident Trips	1,018	2.72	719	1.92
Commercial Vehicle Trips	1.07	0.29	107	0.29
<b>Total</b>	<b>11,729</b>	<b>31.29</b>	<b>8,407</b>	<b>22.43</b>

★

**Vehicle counts at Metroplex Hospital were conducted at eight locations and totaled 7,895 vehicles.**



**Metroplex Hospital**

At the Metroplex Hospital, vehicle counts were conducted at eight locations and totaled 7,895 vehicles, with 0.9 percent (69 trips) being commercial vehicle trips. A total of 74 employees and 128 visitors participated in the survey. It was estimated that 675 of the total 700 employees were at work during the travel survey day.

Figure 33 shows the surveyed trips by trip purpose at the Metroplex Hospital. Over half (55.2 percent) of the surveyed trips were HBNW. Approximately one-third of the surveyed trips were HBW trips. Over 5 percent of the surveyed trips were NON-RES, over 4 percent of the surveyed trips were NHB-O, and less than 1 percent of the surveyed trips were NHB-D.

**Figure 33. Surveyed Trips by Trip Purpose at the Metroplex Hospital.**

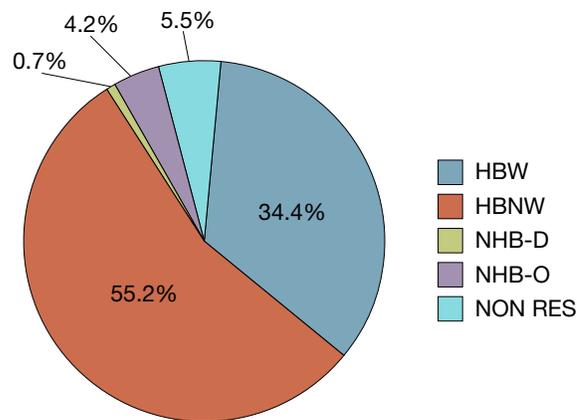
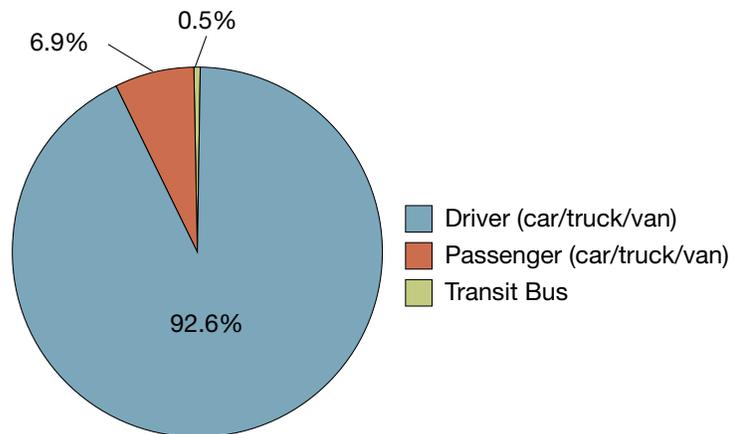


Figure 34 shows the distribution of mode of travel to the Metroplex Hospital. A majority of surveyed trips were made as a driver. Almost 7 percent of the surveyed trips were made as a passenger. Only a small percentage (0.5 percent) of the surveyed trips, were made using transit bus.

**Figure 34. Distribution of Mode of Travel to the Metroplex Hospital.**



The internal survey trips were geocoded for both employees and visitors to the TAZs in the KTUTS area. Table 18 provides the average trip lengths for the Metroplex Hospital trips and Table 19 shows the expanded survey results for the Metroplex Hospital.

**Table 18. Average Trip Length for Surveyed Trips to the Metroplex Hospital.**

Trip Purpose	Average Person Miles	Average Vehicle Miles
HBW	2.86	3.00
HBNW	7.75	8.00
NHB-D	2.75	3.00
NON-RES	-	-
ALL	5.74	5.81

**Table 19. Metroplex Hospital Person and Auto-Driver Trips and Attraction Rates.**

Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	1,350	1.93	1,317	1.88
HBNW	8,137	11.62	5,641	8.06
NHB	310	0.44	221	0.32
Non-Resident Trips	619	0.88	427	0.61
Commercial Vehicle Trips	69	0.10	6,935	0.10
<b>Total</b>	<b>10,485</b>	<b>14.97</b>	<b>7,675</b>	<b>10.97</b>

### **Scott & White Hospital**

Vehicle counts at the Scott & White Hospital were conducted at 12 locations and totaled 26,916 vehicles, with 1.8 percent (469 trips) being commercial vehicle trips. Intercept surveys were not conducted at the site as originally intended. Thus, further disaggregated data are not available. It was estimated that 6,200 of the total 7,000 employees were at work during the travel survey day.

Table 20 shows the expanded survey results for the Scott & White Hospital. The total trips and trip rates were estimated by multiplying the non-commercial vehicle counts with the average employee and visitor auto-driver vehicle occupancy.

**Table 20. Scott & White Hospital Person and Auto-Driver Trips and Attraction Rates**

Trip Purpose	Person Trips	Person Trip Rates	Auto-Driver Trips	Auto-Driver Trip Rates
HBW	11,668	1.67	11,559	1.65
HBNW	20,494	2.93	12,236	1.75
NHB	899	0.13	607	0.09
Non-Resident Trips	2,282	0.33	1,438	0.21
Commercial Vehicle Trips	469	0.07	469	0.07
<b>Total</b>	<b>35,812</b>	<b>5.13</b>	<b>26,309</b>	<b>3.77</b>

The total trips for each special generator were estimated by multiplying the non-commercial vehicle counts with the average employee and visitor auto-driver vehicle occupancy. The trip rates for each special generator were estimated by dividing the total trips by the total employment at the site.



Scott & White Hospital, Temple, Texas

## EXTERNAL SURVEY

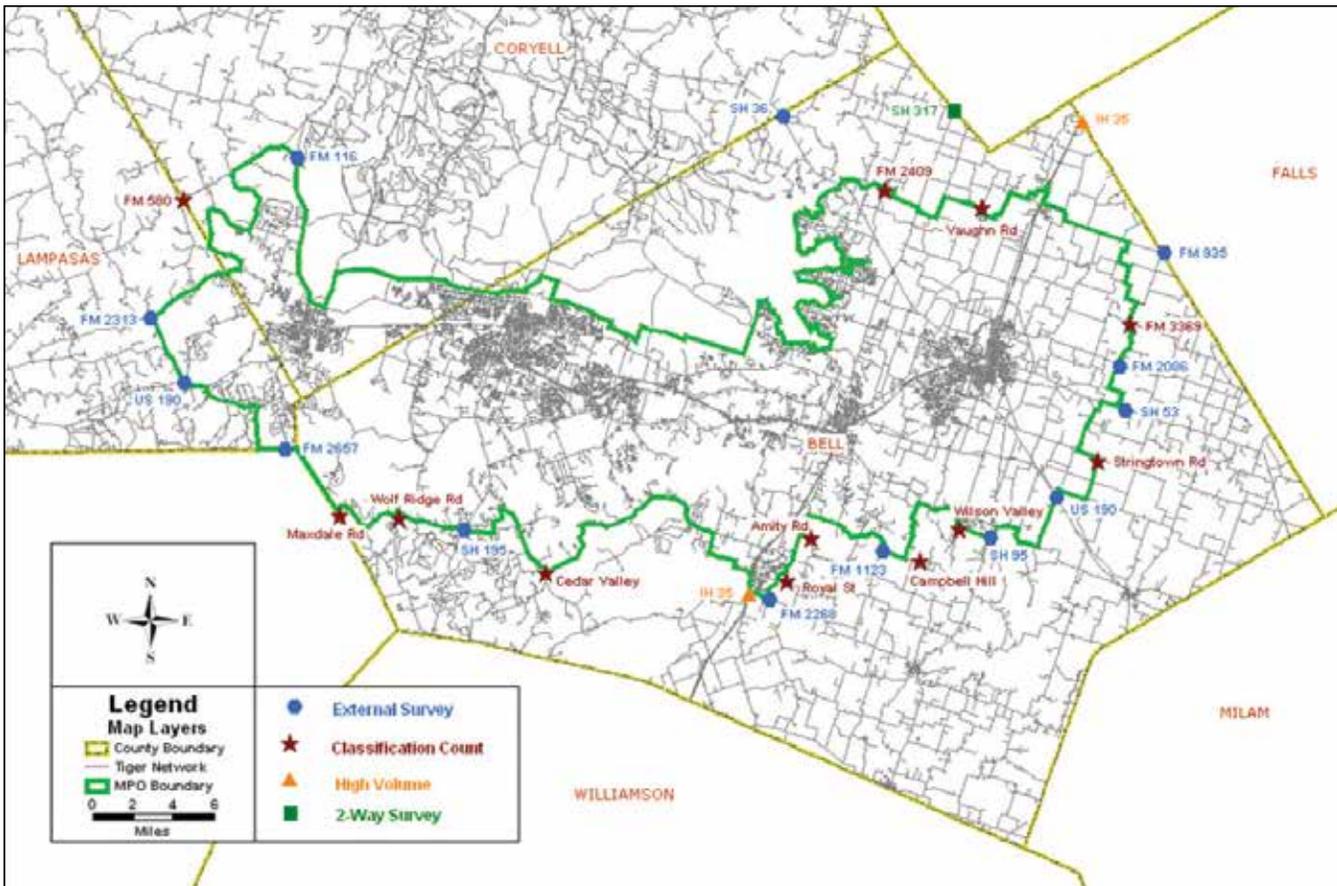
The primary purpose of the external station survey is to understand the travel patterns of people and vehicles entering and exiting the study area. These trips are subsequently divided between trips passing through the study area (external-through trips) and trips by persons coming into the study area to conduct activities within the study area (external-local trips). Surveys are conducted during daylight hours for one day at each designated location. Additionally, 24-hour vehicle classification counts are performed on the same day as the survey at each survey location. These counts provide a basis for expanding the survey data to represent the average weekday movements into and out of the study area. Data are also collected on the movements of the vehicle during the survey day prior to the point at which the vehicle is surveyed. These data provide a basis for estimating the amount of travel occurring within the study area prior to the time of the survey.

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The primary purpose of the external station survey is to understand the travel patterns of people and vehicles entering and exiting the study area.

There were 28 roadways/highways that crossed the border of the KTUTS area, and 14 of these locations were selected as locations to conduct external travel surveys. One of the external stations selected for surveying was surveyed in both directions because it bordered the Waco study area. Thus, external travel data at this site were collected for both the KTUTS area and the Waco area. Two additional sites were designated as high-volume sites. Instead of performing a

Figure 35. KTUTS External Station Locations.



travel survey at these locations, a license plate matching method was used in collecting external travel data for non-commercial vehicles at these sites. Travel data for commercial vehicles was gathered using an intercept interview method at weigh stations, rest areas, and truck stops. Figure 35 shows the locations of the external station and vehicle classification sites for the KTUTS area.

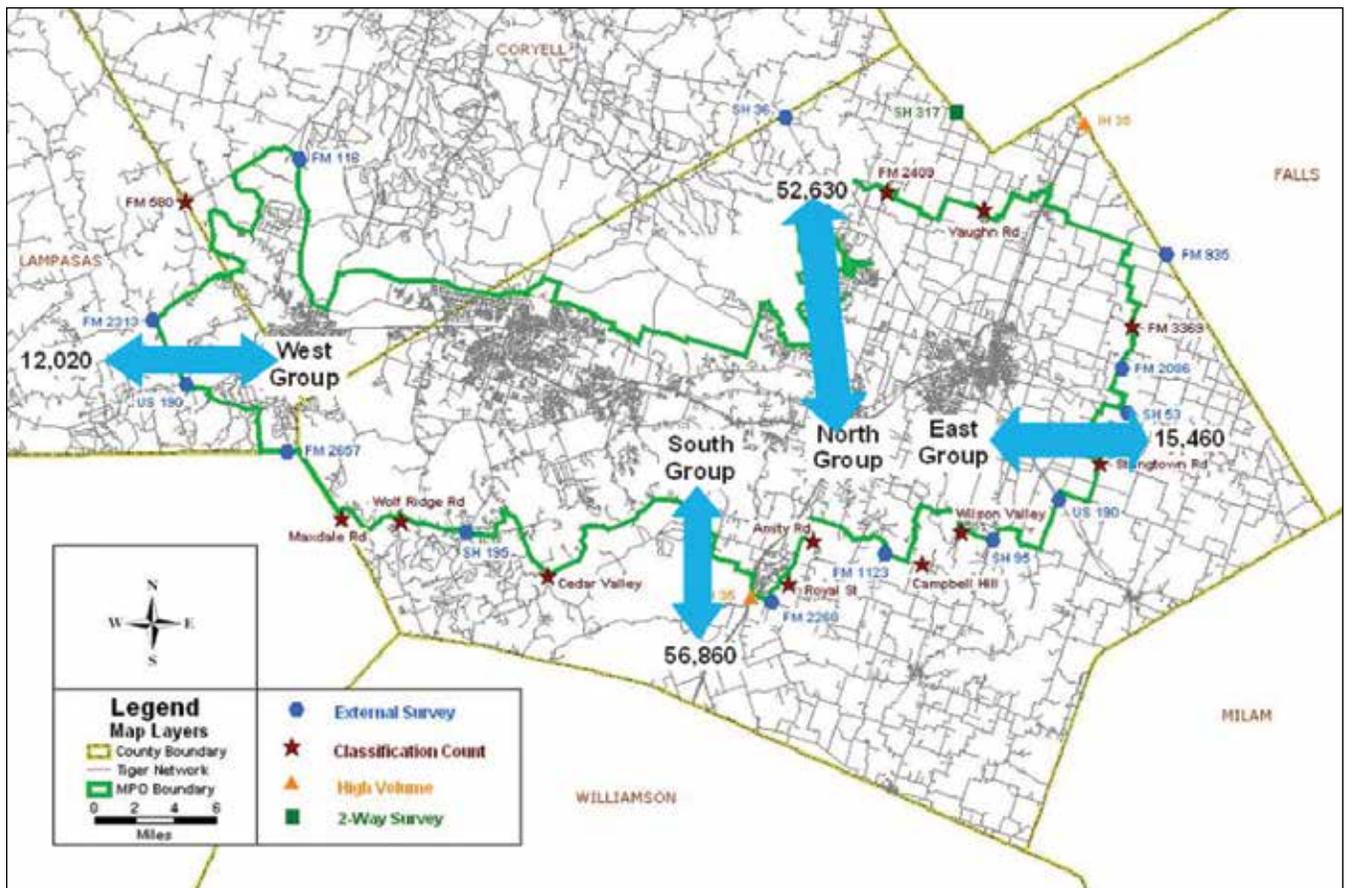
Just under 4,500 vehicles were surveyed as part of the KTUTS external survey. Approximately 80.6 percent of the surveyed vehicles were non-commercial vehicles and 19.4 percent were commercial vehicles. These estimates do not reflect those non-commercial vehicles at the high-volume stations on IH 35 that were not surveyed, but were included in the license plate matching portion of the study.

The estimates presented in this section are based on expanded survey data. Nearly 178,000 vehicles were estimated to enter or leave the KTUTS area on a daily basis. It is estimated that about 145,600 persons enter or leave by non-commercial vehicles and that about 32,400 persons enter or leave by commercial vehicles. Figures 36 and 37 show the estimates of external-local and external-through trip movements of non-commercial and commercial vehicles by direction and location group, respectively.

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**It is estimated that nearly  
178,000 vehicles enter  
or leave the KTUTS area  
on a daily basis.**

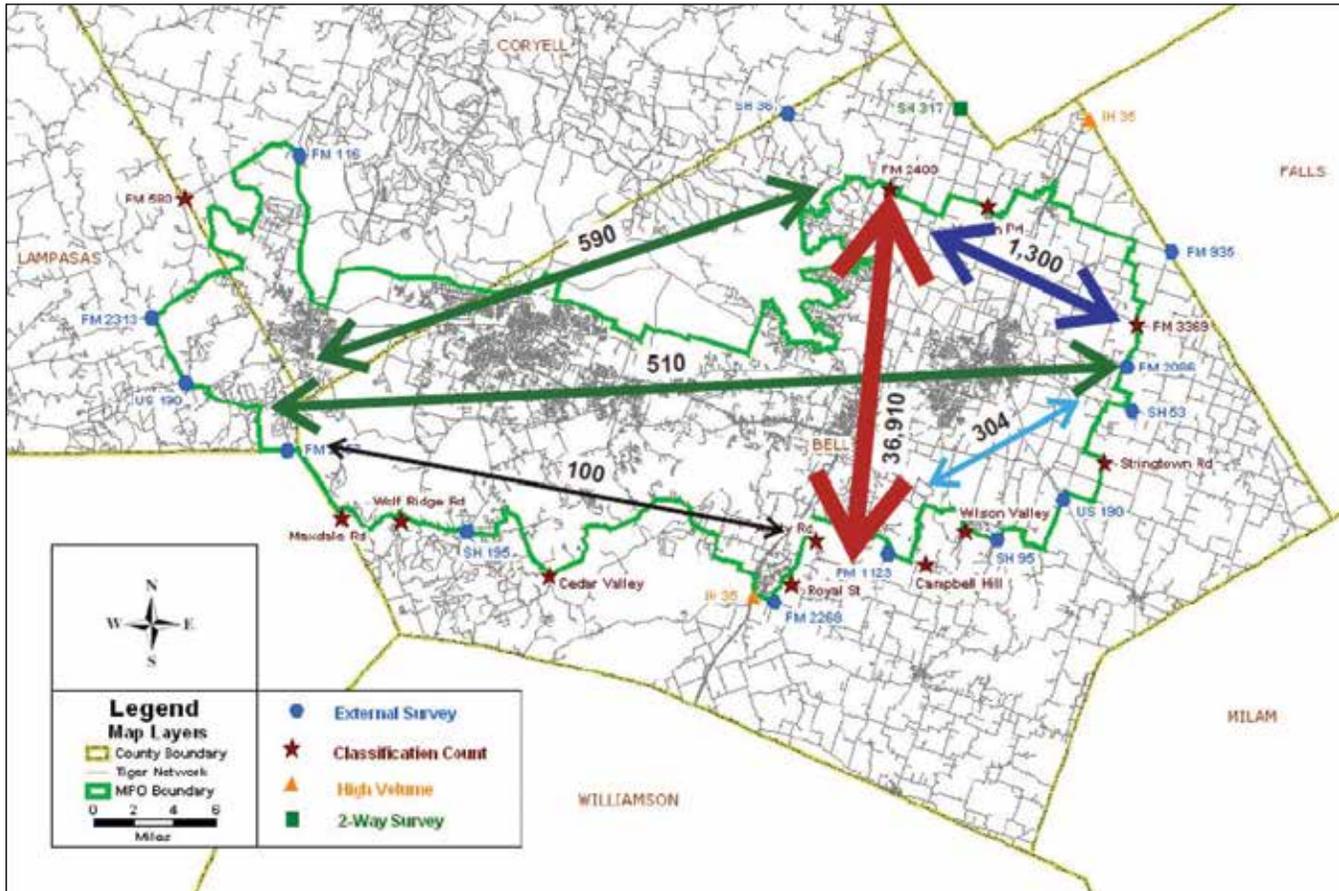
**Figure 36. Estimates of External-Local Trip Movements by Location Group.**



Source: 2006 Killeen-Temple External Survey Technical Summary, p. 32.

The external stations were grouped by location and included North, East, South and West groups. The South group had the largest estimated number of external-local trip movements, with nearly 57,000 total daily trips. The North group had the second largest estimated number of external-local trips with nearly 53,000 trips. The most common external-through movement was between the North and South groups, with just under 37,000 external-through trips estimated between these two locations.

**Figure 37. Estimates of External-Through Trip Movements by Location Group.**



Source: 2006 Killeen-Temple External Survey Technical Summary, p. 33.

### COMMERCIAL VEHICLE SURVEY

The primary purpose of the commercial vehicle survey is to collect data on commercial vehicle trip making that is needed to estimate total commercial vehicle travel in the KTUTS area. In the travel demand model, trips made by commercial vehicles are modeled separately from trips made by non-commercial or private passenger vehicles. The commercial vehicle survey is concerned with internal commercial vehicle trips, which are trips made within the study area. Commercial vehicle trips that are coming into or departing the study area boundary are surveyed as a part of the external station survey. The surveys collect data on commercial cargo/freight vehicles, as well as vehicles used for commercial services, such as plumbers, electricians, deliveries, and governmental fleet vehicles. The data are used in the trip generation step of the travel demand model to estimate total trips and travel patterns for commercial vehicle trips.

In the 2008/2009 KTUTS Commercial Vehicle Survey, a sample of vehicles was randomly selected from motor carrier and vehicle registration databases. The establishments or agencies operating the selected vehicles were contacted and asked to participate in the survey. A total of 304 commercial vehicles participated in the survey. The drivers of the vehicles were asked to keep a 24-hour diary of the locations of all trips made by the vehicle. A variety of questions were asked about the vehicle, such as the type of cargo being transported (if any) and the purpose of the trip. The questions of primary concern for estimating commercial vehicle trip patterns were the location and time of each trip from when the driver of the vehicle started his or her daily activities until the driver of the vehicle completed his or her daily activities.

The number of commercial vehicles in a designated study area cannot be determined reliably from vehicle registration data due to the presence of commercial vehicles registered in other counties, and in other states. The commercial VMT observed from sampled commercial vehicles in the KTUTS area was expanded using VMT estimates from the Highway Performance Monitoring System (HPMS) data, combined with vehicle classification counts for roadway functional classification (freeway, arterial, collector, and local). Table 21 provides the estimated VMT for commercial vehicles operating in the KTUTS area by roadway functional classification. The total commercial VMT was 1,287,014 miles, with external commercial VMT estimated at 457,001 miles and internal commercial VMT estimated at 812,013 miles.

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**On a daily basis, more than  
16,414 commercial vehicles  
were operating in the KTUTS  
area, with each vehicle  
averaging 8.2 trips per day.**

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**Table 21. Estimated VMT for Commercial Vehicles Operating in the KTUTS Area by Roadway Functional Classification.**

Functional Classification	Weekday VMT	Percent Commercial Vehicles	Commercial Vehicles Weekday VMT
Freeway	2,900,605	17.3	501,849
Arterial	3,908,506	10.6	415,202
Collector	1,719,616	16.6	284,878
Local	611,683	13.9	85,085
<b>All Classifications</b>	<b>9,140,410</b>	<b>14.1</b>	<b>1,287,014</b>

On a daily basis, more than 16,414 commercial vehicles were operating in the KTUTS area, with each vehicle averaging 8.2 trips per day. The average distance traveled was 6.6 miles. Approximately 51 percent of the surveyed commercial vehicles in the study area in 2008/2009 were cargo or freight transport, with 49 percent being local services transport. Among the surveyed commercial vehicles, the most frequently reported types of cargo included manufactured goods and equipment (25.2 percent of the trips); food, health, and beauty products (23.2 percent of the trips); and clay/concrete/glass or stone (11.4 percent of the trips). Nearly 16 percent of the surveyed commercial cargo vehicle trips were not carrying any cargo.



The travel surveys conducted provided travel behavior information needed to calibrate and validate the KTUTS area travel demand model.



## SUMMARY OF FINDINGS

The travel surveys conducted in the KTUTS area during the period between 2006 and 2010 provide the household, work place, external station, and commercial vehicle travel behavior information needed to estimate, calibrate, and validate a travel demand model. This model can be used as a transportation analysis tool for planning improvements to the region's transportation system for the next 20 years. The travel demand model is the preferred tool for supporting analysis and evaluation of proposed transportation alternatives within the transportation planning process. The combined population of Bell County and Coryell County is forecasted to increase from 350,947 in 2007 to 559,418 by 2035, an increase of about 59.4 percent. The daily VMT is expected to increase by 41.3 percent during this 28-year period, from 8,839,270 miles in 2007 to 12,488,220 miles by 2035. With this growth, TxDOT and the KTUTS MPO will need to plan for new and/or improved facilities to provide added transportation capacity during the next 20 years. Such facilities will be needed to maintain the relatively high level of mobility currently enjoyed by travelers in the KTUTS area.

### *Household Travel*

Persons commuting to work in the KTUTS area use public transportation less often than the average commuter in Texas. Over 97 percent (97.1 percent) of the households have at least one vehicle available. The average household size in the study area in 2007/2008 was 2.67 persons, which was close to the estimate of 2.81 for Texas. The average number of trips per household was around 9.6 trips per day, with each person in the household making between three and four trips per day. The average person trip length was 5.1 miles, and the average duration on the trip was 10.1 minutes.

Trip purposes in the household survey were categorized as internal (HBW, HBNW, and NHB) trips. HBW trips in the KTUTS area in 2007/2008 had the longest average travel distance of 6.9 miles, and accounted for 13.1 percent of the total household person trips. In terms of trip purpose by destination, the

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return-to-home trip was the most frequent trip destination, which accounted for 36.2 percent of the total household person trips. HBNW trips accounted for 57.5 percent of the total household person trips, with an average travel distance of 4.9 miles. NHB trips accounted for around 29.4 percent of the total household person trips, with an average travel distance of 4.4 miles. Trips to shopping, work, pick-up/drop-off, and personal business comprised around 40.1 percent of the total person trips by destination purpose.

### ***Work Place Travel***

Trip purposes in the work place survey were categorized to include not only internal trips but also external (EXT-O, EXT-D, and NON-RES) trips from and to the study area. In terms of trip purposes to and from the work place based on survey trips, external trips (EXT-D, EXT-O, NON-RES) accounted for 8.8 percent of the total person trips in the KTUTS area. The majority of trips (91.2 percent) were internal trips, of which more than 83.5 percent were home-based (50.3 percent HBNW and 33.2 percent HBW), and 16.5 percent were NHB trips. The average person trip length for HBW trips was 6.9 miles, compared to 4.9 miles for HBNW trips, and 4.4 miles for NHB trips.

### ***External-Local and External-Through Travel***

Nearly 178,000 vehicles entered or exited the KTUTS area on an average weekday basis. Approximately 77 percent of the total daily external trip movements were external-local trips, while the remaining 23 percent were external-through trips. Of the total external-local trips, 84 percent were made by non-commercial vehicles and 16 percent were made by commercial vehicles. Approximately 74 percent of the total external-through trips were made by non-commercial vehicles, and the remaining 26 percent were made by commercial vehicles.

### ***Commercial Vehicle Travel***

The total commercial VMT for the KTUTS area in 2006 was estimated at 1,287,014 miles, of which 475,001 miles were external commercial VMT and 812,013 miles were internal commercial VMT. Approximately 125,900 total trips were made by commercial vehicles in the study area. On an average weekday basis, approximately 16,414 commercial vehicles were found to be operating in the study area, with each surveyed vehicle averaging 8.2 trips per day. Based on surveyed inter-zonal trips, the average travel distance was 6.6 miles.

Approximately 51 percent of the surveyed commercial vehicles were cargo or freight transport, while the remaining 49 percent were local services transport. Among the surveyed commercial vehicles, the most frequently reported types of cargo included manufactured goods and equipment (25.2 percent of the trips); food, health, and beauty products (23.2 percent of the trips); and clay/concrete/glass or stone (11.4 percent of the trips). Nearly 16 percent of the surveyed commercial cargo vehicle trips were not carrying any cargo.



**Persons commuting to work in the KTUTS area use public transportation less often than the average commuter in Texas.**

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## COMPARISON TO OTHER AREAS

Table 22 provides a comparison of the household survey summary data for the Bell and Coryell Counties to McLennan County, Potter and Randall Counties, and Cameron and Hidalgo Counties.

**Table 22. Comparative Household Survey Data for Killeen-Temple Study Area, McLennan County, Potter and Randall Counties, and Cameron and Hidalgo Counties.**

Urban Area	Bell and Coryell Counties	McLennan County	Potter and Randall Counties	Cameron and Hidalgo Counties
<b>Demographics</b>				
Household Population	350,947	225,366	229,693	1,030,139
Licensed Drivers	243,610	151,191	164,001	585,035
Number of Households	125,934	83,995	88,507	294,825
Average Household Size	2.67	2.68	2.60	3.49
Number of Motor Vehicles	134,498	158,805	178,784	555,443
Motor Vehicles per Household	1.07	1.89	2.02	1.88
<b>Number of Daily Trips by Mode</b>				
Total Person Trips	1,212,890	712,766	830,583	3,583,480
Automobile-Driver Trips	848,141	450,637	523,635	2,023,295
Motor Vehicle Passenger Trips	288,138	223,990	265,544	1,243,681
School Bus Trips	32,618	3,201	7,872	188,781
Walk Trips	35,372	16,627	11,563	93,337
Public Transit Trips	831	3,201	7,872	9,889
Bicycle Trips	1,888	4,781	2,002	6,571
Commercial Vehicle Trips*	125,862	111,659	81,403	83,600
Other Modes/Taxi	2,109	NA	1,873	3,709
<b>Number of Daily Trips by Destination/Purpose</b>				
Trips to Home	469,134	254,084	300,993	1,322,199
Trips to Work	150,646	80,919	86,938	353,105
Trips Work Related	32,199	21,604	25,302	109,126
Trips to Shop	128,720	74,105	95,421	333,674
Trips to Pick-Up/Drop Off Passenger	119,222	65,744	77,014	410,936
Trips for Personal Business	97,279	59,229	73,011	228,654
Trips for Social/Recreation	77,136	69,543	68,556	276,680
Trips for School K-12	69,738	35,467	46,973	292,203
Trips for School Post Secondary	13,519	5,739	4,897	46,762
Trips for Meal/Eat	67,322	40,757	46,049	171,603
Trips to Change Mode	9,462	4,038	2,836	24,622
Other Trips	10,863	1,537	2,590	3,596
<b>Daily Trip Rates</b>				
Person Trips per Person	3.60	3.16	3.62	3.48
Person Trips per Household	9.63	8.48	9.38	12.15
<b>Trip Lengths and Durations</b>				
Average Person Trip Length in Miles	5.1	5.8	5.9	6.5
Average Vehicle Trip Length in Miles	5.4	6.3	6.1	7.0
Average Person Trip Duration in Minutes	10.1	8.8	4.7	9.2
Average Vehicle Trip Duration in Minutes	10.3	9.4	5.0	9.8
<b>Vehicle Miles of Travel (VMT)</b>				
VMT per Capita	25.2	12.6	11.4	13.8

\*Value taken from commercial vehicle reports.

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## GLOSSARY AND TERMINOLOGY

Within the context of travel surveys there are a number of terms used that may cause confusion. These terms are defined as follows.

*Attractions:* The number of trips that are attracted to a location. Attractions are computed by purpose and mode of travel for different land use categories.

*External Destination (EXT-D) Trip:* A trip whose destination is outside the study area when leaving the establishment.

*External Origin (EXT-O):* A trip that originated outside the study area.

*Home Based Non Work (HBNW) Trip:* A trip which that has one end at home and the other at a location other than the work location. It is non-directional in terms of the activity/purpose.

*Home-Based Work (HBW) Trip:* A trip which that has one end at home and the other at work. It is non-directional in terms of the activity/purpose, i.e., a trip from home to work or from work to home is still defined as a HBW trip.

*Linked Trips:* Trips are linked (i.e., combined) into a single trip that reflects what is perceived to be the true purpose of the trip. Only trips that involve a serve passenger or change mode of travel between home and work (or vice versa) are considered for linking. For example, a person driving a child to a day care center (or school) and then proceeding on to work would have made two unlinked trips, an HBNW trip and an NHB trip. These two trips would be “linked” to create one trip, a HBW trip.

*Mode of Travel:* The physical means used to make a trip. The modes recorded in the survey included walk, vehicle driver, vehicle passenger, carpool driver, carpool passenger, vanpool driver, vanpool passenger, commercial vehicle driver, commercial vehicle passenger, public transportation, school bus, taxi/paid limo, bicycle, motorcycle/moped, and other.

*Non Home Based (NHB) Trip:* A trip which that has neither end at home.

*Non-Resident (NON-RES) Trip:* An internal trip to the establishment made by a person who lives outside the study area.

*Person Trip:* The movement of an individual from one location to another location. In the 2007-2008 KTUTS Area Household Travel Survey, these trips were recorded for persons five years of age or older in a surveyed household.

*Trip Activity:* The activity the individual did at the location the trip began and/or the location the trip ended. These activities were recorded in the survey and post processed to identify the purpose associated with the activity.

*Trip Attractions:* The number of trips that are attracted to a location. These are computed by purpose and mode of travel for different land use categories.

*Trip Productions:* The number of trips that are produced by members of a household. These are computed by purpose and mode of travel. Production rates refer to the number of trip productions divided by the number of households.

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*Trip Purpose:* The purpose of the trip being made by an individual. It is stated in terms of the purpose at the location the trip began and the purpose at the location the trip ended. For example, a trip that began at home and ended at work would be referred to as a home-based work (HBW) trip.

*Vehicle Availability:* The vehicles available to members of a household for travel.

*Vehicle Miles of Travel:* A measurement of the total miles traveled by all vehicles in the area for a specified time period.

*Vehicle Trip:* The movement of a vehicle from one location to another location. These trips are recorded for the person driving the vehicle.

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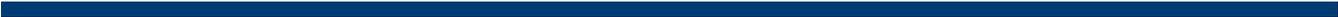
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