1.0 Introduction

This paper describes a cost-effective comprehensive travel diary survey that was designed and implemented in Edmonton in the fall of 1994.

The City of Edmonton was in the process of updating its long range transportation plan to guide the provision of transportation facilities and services in the City for the next 25 years. Data on existing travel patterns was needed both to give city staff and the general public an understanding of the current travel demand market, and to provide statistically representative input to the calibration of a comprehensive travel forecasting model to be used to assess alternative future transportation and land-use growth strategies.

Previous transportation planning in Edmonton had focused on the need to maintain levels of service on the roadway and transit systems in the peak periods of demand. Data collection had thus concentrated on peak period travel, and the main trip purposes made at these times, journeys to work and post-secondary education.

A number of important issues required the new Transportation Master Plan for Edmonton to consider ***all*** travel made in the City, not just peak period movements. These included:

- Rising concerns about the environmental impacts of transportation,
- The appropriate level of public transport service provision throughout the day,
- The role of pedestrian and bicycle modes in the transportation system,
- The impacts of alternative urban forms, and levels of accessibility, on travel demand, and
- The impacts of changes in the age profile of the population on transportation needs.

This led to the need to collect travel data for the entire day, not just for peak periods, and to include trips made by all persons by all modes for all purposes.

In late August 1994 the City of Edmonton requested consultants to submit proposals for the design and implementation of a comprehensive household travel survey, based on a terms of reference outlining needs. The time-frame for the long range transportation plan update required that the travel survey be completed within 6 months. The sample size and budget for the project was dependent upon the consultants proposals, although the City had an overall budget limit for the project. Following interviews a Consultant was appointed, and the travel survey was conducted in the fall of 1994, with final results and documents provided to the City in early 1995.

This paper describes the key features of the travel survey that was successfully implemented. Sections 2 to 4 describe the overall specification and design of the survey. Section 2 outlines the detail survey requirements identified by the City, in consultation with consultant staff; Section 3 the specification of the survey method and instrument; and Section 4 issues related to sample size and selection. Sections 5 to 7 outline the implementation of the survey and processing of results. Section 8 draws some conclusions about the overall effectiveness of the travel survey.

2.0 Detail Survey Requirements

One of the most important stages in the design of the travel survey was the identification of the data that should be collected. It was evident that the opportunity to undertake a major travel survey in the Edmonton area might not occur again for a number of years, for budget reasons. It was vital to ensure that the survey obtained travel data to meet both short-term City needs, and also act as the principal travel data source over the medium term.

The specification of data to be obtained from the travel survey was developed initially by the City of Edmonton to meet the needs of the intended travel forecasting model calibration. This in turn required the City to have a very clear idea of the structure of the forecasting model they intended to create, and the variables that might be incorporated into each stage. This model specification was itself in turn derived from an identification of the transportation issues that might be facing Edmonton over the next 25 years. This phase of issue identification and travel model specification is beyond the scope of this paper, but it was an essential pre-requisite in the survey design process.

Travel Patterns to be Surveyed

From the above brief discussion of Transportation Master Plan issues, it was evident that travel data was required for trips made throughout a typical day in Edmonton, by all persons on all modes for all purposes.

Personal Trips only a Typical Weekday

At the outset it was decided that the travel survey should collect data on all "personal" trips made on a typical weekday - trips made in commercial vehicles for commercial purposes were to be studied in a separate study. (These personal trips would include trips made to work or in the course of work, as long as the main function of the trip was driving the vehicle itself e.g. as a truck, bus, or taxi driver). This meant that a survey based on households and the trips made by household members was appropriate.

What is a Trip?

For the survey it was decided that a trip should be defined as:

- ***"Travel by an individual, whether by motorized vehicle, bicycle, or on foot, which is 100 meters (approximately two blocks) or more in length".***

No exceptions were to be made to this length requirement.

The minimum 100 meter definition for trip was designed to pick up all short distance trips, particularly by walk or bicycle, which have sometimes been excluded in other travel surveys, whilst eliminating very short distance movements made within a home or office which are not traditionally considered a trip.

Study Area

The City of Edmonton is surrounded by a number of urban and rural municipalities that interact with it. Statistics Canada defines the Edmonton Census Metropolitan Area (CMA) to be up to 80 kilometres beyond the city boundary. The overall Edmonton CMA has a current population of 866,000, and Edmonton itself a population of 634,000, 73% of the CMA total. Population growth rates in urban communities immediately adjacent to Edmonton, such as St. Albert and Sherwood Park, are currently higher than in Edmonton. Employment opportunities tend to be concentrated in Edmonton, with 325,000, or 81% of the 400,000 jobs in the CMA located in the city. There are many people living in the region who commute to work in Edmonton.

Edmonton transportation facilities are therefore used to a significant degree by persons living outside the City boundaries. In the Edmonton Transportation Master Plan the existing and future travel patterns of these people have to be considered along with those of Edmonton residents. The logical catchment area for the Edmonton travel survey was the entire Edmonton CMA.

At the time of the travel survey the Alberta Government was in the process of making changes to the formal organizations through which regional planning was coordinated, which presented difficulties for the City of Edmonton in coordinating a travel survey for the whole region. There was also some concern over the City commissioning surveys of persons who did not live in the city itself. The Provincial Transportation Department, Alberta Transportation, was therefore approached with a request both for financial support for travel surveys in the CMA area outside Edmonton, and to liaise with these other municipalities. Alberta Transportation saw the merits of obtaining travel data for the complete CMA, and provided valuable assistance in these areas.

Day of Week / Time of Year

A strategic decision was also made for the Master Plan study to consider "typical weekday" travel needs. Existing traffic and transit count data showed that in general peak travel demands occurred on weekdays (Monday to Friday), so that the "worst case" travel conditions requiring solutions were experienced on these days.

At some locations peak period travel levels were lower on Fridays, and to a lesser extent Mondays, than other weekdays, perhaps because of the number of persons working flexible working hours allowing certain days off work. However many other locations showed no difference in Monday or Friday levels. Some locations showed higher peak travel levels on Fridays, perhaps reflecting travel associated with weekend activities. In addition, travel patterns in the University area were known to vary by the class timing patterns which operated either on Monday / Wednesday / Friday or Tuesday / Thursday modules.

As a result it was concluded that each weekday was as typical as any other overall, and that overall the travel survey should collect representative data for each day.

Travel patterns also vary significantly throughout the year in Edmonton, because of:

- Winter travel conditions making travel by all modes more difficult - experienced from mid October to mid April, with severe conditions from December through February,
- School schedules with school years from September through June, and Post-Secondary Education institutions with school years from September through April,
- Vacation schedules (generally in the summer), and statutory holiday times such as Christmas, and
- Transportation network construction and maintenance schedules planned around the summer construction season, lasting from May through October and potentially causing disruption to travel patterns.

Edmonton roadway and transit facilities and services are generally planned for the heavier demands experienced in the fall and winter, when weather conditions limit travel by other modes and all students are attending school. Traditionally travel data is collected in the late fall (November) or early spring (March), avoiding the worst winter conditions. A November date was chosen for the Travel Survey, because this gave the longest continuous time period of consistent travel patterns - in late March school vacations commence, and the Easter vacation can conflict.

Person Type

Trips by all person types, not just adults or adult workers, were seen to be significant, for different reasons. Children and students made many trips on transit, and used walk and bicycle modes. Many adult trips were also made to satisfy children's needs. Senior citizens also had particular travel needs. Data on trips made by all household members was needed.

There was initial concern about requesting information on travel by children, because of the legitimate safety concerns of parents about divulging such information. However the expert consultant advice, based on their experience with other travel surveys, was that it was possible to obtain such data, even for very young children, as long as the survey and method was well designed and contained appropriate safeguards for concerned parents.

Many other household surveys have not included data on children less than 5 years old, on the basis that they make no trips independent of other household members. However some recent practitioners argue for the inclusion of these infants, because of the possibility of a non-household caretaker traveling with a household infant. If infants are excluded the full household-based travel in these cases would not be obtained.

As a result it was decided to obtain travel data for all persons in the household.

Travel Modes and Purposes

Travel by all modes and purposes was to be considered and explicitly identified. By this definition trips by walk and bicycle modes were to be included whenever made.

"Change of mode" was defined to be a valid trip purpose to allow walk (or bicycle) trips exceeding 100 metres, made as part of a journey also using car or transit, to be explicitly identified as separate trips in the survey data collected. Analysts subsequently using the survey data could consider whether to combine such trips into trips by the primary car or transit mode only. Other special trip purposes included "pick up / drop off passengers" and "along for the ride" (the latter trip purpose was primarily envisaged to facilitate the coding of trips made by very young children accompanying another family member).

The City naturally wished to obtain the maximum amount of high quality travel data and the maximum number of surveys, within an overall budget. The Consultant was concerned to ensure that it was practical to obtain the requested data, and that the reliability of the results could be maintained. There were a number of interesting but amicable meetings between the City and consultant staff, where trade-offs were discussed between:

- the type and amount of data that could be collected in each individual survey,
- the practical difficulties of obtaining specific pieces of data,
- the quality of any data that might be obtained,
- time and cost implications of specific requirements, and
- the number of households that could be surveyed.

The final agreed items of travel-related data obtained from the Travel Survey are summarized in Table 1.

Table 1 - Data to Be Collected in Travel Survey

HOUSEHOLD DEMOGRAPHIC DATA
• Address • Type (e.g. detached walk-up apartment) • Number of people residing • Number of "Out of Area" visitors staying at house • Number of motor vehicles available for use • Number of bicycles at household used in last year • Combined annual income of all household members
PERSON DATA
• Relationship to head of household • Age • Gender • Whether currently licensed to drive • Major and minor employment and school status • Type of industry of employment • Whether the household member worked on the day they were surveyed • Employment location • Occupation code • Whether or not the employer requires a specific start time for work, specific start work time, what that time is • Ability of employed persons to vary work start time • Need for auto at the workplace • Whether or not the employer provides parking and what the cost of that parking is • Whether or not any individual in the household has a transit pass and how often the transit pass was used on the previous weekend • Whether or not any individual in the household has a long-term disability and what kind
TRIP DATA
• The travel day and date • Trip number (puts trips into time sequence) • Location at 4:00 AM on the travel day (home or other) • Departure time from this location (if any) • Trip origin - note: deduced from survey data • Trip purpose at origin - note: deduced from survey data • Trip destination • Trip purpose at destination • Type of land use at destination • Departure time from origin - note: deduced from survey data • Arrival time at the destination • Mode of travel • Auto Occupancy if mode is auto • Price paid for tolls, fares, and/or parking • Alternate mode choice if mode used was not available

Data to be Collected

Household Data

The household demographic data collected was typical of many household travel surveys, enabling disaggregation by different definitions of household type e.g. by size, income, car ownership etc. The questions on household car and bicycle availability were designed to obtain information on how many vehicles were actually available for use by household members. For cars, this included company vehicles operated by a resident at the interview address and normally parked or garaged at that address.

Person Data

A number of special questions were asked about each person, to help understand travel needs and choices. These included:

- Whether the person had a long-term disability or handicap, required a mobility aid, or was a registered member of the Disabled Transportation System operated in the City.

A major issue in the City of Edmonton is the amount and cost of the Disabled Transportation System provided, and how needs might change in the future. This question was designed to help understand the potential demand for the service; give a demographic breakdown of potential users; and give details of current travel patterns of those with mobility difficulties.

- For employed persons, whether they worked at home on the travel day; had a requirement to be at work at a specific time, and whether this could be arranged to be 30 minutes later on a regular basis; whether the employee's car was needed at work as part of their work; whether parking was offered, where it was offered, and at what cost.

All these questions were designed to understand choices workers made on trips to and from work. They would give current data on trip-making itself; time of day choice and the potential for flexibility in start times, and hence peak spreading; and constraints on choice of work through the need to use a car through the day for work, and parking incentives provided at work.

Trip Data

The collection of fine level trip data for each trip made over 100 metres in length, with each change of mode or trip purpose explicitly a separate trip, was in itself a special feature.

For persons traveling in cars with more than one passenger, the number of total passengers, and the number of passengers from the household of the trip-maker, were obtained. This information would help to identify patterns and potential for multi-occupancy use of vehicles.

For each trip made a special "imagine" question was asked to identify the preferred alternative travel option, including not making the trip at all, if the chosen mode was not available. This question was intended to help understand existing and potential travel choices available to individuals. It was also theoretically possible to use responses to this question in travel model calibration to supplement "real" travel choice data collected, particular for modes with a low frequency of selection in the current travel market.

3.0 Specification of the Survey Method and Instrument

Alternative Methods Available

Several general approaches to collecting the travel information were considered:

- **Mail Research:** Candidate households would be identified and sent a questionnaire which would be completed and returned by mail. If necessary a follow-up telephone call would be made to clarify or complete the survey data. Generally, the advantages of mail research is that it can be less expensive on a unit basis where survey sample sizes are very large. These savings can be eroded where response rates are insufficient to achieve sample rate targets, or significant follow-up is required to complete the survey. The major disadvantages include: the survey return rate will be unknown; the potential for self selection bias can be significant (e.g. respondents decide whether they will respond to the survey affecting the possible representativeness of the survey sample); and, there is a possibility of incomplete and inconsistent survey responses.

- **Telephone Research:** Direct telephone research generally involves: contacting candidate households and soliciting their participation in the survey; mailing an information package to those households agreeing to participate in the survey; and calling the selected households to obtain information about travel during the previous day. The advantages of direct telephone research include: the target number of survey responses (by strata) can be controlled; respondents can be directly probed to ensure as complete recollection of travel activities as possible; and, respondents can be screened for inclusion in the study. The major disadvantage of this approach is that the recollection of the previous day's trips may not be as accurate as it would be if they had kept a log or diary of their travel activity on that day. Also, the length of the telephone survey may be problematic where the number of residents and vehicles of the household are large.

- **Travel Diary:** The travel diary approach is essentially a modification of the telephone research approach, which attempts to overcome some of the limitations of telephone research, namely, the problem of survey respondents remembering all the trips taken during the travel day, and streamlining the data collection process over the telephone. Implementation of the travel diary approach involves the following: candidate households are called and screened for their participation in the survey; participating households are sent an information packaging including a travel diary to record the trips of the household members; the household would be contacted 24 hours prior to the identified travel day to record their trips on their travel diaries; and, on the day following the travel day, households are called to collect the survey information. This approach has several advantages, which include: a high level of reporting accuracy, especially for non-work related trips which are generally under reported in household travel surveys; a high survey completion rate; and because of the higher level of reporting accuracy, it is possible to reduce the total survey sample size to maintain the same level of statistical confidence in the survey sample results. The major disadvantage is that this approach can result in a higher cost per completed survey due to the greater level of contact with candidate and participating households.

Selection of Travel Diary Approach

The travel diary approach was seen to be advantageous over mail and direct telephone research, primarily from the perspective of collecting a more complete data set on the non-work based trips. The potential for under reporting non-work based trips from direct telephone research can be significant, and it was expected that this would be reduced significantly from employing the travel diary approach. In addition, the travel diary approach has the key advantages of direct telephone research over mail research, where the self selection bias is reduced, and survey completeness can be controlled through the data collection process.

Design and Testing of Survey Instrument

Upon selection of the travel diary approach, the data items to be collected were identified and the survey instrument and other mail-out materials were developed. The mail out package included:

- A letter of introduction from the Mayor and City of Edmonton Transportation Department,
- Household Travel Survey Instructions page,
- Household Travel Survey questionnaire,
- Example of a completed travel diary,
- Travel diaries (the number provided depended upon the household size), and
- A reminder notice of the household's travel day.

The pretest of the survey was conducted in early October, 1994. Wednesday, October 12 was the assigned travel day for all the pretest participants. One hundred and eight households were selected for recruiting, of which 39 households agreed to participate. Overall, 35 percent of those contacted agreed, 28 percent refused and at 36 percent of the households there was no answer.

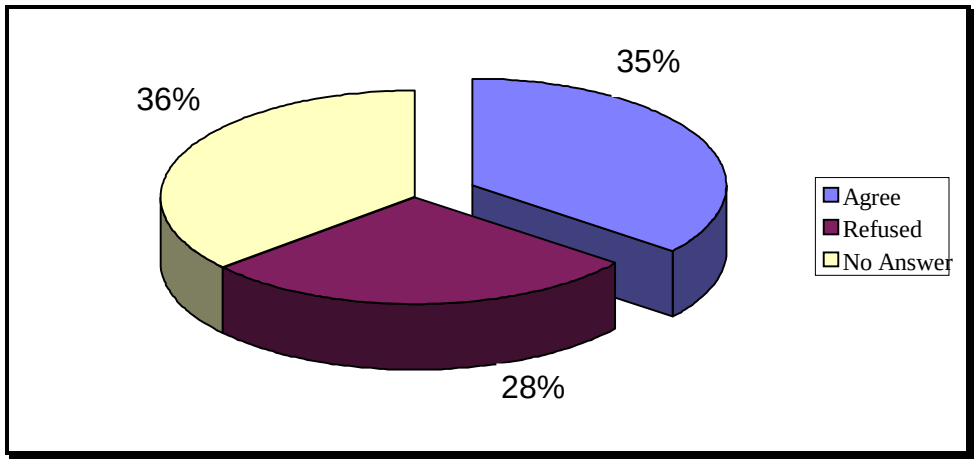


Figure 1 - Pre-test Results

In general, only a few minor problems were uncovered during the pre-test. No question failed to elicit an appropriate response. Some portions of the questionnaire form were adjusted for greater clarity. The average time to complete an interview during the pre-test was just over 19 minutes.

4.0 Sample Size, Stratification and Selection

Statistical Accuracy Considerations & Results

Whenever a sample is taken to estimate the characteristics of a population, the sample estimate will vary from the actual data due to sampling error. In general, sampling error is reduced where the degree of variation which exists in the population is small, and the sample size is large. As a result, the accuracy of any survey results will vary with these parameters and be different for each data item included in the sample.

The City was committed to a sufficiently large sample size, in order to obtain sufficient observations for subsets of the total sample (by household or person category; travel mode; travel purpose; time of day) to enable robust development of statistical relationships. Sufficient observations were to be obtained to enable analysis of travel patterns and choices in households with a range of income and car ownership levels, and of choices by all modes including transit, walk and bicycle. From previous surveys and Statistics Canada data it was known that low income households (annual income less than $15,000 per year) made up around 15% of all households in the CMA; and that around 15% of households in Edmonton did not own a car. It was also known that transit and walk modes were used for around 13% and 5% respectively of trips to work. These relatively high percentages for these sub-groups meant that with a sample size of around 4,000 - 5,000 for the City itself it should be possible to obtain observations of around 200 + households in each desired sub-category, with random sampling. A target sample size of 6,000 households for the Edmonton CMA was selected. There are obvious tradeoffs between greater survey results accuracy, the survey sample size and cost of implementing the survey.

This target 6,000 household sample size is larger than that used in some recent travel surveys in the United States, where sample sizes of 1,000 to 1,200 were used. In the U.S. car ownership rates are generally higher than in Edmonton, and transit use lower. In this situation it is recognized that even with large sample sizes, insufficient numbers of observations of low car-owning and / or transit-using households will be obtained from purely random samples. These household categories have to be specially targeted by some form of sample stratification. A brief discussion of sample stratification issues is given below.

One of the key variables used in travel demand forecasting is the number of trips per household in the study area. This variable has been used to demonstrate the accuracy level of the results obtained for this survey. The Household Travel Survey indicates that, after scaling, the sample households in the Edmonton CMA generated an average of 9.61 daily person trips per household. At a 90% confidence level, we estimate that the actual average number of trips for these households will range from 9.45 to 9.77 trips per household. In other words, 9 times out of 10, the average number of trips generated per household can be expected to vary plus of minus 1.7%.

When looking at other data items or subsets of the data base, such as the trip generation rate by household size, the accuracy of the data can be expected to differ. Generally, when looking at specific data which represents a subset of the total data collection, the accuracy of the results will be lower. This is evidenced from a review of the sampling error of household trip generation rates by household size, where the confidence interval varies between plus or minus 2.2% to 3.7%.

Sample Stratification Issues

The use of stratification in designing the sample structure can result in either economies (smaller sample sizes) or greater accuracy. The desirability of sample stratification depends, in part, on the extent to which households in the individual strata tend to be homogeneous, but with a stratum mean which is different that the overall sample mean.

One method of stratifying the sample households is to set quotas to ensure a specified level of confidence, for example, ± 10% at the 98% confidence level, for each of the chosen strata. This method of equal precision for each strata has two difficulties. First of all, the accuracy requirement of a stratum should be related to the size of the stratum in the universe. Why should a stratum that contributes only five percent of the vehicle kilometers of travel (VKMT) have the same precision as a stratum that contributes 60% of the VKMT? Secondly, if a maximum quota is set which represents only one-half the frequency of occurrence, then halfway through the pre-interview, contacts with households wishing to participate but fall in the already filled stratum will be discarded with the attendant high costs.

The use of strata and some of the attendant difficulties were discussed with the project team. A simple random sample of such a size would be distributed among the different household size/auto ownership/income groups with sufficient representation from each group. It was decided to take a simple random sample from the universe of households with listed telephones in the Edmonton area.

The project team was concerned about keeping track of the representative nature of the sample as interviewing progressed. A way of accomplishing this outcome is to select a random set of residential telephone numbers and in a qualifying telephone interview, determine the socioeconomic characteristics of the household (e.g. family size and autos owned). The telephone conversation can also determine their willingness to participate in the survey and be used to schedule the data collection interview. By keeping track of the prior telephone acceptances by the socioeconomic characteristics of the household, one can track the sample distribution. A special tracking software was used to tabulate the refusals, agrees, and other outcomes, as well as the specific characteristics of the agreeing households.

The actual number of candidate sample households per stratum allowing proportionate allocation method would be a function of the frequency of their occurrence in the population of all households in the Edmonton area. This means that the number of households in a stratum should approximately represent the proportion of those households among the households in the Edmonton area which have telephone service. For example, if 10% of the households with telephones are one-person one-car households, then 600 sample households would be expected in that stratum.

It must be stressed that although the sample is a simple random sample, the decision to stratify on any set of variables is not foreclosed. In fact, the sample was stratified during the expansion process to account for under-representation of the lower demographic categories.

One can also post stratify the sample on any of the number of selected variables in the search of further explanatory variables of travel behavior. For instance, many studies are looking at the relationships between household members as an explanatory variable. Different sets of relationships are referred to as a household's "life-cycle", since a two person household may consist of two employed adults, one employed adult and one child, two retired individuals, etc. The travel survey is a robust data set for this type of analysis, since person data includes good detail on respondent age, relationship, employment status, and other pertinent characteristics.

Implications For Expansion

Obviously, if the sample is stratified, these strata must be accounted for in the process used to expand the survey to be representative of the population. Likewise, setting strata necessarily limits the possible expansion process options available to the analyst.

During the survey, on-going reports of average household size and number of automobiles revealed an under reporting of households with only one person. While this result was not surprising, the issue of setting quotas to ensure minimum sample sizes to allow for a representative sample to be drawn from each sub-set of the data was considered. One area of possible concern during the survey was the number of single person households for which information would be obtained. During the survey process it was estimated that a total of about 1,000 households would be completed for single person households and that this size of sample would be sufficient to ensure representative scaling of the sample results. In the end, a total of 998 completed single individual household surveys were achieved.

Sample Selection Method

The sample was selected at random from a database (sample frame) consisting of each household with a published telephone number within the study area. The sample frame was comprised of all households in the CMA with approximately 75% of the households located within the City of Edmonton, 9% located in Sherwood Park or St. Albert, and the remaining 16% in the surrounding municipal and rural areas.

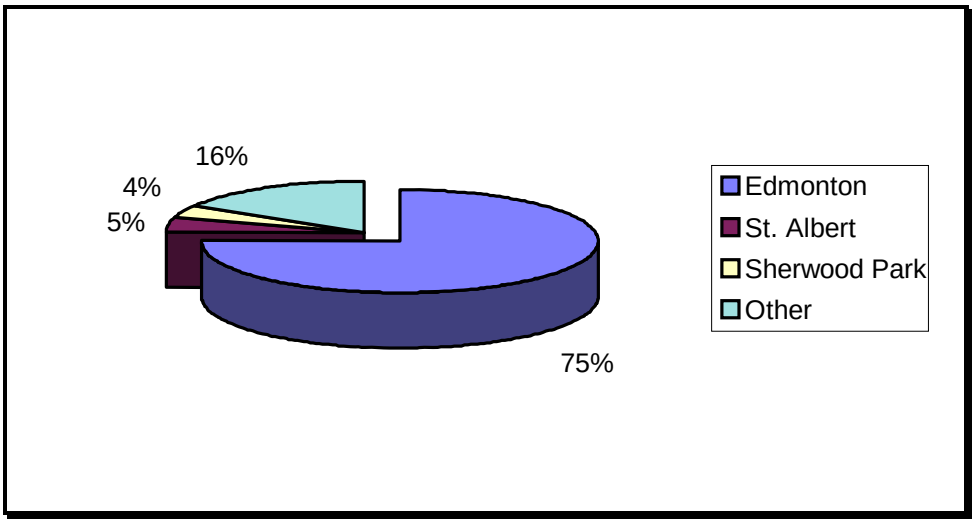


Figure 2 - Sample Frame

Sources Of Potential Bias

Self-Selection and Under-Represented Populations

In even the most carefully constructed household surveys, bias arises from self-selection by households concerning response to the survey. Our experience shows that households with two or three persons with a middle to high-income range for the household and at least one vehicle are more likely to respond than very large or single-person households with lower income.

Refusals are generated at various times during the survey process. A number of households will refuse to participate at the outset of the first telephone contact. Others will terminate the recruiting interview or refuse to be recruited. A third set will agree to be recruited but will not complete the diaries or will refuse to furnish the information when called. To account for the loss of households at these various points in the survey, the number of recruited samples was much higher than the total samples required.

In addition, interviewers were trained to elicit the reasons for refusing to participate, and to try to alleviate respondent's fears by explaining how important their participation is to the success of the survey. For instance, some single-person elderly households will resist recruiting because they don't travel much. Our interviewers were trained to explain to them that they represent other households and how important it is for them to respond.

Unlisted Telephone Numbers

One consideration in a discussion of potential bias is the issue of households with unlisted telephone numbers. The proportion of listed and unlisted telephones in the Edmonton area is unknown. Differences in travel estimations would be the result of unlisted telephone households being significantly different in travel for reasons unrelated to the collected socioeconomic data (e.g. household size, number of autos, income).

Selection of Final Sample Size

The sample drawn for the survey was a random sample using an electronic published telephone directory as the sample frame. Consideration was given to the possibility of stratifying the sample to account for sampling problems related to either the geographic or demographic representatives of the sample. Two key demographic variables (number persons per household and number of vehicles available per household) were tracked on a daily basis to determine the success in achieving representativeness across these variables.

5.0 Survey Implementation and Monitoring

The survey process involved four basic steps, each of which is discussed below. The progress of the survey was tracked on a daily basis and weekly reports were prepared. The final summary statistics indicate the timing of the survey and associated completion rates.

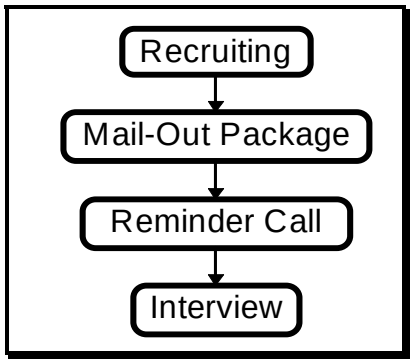


Figure 3 - Survey Process

Staffing

The survey team included the following:

Survey Supervisors: A total of six supervisors were responsible for managing the data collection process on a day-to-day basis. Their duties included: preparing recruiting, reminder calls, data collection and follow-up telephone lists for the surveyors, monitoring the recruiting and data collection activities of the surveyors, and responding to issues which arose during the surveyors discussions with survey respondents. Each supervisor was responsible for reviewing the work completed by members of their assigned survey team. This included reviewing completed data forms, performing specific logic tests on the travel information, random call backs to households to solicit feedback on the survey process and the surveyor collecting the data, and in some circumstances call backs to collect or clarify information provided by the household. Three to four supervisors worked each data collection day (depending upon the number of surveyors required) and were responsible for a specific survey team. A senior survey supervisor was assigned for each day and was responsible for assigning specific duties to the supervisors, and reviewing the completed work submitted for each survey team.

Surveyors: A total of 52 surveyors worked on the survey, with up to 40 working on any data collection day. The additional surveyors available to the project were necessary to cover illness and possibility that some surveyors were not able to work each data collection day. Each surveyor was assigned to a survey team with a specific function (recruiting, data collection, reminder calls, etc.) and reporting to an assigned supervisor.

A full training session for the survey staff was conducted after the pretest forms and procedures were analyzed and finalized. This training included the 50 field interviewers, the supervisors, representatives from the City and the project team. Each member received a detailed interviewer's procedure manual.

As in the supervisor training, the project was introduced and discussed, and the survey procedures described. The greatest amount of time was devoted to the definition of the data items being requested. General interviewing techniques were explained, such as what to do with refusals, and how to probe for more information without leading the respondent.

After the general session, the interviewers broke out into work groups led by their supervisors. Each supervisor led each member of the group in completing two mock interviews, answering questions and clarifying definitions during the course of the mock interview. A question and answer period were then held for the whole group.

Recruitment of Participant Households

Households in the study area were randomly selected from a data base of listed residents and asked to participate in the survey. Recruiting started on October 25, 1994, one week prior to the first travel day. Households were recruited Monday through Saturday from this date until Friday December 9, 1994. While the last travel day for which information was collected was December 14 (Wednesday), two additional travel days were recruited as contingency to ensure that enough completed surveys were achieved.

Each household contacted was approached with the same introduction. Individual respondents were screened to ensure that a senior member of the household was engaged who was able to make the commitment to participate in the survey.

If agreement to participate in the survey was achieved, the following information was collected prior to completion of the call:

Number Of Vehicles: To track the progress of the survey, the number of vehicles available to the household was surveyed. This was tabulated and reviewed daily to ensure that a representative sample was being achieved across this parameter.

Number Of Persons: As above, the number of persons residing at the household was obtained to track the representativeness of the survey and determine the number of travel diaries which were to be included in each package.

Address: The correct mailing address was confirmed to ensure that the package was sent to the correct household.

Assignment Of Travel Day

Each household agreeing to participate in the survey was assigned a travel day. If the household was not available to participate on this day, an alternate day was assigned. The household was not given an opportunity to choose their travel day. This random assignment of travel days to households helped to ensure there was no systematic bias introduced by allowing the household to "self select" their travel day.

Mail-Out of Packages

The mail-out package for each household recruited to participate in the survey contained six pieces. The package was color coded to facilitate questions from households regarding which piece of the package was being referred to. The pieces are as follows:

Letter Of Introduction (white): Three letters of introduction were prepared and incorporated in different packages depending upon the location of the household. For those households recruited in the City of Edmonton, a letter of introduction was provided from both the Mayor of the City of Edmonton and project leaders (City Department of Transportation and Consultant). Those households located outside the City of Edmonton were provided a letter of introduction from the Consultant.

Instructions/Definitions (pink): A one page set of instructions outlining the six basic steps required to complete the survey. On the reverse side, several important definitions were provided to assist the household understand the survey questionnaire.

Household Data/Person Data (white fold-out): The Household data and Person data were combined into a single fold-out form.

Travel Diaries (green): A travel diary to record trip data was provided for each member of the household, with several extras provided for the possibility that some household members may need more than one, or that visitors may be staying with the household.

Example Travel Diary (blue): An completed example travel diary was provided to indicate the manner in which trip data should be recorded.

Travel Day Reminder (yellow): A reminder notice indicating the households travel day was provided.

The package was mailed in a 9 inch by 13 inch envelope indicating on the address label the individual who agreed to participate in the survey. The envelope was marked with a return address (Household Travel Survey) and an "Open Immediately !" label.

All mail-out packages were prepared and mailed the day after the household had agreed to participate in the survey. This involved preparing mailing labels for each package. The mailing label identified the individual who had agreed to participate, on behalf of the household, and the number of individuals who had been indicated as residing in the household. This allowed the package to be stuffed with sufficient travel diaries. The standard mail-out package was provided to each household, with the appropriate number of travel diaries and a reminder notice indicated the assigned travel day. The mailing label also included a survey number which allowed the household to be tracked during the survey process.

Mail-Out Preparation: Each day, a list of households recruited to complete the survey was produced. From this list, address labels, including the number of household members was prepared and used to prepare the mail-out package. Several individuals were responsible for the preparation of the packages and ensuring they were mailed out the day following recruitment.

Recruiting and data collection were conducted six days per week (Monday through Saturday). During the week, calls to households were made from approximately 5:00PM to 9:30PM. On Saturday, calls were made from approximately 10:00AM to 2:00PM. Exceptions to this were made in instances where households requested us to call them at a specific time during the day to collect information.

Data Collection

Each household was called a day before their scheduled travel day to remind them to complete the Person and Household data and to ensure that everyone in the household was issued a travel diary and ready to record their trips for the assigned day. In some instances, the household indicated that they would not be participating in the survey. This was considered to be a "late refusal" to participate in the survey and these households were dropped from the data collection process.

Households were next contacted the day following their travel day to collect the household, person and trip diary information. If necessary, households were contacted up to three days following their assigned travel day to collect information. If no contact was made with the household over this period, it was dropped from the data collection phase of the survey.

In some instances, households contacted us to inquire about providing the survey information. Where the travel day was more than three days prior, the information was accepted if all the trip information for each member of the household had been recorded on the diary on the travel day.

In a very small number of instances (less than 10), participating households contacted us to request that they provide the information on travel survey forms provided in the mail-out

package, rather than over the telephone. When this information was received, it was reviewed for completeness and utilized where appropriate.

Progress Monitoring

Each week of the data collection phase, a status report was prepared and submitted to the City for their information and review. This report included important information regarding the progress made in recruiting households to participate in the survey and the number of surveys completed. In addition, specific issues related to the collection of the data and representativeness of the survey were outlined where appropriate.

Survey Tracking Data: Each day of the survey, there were several important data issues and lists which needed to be prepared. These included: the number of recruited households (including the address and number of household members); the number of completed surveys (including the number of household members and household income); the status of all non-completed surveys; and the lists of households to be recruited that day. The necessary information was entered into a computerized tracking system and the necessary reports and lists produced each day. This included the mailing lists and labels for the mail-out as well as lists of calls by type which would be made that day (recruiting, reminder calls, or data collection). Weekly progress reports were prepared and provided to the client for review. The final progress report statistics are provided as a summary of some basic survey parameters.

Summary of Contact Attempts and Completions

An attempt was made to contact 18,764 households. Of this total, 8,782 (46.8%) agreed to participate in the survey. Just over one-third households contacted (6,301) refused to participate in the survey outright. Approximately 11% of the number called were disconnected or not in service. For almost 3% of the numbers called (509 households) no one was reached at the household (Quits) after 5 attempts on consecutive days. Approximately 6% of households contacted were either commercial numbers, out of the study area, or a language problem was encountered (Other).

Table 2 - Results of Households Contacted

Households contacted	18,764	100%
- refused to participate	6,301	34%
- disconnected or not in service	2,088	11%
- no-one home after five attempts	509	3%
- other	1,084	6%
Households recruited	8,782	46%

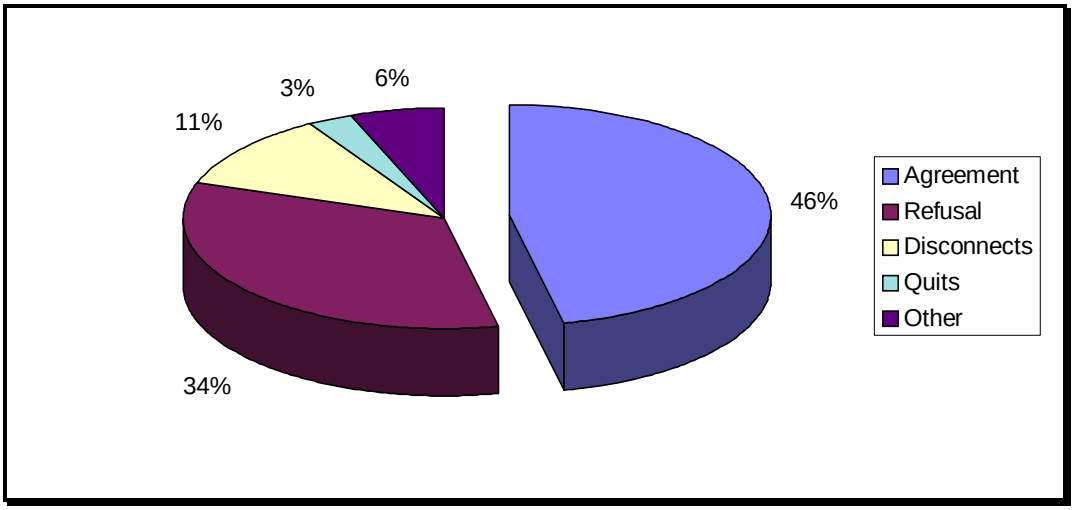


Figure 4 - Results of Households Contacted

Of the 8,782 households who agreed to participate in the survey, 232 households were recruited near the end of the survey as a contingency. Ultimately, these were not required and data was not collected from these households. A total of 8,529 households were mailed travel diaries and assigned a travel day.

From the 8,529 households recruited, 6,402 households participated in the survey, reflecting a post recruiting completion rate of just over 75%. Almost 21% (1,779) did not participate in the survey after they had agreed to and are classified as “late” refusals. Approximately 3.5% of households could not be contacted within three days of their travel day (usually the person was not home when called) and were classified as “Quits”. A small number of surveys were not completed (less than 1 percent), due to language problems.

Of these 6,402 households who participated in the survey, 6,020 households provided complete information for all components of the survey. The majority of the remaining 382 households who completed a survey but were not included in the final results, were not included due to incomplete survey information.

Table 3 - Results of Households Recruited

Households recruited	8,782	
- extra household recruited but not required	232	
Households participating in the survey	8,529	100%
- refused to participate after receiving survey	1,779	21%
- unable to contact within three days	299	4%
- language difficulties	50	0%
- incomplete information or survey results not usable	382	4%
Households completing the survey	6,020	71%

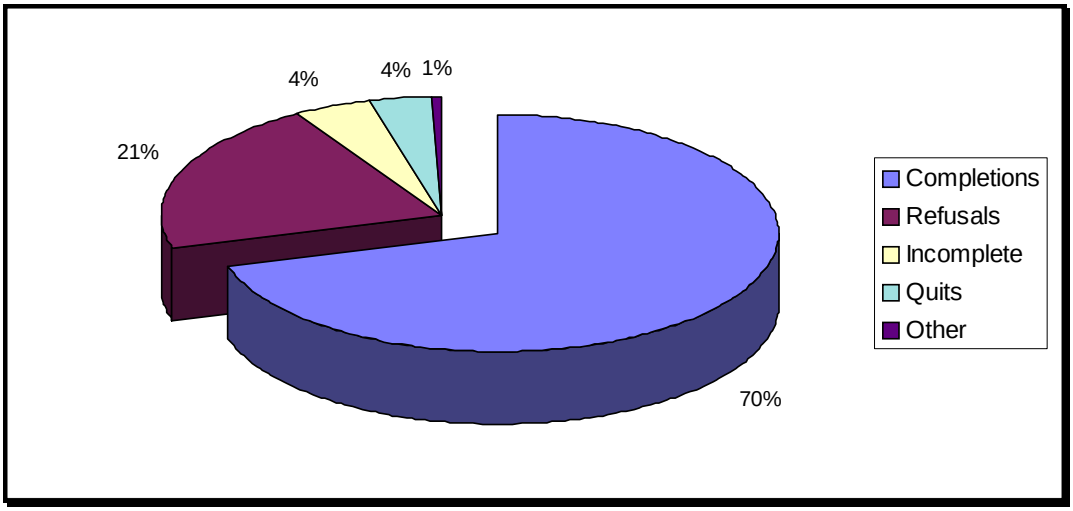


Figure 5 - Results of Households Recruited

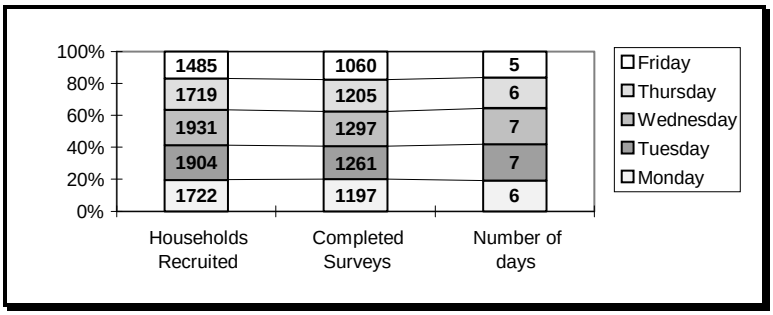


Figure 6 - Survey Distribution by Day of Week

A summary of the number of recruits agreeing to participate in the travel survey and the number of participants completing the survey by day of travel is illustrated in Figure 6.

While there are some minor differences in the completion rate by travel day, the proportion of completed surveys by day of travel is very close to the proportion which would be expected by a random allocation of travel days as implemented in conducting the survey.

Public Inquiries

Many inquiries were made by survey respondents and potential respondents. A large number of these related to the legitimacy of the survey and the use of the findings. Most of these inquiries were handled by the City of Edmonton Department of Transportation. Other were handled by the Consultant and Alberta Transportation & Utilities. Other agencies were informed about the survey to ensure that any inquiries were satisfactorily dealt with. These included the City of Edmonton's Citizens Action Center, the Better Business Bureau and the RCMP detachments in the surrounding areas included in the survey. On-going coordination of these groups was provided by the Consultant to ensure that appropriate and consistent information about the survey was provided to specific questions.

Many of the questions raised about the survey fell into the following categories:

Legitimacy Of The Survey: Due to the nature of the survey, where specific information about the household, its members, and their activities, was being collected, some survey respondents were concerned about its legitimacy and contacted either the City of Edmonton, Province of Alberta or other agency to determine if the survey was sanctioned. This concern was expected given the nature of the information requested and the number of illegitimate telephone activities which occur.

Need For Providing Household Income: Many households questioned the need for providing household income. A typical reaction to this question for some respondents is that it is a travel survey and has nothing to do with income.

Concern About The Travel Day Being Representative Of Travel: Some households questioned the random assignment of the travel day, as they felt it did not reflect an average travel day for their household. This could have been due to a number of circumstances, including: illness of family members, their day off work.

What Will The Survey Results Be Used For?: Some households questioned the need to conduct the survey, and what the survey results would be used for. This often lead to other questions about need for so much detail about each trip made.

In general, many of the survey respondents and potential survey respondents who had some question about the survey indicated that they would participate in the survey.

Cost Summary

The total budget for the Household Travel Survey was $276,000 (excluding GST). This included all aspects of data collection, entry, expansion and analysis, as well as the preparation of two reports: a Technical Report detailing the survey process; and a Project Report summarizing the results of the survey. Of this budget, approximately $200,000 was budgeted for implementing the survey and collecting the data. This represents approximately $33 per completed survey. Approximately $47,000 was allocated to data entry, geocoding, and data verification. The remainder of the budget was allocated for data analysis and the preparation of the technical and project reports.

6.0 Data Processing, Expansion and Validation

The data collected during the survey was processed and edited using a variety of computer software and custom programs in order to:

- ensure the accuracy of the data,
- verify the logic and consistency of each trip,
- to geocode place of residence, place of work and origin and destination of each trip, and
- determine which trips should be 'linked' in order to obtain a clearer picture of trip-making activity.

Data Verification

The survey data was checked and verified both during data collection and data entry to ensure the quality and accuracy of the results. Checks were also conducted to make sure that the information provided by the survey respondents were logical. Some of the types of logic checks are described below. It should be noted that there may be some exceptions to each of the logic checks. For example, although it is unlikely that a 'child' residing in the household is older than 50 years old, it is still possible. Similarly, if a person is employed they should be 16 years or older but again, there are exceptions.

PERSON INFORMATION

1. At least one person in the household must be the head of the household.
2. Head of household should be older than 17.
3. If a person is less than 40 years old, the person should not be a grandparent.
4. If a person is older than 35, the person cannot be a grandchild.
5. If a person is less than 17 years old, it is unlikely they are a spouse/partner.
6. If the person has a valid drivers license, the person should be 16 years or older.
7. If the person is retired, the person should be older than 40.
8. If the person is employed (full-time or part-time), they should be 16 years or older.
9. If the person is a pre-schooler, they should be 6 years old or younger.
10. If the person is in kindergarten/elementary school, they should be between 4 and 13 years old.
11. If the person is in junior high school, they should be between 12 and 16 years old.
12. If the person is in high school, they should be at least 15 years old.
13. If the person is in post-secondary education, they should be at least 16 years old.
14. If the person needs their car at work either frequently or infrequently, they should have a valid drivers license.

TRIP INFORMATION

1. If the trip purpose is work or work-related, the person should be employed in the PERSON data.
2. If the trip purpose is a work trip, the person should be noted as having worked on the travel day in the PERSON data.
3. If the trip purpose is pre-school/daycare, the person should be under 12 years old. There may be some exceptions as an older child may also be going to a babysitter or after-school care.
4. If the trip purpose is grade school, the person should be older than 5 years and less than 20 years. Some exceptions exist as some older people may be upgrading their education.
5. If the trip purpose is post-secondary, the person should be older than 16 years old.
6. If the trip mode was auto driver, the person had a valid drivers license. Note that in some cases, a driver could be 14 years old and driving with a learners license accompanied by a person with a valid drivers license..
7. Check that the number of people in the car from the household is less than the total number of people living in the household.
8. If mode was not auto and a private vehicle was available as a driver, check that the person has a valid drivers license.

Geo-Coding

Geo-coding involves referencing an address or location to a specific X and Y map coordinate. Data which was geo-coded included the place of residence (household address), place of work (for those people who are employed either full-time or part-time), and the origin and destination of each trip. The coordinate system used was the City of Edmonton **G**eographic **B**ased **I**nformation **S**ystem.

Address Coding Conventions

Using an address file provided by the City of Edmonton Planning Department, most addresses in the City of Edmonton could be referenced and given a specific X and Y map coordinate. Surveyors, as part of their training, were instructed to obtain either the exact address of each trip origin and destination or, where an address was not available, the closest intersection. In order to geo-code an address or intersection, each location was coded in a consistent manner as per the examples in the following table.

Table 4 - Address Coding Conventions

Example	10512 112 St, Edmonton	15604 Stony Plain Rd, Edmonton	Intersection of 105 St. and 104 Ave., Edmonton
Address number	10512	15604	
Street	112	STONY PLAIN	105 STREET/104 AVENUE
Street name	STREET	ROAD	
City	EDMONTON	EDMONTON	EDMONTON

Then, using a series of custom-written programs, the GBIS X and Y coordinates were assigned to each household, place of work, and trip origin and destination.

The address file contained coordinates for about 157,000 locations in the City of Edmonton. In many instances however, an origin or destination noted in the travel survey was not found in the address file. In these cases, the GBIS coordinates for the closest address in the address file were used to represent the location of the origin or destination. Where it was not possible to find a 'closest' address, the origin or destination was not assigned an X-Y coordinate.

Transportation Zone System and GBIS Coordinates

The GBIS coordinates were then used to correlate each household, place of work, and trip origin and destination to the transportation zone system, illustrated in Figure 8. The City of Edmonton Transportation Department provided a file containing the X and Y GBIS coordinates of each polygon vertex of each transportation zone. A custom-written program was developed which would determine the location of any GBIS coordinate pair within the transportation zone system.

Where GBIS coordinates were not available, a transportation zone was manually assigned to the location. All locations outside of the City of Edmonton were geo-coded manually to the transportation zone system.

Geo-Code Accuracy

The resultant geo-coding was done to three levels of accuracy as follows:

1. **Exact address matching**. Addresses were exactly matched to the Edmonton address file and precise GBIS coordinates obtained.

2. **Approximate address matching**. Where the closest intersection was coded, the location was coded to the address closest to that intersection. For example, the

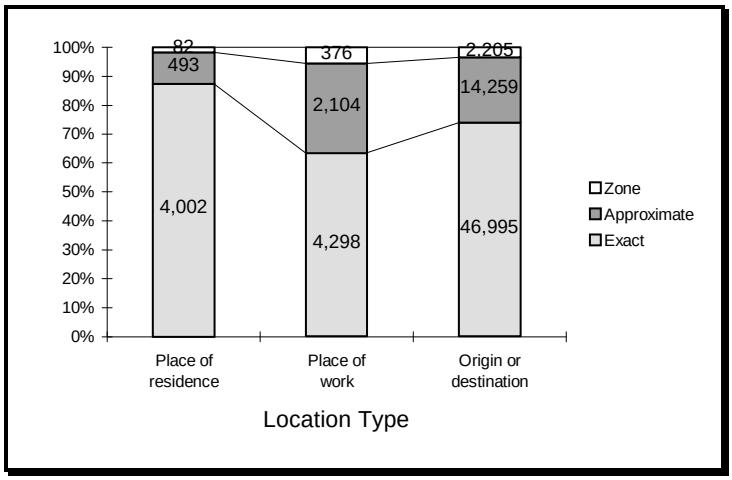


Figure 7 - Edmonton Geo-code Accuracy

intersection of 104 Avenue and 105 Street would be close to 10420 105 Street. As well, some addresses were not defined in the City of Edmonton address file. In these cases, the address was coded to the next closest address. For example, 15621 Stony Plain Road is close to 15654 Stony Plain Road.

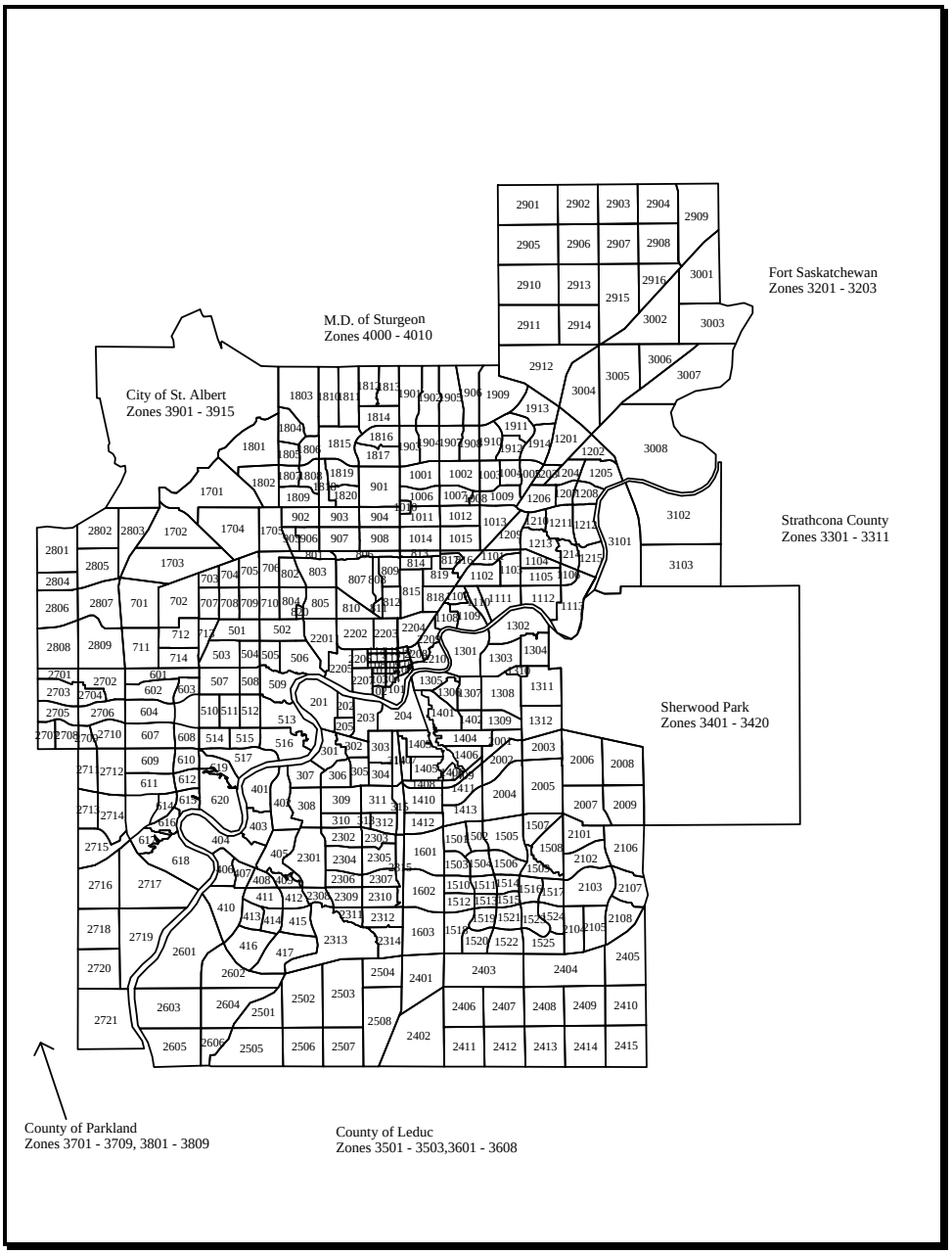


Figure 8 - Transportation Zone System

3. **Match the address to the transportation zone system**. Where neither an exact or approximate address match was possible, the address or location was manually coded to the appropriate transportation zone. As the GBIS system only references addresses within the City of Edmonton, all locations outside the City were matched to the appropriate transportation zone. When a place of work or trip origin/destination was outside the study area, the location was referenced to either the closest external roadway (i.e. Highway 2 south) or as Zone 9999. The latter denotes locations external to the study area where it was not possible to deduce the closest external roadway.

Over 95% of all locations in the City of Edmonton were geo-coded to an exact or approximate X and Y coordinate.

Data-base Formats

The survey data was keypunched into three separate database files; household data, person data and trip data. The trip data was then used to develop an origin-destination trip file. All database files were created using FoxPro which uses the standard DBF file format. The relationship of each database file is illustrated in Figure 9.

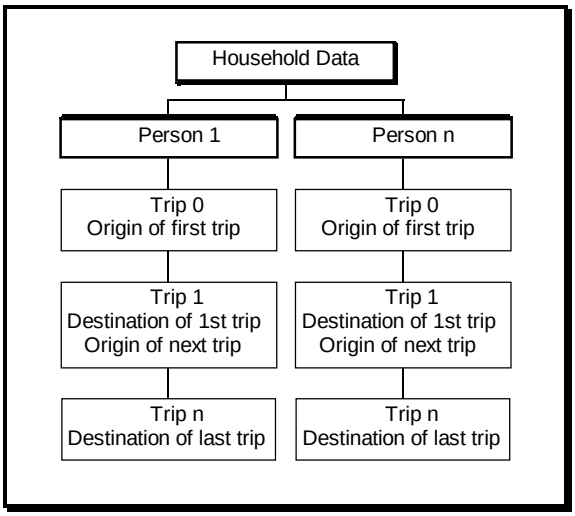


Figure 9 - Database Hierarchy

Household Data

The household database contains the information collected about each of the 6,020 households who completed the survey. Each household is referenced by a unique 5 digit *sample number*.

Person Data

The person database contains the information collected about each of the 17,168 residents of the 6,020 households who completed the survey. Each person is referenced by both the household *sample number* well as by a unique *person number*.

Trip Data

The trip database contains the information collected about each of the 83,232 trips made by the 17,168 residents of the 6,020 households who completed the survey. Each trip is referenced by the household *sample number*, the *person number*, and a unique *trip number*.

Origin-Destination Trip Data

The origin-destination database is derived from the trips database and contains the origin and the destination of each trip.

Linked Trip Identification

Every trip which meets the definition of a trip described earlier is coded in the TRIPS database. While tracking each trip link has advantages (i.e. it permits the analysis of walk times, wait times at bus stops, and analysis of trip diversions or chaining), a disadvantage is that the trip purposes and travel modes in the database are 'link specific' rather than 'trip specific'. For example, if a person drives a vehicle to a parkade and then walks three blocks to work, the resultant trip analysis would indicate that the person made one *change mode trip by vehicle* and then made one *work trip by the walk mode*. However, for the purposes of analyzing this trip using the standard purposes and modes of the transportation model, this person would be described as having made one *work trip by vehicle*.

In order to analyze the trips in terms of standard transportation modeling purposes and modes, two trip types were 'linked' together. These two trip types included certain 'pick-up/drop off passenger' and 'change mode' trips. To assist in defining these trip types, a field was defined in the TRIPS databases called LINK_OUT. This field is used to flag those trips which are to be linked when creating the Origin-Destination Trips file. The following trip types were linked..

- **Pick-up/drop-off passengers** (PURPOSE=10). If the difference between the arrival and departure time for this trip is less than or equal to 5 minutes, the LINK_OUT field was coded as 1. If the difference between the arrival and departure time for this trip is less than or equal to 10 minutes, the LINK_OUT field was coded as 2. All trip links coded with a 1 or 2 are linked when the Origin-Destination Trips file is created. However, all pick-up/drop-off passengers where the difference in the arrival and departure time were greater that 10 minutes are not linked. As well, all pick-up/drop-off passenger trips where the ONLY purpose of the trip is to serve a passenger are not linked.

- **Purpose is to change mode** (PURPOSE=11). If the purpose of the trip is only to change mode, then the trip is linked *if* the mode change involves walking to/from a bus or walking to/from a vehicle. Also, all LRT to BUS, BUS to BUS, or BUS to LRT trips are linked. Valid change mode trips include vehicle (driver or passenger) access to/from transit, vehicle driver to vehicle passenger, taxi to other, and bus to taxi.

  Two codes are used in the LINK_OUT field to define the change mode trips which are to be linked. If the trip is a 'prior' to the valid mode, LINK_OUT is coded as 100. Examples include *walk to bus or walk to vehicle* where the walk trip is prior to the valid mode. If the trip is 'after' the valid mode, LINK_OUT is coded as 200. Examples include *bus to walk or vehicle to walk* where the walk trip is after the valid mode. These two codes are used since the trip linkage is treated differently in each case. If the code is 100 (link-out prior trip), then the trip is simply linked to the next trip. However, if the code is 200 (link-out the subsequent trip), then the mode of the current trip must replace the mode of the subsequent trip before the current trip is linked. For example, for a bus to walk trip where the trip purpose is first to change mode (to walk) and then walk to work, you would keep all characteristics of the work trip EXCEPT the mode, which you would change from 'walk' to 'bus'.

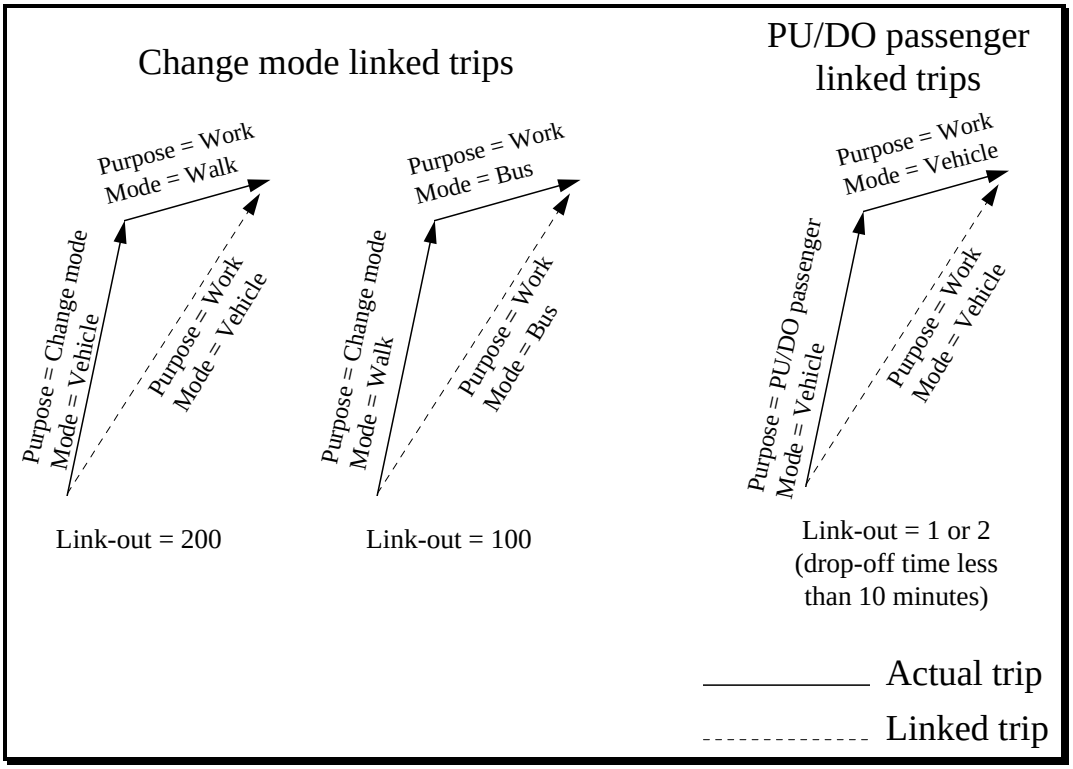


Figure 10 - Types of Linked Trips

Nearly 3,800 trips are linked together using these definitions. The number of linked trips by type of linked trip is summarized as follows.

Table 5 - Number of Linked Trips

Trip Type	Number of trips
PU/DO passenger where drop off time is less than 5 minutes (LINK_OUT=1)	2,575
PU/DO passenger where drop off time is greater than 5 minutes and less than 10 minutes (LINK_OUT=2)	432
Change mode (LINK_OUT=100)	512
Change mode (LINK_OUT=200)	274

Origin - Destination Trip Data

The origin-destination trip database is derived from the trips database but instead of storing the trips in 'trip link' format, the trips are stored in 'origin-destination format. A total of 62,476 origin-destination trips were derived from the trips database. These origin-destination pairs do not include the trips which were linked as discussed in the previous section.

Data Expansion

In 1994, the number of households within the study area has been estimated by the City of Edmonton to be 318,740. A total of 6,020 household travel surveys with complete data have been utilized, representing a sampling rate of 1.9% of all households. The expansion of the survey data was undertaken by weighting the sample across three variables; geographic location, household income and number of people in the household. The process which was applied to develop the final expansion or scaling factors is described below.

Inclusion Of "Not Reported" Household Income

For approximately 11% (665) of the 6,020 complete surveys, the household income was not reported. It was felt that an attempt should be made to include this data in the analysis. As each stage of the expansion utilizes household income as a parameter, it was necessary to estimate the household income for these records to include it in the sample.

Of primary importance in considering an appropriate approach to attaching an income to the "not reported" cases was the relationship between income and the number and types of trips which are generated. A regression analysis of the 5,355 records for which income was reported revealed a very strong relationship between trip generation and income; household size; and the number of automobiles available to the household. Similarly, household income and the number of automobiles was strongly correlated.

The preferable approach to estimating household income for the "not reported" records takes advantage of these relationships. An income category was assigned to each "not reported" record using the following procedure:

- The "not reported" cases, disaggregated by transportation superzone; household size and number of automobiles, were compared to the survey total for each comparable disaggregation of the "reported" cases.
- The "not reported" records for each cell were allocated pro rata to an income category on the basis of the proportion of each income category was represented for the "reported" cases.

Table 6 - Raw Survey Responses by Household Income and People in Household

	Household income					
People in household	**Not reported**	**less than $15,000**	**$15,000 to $24,999**	**$25,000 to $59,999**	**$60,000 +**	**TOTAL**
1	113	211	196	440	38	998
2	274	124	204	867	473	1,942
3	92	52	73	491	362	1,070
4	129	26	55	576	534	1,320
5+	57	13	28	329	263	690
TOTAL	665	426	556	2,703	1,670	6,020

Table 7 - Adjusted Survey Sample by Household Income and People in Household

	Household income				
People in household	**less than $15,000**	**$15,000 to $24,999**	**$25,000 to $59,999**	**$60,000+**	**TOTAL**
1	239	224	491	44	998
2	138	240	1,010	554	1,942
3	55	80	539	396	1,070
4	26	59	638	597	1,320
5+	13	30	359	288	690
TOTAL	471	633	3,037	1,879	6,020

Stage 1 Expansion - Household Size , Income and Geographic Location

In the first stage of the expansion process, scaling factors were developed for each of the 17 regional traffic superzones across two variables: household size and household income. The scaling factor is equal to the ratio of estimated number of households divided by the number of surveyed households within each stratum. This results in a total of 340 individual scaling factors (17 superzones, 5 household sizes, 4 household income groups).

After the Stage 1 expansion, the number of scaled households, disaggregated by household size and income, was compared to the 1994 household totals, which were derived from special cross-tabulations obtained from Statistics Canada. Overall, the scaled households were -1.0 percent of the actual number of households as indicated in the following table. The expanded household results were very representative except for the following groups of households; those with a household size of 3 or greater and a household income of less than $25,000. Within these strata, the total number of surveyed households was proportionately less than the number of observed households by between 5% and 31%.

Table 8 - Comparison of Scaled to Observed Households (Stage 1)

	Household income				
People in household	**less than $15,000**	**$15,000 to $24,999**	**$25,000 to $59,999**	**$60,000+**	**TOTAL**
1	-1.0%	0.0%	0.0%	0.0%	-0.4%
2	0.0%	0.0%	0.0%	0.0%	0.0%
3	-11.0%	-4.6%	0.0%	-0.2%	-1.5%
4	-23.9%	-4.9%	-0.1%	0.0%	-1.6%
5+	-30.7%	-17.3%	-0.3%	-0.5%	-2.9%
TOTAL	-4.1%	-2.0%	0.0%	-0.2%	-1.0%

Stage 2 Expansion - Adjusting for income and household size

The results of the Stage 2 expansion, disaggregated by household size and household income, is presented in the following table.

Table 9 - Comparison of Scaled to Observed Households (Stage 2)

	Household income				
People in household	**less than $15,000**	**$15,000 to $24,999**	**$25,000 to $59,999**	**$60,000+**	**TOTAL**
1	0.0%	0.0%	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%	0.0%	0.0%
3	-1.2%	-0.2%	0.0%	0.0%	-0.1%
4	-5.7%	-0.2%	0.0%	0.0%	-0.3%
5+	-9.4%	-3.0%	0.0%	0.0%	-0.6%
TOTAL	-0.8%	-0.2%	0.0%	0.0%	-0.1%

As shown by this table, the scaled households closely matches the observed households within each income and household size stratum and is within -0.1% of the total.

Stage 3 Expansion - Adjusting to observed households by superzone

The final stage of the expansion process balances the scaling factors by geographic region. The Stage 2 scaling factors were adjusted by multiplying the scaling factor by the ratio of total number of households in each superzone to the Stage 2 scaled number of households in each superzone.

Table 10 - Comparison of Scaled to Observed Households (Stage 3)

	Household income				
People in household	**less than $15,000**	**$15,000 to $24,999**	**$25,000 to $59,999**	**$60,000+**	**TOTAL**
1	0.7%	0.6%	0.5%	0.9%	0.6%
2	0.4%	0.2%	0.1%	0.1%	0.2%
3	-1.4%	-0.3%	-0.1%	-0.1%	-0.2%
4	-5.9%	-0.5%	-0.2%	0.0%	-0.4%
5+	-9.5%	-3.5%	-0.2%	0.0%	-0.7%
TOTAL	-0.3%	0.0%	0.0%	0.1%	-0.0%

Data Validity

To validate the survey data, comparisons were made between the scaled survey results and various demographic and travel data sources. Specifically, the scaled survey data was compared to:

- population by regional superzone,
- number of registered automobiles,
- vehicle trips measured at various screenlines throughout the City of Edmonton,
- total number of daily bus trips.

Results are summarized in Table 11.

Table 11 - Comparison of 1994 Observed Data with Scaled Household Travel Survey Results

Comparison Measure	1994 Observed	Scaled Household Travel Survey Population	% Difference
POPULATION			
City Population	628,400	620,500	-1%
Region Population	232,500	232,300	0%
PRIVATE VEHICLES			
City Registered Private Vehicles	363,600	386,900	6%
Region Registered Private Vehicles	95,152	95,031	8%
TRAFFIC FLOW		**AM PEAK PERIOD (Peak Direction)**	**DAILY (2-WAY)**
River		3%	-15%
CNR		2%	-18%
Whitemud		3%	-20%
CPR		8%	-16%
DAILY BUS TRIPS			
Total - CMA	171,800	188,500	10%

The 1994 control totals for each of these parameters are estimates derived by the City of Edmonton Transportation Department and are based on the best available census and other statistical and historical data. The compilation of each of these observed "control totals" presented some difficulties, as discussed below.

Population

The Travel Survey did not cover "group residences" such as prisons or long-term stay medical facilities. Observed population totals had to be adjusted for this category of person.

Private Vehicle Registrations

The observed data was derived from 1993 statistics on private vehicle registrations of vehicles on the Edmonton CMA. The Travel Survey was conducted one year later, and obtained data on vehicles "available for use" in the household, which might include some vehicles registered for commercial use, and vehicles registered outside the CMA. As noted in this table, a difference of 7.0% is observed between the 1994 observed estimate and scaled survey number of registered private vehicles in the Edmonton CMA.

Observed Private Vehicle Screenline Flows

The surveyed Origin-Destination vehicle trip table was assigned to the existing roadway network using the EMME/2 travel model, and the results compared to observed count data (adjusted to remove trucks and scheduled buses). It was recognized that these observed screenlines still included significant amounts of vehicular traffic not captured in the Household Travel Survey. Types of vehicle trips which were not surveyed as part of the travel survey include:

- Bus trips (school bus; non-scheduled services; out of service scheduled services)
- DATS (Disabled Transportation) vehicle trips
- Commercial trips made in "non-truck" company vehicles
- Vehicle trips made in the CMA by persons living outside the CMA (in own vehicle; rental vehicles, etc.)
- Vehicle trips made by group home residents living in the CMA
- Taxi trips made to/from passenger pick-up/drop off points.

It is difficult to estimate what proportion these trips are of total vehicle trips. Although the number of vehicles making these trips may be small in comparison to total vehicles in the CMA, the vehicle-kilometres traveled per day will be significantly larger than for the average private vehicle. Their impact on traffic volumes will therefore be much larger than the number of vehicles involved. A very limited survey carried out on arterial roadways adjacent to the downtown area, to estimate the potential proportion of such traffic in daily traffic flows indicated that these could exceed 10% of daily flows.

Bus Trips

The observed bus trips were derived from data on the number of boardings on each bus route in the Edmonton area. Edmonton and the surrounding municipalities have an integrated transit and fare system, with transfers a common requirement to complete a transit trip. The observed bus boardings have to be converted to bus trips using a boarding per trip ratio, which is difficult to estimate for all trips made.

Summary

Based on the results in Table 11, and with the concerns about the observed "control totals", the scaled survey data was considered to be valid when compared to a wide range of 1994 demographic and travel data. The survey results are considered to be representative of demographic and travel characteristics in the Edmonton Census Metropolitan Area.

7.0 Results Tabulation and Presentation

The Household Travel Survey captured both detailed demographic about the people living in the Edmonton Census Metropolitan Area and the trips made by this population on a typical weekday. A sampling of the travel survey results is presented in this section.

Demographic Characteristics

Household Size (persons)

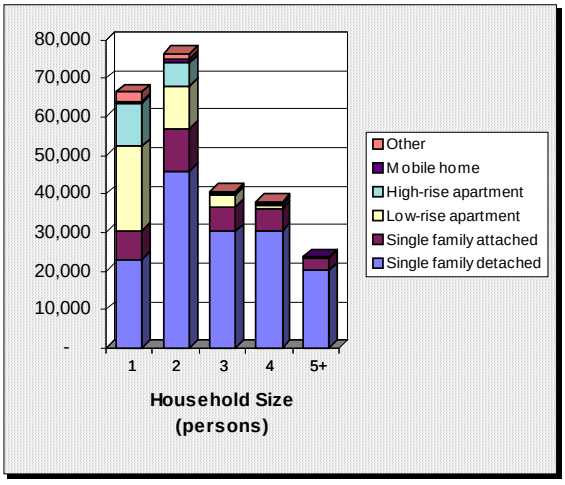
In the City of Edmonton there are approximately 245,300 private households with a total population of 628,400 people.

Table 12 - Number of Households in the City of Edmonton by Household Size and Type of Household

City of Edmonton	**Household Size (persons)**							
Type of household	1	2	3	4	5 +	TOTAL	%	Persons per household
Single family detached	22,936	45,891	30,264	30,465	20,140	149,696	61.0%	2.91
Single family attached	7,482	11,065	6,260	5,756	3,153	33,717	13.7%	2.61
Low-rise apartment	21,965	11,027	3,148	1,056	289	37,485	15.3%	1.59
High-rise apartment	11,312	6,003	558	173		18,047	7.4%	1.42
Mobile home	431	997	201	210	47	1,887	0.8%	2.18
Other	2,341	1,522	275	304		4,442	1.8%	1.67
TOTAL	66,467	76,506	40,707	37,964	23,630	245,274	100.0%	2.56
%	27.1%	31.2%	16.6%	15.5%	9.6%	100.0%		

The average household size in the City of Edmonton is 2.56 persons. Over 58% of households in Edmonton have one or two persons.

Figure 11 - Number of Households in the City of Edmonton by Household Size and Type of Household



The majority of the population in the City of Edmonton live in single-family detached houses. The proportion of households in single-family detached houses increases significantly with the number of people in the household, from about one-third for single person households to over 80% for households with 5 or more persons. Approximately one out of every four people live in either a low-rise or high rise apartment. Multi-family units comprises approximately 50% of housing for single person households. This decreases dramatically as household size increases. For two person households, multi-family (apartments) comprises 22% of housing, decreasing to 9% for three person households.

The average household size for persons living in single family attached or detached houses is nearly twice that for persons living in an apartment.

Automobiles Available for Use

Table 13 - Number of Households in the City of Edmonton by Household Size and Number of Automobiles

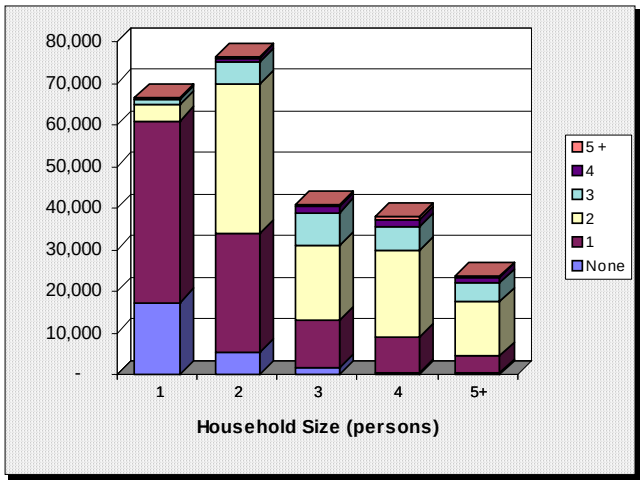
City of Edmonton	**Household Size (persons)**							
No. of autos	1	2	3	4	5 +	TOTAL	%	Persons per household
None	17,345	5,124	1,685	496	233	24,883	10.1%	1.44
1	43,700	28,897	11,354	8,317	4,092	96,361	39.3%	1.98
2	3,925	35,908	17,919	20,960	13,057	91,768	37.4%	3.08
3	1,163	5,233	8,048	5,622	4,711	24,776	10.1%	3.40
4	210	991	1,437	1,825	1,331	5,793	2.4%	3.69
5 +	125	353	264	744	206	1,691	0.7%	3.37
TOTAL	66,467	76,506	40,707	37,964	23,630	245,274	100.0%	2.56
%	27.1%	31.2%	16.6%	15.5%	9.6%	100.0%		
Autos per household	0.85	1.60	1.93	2.06	2.15	1.58		

The number of automobiles available to each household depends significantly on the average household size. Generally, as household size increases, the average number of automobiles per household also increases. Single person households averaged less than one automobile (0.8). This is due to a significant proportion of single person households with no automobiles (26%).

Households with 2 or more persons averaged between 1.6 and 2.15 automobiles per household. The proportion of households with two automobiles increases from 47% for 2 person households to 55 % for households with five or more people.

The proportion of households with three automobiles increases significantly when there are three or more people per household (from 4.4% to 18%). A very small proportion of households has four or more automobiles (approximately 3 percent).

Figure 12 - Number of Households in the City of Edmonton by Household Size and Number of Automobiles



Trip Generation

Household size, income levels, and the availability of autos are all important determining factors in the number of trips generated by a household. The following tables illustrate the daily person trip generation rates by each of these three parameters.

Table 14 - Daily Person Trips per Household by Household Income and Size (City of Edmonton)

City of Edmonton	**Household Income**				
Household size (persons)	< $15,000	$15 - $24,999	$25 - $59,999	$60,000+	TOTAL
1	3.27	3.73	4.32	4.01	3.77
2	6.57	6.01	7.13	8.14	7.12
3	9.66	9.78	10.36	11.70	10.69
4	12.48	13.21	14.66	15.61	14.83
5+	n/a	15.70	19.14	20.00	19.30
TOTAL	5.58	6.59	9.51	12.63	9.17

An average of 9.2 daily person trips are generated by each household in the City of Edmonton. As can be expected, more trips are generated by households where more people live.

As well, the number of trips generated by a household is observed to increase with household income.

Table 15 - Daily Person Trips per Household by Household Size and Number of Vehicles(City of Edmonton)

City of Edmonton	**Household Size (persons)**					
Number of vehicles	1	2	3	4	5+	TOTAL
None	2.82	6.17	9.73	n/a	n/a	4.19
1	4.03	6.55	9.46	13.47	17.39	6.81
2	4.61	7.59	11.24	15.13	20.17	11.69
3	4.93	7.86	11.12	15.03	19.95	12.71
4	n/a	n/a	12.42	17.38	17.08	14.11
5 +	n/a	n/a	n/a	n/a	n/a	12.01
TOTAL	3.77	7.12	10.69	14.83	19.30	9.17

The daily person trip generation rate is observed to increases as the number of vehicles available for use by the household increases. For households with no vehicles, the trip rate averages 4.2 daily person trips per household while for households with three or more vehicles, the trip rate ranges from 12.0 to 14.1 person trips per household.

Figure 13 - Daily Person Trips per Household by Household Size (City of Edmonton)

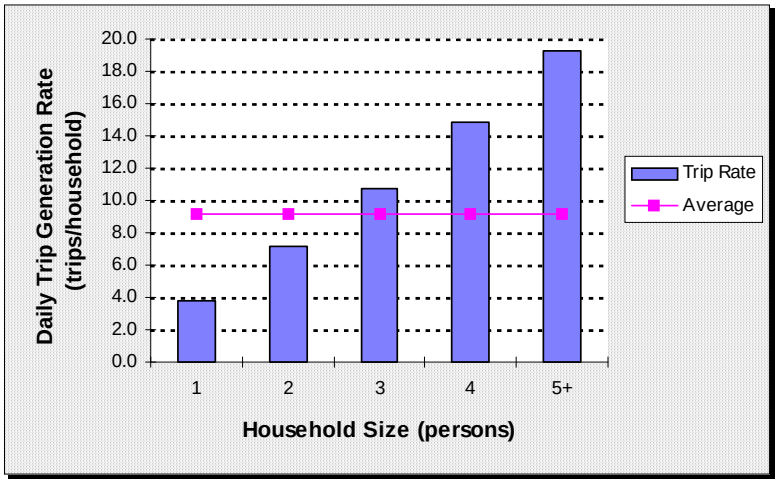


Figure 14 - Daily Person Trips per Household by Number of Vehicles (City of Edmonton)

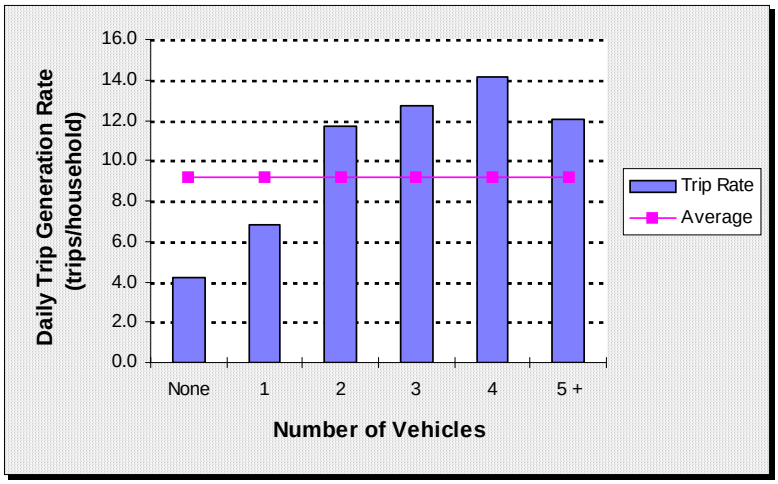
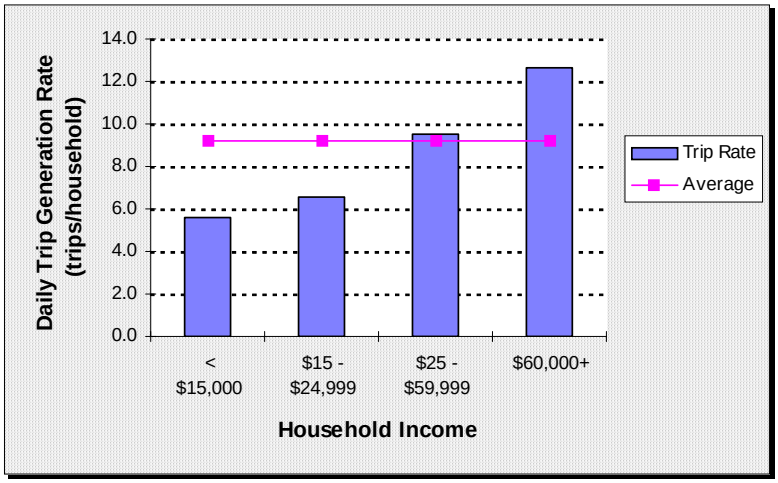


Figure 15 - Daily Person Trips per Household by Household Income (City of Edmonton)

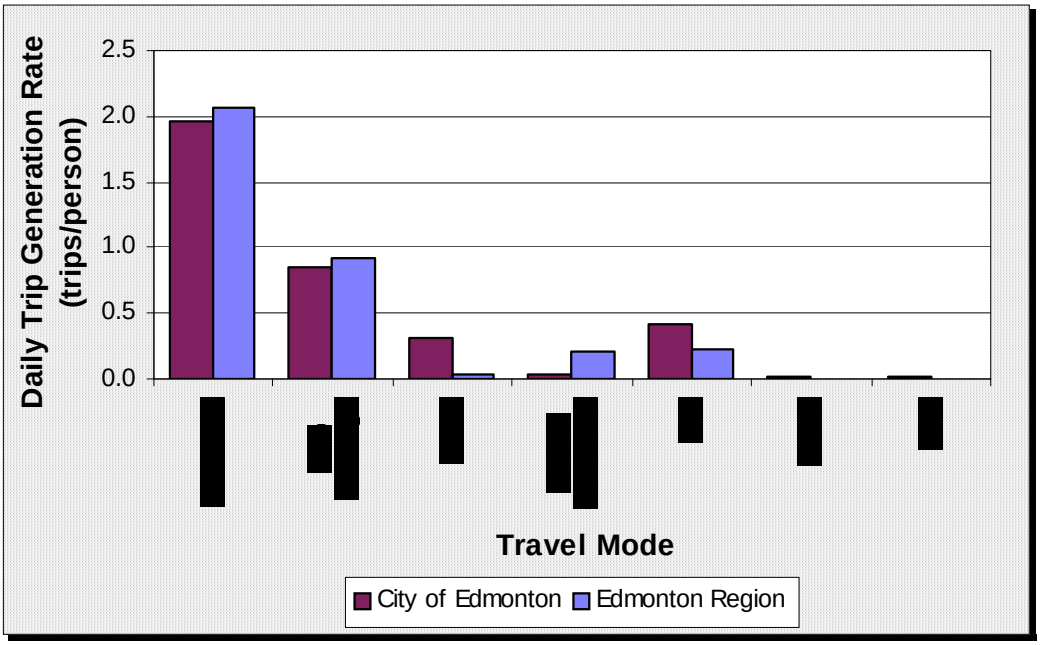


Daily Trip Generation Rates per Person

Table 16 - Daily Trips per Person by Travel Mode, Age Group and Gender (City of Edmonton)

City of Edmonton	Age Group			Gender		All
Travel Mode	**< 16**	**16 - 64**	**65 +**	**Male**	**Female**	**Persons**
Auto Driver	0.00	2.65	1.80	2.29	1.66	1.96
Auto Passenger	1.96	0.51	0.51	0.68	0.99	0.85
Transit	0.25	0.33	0.31	0.25	0.37	0.31
School/Private Bus	0.15	0.01	0.00	0.04	0.04	0.04
Walk	0.78	0.30	0.30	0.41	0.41	0.41
Bicycle	0.02	0.02	0.01	0.03	0.00	0.02
Other	0.01	0.02	0.05	0.02	0.03	0.02
All Modes	3.18	3.84	2.97	3.72	3.50	3.61

Figure 16 - Daily Trips per Person by Travel Mode



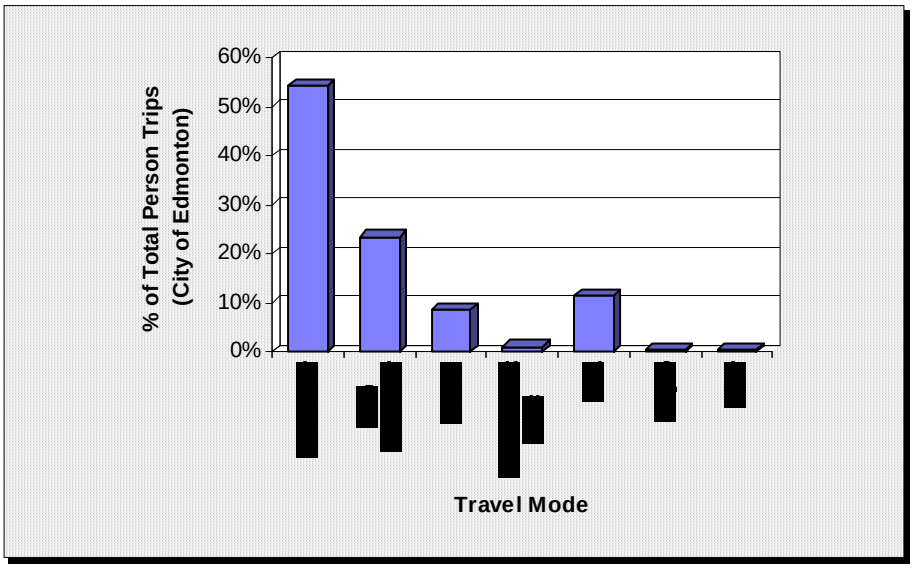
Person Trips Characteristics

On an average weekday, over 3,000,000 person trips are made by residents living in the study area, of which 73% are made by residents of the City of Edmonton. The travel modes of these person trips are summarized below.

Table 17 - Travel Mode (Daily Person Trips)

	City of Edmonton		***Edmonton Region***	
Travel Mode	**Daily Person Trips**	**%**	**Daily Person Trips**	**%**
Auto Driver	1,221,704	54.3%	482,964	59.3%
Auto Passenger	527,199	23.4%	216,670	26.6%
Transit	194,308	8.6%	9,526	1.2%
School/Private Bus	25,062	1.1%	48,374	5.9%
Walk	257,789	11.5%	54,264	6.7%
Bicycle	10,121	0.4%	675	0.1%
Other	13,563	0.6%	2,011	0.2%
TOTAL	2,249,745	100.0%	814,484	100.0%

Figure 17 - % of Daily Person Trips by Travel Mode (City of Edmonton)



Over half of all person trips are made by driving a car, with residents in the Edmonton region relying more on the automobile than City of Edmonton residents. One quarter of all trips are made as an auto passenger.

Approximately one out of every twelve trips (8.6%) in the City of Edmonton are made by transit (bus and LRT) while in the Edmonton region, only about 1% of all trips are made by public transit. All of the transit trips in the Edmonton region are made either within or to/from Sherwood Park or St. Albert.

Walking trips account for about 12% of all City of Edmonton trips but only 7% of all trips made in the Edmonton region. Trips by bicycle during the survey period (November and December) are limited.

Trip Purpose

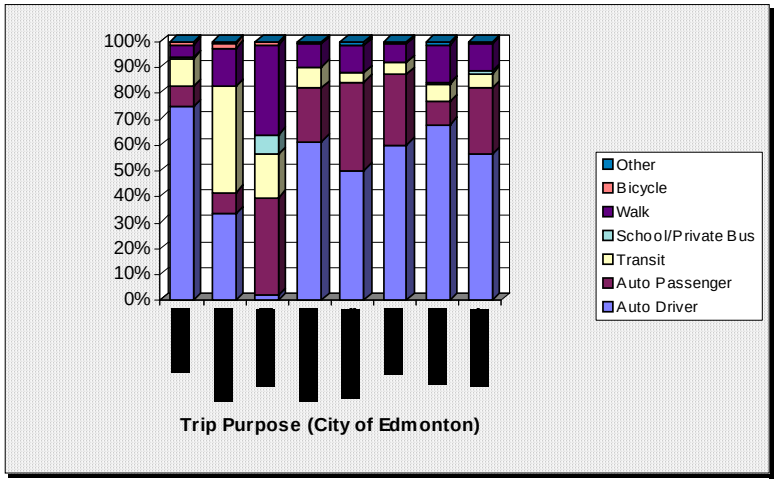
The distribution of daily person trips by trip purpose is shown below.

Table 18 - Trip Purposes (Daily Person Trips)

	City of Edmonton		***Edmonton Region***	
Trip Purpose	**Daily Person Trips**	**%**	**Daily Person Trips**	**%**
Home-based Work	379,140	16.9%	127,651	15.7%
Home-based Post Secondary	70,900	3.2%	8,784	1.1%
Home-based School	241,030	10.7%	107,523	13.2%
Home-based Shopping	237,853	10.6%	71,451	8.8%
Home-based Social/Recreation	209,409	9.3%	84,212	10.3%
Home-based Other	548,751	24.4%	192,808	23.7%
Home-based Sub-total	*1,687,083*	*75.0%*	*592,429*	*72.7%*
Non home-based Work	76,831	3.4%	26,779	3.3%
Non home-based Other	485,831	21.6%	195,274	24.0%
Non home-based Sub-total	*562,662*	*25.0%*	*222,053*	*27.3%*
TOTAL	***2,249,745***	***100.0%***	***814,484***	***100.0%***

In the City of Edmonton, three out of every four person trips are home-based, which means that the person's home is either the origin or the destination of the trip. Travel to and from the workplace make up approximately 20% of all daily person trips. About 80% of these work trips are made by vehicle, either as a driver or as a passenger.

Figure 18 - Trip Purpose by Travel Mode for Daily Person Trips in the City of Edmonton



Post-secondary trips are made equally by automobile (40%) and transit (40%) while the majority of trips to school are either made by walking or as an auto passenger.

Trips for such purposes as to eat a meal, personal business, just along for the ride or to pick-up or drop-off passengers account for about 40% of all person trips. Nearly half of these kind of trips are non-home based.

Since 'other' trips make up such a significant percentage of all person trips made during an average weekday, a more detailed examination of these types of trips was undertaken. Using the original travel survey classifications for trip purpose, the specific purposes of trips in the City of Edmonton which are generalized as 'other' are summarized as follows:

Table 19 - Other Trip Purposes - City of Edmonton (Daily Person Trips)

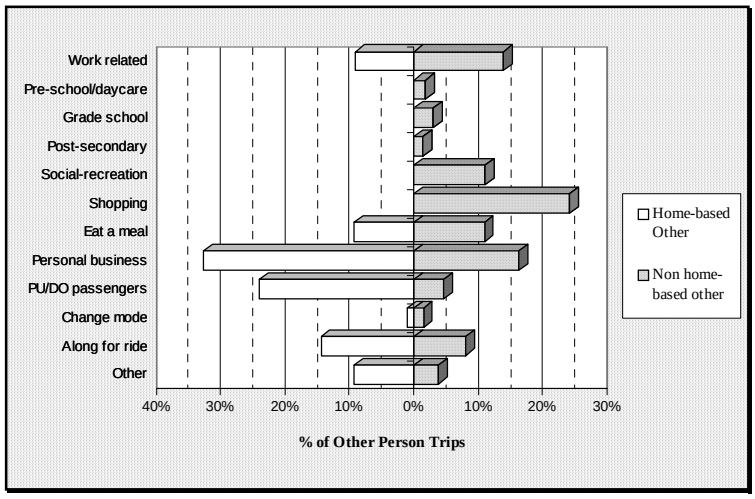
Trip Purpose	Home-based	%	Non-home based	%
Work related	49,659	9.0%	67,082	13.8%
Pre-school/daycare	n/a	n/a	8,682	1.8%
Grade school	n/a	n/a	14,590	3.0%
Post-secondary	n/a	n/a	6,863	1.4%
Social-recreation	n/a	n/a	53,823	11.1%
Shopping	n/a	n/a	117,424	24.2%
Eat a meal	51,328	9.4%	53,089	10.9%
Personal business	179,323	32.7%	78,625	16.2%
PU/DO passengers	131,905	24.0%	22,041	4.5%
Change mode	5,720	1.0%	7,002	1.4%
Along for ride	79,373	14.5%	38,642	8.0%
Other	51,443	9.4%	17,970	3.7%
TOTAL	548,751	100.0%	485,831	100.0%

The majority of home-based 'other' trips are made for personal business. Personal business trips are defined as trips made to obtain services as opposed to purchasing goods. Trips to a bank, to the post office, to a doctor or dentist, and to a barber are considered personal trips. Trips made to have an item repaired, such as a car or radio, or to have clothes cleaned, are also considered to be personal trips. In this table, 'n/a' indicates that the value is not applicable since these home-based trip purposes are already described as part of the eight standard trip purposes.

Trips which are made to either pick-up or drop-off a passenger make up over 20% of these other trips. These trips include bringing a child to school or day-care, or dropping some-one off at an LRT station.

Of the non home-based 'other' trips, shopping was the pre-dominant trip purpose (24%) while work-related trips ranked second at 14% .

Figure 19 - Other Person Trip Purposes (City of Edmonton)



Trips by Time of Day

The distribution of all person trips by time of day is presented in the following figures.

Figure 20 - Distribution of Person Trips by Time of Day

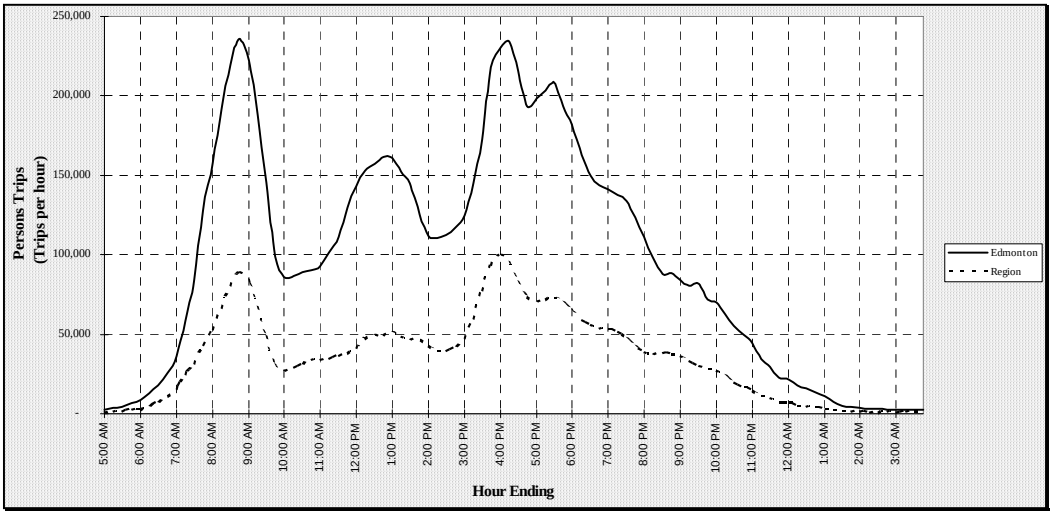
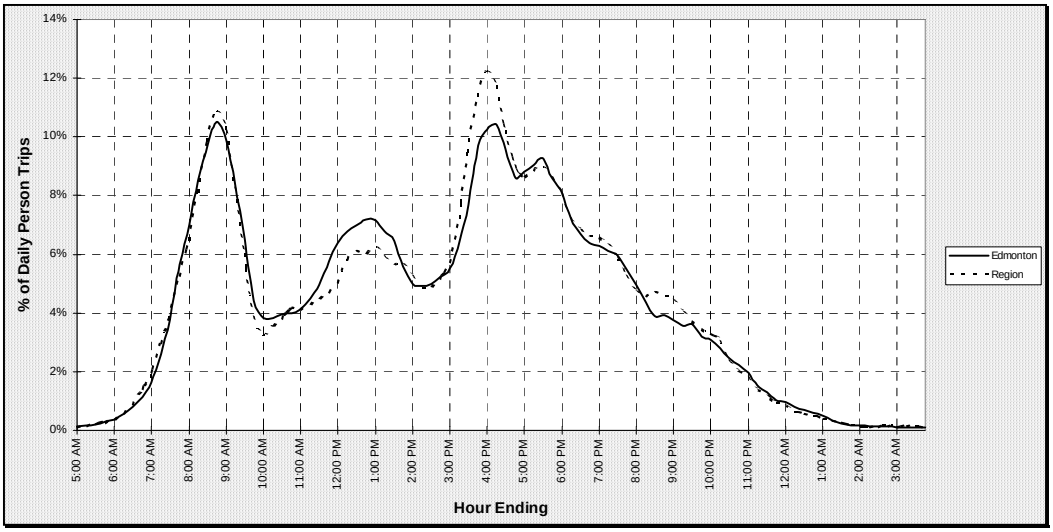


Figure 21 - Distribution of Person Trips by Time of Day (% of Daily Trips)



Total person trips by time of day exhibit similar characteristics for both trips made by residents of the City of Edmonton and by residents of the Edmonton Region. A well-defined peak hour is observed between 7:45AM and 8:45AM and again between 3:00PM and 4:00PM. The PM peak is somewhat more accentuated for the Region traffic. A noon-hour peak is more evident in the City than in the Region while more trips take place during the PM peak in the Region than in the City.

Trip Length and Travel Time

The average trip length (kilometres) and travel time (minutes) for all trips made by residents of the City of Edmonton are presented below.

Table 20 - Average Person Trip Length and Travel Time by Trip Purpose - City of Edmonton

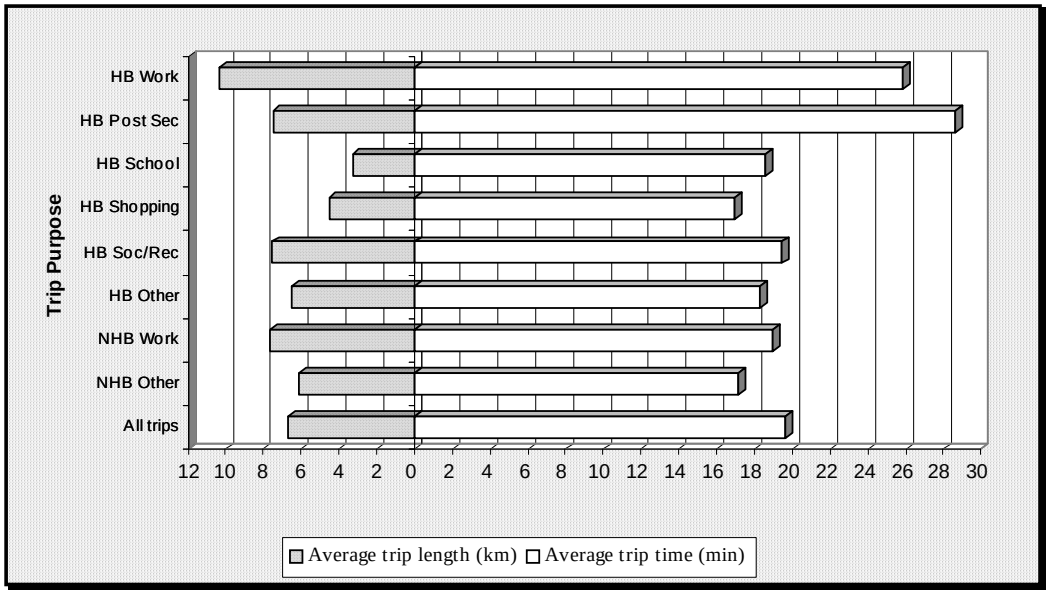
City of Edmonton	Person Trips	%	Person-km	%	Average trip length (km)	Average trip time (min)
HB Work	379,140	16.9%	3,907,325	26.0%	10.3	25.8
HB Post Sec	70,900	3.2%	531,435	3.5%	7.5	28.6
HB School	241,030	10.7%	794,517	5.3%	3.3	18.6
HB Shopping	237,853	10.6%	1,081,706	7.2%	4.5	16.9
HB Soc/Rec	209,409	9.3%	1,588,584	10.6%	7.6	19.4
HB Other	548,751	24.4%	3,584,916	23.8%	6.5	18.3
NHB Work	76,831	3.4%	587,640	3.9%	7.6	18.9
NHB Other	485,831	21.6%	2,975,856	19.8%	6.1	17.2
TOTAL	2,249,745	100.0%	15,051,978	100.0%	6.7	19.7

The total distance traveled by residents of the City of Edmonton on an average weekday is approximately 15,000,000 kilometres. One out of every four kilometres traveled is made by a person traveling between home and the workplace.

The average trip length for all person trips made by all residents of the City of Edmonton is estimated to be 6.7 km per trip. The work trip has the longest average trip length at 10.3 km while school trips are the shortest with an average of 3.3 km.

An average travel time of about 20 minutes is observed for all person trips made by City of Edmonton residents. Shopping trips have on average the shortest travel time, with each trip taking about 17 minutes, while post-secondary trips have the longest average travel time of 29 minutes.

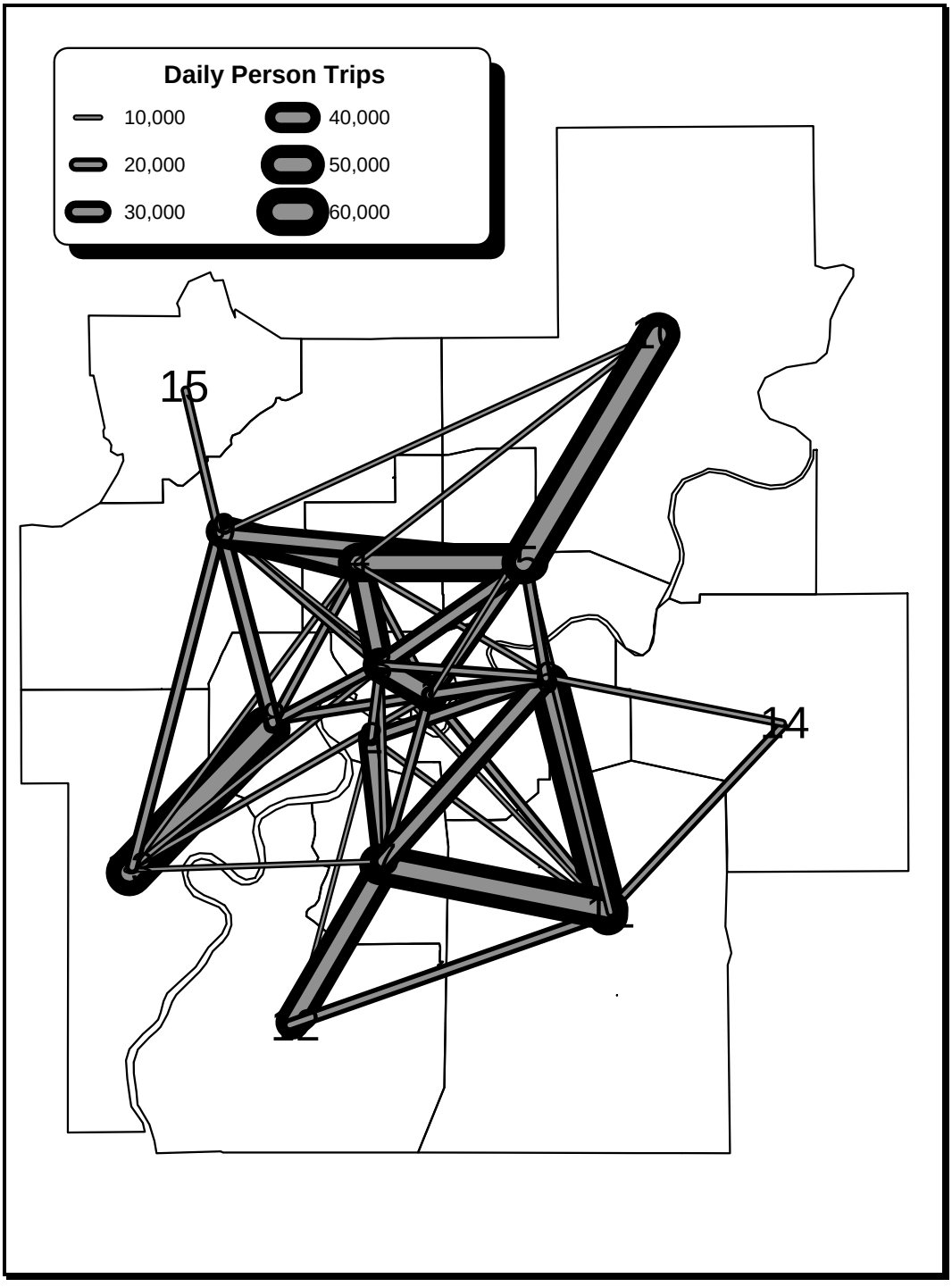
Figure 22 - Average Person Trip Length and Travel Time by Trip Purpose - City of Edmonton



Trip Origins and Destinations

The following figure presents the major daily trip origins and destinations for all daily person trips and trip purposes in the form of a travel desire map. The map illustrates the major trip movements between thirteen City zones as well as to St. Albert and Sherwood Park.

Figure 23 - Daily Person Trips - All Trip Purposes



8.0 Conclusions

The City of Edmonton Household Travel Survey was extremely successful. Detailed demographic and travel information for a complete day was collected for over 6,000 households, for a total cost under $300,000, or less than $50 per household. The travel diary survey method and instrument worked very efficiently and effectively, and it was possible to obtain high quality and statistically valid data even though a large amount of information was being sought from each household.

This data has proved to be invaluable in the ongoing Edmonton Transportation Master Plan study. It has been used to calibrate a state-of-the-art urban travel forecasting model which incorporates segmentation by 25 person-purpose trip categories; time of day choice including peak spreading; and nested logit mode choice for 7 mode types including non-motorized modes, transit park-and-ride, and single and high occupancy vehicles. Sufficient travel data was collected to enable each component and market segment of the overall model.

The description of the travel data results by themselves also proved to be invaluable tool in educating both City transportation department staff and the general public about the mix of travel patterns currently being made throughout the day, and thus possible future transportation demands and needs. The Survey Results document produced by the Consultant, together with summaries and presentations of these made by City staff, enabled all interested persons to have a clear factual comprehensive picture of today's travel demand. This has allowed the debate about the future directions for the Edmonton transportation system to take place on an agreed common base of the existing situation.

The City of Edmonton intends to use similar daily travel diary surveys in the future to monitor changes in travel patterns and behaviour. In addition to a survey for a typical fall weekday there are some thoughts to conducting additional surveys on weekends and in the summer, so that the total annual travel market in Edmonton is completely understood.

It is recognized that the Edmonton travel diary survey approach collected travel for a single "typical" fall weekday. Recent state-of-the-art household travel surveys in the USA have also conducted two-day rather than one-day surveys, and been "activity-based" rather than "travel-based". Both of these approaches have merit, and have to be considered when travel surveys are being planned. However there are cost and complexity issues associated with these other approaches. The Edmonton survey met all defined needs, and is seen as a valuable tool for many other cities.

The financial and administration assistance provided by Alberta Transportation for the "regional" component of the Edmonton Household Travel Survey enabled that portion of the survey to be undertaken, and is gratefully acknowledged.

DESIGN AND IMPLEMENTATION OF A COMPREHENSIVE TRAVEL DIARY SURVEY IN THE EDMONTON REGION

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Abstract

A comprehensive travel diary survey with some novel features was designed and implemented in the Edmonton Region in the Fall of 1994. The intention was to gather disaggregate descriptions of all trips longer than 100 metres made during a 24-hour period by all members of surveyed households. A total of 6020 households were covered, including just over 17100 people and 62400 trips on 14 different mode categories.

The survey method drew upon current experience in the United States and elsewhere, with innovations made to suit the Edmonton context and specific requirements. In striking a balance between cost, complexity and sample size, a system was developed where survey material was sent by post to participating households and a series of telephone 'call-backs' made to assist in completion of the forms and to collect the information after it was recorded by the household. This allowed a large amount of relatively complex information to be obtained from individual households at reasonable cost, including various household socio-economic conditions and constraints, details concerning complex trip-chains and even some stated preference observations concerning mode choice and trip generation.

The information thus obtained has been used by the City of Edmonton in analysis and modelling for the update of its long range transportation plan. Previous transportation planning in Edmonton to a large extent concentrated on the identification of the infrastructure improvements required to maintain levels of service in peak periods, which led to a focus on peak period data in general, and the journey to work data, in particular. Rising concerns about the environmental impacts of transport, the need for and appropriate use of public transport services, the potential roles of pedestrian and bicycle modes and the interaction between transport accessibility and urban form all had to be addressed in the new long range transportation plan. Consequently, information on the entire day rather than just the peak periods was essential and detailed disaggregate choice behaviour data for entire households were needed to calibrate the nested logit state-of-the-art travel demand model and evaluation system being developed.

This paper covers key features of the survey design and implementation, including specification of the instrument and the sample to meet the needs of the modelling and analysis work to be done, organization and monitoring of the field work, coding and checking, and tabulation/display. It is concluded that the overall survey process was very successful in providing an appropriately-sized sample of reliable information at comparatively low cost - and that, as such, it should be described to practitioners elsewhere.

KEY WORDS

travel survey; 24-hour travel diary; disaggregate behaviour choice data; revealed preference; stated preference