A. Survey Methods

APPENDIX A

SURVEY METHODS

Background

Travel surveys conducted in the 1950's and 1960's were very large and expensive projects, perhaps involving five percent of all households, and probably using a home interview to collect the information on daily travel. These large samples were used to prepare zone-to-zone trip tables. In the 1980's the trend was toward smaller samples, usually less than 1 percent of all households, and using either a mail-out/mail-back, or mail-out/telephone-back method for data collection. The goal became to collect travel data to calibrate trip generation, trip distribution, and mode choice, rather than attempting to establish accurate zone-to-zone trip tables

The Puget Sound Regional Council (PSRC) followed that trend, and used Michael E. Smith's approach for "Small-Sample Home Interview Travel Surveys," in designing the first of six surveys. The survey in Kitsap County would assist in two ways: (l) it would be the first time a household travel survey had been conducted in Kitsap County, and (2) it would serve as a test for the household travel surveys to be conducted in the remaining three counties.

Approximately 4,500 households or about .5 percent of all households in the Puget Sound region were surveyed between 1985 and 1988. Six separate surveys were conducted, three in King County conducted jointly with the Municipality of Metropolitan Seattle (Metro), and one each in Kitsap, Pierce and Snohomish counties.

The 2006 PSRC Household Activity and Travel Survey was undertaken to obtain information on region wide household activities and the travel these activities generate. PSRC will use the data to update, develop, and calibrate statewide and urban travel demand models. The primary use of the models is to estimate future travel demand and travel patterns. Other uses include air quality conformity, alternatives analysis, and detour analysis.

In the design of the 2006, basic demographics, activities, and tour and travel characteristics were collected for every member (including children) of 4,746 households during a consecutive 48-hour travel period. Vehicle GPS data were collected from a subsample of 220 of these households, with completed activity/travel diaries also collected for each household member. (Up to three-vehicles per household were equipped with GPS units).

Finally, a follow-up attitude perception and stated preference (SP) survey was conducted with a subsample of 916 respondents whose revealed trips fit criteria of interest for possible public transit and highway toll alternatives. A customized preference/choice survey instrument was generated using actual origin-destination data taken from trips reported in the household activity survey.

Sample Design and Selection

The minimum sample size for the base household activity survey was set at 4,600 households. This was divided between a main sample and transit rider and transit access oversamples. A two-day activity/travel diary was collected for all members of sampled households. The sample size for the SP survey was set at a minimum of 800 individuals sampled from the 4,600 households who completed the household survey. See Sampling Technical Document Attachment A1.

Rationale for Using Multiple Sample Frames

Ideally, a household travel/activity survey would be conducted using a single, geographically stratified RDD (random-digit-dial) sampling frame. One problem with this approach is the number of transit riders sampled is usually too small for analysis. Transit riders would fall into the RDD sample according to their incidence in the overall population. For example, if transit ridership in the PSRC area is 5% or less, the number of transit riders coming from the household survey (n=4,600) would be 230 or fewer. Moreover, using a region-wide RDD frame to oversample transit riders, particularly if they represent less than 10% of the total area households, is not very efficient.

Another strategy for increasing the number of transit riders in a sample was needed. The sampling design, thus, provided for oversampling of households within defined 4-plus zip codes where transit options (access) are currently available. Within this transit access oversample, small oversamples of households whose member(s) use ferry service or park & ride lots were included.

Sampling Targets and Results

The sample size for the main RDD household activity survey was set at 3,600 households; for transit access households, the sample target was 1,000. Regardless of survey activity, a two-day activity/travel diary was collected for all members of sampled households. By definition, a completed household was a household where two-day travel inventories and related information was retrieved from every member. The sample for the SP survey was set at 800 individuals

sampled from the 4,600 households who completed the household survey. Table A1 on the following page shows the recommended and completed sample sizes by survey activity.

Table A1. Recommended and Completed Sample Sizes by Survey Activity

Survey Activity	Sample Size	Completed No. of Households
Household Survey – Main Sample (Random-Digit-Dial)	3,600	3,937
Household Survey – Transit Rider & Transit Access Oversamples	1,000	809
Stated Preference Survey	800	916

While the completed transit rider and transit access oversample was somewhat less than the target, an additional 742 households of the completed RDD sample (18.8%) reported at least one trip by public train or bus during their 48-hour assigned travel period, and 196 RDD households (5%) reported at least one trip by ferry. Thus, overall the number of transit rider and transit access households completed will be sufficient for robust transit rider activity and travel analysis.

For the main RDD survey, the region was divided into five geographic sampling areas. Each sampling area was defined by counties, or within King County, by the City of Seattle and those areas within King but outside Seattle. For the most part, the types of travel patterns and behaviors generated by households within each of these areas are similar. The five sampling areas were the following:

1. King County outside Seattle
2. the City of Seattle
3. Kitsap County
4. Pierce County
5. Snohomish County

To ensure both representation by household density across the region, and adequate statistical validity within less populated counties, the RDD sample required the completion of 48-hour activity/travel diaries in each sampling area from the number of households as shown below:

Table A2: Recommended and Completed RDD Sample Sizes by Geographic Area

Counties	Sample Size	Completed # of Households
King Without Seattle	900	1,054
City of Seattle	900	982
Kitsap County	400	589
Pierce County	750	624
Snohomish County	650	688
TOTAL	3,600	3,937

Again, while Pierce County response rates were somewhat low, the completed sample size is sufficient for robust statistical analysis. Regional RDD results will be weighted by geographic area household density, proportional to the 2004 American Community Survey[1] Census data shown below.

Table A3: 2004 American Community Survey Data for Number of Households by Sampling Area

Counties	Number of Households	Percent of Households
King Without Seattle	469,354	34.8%
City of Seattle	266,569	19.8%
Kitsap County	89,978[2]	6.7%
Pierce County	281,307	20.9%
Snohomish County	240,563	17.8%
TOTAL	1,347,771	100.0%

Variables of household size, number of vehicles available to a household, and the number of workers per have been found to be highly correlated with travel behavior and travel patterns. Therefore, a final modeling concern for the RDD sample design was the degree to which, for completed sample size within the region, the number of autos available to a household matched household size, again as documented by the 2004 American Community Survey. Independently, the number of workers per household was also to be representative of Census data for the region.

[1] Source: U.S. Census Bureau, 2004 American Community Survey

[2] 2004 American Community Survey data not available for Kitsap County. PSRC 2004 estimate is cited

The stratification of households by household size and autos available identified 16 potential cells for sample monitoring. (Autos by 0 autos, 1 auto, 2 autos, and 3+ autos; household size by 1-person, 2-persons, 3-persons, and 4+-persons; 4 x 4). Upon inspection, improbable cells were removed from the tables where the number of autos was greater than household size.

A comparison of the sample design to the completed number of households as stratified by number of autos and household size is shown in Table A3.

Table A3. Recommended and Completed Number of RDD Households by Number of Autos and Household Size

	No Vehicles	1 Vehicle	2 Vehicles	3+ Vehicles	Totals
1-person HH	*184*/**130**	*718*/**875**	*113*/**162**	*41*/**57**	*1,056*/**1,224**
2-person HH	*75*/**26**	*312*/**236**	*621*/**826**	*244*/**361**	*1,224*/**1,443**
3-person HH		*98*/**73**	*260*/**233**	*202*/**208**	*577*/**518**
4+ person HH		*66*/**47**	*352*/**398**	*316*/**305**	*743*/**752**
Totals	*259*/**156**	*1,193*/**1,231**	*1,346*/**1,619**	*802*/**931**	*3,600*/**3,937**

Key: Recommended Sample Size/**Completed # of Households**

The completed sample size was very representative by household size and by number of vehicles, with the exception that the number of zero-vehicle households completed was only 60% of recommended RDD sample size. However, zero-vehicle completes will total 220 when 64 zero-vehicle households collected as a part of the oversample of transit rider and transit access sample are added.

Likewise, the completed RDD sample is representative region-wide by the number of workers per household as shown in Table A4.

Table A4. Recommended and Completed RDD Households by Number of Workers

	No Workers	1 Worker	2 Workers	3+ Workers	Totals
Region Sample Model	24.2%	43.6%	26.8%	5.5%	100.0%
RDD Completed Sample	25.9%	40.6%	29.2%	4.3%	100.0%

Response Rates

In terms of overall 2006 PSRC Household Activity/Travel Survey response rates, based on the American Association for Public Opinion Research's (AAPOR) Response Rate 3 (RR3) calculation method, the overall recruitment response rate (including oversamples) was 36.7%. The participation rate (fully completed household retrievals/recruitments) overall was 54.1%.

Transit Access and Transit Rider Oversample

This frame consisted of directory-listed sample from targeted geographic areas. Areas were selected based on their geographic proximity to specific transit-supported corridors. Households were randomly sampled from this frame. PSRC staff identified the transit access geography according to the following procedure.

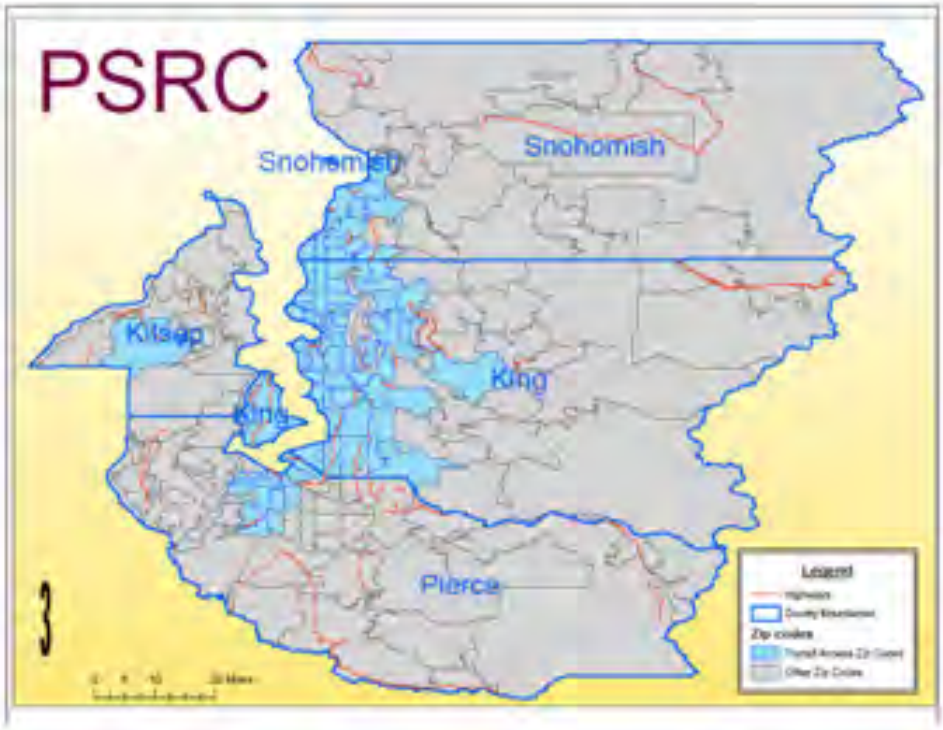
1. "Transit density" from PSRC's modeling network was mapped using percent workers by block group.
2. Zip+2 geographic coverage was purchased from a private vendor.
3. "Transit density" was then overlaid onto the Zip+2 maps and a subset of Zip+2 areas were selected. (See map of transit access areas on the following page.)

Various criteria were used to select the Zip+2 areas including different "density" levels and the amount of overlap between the "density" geography and the Zip+2 geography. A total of 1,724 Zip+2 areas were selected. The distribution of the targeted Zip+2 geography across the region is presented in Table A5.

Table A5. Distribution of Transit Access Targeted Zip+2 Areas

County	Total ZIP+2 Areas in a County	Zip+2 Areas In Targeted Transit Access Area	Percent of County	Percent of Total Targeted Zip+2 Areas
King	4,381	1,382	31.55%	80.2%
Kitsap	905	10	1.10%	0.6%
Pierce	2,882	183	6.35%	10.6%
Snohomish	2,218	149	6.72%	8.6%
Total	10,386	1,724		100.0%

Geographic Stratification for Transit Access Areas



Park-and-Ride Transit Rider Intercept Oversample

Park-and-Ride transit users represent a unique subgroup from a sampling perspective. Their incidence is too low to expect enough for analysis purposes from the RDD or transit access frames.

Therefore, an intercept process at selected park-and-ride lots was used to supplement this frame. Interviewers were placed at these lots to solicit names, phone numbers, and addresses from commuters waiting to board transit buses. Those who agree to participate were contacted at a later time by telephone when the standard recruitment interview was administered. While sampling design called for 150 households completed by this method, actual completes were only 92. However, for analysis this oversample of park and ride user households can be supplemented by 205 RDD or other transit access/ferry user households who had at least one member reporting use of a park and ride lot during their 48-hour travel period

Frame 4: Ferry Rider Intercept Oversample

Like Park-and-Ride transit users, ferry riders also represent a unique subgroup from a sampling perspective.

Therefore, an intercept process at selected ferry debarking locations was used to supplement this frame. Interviewers were placed at these locations to solicit names, phone numbers, and addresses from commuters waiting to board ferries. Those who agree to participate were contacted at a later time by telephone when the standard recruitment interview was administered. While sampling design called for 50 ferry user households to be completed by this method, actual completes were only 18. For analysis this small oversample of ferry user households can be supplemented by 185 RDD or other transit access/park and ride user households who had at least one member reporting use of a ferry during their 48-hour travel period.

GPS Tracking

GPS tracking was designed as a subcomponent of the Household Activity/ Travel Survey. The objective was to compare data results from GPS tracking of a sample of household vehicle(s) trips with the diary trips reported by household members. The research assumption is that respondents frequently underreport trips, and that GPS tracking of a subsample of household vehicles can help identify the types of trips that are most frequently underreported in diaries, as well as profile the respondents most likely to underreport trips. GPS tracking is not deployed with the entire sample since the cost would be prohibitive. For the 2006 survey, 220 households completed both 48-hour diaries for each of their household members, and GPS tracking for up to three of their household vehicles. These households were recruited randomly from the RDD household Activity/Travel Survey sample.

Attitude and Stated Preference Survey

The attitude and stated preference survey was conducted as a follow-up to the 2006 Household Activity/Travel Survey. 1,400 respondents were selected, based on their revealed trips, which met criteria for length of trip and location of origin and destination points, within defined geographic corridors of transit access and/or potential toll alternatives. Approximately one-third of the sample was provided with transit alternatives choice experiments, one-third received choice experiments related to toll usage, and the final third received choice exercises related to both. Overall, completed interviews were obtained from 916 respondents for a response rate of 65.4%.

Survey Methods Background

In the 1950's and 1960's, a home-interview survey was not uncommon. The costs of conducting such a survey now, effectively prohibits this method, except in very small samples, or very large budgets. The only recently conducted home-interview survey was conducted by the North Central Texas COG (1984).

The more common methods used today are:

- telephone screen/mail-out of forms/phone-back
- telephone screen/mail-out of forms/mail-back

For the 2006 Household Activity/Travel Survey respondents were recruited by phone and assigned a 48-hour travel recording period, mailed diaries and instructions for each household member (and if applicable, GPS units for their vehicles). Each household received a reminder call the evening before their 1st travel day and they were recalled the evening after their 2nd travel day to collect person and diary information over the phone. If a household or any member did not want to proceed with the data collection phone interview, they were asked to mail back their completed diaries.

Proxy interviewing was discouraged except for those under 16, but if a member could not be reached otherwise, their diary reporting was accepted by phone from another adult in the household. For 20% of persons 18 or older, activity/travel was reported by proxy; 25% of persons (including children) reported their activity/travel by mail.

The transit rider and transit access oversample was collected using the same methodology as for the Random-Digit-Dial (RDD) sample, with the exception of a small oversample of ferry riders (19 households) and park & ride lot users (92 households). These oversample households were recruited by intercept surveying at, respectively, the ferry docks and representative park & ride lots within the region. This small oversample of interest supplemented the RDD sample of 180 completed households with at least one member who took a ferry trip during their travel days; and 281 RDD completed households with a member who used a park & ride lot during their assigned recording period.

The preference survey was conducted primarily as a mail-back option. Households selected (based on their revealed trips of interest) were phoned to inform them of their selection for the follow-up. Attitudinal questions and four choice experiments, customized to the respondent's revealed trip of interest were mailed. Those not responding by mail were encouraged to respond by phone.

2006 Survey Methodology

There were nine program components to the 2006 Household Activity/Travel Survey: These are:

1. sample design and monitoring
2. designing materials and instruments
3. the pilot
4. data collection and monitoring
5. GPS tracking for a subsample
6. geocoding or all origin and destination points
7. data checking and quality control.
8. design and conduct of the attitudinal and stated preference survey.
9. analysis and reporting

For quality control, interim datasets and reports were scheduled after the completion of 30 (the pilot) 1,500 and 4,600 households. The delivery schedule was adhered to throughout the data collection period with travel days starting the first of April 2006 and ending in mid-June 2006.

In addition to a detailed Work Plan, a Sampling Technical Plan Document, Quality Control Manual, and a Geocoding Procedures Manual were developed. These protocols defined criteria for determining whether a completed household would be accepted. All documents were approved prior to use in the main survey by PSRC.

Design and Implementation of Survey Materials and Instruments

The months of February and March 2006 were devoted to development of data collection materials and instruments, and to a pilot survey. There was a minimum of two iterations and reviews of each item before final drafts were approved.

The following materials and instruments, which provide the program flow, can be found in the Appendices as cited below:

- Pre-Recruitment Letter — Appendix B
- Recruitment Script — Appendix B
- Diary Cover Letter and Diary Format — Appendix B
- Retrieval CATI Script — Appendix B
- Reminder Call Script — Appendix B
- Preference Survey Instrument — Appendix C
- Preference Survey Retrieval Script — Appendix C

A description of these program materials follows.

Pre-Recruitment Letter

A pre-recruitment informational letter was developed and released to replicates (randomly selected portions) of the sample on a scheduled basis. This was done so that respondents did not receive the letter too far in advance of the recruitment phone call.

The households that received pre-recruitment letters were flagged in the data file. All undeliverable mailing was monitored and flagged in the data file. An attempt was made to correct the address through the United States Postal Service (USPS) website. A log was also kept of phone calls to the 1-800 number, to Internet help, and of any mail responses. Any non-routine responses were referred to PSRC. Undeliverable mailings were monitored, logged, and flagged in the data file.

Recruit Script

The telephone recruit script introduced the purpose of the study and secured the agreement of the household to participate. Demographics including the number of persons in the household, number, make, model, and year of vehicles, number of workers, and income were collected. Two-consecutive travel days were randomly assigned to a household by the CATI system, which kept travel day assignments even by eligible days over the interviewing period

In addition, to enhance activity and land-use modeling capabilities, households were asked in the recruit for additional information about their current and previous residence (if they had moved within the last ten years). Questions asked for both current and previous address were: rent or own, type and age of structure, length of residency, and street address, city, county, state. The contact person for the household was also asked for the reasons they chose their current residence.

The CATI screens displayed counts of recruited and retrieved households by data cells within sample areas and by socioeconomic attributes, which were then compared with the Sampling Plan Technical Document on a daily basis. Initial recruitment to retrieval ratios were low for certain populations such as 4+-person and zero-vehicles households. To compensate, PSRC and its partners began implemented five responsive interviewing design strategies[3] over the

[3] [1] Steven Heeringa and Robert Groves, *"Responsive Design for Household Surveys"* in the 2004 Proceedings of the American Statistical Association, Survey Research Methods.

course of the data collection period. Each of these strategies used a series of different or successive recruitment and response techniques. These modifications included:

- Adjusting recruitment sample targets based on the varying actual retrieval rates for different data cells.
- Introducing portions of low-income targeted Random-Digit-Dial (RDD) samples into the traditional RDD sampling frames.
- Introducing differential incentives ($20-$30--not paid for by PSRC) for zero-vehicle and 4+-person households, if all members of the household completed the activity/travel inventories.
- Introducing RDD listed sample targeted by income and household size.
- Conducting refusal conversion interviews for all households recruited in rare population data cells that did not initially complete the travel inventories (retrievals).

Diary Cover Letter and Diary Format

To reduce respondent burden, particular attention was paid to the diary format to ensure that all modeling data requirements were met and that the flow and construction of questions and instructions were clear.

This design captured only two types of activities within the home: (1) home-not working and (2) home–working. Primary and secondary activities at each location were collected; however, the timing of these activities at any one location was collected as a block without differentiating among activities. Activities were collected via closed-ended categories. Thus respondents were required to self-code their activities into pre-set categories using the list and examples in the diary. The diary questions were designed to flow in conjunction with the Computerized Assisted Telephone Interviewing (CATI) customized program, taking the respondents through their activities/locations and travel in chronological order.

Included with the diary was a person information sheet for each member of the household. This information was not included in the recruit since data requested for each member about work and school were extensive. The diary, cover letter, instructions, and person information sheet were thoroughly tested in the pilot, which was conducted in March of 2006. Final copies of the diary cover letter and the diary can be found in Appendix 4.

The activity-travel diary (retrieval interview) format consisted of eight parts:

1. Collecting any changes in or missing data, in regard to number of persons in the household, number and type of vehicles, and number of workers.

2. Collecting person attributes including age, gender, relationship to contact person, driver's license status, education level, use of transit during the last 30 days, transit pass and rate information, disability status, use of Internet and frequency of watching DVDs (activities which substitute for travel)..
3. Collecting person attributes in regard to school and/or work activities
4. Information about work characteristics including shifts worked, hours per week, flexibility, and availability of compressed work week.
5. Usual mode of getting to work and times of travel
6. Information on previous job location (if changed job location within the past 10 years) including reasons for change in location or job.
7. Activity-travel diary in including up to five modes used for each trip, parking information for car, routes, transfers, and fare for public transit and taxi/shuttle modes, and information about which household member(s) traveled with you and (if traveling by car) what household vehicle was used.
8. A series of attitudinal questions were asked of the first person interviewed within a household. These questions included:

    - transit options to work or school
    - importance of delays
    - road and bridge maintenance
    - importance of transportation system
    - levels of state and local funding
    - population expansion and land use
    - freight movement and the economy
    - city or neighborhood composition
    - paying for tolls
    - truck traffic
    - importance of predictably travel
    - affordable transportation costs
    - comfort while traveling
    - privacy while traveling
    - importance of flexibility
    - importance of quickest travel time
    - effect of travel delays

The extent of questions asked for modeling and transit option alternatives resulted in a retrieval interview that averaged 17 minutes in length. Nevertheless sampling completion targets were met.

Personal labels were applied to diaries with the name, ID #, and the travel days for each respondent. A business reply envelope was included with the household packet. A full mailing log was electronically maintained in the database. In total, diary packets were sent to 8, 816 recruited households. Any undeliverable mailings were fully explored and the household was re-contacted by phone for corrected information. The data file was continually edited with these changes by an assigned assistant programmer.

Reminder Call Script

The evening before the first assigned household travel day, the recruited household was called to remind household respondents to start recording their locations and travel at 3:00 a.m. (and to install the GPS units in their vehicles before traveling). Any questions regarding the process or the diaries were answered. Re-mailings and rescheduling of travel dates were edited into the data file on a daily basis by the assistant programmer. Hard refusals at this point were recorded and reviewed by a supervisor for possible refusal conversion.

Retrieval CATI Script

The CATI retrieval script followed the flow of the diary. Respondents did not have to provide a previously reported address and trips taken jointly were recorded and then confirmed in each relevant household member's activity/trip file. Household retrieval phone interviews were scheduled by the Computer Assisted Telephone Interviewing (CATI) system for the evening following the assigned travel days. Retrieval interviews continued to be scheduled for the following five days until the CATI recorded that all members had completed the travel inventory. Phone messages were left with persons or on answering machines. Respondents were asked for the most convenient time to call them back. Attempts were also made during the day and on weekends.

Respondents who were reluctant to complete the person information sheet and activity/travel inventories by phone were asked if they would do so by mail. If mail was indicated, the household was reminded that a postage-paid envelope was provided with the diary package for the return of all completed materials. Difficult to reach respondents were asked to call the toll-free number provided. The CATI system provided all of the real-time tallies specified for the recruit, by person and household as appropriate. The data file was edited daily with any corrected information that was received from respondents. Finally, callbacks were made for home or work

address information when an address was found to be non-geocodable. All corrected information was entered into or edited into the CATI data file.

Preference Survey Instrument

The preference survey instrument was designed by PSRC in consultation with the project's modeling subconsultants, Cambridge Systematics and Mark Bradley. The survey instrument consisted of a series of rotated attitudinal questions and four choice exercises. On third of the sample was provided with transit option choices and one third were provided with toll choices. The final third received both choice set exercises. A document describing the preference survey design is included as Appendix 8.

Weighting of Data for This Report

Figures provided in this report for each of the sample types have not been weighted. However, the RDD sample is largely representative by county and for the region. Regional figures presented in this report are weighted using estimated household totals for each county and the city of Seattle as documented in the 2004 American Community Survey.