

ARIZONA DEPARTMENT OF TRANSPORTATION

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# A STUDY OF TRAVEL BEHAVIOR FOR RETIREMENT COMMUNITIES

Volume I: Final Report

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**A STUDY OF TRAVEL BEHAVIOR  
FOR RETIREMENT COMMUNITIES  
ORIGIN-DESTINATION SURVEY**

**VOLUME I - FINAL REPORT**

Prepared for

The Arizona Department of Transportation  
Phoenix, Arizona

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16. ABSTRACT: The purpose of this survey, conducted for the Arizona Department of Transportation, was to identify how travel characteristics of the residents of a retirement community, particularly Green Valley Arizona, are different from those of the surrounding metropolitan area. Of particular interest was how trip generation, trip distribution, and vehicle occupancy might be different from those currently assumed in the regional modeling process. This Technical Report summarizes the results of the Green Valley Travel Survey and also describes how the PAGTPD travel models were modified to reflect the travel behavior of this self-contained retirement community. The Green Valley travel diary survey was completed by 668 households between March 6 and March 21, 1985. The survey data indicate that: 1) the average Green Valley household made 7.7 vehicle person trips as compared to 7.48 trips generated by the regional model for the average medium income household; 2) the average vehicle occupancy is 1.38 persons/vehicle as compared to 1.51 persons/vehicle that would be predicted by the regional model; 3) a smaller percentage of trips by Green Valley residents are home based work trips that would be predicted by the regional model; 4) the average length of trips made by Green Valley residents is considerably shorter than would be predicted by the regional model; and 5) less than 6 percent of Green Valley residents are under 60 years of age. The implications of the survey findings on the regional travel demand forecasting process are to take the following actions: 1) treat Green Valley zones as a special generator through the application of unique household size and household trip rates; 2) apply vehicle occupancy rates unique to trips originating in the retirement community; and 3) reclassify employment in the retirement community to community shopping center rather than other non-retail. Volume I--Final Report, Volume II--Appendices.					
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## PREFACE

This Technical Report summarizes the results of the Green Valley Arizona Travel Survey and also describes how the Pima Association of Governments Transportation Planning Division (PAGTPD) travel models were modified to reflect the travel behavior of this self-contained retirement community. Green Valley is a growing retirement community located approximately 25 miles south of Tucson along Interstate 19.

The purpose of this survey, conducted for the Arizona Department of Transportation, was to identify how the travel characteristics of the residents of a retirement community, particularly Green Valley, are different from those of the surrounding metropolitan area. Of particular interest was how trip generation trip distribution and vehicle occupancy might be different from those currently assumed in the regional modeling process.

The Green Valley travel diary survey was completed by 668 households between March 6 and March 21, 1985.

The survey data indicates the following:

- o The average Green Valley household made 7.7 vehicle person trips as compared to the 7.48 trips per household generated by the regional models for a medium income household in 1980.
- o The average vehicle occupancy is 1.38 persons/vehicle as compared to 1.51 persons/vehicle that would be predicted by the regional models.
- o As would be expected, a much smaller percentage of trips by Green Valley residents are home based work trips (less than 5%) than would be predicted by the regional models. Nearly one-half of trips made by Green Valley residents are home based other trips, nearly 20 percent home based shop and 30 percent are non-home based trips.
- o In general, the average length of trips made by Green Valley residents is considerably shorter than would be predicted by the regional models. The average trip length for work trips is 15.7

minutes compared to 34.5 minutes, for shop trips 15.7 compared to 14.1 minutes, and for other and non-home based trips, approximately 14 minutes compared to 20 minutes.

- o Less than 6 percent of Green Valley residents are under 60 years of age, 36 percent are in their 60's, 45 percent are in their 70's and 10 percent are over 80.

Other findings of the survey include:

- o 87 percent of Green Valley residents are retired and 11 percent worked either full or part time.
- o An average of 1.30 walk trips were made per household.
- o Less than 0.1 bicycle trip was made per household.
- o 87 percent of the trips made by Green Valley residents are to destinations within Green Valley, over 10 percent are to destinations in Tucson and 3 percent are to other places.
- o Over 64 percent of the households have one automobile or truck, and over 26 percent have more than one.
- o Golf carts are an insignificant means of travel for Green Valley residents. Only 16 percent of Green Valley households own a golf cart, and those that do make an average of 0.3 trip per day in a golf cart.
- o Over three-quarters of Green Valley households (78%) have two residents, almost one in five (19%) have one resident and 3 percent have more than two residents.

The implications of the survey findings on the regional travel demand forecasting process are to take the following actions:

- o Treat Green Valley zones as a special generator through the application of unique household size and household trip rates.
- o Apply vehicle occupancy rates unique to trips originating in the retirement community.
- o Reclassify employment in the retirement community to community shopping center rather than other non-retail.

The authors and the Arizona Department of Transportation would like to thank the following individuals for their assistance on this project: William Sapper, Mark Peterson, Dave Wolfson, Paul Klooz, Terry Rosapep, and Ben Goff and the following Green Valley officials and Project Committee members--Jack Shacklett, John Locke, James Cole, and Louise Gordon.

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## CHAPTER 1

### INTRODUCTION

This Technical Report summarizes the results of the Green Valley Travel Survey and also includes a description of how the Pima Association of Governments Transportation Planning Division (PAGTPD)\* travel models were modified to reflect the travel behavior of this self-contained retirement community.

Green Valley is a growing retirement community located approximately 25 miles south of Tucson along Interstate 19. Its location within the Tucson Metropolitan Area is shown in Figure 1.

The purpose of this survey conducted for the Arizona Department of Transportation was to identify how the travel characteristics of the residents of a retirement community, particularly Green Valley, are different from those of the surrounding metropolitan area. Of particular interest was how trip generation trip distribution and vehicle occupancy might be different from those currently assumed in the regional modelling process.

Considerable previous research has been performed regarding the travel behavior of the elderly. However, this research has focused on the needs of the elderly for improved mobility<sup>1,2</sup> or the use of transit by the elderly.<sup>3,4</sup> Some research has focused on the travel demand by the elderly in different types of urban environments,<sup>5,6</sup> and some research has investigated travel needs as related to the lifestyle or the individual's position in the lifecycle.<sup>7</sup> Hypotheses have been developed regarding the travel behavior of retirement community residents.<sup>8</sup>

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\*PAGTPD is a unit of the Arizona Department of Transportation.

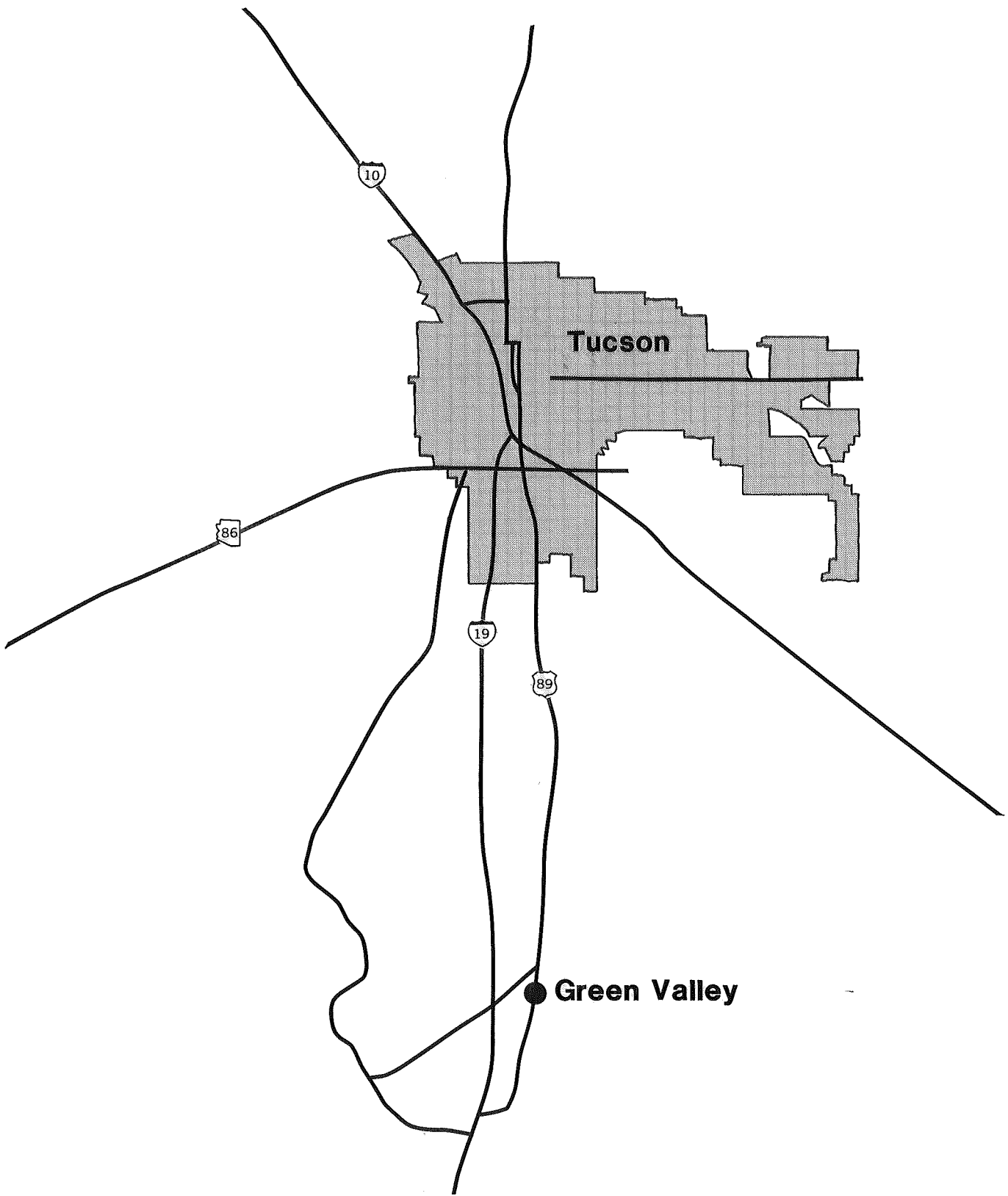


FIGURE 1

LOCATION OF GREEN VALLEY IN  
TUCSON METROPOLITAN ARIZONA

However, no research has been performed to quantify the travel behavior of residents in the growing number of retirement communities designed for the increasing number of active retirees in this country.

The Green Valley travel diary survey was completed by 668 households between March 6 and March 21, 1985. It was designed to collect sufficient data from households in a planned retirement community for a comprehensive analysis of their travel behavior, and to analyze the travel behavior of retirement communities in terms of the generation of trips by purpose, the occupancy of vehicle trips and the destination (Tucson, Green Valley or other locations) of trips made by residents of Green Valley households.

The data collected in the travel survey allow for an assessment of the importance of different socioeconomic characteristics such as household size, income, age and vehicle ownership on a households travel behavior. The results were used to modify the existing regional travel models to better reflect travel generated by retirement communities.

Chapter 2 of this report presents some of the more significant findings of the survey. Chapter 3 describes how the Trip Generation, Vehicle Occupancy and Trip Distribution components of the PAGTPD regional models were modified in order to reflect the travel characteristics of the Green Valley Retirement Community. Finally, Chapter 4 briefly describes the methodology used to perform the survey, how the results were edited and the statistical reliability of the results.

Included in the appendix document are: detailed tabulations of the survey results; a statistical analysis of candidate trip generation variables; detailed descriptions of the survey editing process, the survey procedures, sampling plan, and the conduct of the survey; and copies of the survey forms.

## CHAPTER 2

### SURVEY FINDINGS

This chapter presents a summary of the pertinent travel characteristics of the residents of Green Valley as determined from the travel diary survey. Trip generation rates, trip distribution, vehicle occupancy and other characteristics are summarized from the response of 668 households to the survey.

The results of the survey indicate some significant differences between the travel patterns of Green Valley residents compared to what would be predicted by the PAGTPD regional travel forecasting models for the Tucson Metropolitan Area.

Values for the Tucson Regional Models are taken from the recent update to those models performed as part of the Rillito Corridor Study.<sup>9,10,11</sup>

This chapter presents only a summary of the more significant results. Responses to each individual survey question are presented in Appendix A and more detailed cross-tabulations are included in Appendix B.

#### **TRIP GENERATION**

One of the primary reasons for conducting this survey of a retirement community was to determine if retirees in such an environment travel more or less than the general population of the area. As can be seen in Table 1, the average Green Valley household with an average 1.84 residents per household makes approximately 7.7 person vehicle trips per day. As also can be seen in Table 1, this trip rate does not vary greatly by household size with one person households having a person vehicle trip rate of 7.88, two person households a rate of 7.64, and households with three or more residents a rate of 8.29. In contrast, the regional models predicted for 1980 that the average household would make 7.66 person vehicle trips with an



average household size of approximately 2.66 residents per household. Based on the above data, it can be seen that the trip rate for Green Valley households is essentially the same as the average rate predicted by the regional models.

Table 2 provides information on the Green Valley person vehicle trip rates by income. Income was reported by 422 households or over 63 percent of those participating in the survey. It was expected that income would not be reported by many households, and, in fact, 63 percent is a good response rate. The average trip rate for those not providing their household income was 7.28 compared to 7.69 for all households, not a major difference.

As can be seen in Table 2, the trip rate does increase somewhat with income from 4.79 trips per household for households with incomes under \$10,000, to 9.12 trips per household for households with incomes over \$40,000. The median income for all households responding to this question was in the \$20,000-\$30,000 range, probably around \$28,000 per year.

Tables 1 and 2 also show the variation in trip rate by purpose for different household sizes and income. The trip rate by purpose does not appear to vary significantly for households of different sizes.

When the percent of Green Valley trips made by each purpose are compared to the trip purpose distribution of the regional models in Table 3, it can be seen that the type of trips made by Green Valley residents are significantly different from those predicted by the regional models.

As would be expected, a far lower proportion of work trips are made from Green Valley (less than 5%) and no school trips are made. Almost half (46.5%) of Green Valley trips are home based other trips (social/recreation trips, trips for medical care, visits, etc.) compared to 29 percent for

TABLE 1. VEHICLE PERSON TRIPS BY NUMBER OF HOUSEHOLD OCCUPANTS

HOUSEHOLD SIZE	% HH	HBW	HBS	HBO	NHB	TOTAL
		TR/HH	TR/HH	TR/HH	TR/HH	TR/HH
1 PERSON	19.2	0.30	1.66	3.57	2.34	7.88
2 PERSONS	77.6	0.37	1.39	3.57	2.29	7.64
3 OR MORE PERSONS	3.2	0.00	1.95	3.95	2.38	8.29
ALL	100.0	0.35	1.46	3.58	2.31	7.71

TABLE 2. VEHICLE PERSON TRIPS BY HOUSEHOLD INCOME

HOUSEHOLD INCOME	% HH	HBW	HBS	HBO	NHB	TOTAL
		TR/HH	TR/HH	TR/HH	TR/HH	TR/HH
LESS THAN \$10,000	3.6	0.08	0.75	2.83	1.04	4.79
\$10,000-19,999	12.9	0.62	1.47	3.41	2.05	7.53
\$20,000-29,999	18.3	0.31	1.67	3.38	2.42	7.78
\$30,000-39,999	14.7	0.14	1.28	3.97	2.77	8.15
OVER \$40,000	13.8	0.36	1.47	4.48	2.82	9.12
DON'T KNOW	8.7	0.34	1.62	4.17	2.78	8.95
REFUSED	28.1	0.38	1.46	3.05	1.86	6.76
ALL	100.0	0.35	1.46	3.58	2.30	7.69

HBW - Home-Based Work  
HBS - Home-Based Shop  
HBO - Home-Based Other

NHB - Non-Home Based  
HH - Households  
TR/HH - Trips per Household

TABLE 3. TRIP PURPOSE OF GREEN VALLEY TRIPS COMPARED TO REGIONAL MODELS

	Percent				
	<u>Home Based Work</u>	<u>Home Based Shop</u>	<u>Home Based Other</u>	<u>Home Based School</u>	<u>Non- Home Based</u>
Green Valley	4.52	19.03	46.53	--	29.92
PAGTPD Low Income	14.00	16.00	42.00	8.00	20.00
PAGTPD Medium Income	24.00	8.00	29.00	13.00	26.00
PAGTPD High Income	25.00	9.00	29.00	10.00	27.00

comparable high income, and medium income households and 42 percent for low income households. Nineteen percent of Green Valley trips are home based shop trips compared to 9 percent, 8 percent, and 16 percent for the region as a whole. Non-home based trips, while a little higher for Green Valley residents at almost 30 percent, are a comparable proportion to those used in the regional model for medium and high income households.

Table 4 presents the trip rates by household vehicle ownership. Households reporting to own one vehicle and two or more vehicles had comparable trip rates of 7.89 and 7.53 person vehicle trips per household, respectively. Only one household reported owning no vehicle and 61 households did not respond.

Table 5 contains the trip rates by the type of dwelling unit the household reported living in. Households living in duplexes (townhouses, etc.) and mobile homes reported making fewer trips (6.95 and 6.88 person vehicle trips per household) than did households living in single family detached homes, and apartments and condominiums (8.00 and 7.84 persons vehicle trips per households).

Table 6 is a cross-tabulation of trip rates by both household income and size. Trip rates range from 4 to 12 person vehicle trips per household. However, for most categories, trips were in the 7.5 to 9 person vehicle trips per household range.

#### **TRIP DISTRIBUTION**

A second key travel characteristic determined by the Green Valley travel diary survey is where and how far residents travel. This information was collected in two ways. First, for each trip reported, residents were asked whether their destination for that trip was Green Valley, Tucson

TABLE 4. VEHICLE PERSON TRIPS BY VEHICLE OWNERSHIP

VEHICLE OWNERSHIP	% HH	HBW	HBS	HBO	NHB	TOTAL
		TR/HH	TR/HH	TR/HH	TR/HH	TR/HH
NOT REPORTING	9.3	0.16	1.71	3.18	1.69	6.77
1	64.4	0.35	1.45	3.67	2.41	7.89
2 OR MORE	26.3	0.40	1.41	3.49	2.23	7.53
ALL	100.0	0.35	1.46	3.58	2.30	7.69

TABLE 5. VEHICLE PERSON TRIPS BY TYPE OF DWELLING UNIT

TYPE OF DWELLING UNIT	% HH	HBW	HBS	HBO	NHB	TOTAL
		TR/HH	TR/HH	TR/HH	TR/HH	TR/HH
SINGLE FAMILY HOUSE (SF)	53.1	0.42	1.46	3.71	2.40	8.00
DUPLEX (TOWNHOUSE) (MF)	18.6	0.14	1.46	3.27	2.00	6.88
APARTMENT/ CONDOMINIUMS	22.2	0.35	1.45	3.62	2.41	7.84
MOBILE HOME (SF)	4.6	0.29	1.58	3.00	2.00	6.94
OTHER	1.0	0.29	1.43	4.71	2.29	8.71
UNKNOWN	0.4	0.67	1.00	1.33	0.67	3.67
ALL	100.0	0.35	1.46	3.58	2.30	7.69

HBW - Home-Based Work  
HBS - Home-Based Shop  
HBO - Home-Based Other

NHB - Non-Home Based  
HH - Households  
TR/HH - Trips per Household

TABLE 6

VEHICLE PERSON TRIPS BY PERSONS PER HOUSEHOLD AND HOUSEHOLD INCOME

HOUSEHOLD INCOME	HOUSEHOLD MEMBERS																	
	1						2						3					
	HBW	HBS	HBO	NHB	TOTAL	% HH	HBW	HBS	HBO	NHB	TOTAL	% HH	HBW	HBS	HBO	NHB	TOTAL	% HH
LESS THAN \$10,000	0.00	1.20	2.40	1.40	5.00	3.6	0.11	0.56	2.56	1.00	4.33	0.00	2.00	10.00	0.00	0.00	12.00	0.00
\$10,000-19,999	0.53	1.40	4.00	2.33	8.27	12.9	0.64	1.50	3.31	1.97	7.43	0.00	0.00	1.00	3.00	4.00	0.00	0.00
\$20,000-29,999	0.32	1.45	2.45	2.50	6.73	18.3	0.33	1.72	3.58	2.35	7.97	0.00	1.80	3.60	3.40	8.80	0.00	0.00
\$30,000-39,999	0.26	1.79	4.68	2.79	9.53	14.4	0.09	1.13	3.89	2.80	7.92	0.00	2.00	3.00	4.00	9.00	0.00	0.00
OVER \$40,000	0.20	1.25	4.55	3.10	9.10	13.8	0.43	1.46	4.43	2.78	9.10	0.00	2.40	4.80	2.20	9.40	0.00	0.00
DONT KNOW	0.00	3.08	4.42	2.33	9.83	8.7	0.45	1.16	4.11	2.93	8.70	0.00	3.00	4.00	2.00	9.00	0.00	0.00
REFUSED	0.40	1.66	2.80	1.71	6.57	28.2	0.39	1.41	3.10	1.91	6.82	0.00	1.60	3.20	1.40	6.20	0.00	0.00
ALL	0.30	1.66	3.57	2.34	7.88	100.0	0.37	1.39	3.57	2.29	7.64	0.00	1.95	3.95	2.38	8.29	0.00	0.00

HBW - Home-Based Work  
 HBS - Home-Based Shop  
 HBO - Home-Based Other  
 NHB - Non-Home Based  
 HH - Households  
 TR/HH - Trips per Household

or some other location. In addition, respondents were asked to note the time that they began each trip and the time they reached their destination.

The first finding with regard to the destination of trips made by Green Valley residents was that 86.7 percent of the trips were made to destinations within Green Valley, 10.6 percent to Tucson and 2.7 percent to other locations. Therefore, the vast majority of the trips made by residents of Green Valley are to locations within the retirement community. As can be seen in Table 7, the proportion of trips made by Green Valley residents who remain in Green Valley ranges from 74 percent of non-home based trips to 92 percent of home based other trips.

It should be pointed out that there are very few opportunities for residents to travel outside the community unless they travel 15 to 20 miles to Tucson. In other retirement communities that are less isolated, such as Sun City where developed areas are contiguous to the retirement community, it is highly likely that residents would travel outside the community more frequently.

A second important characteristic of trip distribution is how long trips take. Table 8 shows the average trip length by purpose reported by Green Valley residents in the survey. These times are compared to travel times simulated by the regional models.\* The average time for work trips of 15.7 minutes is less than half that predicted by the regional models, 34.5 minutes. The average reported home-based shop travel time of 15.7 minutes was just 10 percent higher than the 14.1 minutes simulated. The home-based other average trip length is 14.3 minutes compared to 20.3 minutes simulated, and the average reported length of non-home based trips

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\*Travel times from the 1980 simulation were provided by PAGTPD for trips leaving the transportation zones comprising Green Valley.

TABLE 7. VEHICLE PERSON TRIPS - TRIP DESTINATION BY PURPOSE

<u>Destination</u>	<u>Purpose</u>								<u>TOTAL</u>	
	<u>HBW</u>		<u>HBS</u>		<u>HBO</u>		<u>NHB</u>			
	<u>Trips</u>	<u>%</u>	<u>Trips</u>	<u>%</u>	<u>Trips</u>	<u>%</u>	<u>Trips</u>	<u>%</u>	<u>Trips</u>	<u>%</u>
Green Valley	210	90	914	91	2,316	92	1,119	74	4,559	86
Tucson	19	8	65	7	154	6	319	21	557	11
Other	5	2	21	2	43	2	75	5	144	3

TABLE 8. AVERAGE TRIP LENGTH OF GREEN VALLEY TRIPS BY PURPOSE

	<u>Home Based Work</u>	<u>Home Based Shop</u>	<u>Home Based Other</u>	<u>Home Based School</u>	<u>Non-Home Based</u>
Green Valley	15.7	15.7	14.3	--	14.0
PAGTPD Predicted	34.5	14.1	20.3	26.9	20.0



was 14 minutes compared to 20 minutes simulated. The average travel times reported are, in general, considerably lower than those simulated by the models. Therefore, the existing regional trip distribution model is simulating longer trip lengths than were reported in the survey.

Table 9 presents the proportion of surveyed trips by purpose, in each 5 minute increment of trip length. It can be seen that the vast majority of trips, over 60 percent, are between 5 and 10 minutes long. It also can be seen that the proportion of trips in each increment does not differ considerably by trip purpose. This fact is further reinforced by the trip length distribution presented in Figure 2. It is obvious from this graph that the trip length distribution for all trip purposes is not significantly different. For example, 70 percent of shop trips, 66 percent of work trips, 68 percent of non-home based trips, and 65 percent of other trips are less than 15 minutes long.

#### **VEHICLE OCCUPANCY**

A third major characteristic of trips made by Green Valley residents determined by the travel diary survey was average vehicle occupancy. Average vehicle occupancy was determined from the travel diary by estimating how many person trips by purpose were made by drivers and passengers.

Table 10 presents the appropriate vehicle occupancy information. It can be seen that over 5,100 person trips were reported to be made in automobile and trucks and over 3,700 of those trips were made by a person driving the vehicle, therefore, the average vehicle occupancy for all trips is estimated at 1.36 persons per vehicle.

Further analysis of the occupancy data reveals that the vehicle occupancies for trips that leave Green Valley are considerably higher than

TABLE 9. TRIP DURATION BY PURPOSE

<u>Duration</u>	<u>Home- Based Work</u>	<u>Home- Based School</u>	<u>Home- Based Other</u>	<u>Non- Home Based</u>	<u>Total</u>
0-4	5.24%	3.12%	5.37%	11.48%	6.70%
5-9	31.44	32.36	36.25	33.51	34.50
10-14	29.69	35.08	27.05	20.70	26.86
15-19	12.66	9.85	11.34	13.14	11.64
20-24	2.18	2.31	3.27	5.31	3.63
25-29	0.44	1.11	1.29	2.59	1.59
30-34	6.55	3.62	4.36	5.57	4.67
35-39	2.18	0.80	1.49	1.13	1.29
40-44	2.62	2.61	1.33	1.00	1.54
45-49	2.62	4.02	4.04	1.46	3.23
50-54	0.00	0.70	1.70	0.80	1.17
55-59	0.00	0.40	0.32	0.46	0.36
Over 60	4.37	4.02	2.18	2.85	2.82

FIGURE 2

# GREEN VALLEY TRAVEL SURVEY

## TRIP LENGTH DISTRIBUTION BY PURPOSE

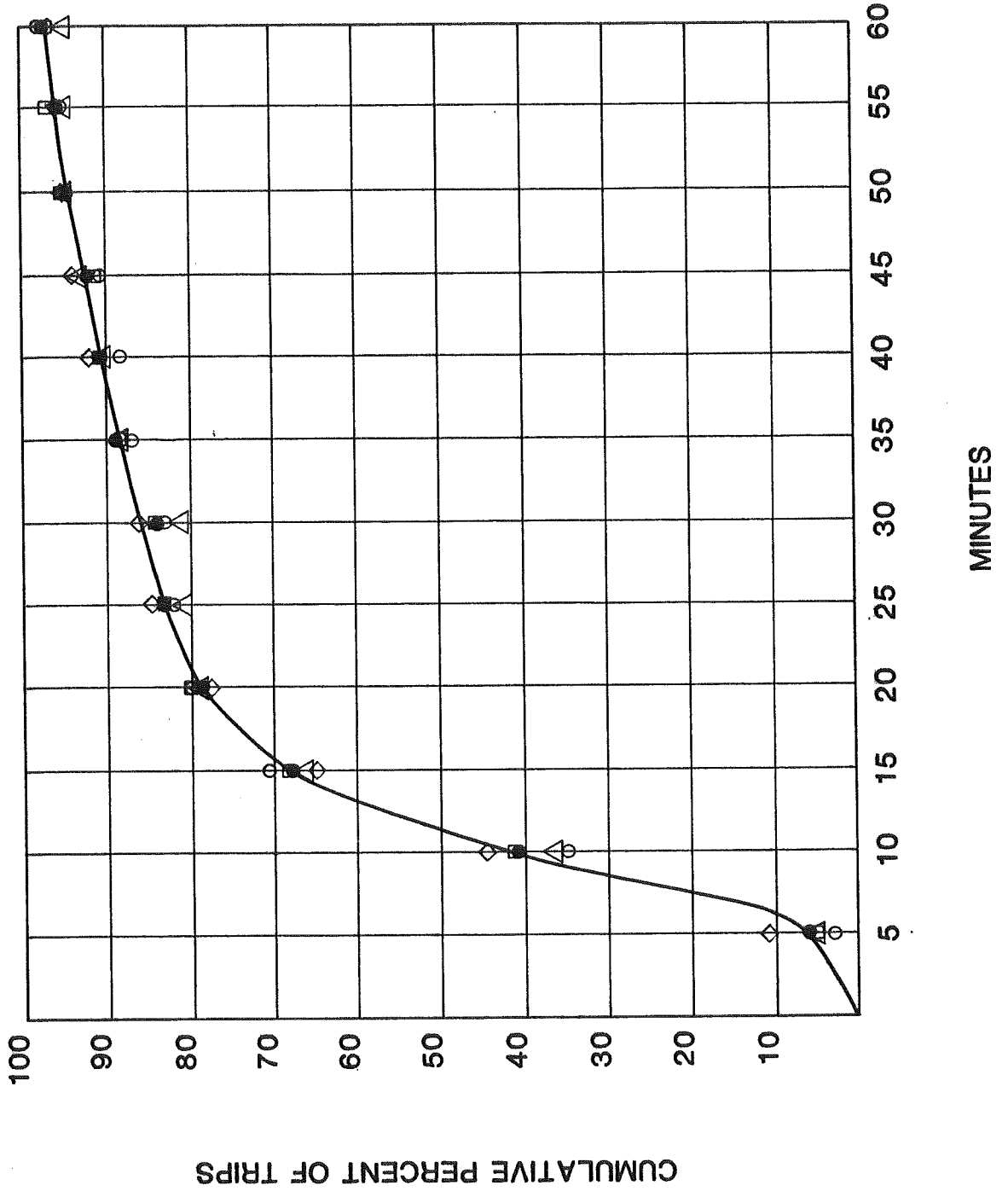


TABLE 10. VEHICLE OCCUPANCY BY TRIP PURPOSE

	<u>HBW</u>	<u>HBS</u>	<u>HBO</u>	<u>NHB</u>	<u>Total</u>
Person Trips	230	980	2390	1540	5140
Vehicle Trips	210	750	1690	1070	3720
Vehicle Occupancy	1.10	1.30	1.41	1.43	1.38
PAGTPD Vehicle Occupancy	1.18	1.46	1.65	1.37	1.51

HBW - Home-Based Work  
 HBS - Home-Based Shopping  
 HBO - Home-Based Other  
 NHB - Non-Home Based

for those that remain within the retirement community. In fact, the overall rate for trips leaving the community is 1.88 compared to 1.31 for those staying within Green Valley. The vehicle occupancies estimated from the survey for all destinations and all trip purposes except for non-home based trips are lower than those used by the regional modeling process. These vehicle occupancies are shown in Table 10 with the comparable regional numbers. The 1.36 vehicle occupancy estimated from the survey is considerably lower than the vehicle occupancy of 1.51 estimated for the same mix of trips using the vehicle occupancies by purpose from the regional models. This difference in vehicle occupancy alone would cause almost 10 percent fewer vehicle trips to be predicted than were reported.

#### **OTHER CHARACTERISTICS**

Considerably more data about the population of Green Valley and their travel behavior can be found in Appendices A and B. Two other characteristics that are summarized here are the age of the population and the time of day that trips are made (temporal distribution).

Table 11 shows the age distribution of the Green Valley population as determined from the survey. As was expected, the population of Green Valley is older. Less than 7 percent of the population is under 60 years old and almost 12 percent is between 60 and 64. Nearly one-quarter of the population reported to be between 65 and 69, another quarter 70 to 74, nearly 28 percent 75 to 79, and over 10 percent over 80. The analysis of travel characteristics did not indicate any difference between the age groups.

The times during the day that trips were made, or temporal distribution, is presented in Table 12. The largest number of hourly trips, nearly 11.25 percent, were made between 11 a.m. and noon, a considerably different

TABLE 11. AGE OF GREEN VALLEY RESIDENTS

<u>Age Group</u>	<u>Percent of Residents</u>
Less than 55	2.6%
55-59	3.6
60-64	11.8
65-69	24.3
70-74	27.8
75-79	17.8
80+	10.3
Unknown	1.6

TABLE 12. DEPARTURE TIME BY TRIP PURPOSE

DEPARTURE	HBW	HBS	HBO	NHB	UNKNOWN	TOTAL
BEFORE 6:00 AM	5.56	0.40	0.88	0.73	0.00	0.95
6:00-6:29 AM	1.28	0.00	0.40	0.00	0.00	0.25
6:30-6:59 AM	4.70	0.10	0.99	0.13	20.00	0.76
7:00-7:29 AM	4.27	0.90	1.07	0.07	0.00	0.89
7:30-7:59 AM	8.55	0.50	2.51	0.53	0.00	1.82
8:00-8:29 AM	5.13	1.70	3.10	1.06	0.00	2.34
8:30-8:59 AM	5.56	1.40	4.18	2.18	0.00	3.13
9:00-9:29 AM	2.14	3.90	5.01	3.70	0.00	4.29
9:30-9:59 AM	2.14	5.00	4.81	4.63	0.00	4.67
10:00-10:29 AM	1.71	8.50	4.85	5.62	0.00	5.62
10:30-10:59 AM	2.14	5.20	4.30	6.87	40.00	5.15
11:00-11:29 AM	4.70	7.60	4.85	7.20	20.00	6.06
11:30-11:59 AM	3.42	5.70	4.50	6.28	0.00	5.19
12:00-12:29 PM	2.99	4.20	3.70	4.76	20.00	4.08
12:30-12:59 PM	2.99	3.20	3.86	5.02	0.00	4.03
1:00-1:29 PM	2.99	4.70	3.86	6.15	0.00	4.63
1:30-1:59 PM	1.71	4.60	4.30	7.07	0.00	5.03
2:00-2:29 PM	3.85	5.60	4.02	7.27	0.00	5.24
2:30-2:59 PM	0.85	5.90	3.06	5.42	0.00	4.18
3:00-3:29 PM	2.14	6.30	3.86	4.10	0.00	4.31
3:30-3:59 PM	4.27	4.80	3.70	4.69	0.00	4.22
4:00-4:29 PM	4.27	5.40	4.85	4.43	0.00	4.81
4:30-4:59 PM	5.56	3.60	3.62	2.78	0.00	3.46
5:00-5:29 PM	6.41	4.00	3.62	2.12	0.00	3.38

TABLE 12. DEPARTURE TIME BY TRIP PURPOSE (Continued)

DEPARTURE	HBW	HBS	HBO	NHB	UNKNOWN	TOTAL
5:30-5:59 PM	2.56	1.70	2.35	0.99	0.00	1.84
6:00-6:29 PM	1.28	1.10	1.95	1.39	0.00	1.60
6:30-6:59 PM	1.28	0.90	1.83	0.79	0.00	1.33
7:00-7:29 PM	0.00	0.90	1.71	0.73	0.00	1.20
7:30-7:59 PM	0.00	0.70	1.23	0.40	0.00	0.84
8:00-8:29 PM	1.28	0.40	1.27	0.53	0.00	0.89
8:30-8:59 PM	0.43	0.20	0.80	0.73	0.00	0.65
9:00-9:29 PM	0.43	0.30	1.51	0.53	0.00	0.95
9:30-9:59 PM	0.00	0.00	0.80	0.13	0.00	0.42
AFTER 10:00 PM	1.28	0.10	1.19	0.59	0.00	0.82
UNKNOWN	2.14	0.50	1.43	0.40	0.00	0.99
TOTAL	4.44	18.99	47.73	28.74	0.09	100.00

HBW - Home-Based Work  
HBS - Home-Based Shop  
HBO - Home-Based Other  
NHB - Non-Home Based



time than the normal peak traffic hours. For a more usual a.m. peak hour of 8 to 9 a.m. and an expected p.m. peak hour of 5-6 p.m. less than 5.5 percent of the trips were made in each hour. In fact, over 50 percent of the trips by Green Valley residents are made during off-peak hours between 10:30 a.m. and 4 p.m.

### CHAPTER 3

#### REGIONAL MODELING IMPLICATIONS OF THE GREEN VALLEY SURVEY

This chapter presents a description of the PAGTPD regional travel demand forecasting models and adjustments that were made to those models, based on the results of the travel survey of Green Valley residents. The PAGTPD models, as all urban transportation forecasting models, are based on the premise that human travel behavior is very orderly, measurable, and basically rational. Order makes it possible to develop mathematical models that replicate how people currently travel. These models incorporate demographic, socioeconomic, and other characteristics of urban changes to replicate existing travel and to forecast future travel behavior to help assure that solutions to transportation problems address current and future needs.

Using inventories of existing travel behavior (such as the origin-destination survey conducted of Green Valley residents), supply of transportation services, and socioeconomic characteristics of an urban area, mathematical behavioral models are traditionally calibrated to estimate a four step modeling process. The models developed are used to predict how many trips start or end in different areas (trip generation), between which areas people travel (trip distribution), whether they drive, take transit, or ride with someone else (modal split), and what facilities they use (trip assignment). This modeling process results in estimations of how many vehicles will use existing and planned roadways, and how many people will use alternative mass transit facilities.

To date, these models have been developed for the "typical" population of an urban area. Little or no effort has been made to model the unique travel needs of the older age cohorts of the population. It should be

emphasized that the revisions to the PAGTPD models described here are designed to improve the simulation of Green Valley travel patterns within the regional modeling framework. Therefore, these recommendations may not be applicable to detailed, site specific, traffic impact analyses.

## **TRIP GENERATION**

The trip generation model is used to estimate the number of person trips produced and attracted in each transportation analysis zone. Trip productions are usually defined as the number of trips by purpose that begin or end at an individual's home. Trip attractions are then defined as the number of trips that begin or end at a non-home location such as work, a shopping center, bank, etc. If a trip neither begins nor ends at home, it is considered a non-home based trip, the origin of the trip is defined as the production, and the destination as the attraction. The estimation of these trip ends is based on causal relationships of land use and socio-economic characteristics to tripmaking.

### **Trip Production Model**

The trip production model currently used by PAGTPD employs cross-classification analysis to estimate the number of internal person trips produced in a zone. Cross-classification analysis is a simple and well understood technique for estimating the trip production characteristics of households which have been stratified into separate categories according to a set of properties that characterize the household.

PAGTPD utilizes zonal household size and zonal household income stratifications for their trip production model. The zonal household size stratifications are applied to the zonal forecasts of population to obtain an estimate of the zonal number of households. The 1980 PAGTPD zonal household size stratifications are:

<u>HH Size Category</u>	<u>Persons/Household</u>
Category 1	2.00
Category 2	2.71
Category 3	3.21

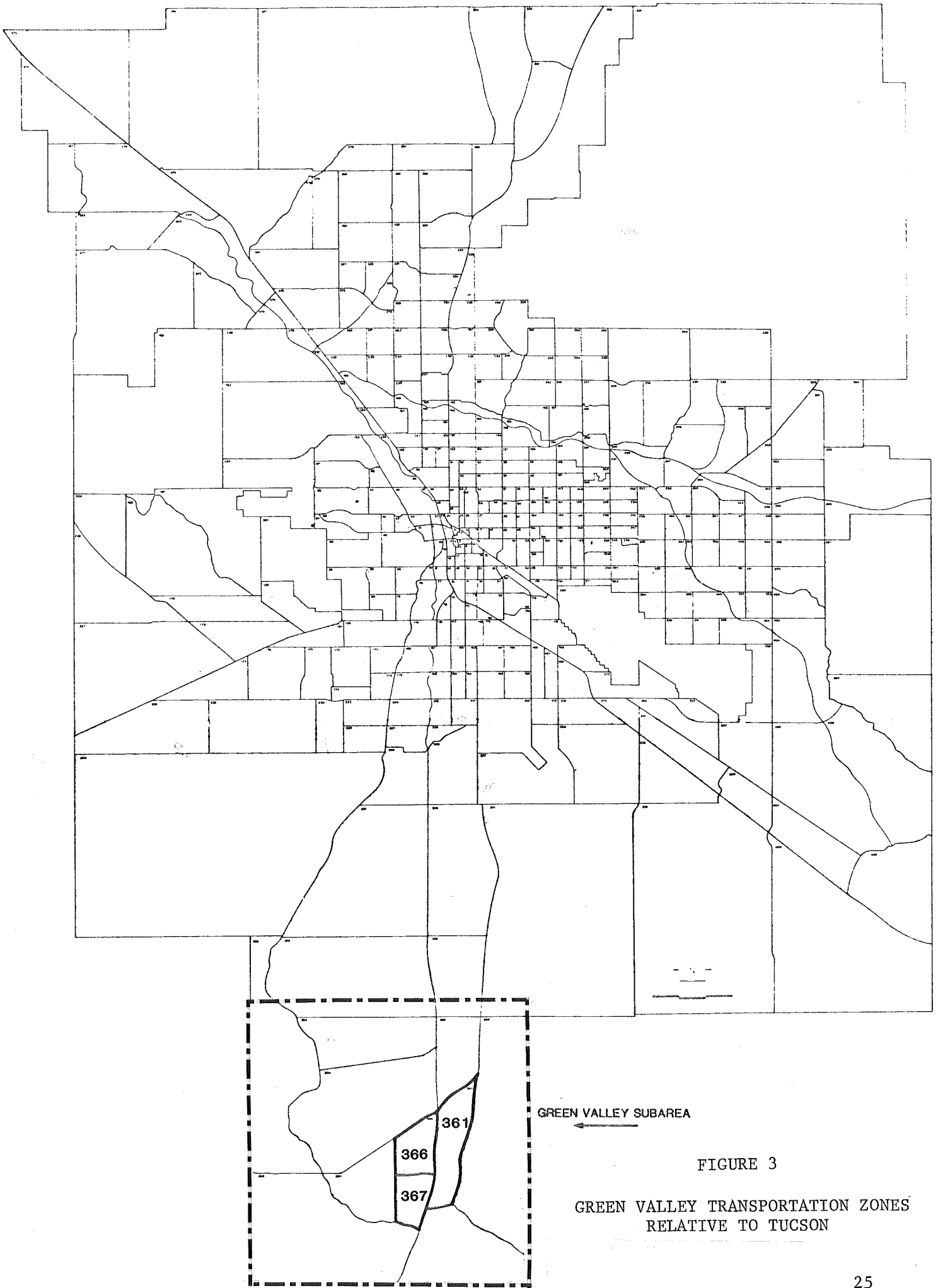
In their 1980 forecasts, PAGTPD assumed 2.71 persons/household (category 2) in the transportation zones encompassing Green Valley (zones 361, 366 and 367 as shown in Figure 3). This 2.71 household size assumption differs significantly from the 1.85 household size resulting from the Green Valley survey. It would be more appropriate to classify the transportation zones encompassing Green Valley as category 1 (2.0 persons/HH).

The next step in the PAGTPD trip production modeling procedure is the application of an overall total person trip rate to the estimate of the zonal number of households. This results in a preliminary estimate of the total number of internal person trips produced in a zone. The 1980 PAGTPD household trip rates are:

<u>Trip Rate Category</u>	<u>Trips/Household</u>
Category 1	4.96
Category 2	7.48
Category 3	10.56

In their 1980 forecasts, PAGTPD assumed 7.48 trips/household (category 2) in the transportation zones encompassing Green Valley. This 7.48 trips/household assumption matches closely with the 7.69 household trip rate resulting from the Green Valley survey. Applications of the model for Green Valley could use either the category 2 (7.48 trips/household) rate or the rate found from the survey (7.69 trips/household).

Trip purpose splits are then applied to the total person trips, based on a zonal income stratification, to obtain preliminary zonal trip productions by five trip purposes: home-based work (HBW), home-based school



GREEN VALLEY SUBAREA  
←

FIGURE 3

GREEN VALLEY TRANSPORTATION ZONES  
RELATIVE TO TUCSON

(HBSCH), home-based shop (HBS), home-based other (HBO), and non-home based (NHB). The 1980 PAGTPD trip purpose percentages by zonal household income stratification are:

<u>Trip Purpose</u>	<u>Household Income</u>		
	<u>Low</u>	<u>Medium</u>	<u>High</u>
HBW	14	24	25
HBSCH	8	13	10
HBS	16	8	9
HBO	42	29	29
NHB	20	26	27
	100%	100%	100%

In their 1980 forecasts, PAGTPD assumed the trip purpose split corresponding to the medium household income stratification for the Green Valley zones. As discussed earlier, this assumption differed significantly from the trip purpose split resulting from the Green Valley survey (HBW-4%, HBSCH-0%, HBS-19%, HBO-47%, and NHB-30%). Considering the unique nature of a retirement community, the trip purpose split derived from the survey should be applied to trips produced in Green Valley.

The final step in the PAGTPD trip generation modeling procedure involves the balancing of trip productions and attractions. Trip attraction totals for the HBW, HBS, and HBO trip purposes are balanced to equal the trip production totals. For the HBSCH and NHB trip purposes, trip production totals are balanced to equal trip attraction totals.

However, prior to this project, due to poor replication of Green Valley travel patterns, PAGTPD applied adjustment factors to the trip productions in the zones encompassing Green Valley. For zones 361, 366, and 367 adjustment factors of 0.23 for HBW trips, 0.70 for HBS trips, 0.62 for HBO trips, and 0.68 for NHB trips were applied to the trip production totals. As a result of the survey findings, this scaling is not necessary.

A comparison of the 1980 trip production totals from the PAGTPD trip production modeling procedure with those derived utilizing Green Valley survey results is presented in Table 13. As seen in this table, the current PAGTPD trip production modeling procedures for Green Valley (zones 361, 366 and 367) greatly underestimate the number of trip productions from Green Valley. The final adjusted PAGTPD total trip productions represent only 28 percent of the total trip productions predicted utilizing the Green Valley survey results.

### **Trip Attraction Model**

The PAGTPD trip attraction model estimates attractions by zone according to the type of employment in that zone. The trip attraction rate for a zone depends on the kind of employment that is present there. Table 14 displays the trip attraction rates used by the PAGTPD models.

As can be seen in Table 14 the number of trips attracted to a zone is considerably different for different types of employment. For example, trip attraction rates for other non-retail employment is considerably lower (5.81 trips per employee) than for regional shopping centers (21.93 trips per employee). Furthermore, as can be seen in Table 14, the purpose split of trip attractions is different depending on the kind of commercial activity (employment) that exists at any location. There are obviously far more home based shopping trips attracted to a location with a commercial shopping center than to a location with other non-retail employment such as a manufacturing plant.

The total trip attractions estimated for all zones in a region should equal the total trip productions for all those zones. Furthermore, the total trip production for each purpose (home based work, home based school, home based shop, etc.) should equal the total trip attractions by purpose.

TABLE 13. 1980 COMPARISON OF PAGTPD VERSUS SURVEY TRIP PRODUCTION RESULTS

	<u>PAGTPD</u>	<u>Survey</u>
Population	7570	7570
Households	2794	4092
<u>Unadjusted Trips</u>		
HBW Trips	5016	1260
HBSCH Trips	0	0
HBS Trips	1671	5987
HBO Trips	6060	14809
NHB Trips	6282	9452
Total Trips	19029	31508
<u>Adjusted Trips</u>		
HBW Trips	1153	1260
HBSCH Trips	0	0
HBS Trips	1168	5987
HBO Trips	3756	14809
NHB Trips	2645	9452
Total Trips	8722	31508

HBW = Home Based Work  
 HBSCH = Home Based School  
 HBS = Home Based Shop  
 HBO = Home Based Other  
 NHB = Non-Home Based



TABLE 14. PAGTPD TRIP ATTRACTION RATES BY PURPOSE

Purpose	Employment Category*										
	CBD	RSC	CSC	OR	ONR	DM	TIA	UA	CC	HOS	DU
HBW	2.395	2.63	2.41	2.84	1.55	0.60	2.11	1.55	0.92	1.55	0.00
HBS	1.885	9.38	7.58	11.17	0.38	0.18	0.00	0.38	0.14	0.38	0.00
HBO	3.040	3.16	2.99	3.33	2.32	1.28	9.23	2.23	0.84	2.32	1.17
NHB	2.455	6.81	5.70	7.91	1.56	0.74	4.98	1.56	0.49	1.56	0.16

\*Employment Categories:

- CBD = Central Business District
- RSC = Regional Shopping Center
- CSC = Commercial Shopping Center
- OR = Other Retail
- ONR = Other Non-Retail
- DM = Davis Monthan AFB
- TIA = Tucson International Airport
- UA = University of Arizona
- CC = Pima Community College
- HOS = Hospital
- DU = Dwelling Units (rate based on households)

Often these do not match and trip attractions regionwide are factored to equal trip productions. Trip productions usually control because there is far more confidence in the trip rates and socioeconomic forecasts at the household end of a trip than there is at the non-home based end.

Applications of the PAGTPD travel forecasting models prior to this project classified employment within the zones comprising Green Valley as other non-retail employment. A more detailed review of the employment within the zones comprising Green Valley clearly indicated that those employed there were primarily working at community shopping centers, and not non-retail positions.

As a result of the employment categorization, commercial activity within Green Valley was not being properly simulated by the PAGTPD travel forecasting models. The model was estimating that the 1,470 workers employed within the Green Valley community were generating 8,500 ( $1,470 \times 5.81$ ) rather than 32,300 ( $1,470 \times 21.98$ ) trip attractions. The low level of trip attractions estimated by the trip generation model for Green Valley was thus affecting how far the model was estimating that Green Valley residents must travel to satisfy their shopping and other needs.

#### **TRIP DISTRIBUTION**

The trip distribution model is used to link up the trip ends estimated in the trip generation step. The output of the trip distribution model is a person trip table, which is a matrix containing the magnitude of person trip movements among the transportation zones in the region. PAGTPD utilizes a gravity model to distribute the internal person trips. The gravity model, which is loosely based on the law of gravitational attraction, has the form:

$$T_{ij} = \frac{[P_i A_j F_{ij} K_{ij}]}{\sum_{j=1}^n [A_j F_{ij} K_{ij}]}$$

Where:

$T_{ij}$  = trips produced at i and attracted at j

$P_i$  = trip productions at i

$A_j$  = trip attractions at j

$F_{ij}$  = calibrated factor based on travel time for interchange ij

$K_{ij}$  = socioeconomic adjustment factor for interchange ij

The calibration term (F-factor) in the gravity model reflects the effect that spatial separation has on the interchange. It is usually a function of trip travel time, which for PAGTPD, is the estimated zone-to-zone highway travel time determined from the network. The socioeconomic term (K-factor) accounts for the social, economic and other influences on travel patterns which are unrelated to travel time.

A proper application of the gravity model trip distribution technique requires a balanced set of trip productions and attractions. That is, if the trip productions and trip attractions for the Green Valley subarea of the Tucson region are not reflective of the number of trips within the area, then the gravity model will not properly distribute the trips. The large number of trips produced by Green Valley households will not be able to find attractions (non-home destinations) within the subarea. If this is the case, the gravity model will send those trips to other parts of the Tucson area, even if it requires a long travel time, because there is nowhere else for the trips to go.

As was discussed earlier, the trip attractions that were being generated by the models in previous simulations for Green Valley zones, were considerably less than required by the kind of commercial activity within this retirement community. Thus, it was hypothesized that the overassignment of trips to Interstate 19 by the regional modeling process was not due to a misspecification of the gravity model parameters, but to the earlier land use/trip generation problems.

It was observed in the survey that 85 percent of the Green Valley trip productions remain within the community. Proper application of the gravity model should result in approximately that many trips staying within the subarea. The adequacy of the gravity model specifications should be judged by how well this survey finding is replicated. If approximately this level of intra-Green Valley trips can be achieved using the regionally calibrated F-factors, and trip productions and trip attractions that reflect the true nature of Green Valley, then no changes should be made to the distribution model to reflect the characteristics of retirement communities.

#### **VEHICLE OCCUPANCY**

The final step in the modeling process is to derive the number of vehicle trips to be assigned to the highway network. This is accomplished through the use of modal split and car occupancy models. A modal split model is used to determine how many of the person trips between two points will be made on transit. Likewise, the car occupancy model determines how many of the person trips made in an automobile will be as the driver of the vehicle and how many as a passenger.

Since virtually no transit trips were reported in the Green Valley survey, it is not appropriate to apply a modal split model to Green Valley trips. However, a considerable proportion of the reported trips were made

as auto passenger, and thus warrant the application of a vehicle occupancy model that reflects the travel habits of retirement community residents.

As can be seen in Table 15, the vehicle occupancy for trips made by Green Valley residents is considerably different than that for trips made in the Tucson region as a whole. Not only are these rates different, but as can be seen the rate for trips remaining within Green Valley is considerably lower than for trips going to Tucson and other locations.

The vehicle occupancies estimated from the survey for all destinations and all trip purposes, except for non-home based trips, are lower than those used by the regional modeling process. If the PAGTPD regional occupancies are applied to the Green Valley mix of trips by purpose, an overall occupancy of 1.51 is estimated compared to the 1.36 found by the survey. If the regional vehicle occupancy rates are applied to trips generated by Green Valley households, almost 10 percent fewer vehicle trips would be generated by the Green Valley Area. However, if the vehicle occupancy rate found by the survey for trips that leave Green Valley is applied to those trips instead of the regional rate, almost 25 percent fewer trips of this type are generated. This analysis shows that application of the survey derived rate to trips leaving Green Valley should result in 25 percent fewer vehicle trips produced in Green Valley being assigned to the regional road network (i.e., Interstate 19) than if the PAGTPD regional rates were applied. Therefore, it is recommended that different vehicle occupancy rates are used for trips staying within Green Valley and trips leaving the retirement community. The recommended rates are those that were found in the survey, and shown in Table 15. These rates should be examined for their stability over time and perhaps adjusted up or down proportional to how the regional rates are changed for future forecasts.

TABLE 15. VEHICLE OCCUPANCY RATES - GREEN VALLEY SURVEY AND TUCSON REGIONAL MODELS<sup>1</sup>

	Purpose			
	Home Based Work	Home Based Shop	Home Based Other	Non-Home Based
Tucson Regional Models (1980)	1.18	1.46	1.65	1.37
Green Valley Survey (Total)	1.08	1.29	1.40	1.42
Green Valley Survey (Within Green Valley)	1.07	1.24	1.37	1.32
Green Valley Survey (Trips Leaving Green Valley)	1.20	2.02	1.81	1.85

<sup>1</sup>Pima Association of Governments, PAGTPD Travel Demand Models, 1981 PAGTPD Model, Technical Report 83-1, January 1983, p. 22.

## **APPLICATION OF MODEL REVISIONS**

The results of the Green Valley Household Origin-Destination Survey indicate that trip generation and occupancy should be modeled uniquely for Green Valley transportation planning zones. However, the data indicate that with appropriate revisions to the trip generation model, no changes to the trip distribution model are necessary.

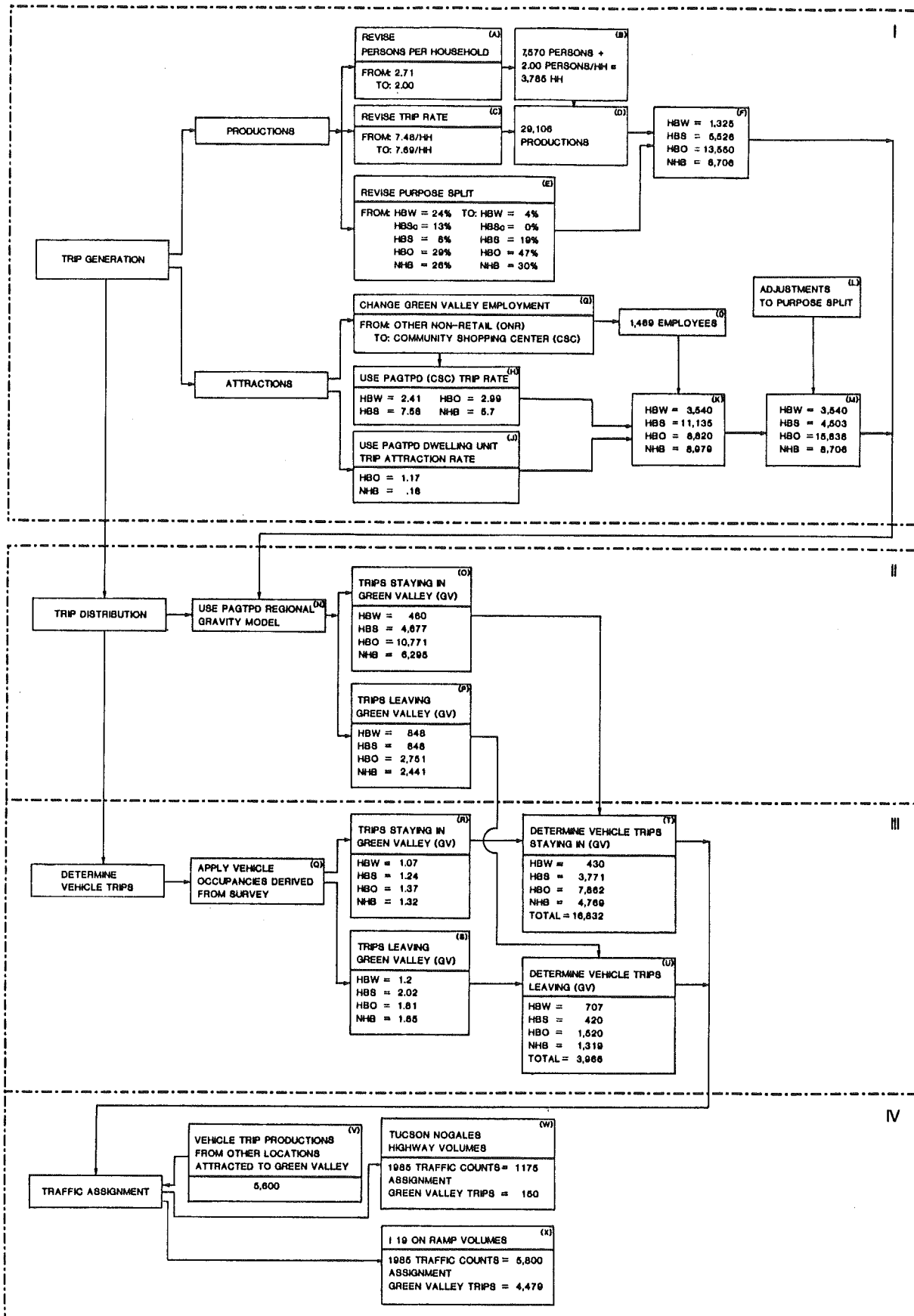
In order to test this hypothesis, a special PAGTPD 1980 traffic simulation was performed. This simulation applied the revisions to the model that were indicated for Green Valley by the survey. The revisions that were made are described by a flowchart included as Figure 4. The flowchart describes the entire traffic simulation and results for the Green Valley traffic analysis zones (361, 366, and 367).

The simulation of Green Valley vehicle traffic is accomplished through four steps: trip generation, trip distribution, modal split (vehicle occupancy), and traffic assignment. The application of each of these steps is described by a block of the flowchart defined by a roman numeral.

### **Trip Generation**

The modifications to the trip generation process are described in Figure 4 by the area captioned by "I". Several modifications were made to the trip generation models. First, since the survey showed that the average size of Green Valley households were closer to 2.0 than 2.71 (Box A, Figure 4), the number of households in Green Valley were estimated by dividing the 1980 population estimate of 7,570 persons by 2 to yield 3,785 households (B). The revised trip rate of 7.69 trips per household (C) was then applied to this household estimate to yield 29,106 daily trip productions generated by the Green Valley transportation zones (D). The revised purpose split (E) derived from the survey results for trip productions was

FIGURE 4  
 REVISIONS TO PAGTPD 1980 TRAVEL FORECASTING MODELS  
 FOR GREEN VALLEY RETIREMENT COMMUNITY



LEGEND  
 HBW = HOME BASE WORK  
 HBS = HOME BASE SHOP  
 HSO = HOME BASED SCHOOL  
 HBO = HOME BASED OTHER  
 NHB = NON-HOME BASED



then used to split the trip productions by purpose (F). This resulted in an estimate of trip productions by purpose as follows:

Home Based Work	=	1,325
Home Based Shop	=	6,526
Home Based Other	=	13,550
Non-Home Based	=	8,706

Trip attractions were revised to reflect more closely the commercial activity occurring in Green Valley (G), and the type of trips made by Green Valley residents. Trip attractions were estimated by applying the total PAGTPD regional model trip attraction rate for commercial shopping center employment instead of for non-retail employment (H) to the 1,469 employees estimated to be working in Green Valley (I). In addition to the trip attractions estimated from commercial activity, trip attractions due to the interaction of Green Valley residents were estimated by applying to the Green Valley dwelling units, from the PAGTPD regional models, the trip attraction rate for dwelling units (J). Adding these two yielded an initial estimate of trip attractions by purpose for the subarea (K).

It was necessary to adjust this purpose split to reflect the nature of trips made by Green Valley residents, as found by the survey. That is, they appear to make far more home based other trips than home based shop trips. This adjustment (L) described in Figure 5 was applied yielding final trip attractions for Green Valley (M) as follows:

Home Based Work	=	3,540
Home Based Shop	=	4,503
Home Based Other	=	15,838
Non-Home Based	=	8,706

These final trip attractions are to be used for the Green Valley transportation zones following the balancing of regional productions and attractions. This is necessary because of the scaling of attractions to match productions by the regional process. For example, if the home based

$$\begin{aligned} \text{F:HBW:ATTR} &= \text{HBW:ATTR} \\ &= 3,540 \end{aligned}$$

$$\begin{aligned} \text{F:HBS:ATTR} &= \left( \frac{\text{PROD:HBS}}{\text{PROD:HBS} + \text{PROD:HBO}} \right) \times (\text{COM:HBS:ATTR} + \text{COM:HBO:ATTR}) \\ &= \left( \frac{5,525}{5,525 + 1,3522} \right) \times (11,135 + 4,392) \\ &= (.29) \times 15,527 \\ &= 4,503 \end{aligned}$$

$$\begin{aligned} \text{F:HBO:ATTR} &= [(\text{COM:HBS:ATTR} + \text{COM:HBO:ATTR}) - \text{F:HBS:ATTR}] + \text{DU:HBO:ATTR} \\ &= [15,527 - 4,503] + 4,814 \\ &= 15,838 \end{aligned}$$

$$\begin{aligned} \text{F:NHB:ATTR} &= \text{NHB:PROD} \\ &= 8,706 \end{aligned}$$

Where:

F:HBW:ATTR = Final Home Based Work Attractions  
 HBW:ATTR = Initial Home Based Work Attractions  
 F:HBS:ATTR = Final Home Based Shop Attractions  
 PROD:HBS = Home Based Shop Attractions  
 PROD:HBO = Home Based Other Productions  
 COM:HBS:ATTR = Home Based Shop Attractions to Commercial Shopping Centers  
 COM:HBO:ATTR = Home Based Other Attractions to Commercial Shopping Centers  
 F:HBO:ATTR = Final Home Based Other Attractions  
 DU:HBO:ATTR = Home Based Other Attractions to Dwelling Units  
 F:NHB:ATTR = Final Non-Home Based Attractions  
 NHB:PROD = Non-Home Based Productions

FIGURE 5. GREEN VALLEY TRIP ATTRACTION ADJUSTMENTS

shop attractions developed for Green Valley were scaled as part of the balancing of productions and attractions, the final home based shop attractions for Green Valley would be approximately 1,300 rather than the 4,500 estimated.

### **Trip Distribution**

Following the estimate of how many trips will begin or end in each transportation zone, it must be determined how these origins and destinations will be linked (i.e., trip distribution). This phase of the simulation is depicted by the area labeled II in Figure 4.

As a result of the considerably different productions and attractions resulting from the modifications to the trip generation process, it was not necessary to modify the regional trip distribution process for Green Valley. The PAGTPD trip distribution gravity model (N) was applied to the Green Valley traffic zones, the same as it was applied to all zones regionally.

As a result of the gravity model application, it was estimated that 22,203 person trip productions would be made by Green Valley residents to attractions within the Green Valley subarea (0). As shown in Table 16, this compares to an estimate of 25,110 trips staying within Green Valley, if the destinations reported by the survey were applied directly to the trip productions generated by the model. Thus, the model is estimating 2,900 (12%) fewer person trips remaining in Green Valley than would have been indicated by the survey. A further analysis of the number of Green Valley productions by purpose not leaving the subarea, reveals that the model replicates the survey within an acceptable percentage for all purposes

TABLE 16. PRODUCTIONS BY PURPOSE REMAINING IN GREEN VALLEY -  
MODEL VS. SURVEY

Destination	Purpose									
	HBW		HBS		HBO		NHB		TOTAL	
	Trips	%	Trips	%	Trips	%	Trips	%	Trips	%
Survey	1,177	90	5,028	91	21,440	92	6,465	74	25,110	86
Model	460	35	4,677	85	10,771	80	6,295	72	22,203	76
Difference	717		351		1,669		170		2,907	10

HBW = Home Based Work  
HBS = Home Based Shop  
HBO = Home Based Other  
NHB = Non-Home Based

except home based work trips, for which the model only estimates 39 percent of the number of work trips remaining in Green Valley that would be expected from the survey results. Since home based work trips are only 4 percent of the trips produced by Green Valley residents, this major discrepancy for home based work trips is not significant to the overall model performance.

### **Estimate Vehicle Trips**

Following the simulation of person trips between traffic zones, the next step is to estimate how many vehicles will be used to make those trips. Vehicle trips are derived by applying the vehicle occupancies derived from the survey to the person trip table (Q). Since the survey found a significant difference in occupancy rates by purpose, and by destination; different vehicle occupancies by purpose were applied to trips remaining in Green Valley and trips leaving the retirement community (R and S). This resulted in a simulation of 16,832 vehicle trips being produced by Green Valley residents that are not leaving the community (T). Likewise, the number of vehicle trips made to and from other areas is 3,966 (U). The resultant vehicle trip productions by purpose are shown in Table 17.

As was discussed in the previous section, the simulation has over-estimated the number of person trips leaving Green Valley by approximately 2,900. When vehicle occupancies are applied to these trips, as shown in Table 18, almost 1,800 additional vehicle trips more than appropriate are estimated to be leaving Green Valley on a given weekday. Even if 25 percent of these trips are made during any one hour, the few additional vehicles will have an insignificant impact on the regional highway network.

TABLE 17. FINAL GREEN VALLEY VEHICLE TRIP PRODUCTIONS -  
1980 SIMULATION

<u>Purpose</u>	<u>Vehicle Trips Staying in Green Valley</u>	<u>Vehicle Trips Leaving Green Valley</u>
Home Based Work	430	710
Home Based Shop	3,770	420
Home Based Other	7,860	1,520
Non-Home Based	4,770	1,320
Total	16,830	3,970

TABLE 18. OVERESTIMATION OF TRIP PRODUCTIONS LEAVING GREEN VALLEY -  
MODEL APPLICATION

	<u>Home Based Work</u>	<u>Home Based Shop</u>	<u>Home Based Other</u>	<u>Non- Home Based</u>	<u>Total</u>
Additional Person Trip Productions Leaving Green Valley	717	351	1,669	170	2,907
Vehicle Occupancy of Trips Leaving Green Valley	1.2	2.02	1.81	1.85	
Additional Vehicle Trips Using Facilities Outside Green Valley	600	170	920	90	1,780

## **Trip Assignment**

A regional traffic assignment was performed using the vehicle trip tables that resulted from the previous model applications (Section IV of Figure 4). This regional assignment included:

- o the 3,966 daily vehicle trips produced by Green Valley residents that leave the community a portion of these trips that remain in Green Valley, and
- o an estimated 5,600 vehicle trips that would be attracted to Green Valley and produced by residents of other areas.

These trips are assigned to the regional highway network along with trips between other origins and destinations. Therefore, it is difficult to assess how much of the vehicle traffic assigned to each link is from trips produced by Green Valley zones.

However, as a measure of the quality of the traffic assignment, a comparison was made between traffic counts on ramps entering I-19 northbound with simulated traffic assigned to I-19 northbound. Traffic counts were performed by Pima County for all ramps entering I-19 in March 1985, and are shown in Table 19. In addition to the 4,950 vehicles counted going northbound, 2,350 vehicles were counted on the Tucson Nogales Highway north of Green Valley.

The results of the simulation indicate that approximately 9,300 daily vehicle trips are traveling between Green Valley and areas to the north. Thus, approximately 4,650 trips would be coming from Green Valley going north. The traffic counts indicate that 6,125 vehicle trips leave Green Valley and travel northbound.

Several factors indicate that there would not be a perfect match between traffic counts and assigned volumes. First, since the traffic counts were conducted in 1985, they include five year's of growth in



TABLE 19. TRAFFIC COUNTS ON I-19 ENTRANCE RAMPS

<u>Entrance</u>	<u>Northbound Volume</u>	<u>Southbound Volume</u>
Continental	2,083	571
Esperanza	1,480	1,854
Duval Mine	<u>1,387</u>	<u>1,835</u>
Total	4,950	4,260

traffic beyond the 1980 simulation. Furthermore, the traffic counts include trips between Green Valley zones. Therefore, it is expected that the traffic counts would be higher than the assigned volumes that were estimated for 1980. Another factor is that 890 extra trips are assigned because of the underestimation of Green Valley to Green Valley vehicle trips discussed in the previous section. With these factors in mind, the simulated traffic to the north matches the traffic counts reasonably well.

### **Overall Results of the Simulation**

The revised 1980 simulation using the results of the Green Valley survey performs reasonably well. There appears to be a slight oversimulation of vehicle trips on the regional highway network, but well within an acceptable level of error. The most significant discrepancy between simulated travel and the survey results is for home based work trips. However, since home based work trips account for only 4 percent of the trips made by Green Valley residents, and the oversimulation of work trips leaving Green Valley is well under 1,000 vehicle trips a day, it was not felt appropriate to further revise the models to improve the simulation of work trips.

## CHAPTER 4

### TRANSFERABILITY OF GREEN VALLEY SURVEY RESULTS

#### **INTRODUCTION**

Limited previous research has been performed regarding the specific travel characteristics of older citizens. The majority of this research is general in nature, and has included retirees living in the general community, or high density retirement centers, and not necessarily planned retirement communities such as Green Valley. While research related to the general travel characteristics of the retirement population is important, it is not necessarily relevant to a planned low density retirement community similar to Green Valley. An important contribution of this study was to provide data transferable to other existing planned retirement communities, and for use in planning future communities of this nature.

This chapter discusses how the findings of this study can be transferred to other retirement communities within and outside of Arizona. The characteristics of Green Valley and its residents are summarized to provide a baseline for comparison to other existing or proposed retirement communities. Finally the adoption of the methods used and results of this study for the evaluation of other retirement communities is briefly discussed.

#### **DEMOGRAPHIC CHARACTERISTICS OF GREEN VALLEY COMMUNITY**

Green Valley is a discrete low density residential community with a population of 12,000 located 25 miles south of the Tucson CBD, and approximately 15 miles from the Tucson urbanized area. It covers about 10 square miles and is comprised primarily of single family houses (53 percent), but also includes a large proportion of townhouses or duplexes (19 percent), and apartments or condominiums (22 percent). This

development is comparable to a typical suburban community that is designed around the automobile as the principal means of transportation.

In addition to providing housing for residents, Green Valley provides a large number of recreational, shopping, banking, medical and other facilities to serve the daily needs of the community. These facilities are located at shopping centers and other points throughout the community. Thus, residents must drive or be driven in order to meet the majority of their daily needs within the community.

Being a retirement community, the residents of the community are generally older. Less than 7 percent of the population is under 60 years old, and another 12 percent is between 60 and 64. Nearly 25 percent of the population was reported to be between 65 and 69; another 25 percent--69 to 74, nearly 28 percent--75 to 79, and over 10 percent over 80.

Household size was generally smaller than those of the Tucson metropolitan area. Almost two-thirds of the Green Valley households (78 percent) had two occupants. Only three percent of the households had three or more residents, and almost a fifth of the households had a single occupants.

## **NATURE OF GREEN VALLEY TRAVEL BEHAVIOR**

### **Trip Generation**

It has been suggested that the travel behavior of retirement community residents would be different depending on the residents' age and the size and income of the household.

The results of the Green Valley household survey indicate that retirement community residents make more trips than was previously expected.

Trip generation rates have previously been reported for California, Arizona, and Florida retirement communities.\* These trip generation rates ranged from 2.9 to 7.8 vehicle trips per household. However, these were derived for all types of retirement centers and communities using traffic counts and reflect both trips to the community by outsiders and through trips. The generally accepted rate ranges between three and four trips per household. The Green Valley Survey found the average household made 7.7 vehicle person trips and 5.6 vehicle trips.

The survey also found that the trip rate did not vary significantly by household size, income, or type. A single occupant household was found to produce 7.9 person trips, a two person household 7.64, and larger households 8.29. This spread of less than 10 percent indicates that all households made approximately the same amount of trips regardless of household size. This is probably due to the need to travel for household necessities regardless of the number of residents, and an increased propensity to leave the house for social reasons by residents living alone.

Trips produced per household did not vary a great deal with household income. The reported trips per household for households with income below \$10,000 (3 percent of households) was the only exception, reporting an average of 4.8 person trips per household. The remaining income groups reported trip rates ranging from 7.5 to 9.1 person trips per household.

Trip production rates were found to vary by less than 15 percent when disaggregated by type of dwelling unit. The trip rate varied from 6.9 person trips per household for residents of townhouses to 8.0 person trips for residents of single family households.

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\* Buick et al.

### **Trip Distribution**

A further intent of the survey was an assessment of how far and where the trips produced in Green Valley go in order to satisfy the purpose of the trip. The ultimate destination of these trips is dependent on the locations of work, shop and other activities; and the nature of the available transportation facilities between the trip origin and destination. These factors, in addition to the general propensity of the residents to travel, lead to a distribution of trip lengths for trips made by residents of a community.

As pointed out earlier Green Valley is located 25 miles south of Tucson with minimal development between Green Valley and the city limits. Furthermore there is a great deal of shopping, banking and other activity within the community to meet normal everyday needs. Therefore it is likely that most everyday travel would be made within the community to avoid the long trip to Tucson. In other retirement communities that are less isolated, such as Sun City in the Phoenix metropolitan area where developed areas are contiguous to the retirement community, it is likely that residents would travel outside the community more frequently.

The survey found that 87 percent of the trips made by Green Valley residents were made to destinations within Green Valley. The most likely trips to be made outside Green Valley were non-home based trips (74 %). One reason for these higher level of non-home based trip made outside Green Valley could be that residents would make several trips from one location to another while in Tucson. It was also found that the trip length distribution for all trip purposes is not significantly different. For example 70 percent of shop trips, 66 percent of work trips, 68 percent of non-home based trips, and 65 percent of the other trips are less than 15 minutes long.

An attempt was made to replicate the travel destinations found in the survey by applying the Tucson gravity model using the F Factors calibrated for the area as a whole. When the trip generation characteristics were revised to reflect the results of this survey the gravity model was able to replicate reasonably well the trip destinations found in the survey. In a similar manner, it may be possible in other areas to distribute trips from a retirement community using the regionally calibrated trip distribution model.

### **Vehicle Occupancy**

In general the vehicle occupancies found in the survey (1.38) are lower than those predicted by the PAGTPD model (1.51). However the occupancies for trips leaving Green Valley (1.88) are considerably larger than those for trips staying within the community (1.31).

It is not surprising that the vehicle occupancies for trips made by Green Valley residents are lower than the PAGTPD occupancies that are based on regional data. The average household size of Green Valley is lower than for the region as a whole and furthermore there are no children to be driven from place to place.

It is also not surprising that trips leaving Green Valley had almost three times as many passengers as trips staying within the community. The trip length for trips leaving Green Valley are long because of the isolated location, therefore residents are more likely to travel together when leaving the community.

Other retirement communities clearly can conclude from these results that the vehicle occupancies for trips made by their residents within the community will be lower than the general urban populations. However the location of those communities relative to surrounding development may

indicate a higher or lower occupancy than found in this study or trips outside the retirement community itself.

### **Temporal Distribution**

The times during the day, or temporal distribution of trips made by Green Valley residents, were quite different than normally expected. The peak hour for Green Valley trips was between 11 a.m. and noon when 11.25 percent of the trips were made. During the more usual peak hours 8 to 9 a.m. and 5 to 6 p.m. less than 5.5 percent of the trips by Green Valley residents were made in each hour. Therefore when evaluating the traffic impact of planned retirement communities planners should consider that the peak hours for urban traffic do not coincide with the peak travel hours of retirement community residents.

The temporal distribution found for Green Valley is likely to be highly transferable to retirement communities in other locations. The hours chosen to travel should be independent of the location of the community and more related to retirees life style and daily habits. The only exception would be if a community is located in a highly congested area during peak periods, retirees may further avoid driving in those peak hours.

### **TRANSFERABILITY OF STUDY METHODOLOGY**

If the characteristics of a retirement community are similar to those of Green Valley the results of this study could be directly transferable. However before these results are used a careful comparison of the locational, physical and demographic characteristics should be made.

An aspect of this study that should be of interest to other areas of retirement settlement is how the PAGTPD models were revised to simulate the



travel characteristics of the Green Valley retirement community. With certain adjustments to regional models, it may be possible to replicate the travel patterns of the retirement community, or forecast the traffic impacts of proposed new communities. In addition, if area specific data is needed, the survey methodology used in this study can be applied in other locations. The survey was completed by over 60 percent of the residents contacted, and the results have been quite useful for travel modeling purposes.

## CHAPTER 5

### COMPARISON OF GREEN VALLEY SURVEY RESULTS WITH PHOENIX

The Tucson regional transportation planning process is not alone in its lack of accurate travel data to use for forecasting the travel behavior of retirement communities. This problem, while identified by PAGTPD staff, has consequences for travel forecasting and transportation planning in other urban areas with retirement communities. These areas exist not only in Arizona, but in other states such as Florida and California.

#### **SOURCE OF COMPARATIVE DATA**

There appears to be a dearth of research into the travel pattern of retirees, and more specifically, of residents of planned retirement communities. It was not possible to find a comparable survey to compare to the results of the Green Valley origin-destination survey. An attempt was made, however, to compare the results of this survey to the travel characteristics of retirees in the Phoenix metropolitan area.

This comparison was performed using two sources of data provided by the Maricopa Association of Governments (MAG). The first was the result of a survey of the trip generation characteristics of retiree households, performed as part of a larger origin-destination survey conducted in 1980. The second was the result of a trip distribution simulation for Phoenix transportation zones identified as having a significant retirement population.

The 1980 survey of 1,461 households included 68 households identified as having retirees as residents. This relatively small sample does not provide as statistically accurate an estimate of travel behavior as the 666 households surveyed in Green Valley.

The household income for the 68 retirement zone households sampled in the 1980 household origin-destination survey was compared to that found in the Green Valley survey. The income reported by Phoenix area households was inflated to 1985 conditions and slotted into the closest range reported in the Green Valley survey. This comparison, shown in Table 20, revealed that the Phoenix area households surveyed were of a slightly lower income than those in Green Valley. Over 47 percent of the Phoenix households had an income less than \$20,000 compared to approximately 26 percent of the Green Valley households. Due to the generally higher income in Green Valley, it would be expected that the trip rate would be higher there. Furthermore, the retirement zone households surveyed in Phoenix were not necessarily all in retirement communities, where retirees are usually more active, but included other retiree households.

The trip length simulation performed by MAG was for zones having identified retirement communities within them. MAG reported that over 45 percent of the identified zones had less than half of the population residing within them who were 65 or older. In contrast, over 75 percent the households surveyed in Green Valley had a head of household over 65, and over 65 percent of all residents were over age 65.

Therefore, it is clear that the Phoenix data is not ideal for determining the transferability of the Green Valley survey results. However, it is the best source of data currently available.

#### **TRIP PRODUCTION RATES**

The Green Valley survey found an overall trip production rate of 7.69 trips per household. The trip rate reported in the Phoenix survey was only 4.08 trips per household, almost half the Green Valley rate. Table 21 displays a comparison of the trip rate by household size. The Green Valley

TABLE 20. COMPARISON OF GREEN VALLEY HOUSEHOLD INCOME  
TO PHOENIX RETIREMENT HOUSEHOLDS

<u>Income Group Range</u>	<u>Percent of Phoenix Retirement Households*</u>	<u>Percent of Green Valley Households</u>
Less than \$10,000	10.3%	5.7%
\$10,000-\$19,999	36.8%	20.5%
\$20,000-\$29,000	17.6%	29.0%
\$30,000-\$39,999	14.7%	22.9%
Over \$40,000	20.6%	21.9%

\*Phoenix household incomes inflated from 1980 to 1985 by assuming  
a 30 percent increase in the consumer price index.

TABLE 21. COMPARISON OF PHOENIX RETIREMENT ZONE TRIP RATES TO GREEN VALLEY BY HOUSEHOLD SIZE

<u>Persons Per Household</u>	<u>Phoenix Retirement Zones</u>		<u>Green Valley</u>	
	<u>Households</u>	<u>Trips/HH</u>	<u>Households</u>	<u>Trips/HH</u>
1	17	2.35	128	7.88
2	50	4.70	517	7.64
3	1	2.00	21	8.29
All Households	68	4.08	666	7.69

survey found less than a 10 percent difference in trip rate by household size, while the Phoenix survey found more than a 100 percent difference.

It is clear from this comparison that the results of the trip generation rate found in Green Valley is considerably different than that found by the Phoenix survey. However, as stated earlier, the Phoenix survey includes households not within retirement communities, where residents are more active, and is also for a small number of households.

#### **PURPOSE OF TRIPS**

The Green Valley survey found a considerable difference in the proportion of trips made by purpose for those surveyed compared to the purpose split used in the PAGTPD models.

As can be seen in Table 22, the proportion of trips reported made for each purpose in the Phoenix survey of retirees compares very well to those reported in the Green Valley survey. Both surveys found work trips to be close to 5 percent of all trips and home based other trips close to 50 percent of the total. The major difference in the distribution is for non-home based trips, which account for 30 percent of the trips reported in the Green Valley survey and only 17 percent of those reported in the Phoenix survey.

#### **TRIP DISTRIBUTION**

A major finding of the Green Valley survey was that approximately 85 percent of the trips produced by Green Valley households remained within the retirement community. It was not possible to make a similar comparison to the Phoenix survey. Therefore, a comparison of trip lengths was made.

TABLE 22. COMPARISON OF TRIP PURPOSE PHOENIX  
RETIREMENT ZONES AND GREEN VALLEY

<u>Purpose</u>	<u>Phoenix</u>	<u>Green Valley</u>
Home Based Work	5%	4%
Home Based Shop	26%	19%
Home Based Other	51%	47%
Non-Home Based	17%	30%

The length of trips made by residents of an area is dependent on their location within a region and available opportunities near where they live. Therefore, it would not be expected to find the same trip lengths for retirees of two different areas. As shown in Table 23, the trip lengths found for Phoenix retirement zones were longer for work trips and shorter for shop and non-home based trips than those reported in the Green Valley survey. The length of home based other trips was approximately the same for both groups.

A more significant finding is that the Phoenix simulated trip length by purpose was nearly the same as that reported in the Phoenix survey. This shows that just as the PAGTPD regional trip distribution model adequately simulates the destination of Green Valley trips, the MAG trip distribution model simulates the trip length of trips made by Phoenix retirees.

## **CONCLUSION**

The results of the comparison between the findings of the Green Valley survey and data for Phoenix retirees is generally favorable. No conclusive findings can be made regarding the transferability of the Green Valley survey from this analysis. However, the overall indications are that the Green Valley findings are transferrable to other retirement communities.



TABLE 23. COMPARISON OF TRIP LENGTHS BY PURPOSE\*  
 GREEN VALLEY SURVEY (AND) PHOENIX  
 RETIREMENT ZONES

<u>Purpose</u>	<u>Average Trip Length (Minutes)</u>		
	<u>Phoenix Survey</u>	<u>Phoenix Simulation</u>	<u>Green Valley Survey</u>
Home Based Work	20.8	19.2	15.7
Home Based Shop	12.0	10.0	15.7
Home Based Other	14.4	13.9	14.3
Non-Home Based	11.6	10.2	14.0

\*Source of Phoenix data: Letter from Mark Schlappi, Maricoppa Association of Governments, November 18, 1985.

## CHAPTER 6

### SURVEY METHODOLOGY

This chapter presents a summary of how the sample for the Green Valley Travel Diary Survey was selected, how the data was collected and edited, and the statistical reliability of the more important variables. A more detailed description of the methodology is available in the **Task 1 - Data Collection** report dated April 1, 1985.

#### **SAMPLE DESIGN AND SELECTION**

The Green Valley Travel Diary Survey was designed to collect travel characteristics that are representative of retirement communities travel during the winter months when the maximum number of retirees are in residence.

The primary survey instrument consisted of a travel diary to be maintained by household residents for a selected day. For every trip they made that day, they were asked to identify, using a survey instrument similar to that shown in Figure 6, the following information:

- o What time they started the trip;
- o Where they went;
- o Where their destination was located;
- o What time they arrived at their destination
- o What the purpose of the trip was;
- o What type of vehicle was used;
- o Whether they were the driver or passenger; and
- o Who else traveled with them.

The next day, a member of the survey crew contacted the household and transcribed the travel diary information for keying.

#### **DATA COLLECTION**

In order to identify households for survey over 1,100 telephone numbers were selected at random from the February 1985 edition of the Green Valley Community Directory sponsored by the Green Valley Community

Figure 6  
Sample Survey  
Instrument

PERSONAL TRAVEL RECORD FOR \_\_\_\_\_ No. \_\_\_\_\_  
ON \_\_\_\_\_ MARCH \_\_\_\_\_, 1985

o If you did not make any trips by motorized vehicle, check this box  and answer the questions at bottom of page

o Please list your motorized trips in the order that you made them

A	B	C	D	E	F	G	H	I	J
TRIP NO.	I LEFT AT:	TO GO TO:	LOCATED IN:	I GOT THERE AT:	PURPOSE I WENT TO THIS PLACE WAS FOR:	VEHICLE I TRAVELLED IN WAS:	I TRAVELLED THERE AS:	HOUSEHOLD MEMBERS WHO TRAVELLED WITH ME WERE:	NUMBER OF NON-HOUSEHOLD MEMBERS WITH ME WERE:
TRIP 1	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 2	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 3	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 4	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 5	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 6	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 7	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 8	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 9	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		
TRIP 10	am : _____ pm		Green Valley <input type="checkbox"/> Tucson <input type="checkbox"/> Other _____ <input type="checkbox"/> <small>Specify _____</small>	am : _____ or pm		Auto <input type="checkbox"/> Van or Truck <input type="checkbox"/> Golf Cart <input type="checkbox"/> Other _____ <input type="checkbox"/>	Driver <input type="checkbox"/> Passenger <input type="checkbox"/>		

If you made more than 10 trips please continue on back of page

I made \_\_\_\_\_ trips to or from my home by walking without using any motorized vehicle

I made \_\_\_\_\_ trips to or from my home by bicycle without using any motorized vehicle

Coordinating Council. An estimated 8,000 listings are included in that directory, therefore, in order to randomly select 1,100 households every seventh listing in the directory was chosen.

The survey was conducted weekdays between March 6 and March 21, 1985 from noon until 8 p.m. and also on Saturday March 16 from 9 a.m. until 5 p.m. The Saturday survey date was necessary in order to collect survey diaries kept by survey respondents for the previous Friday. This provided a representative sample of Friday trip behavior.

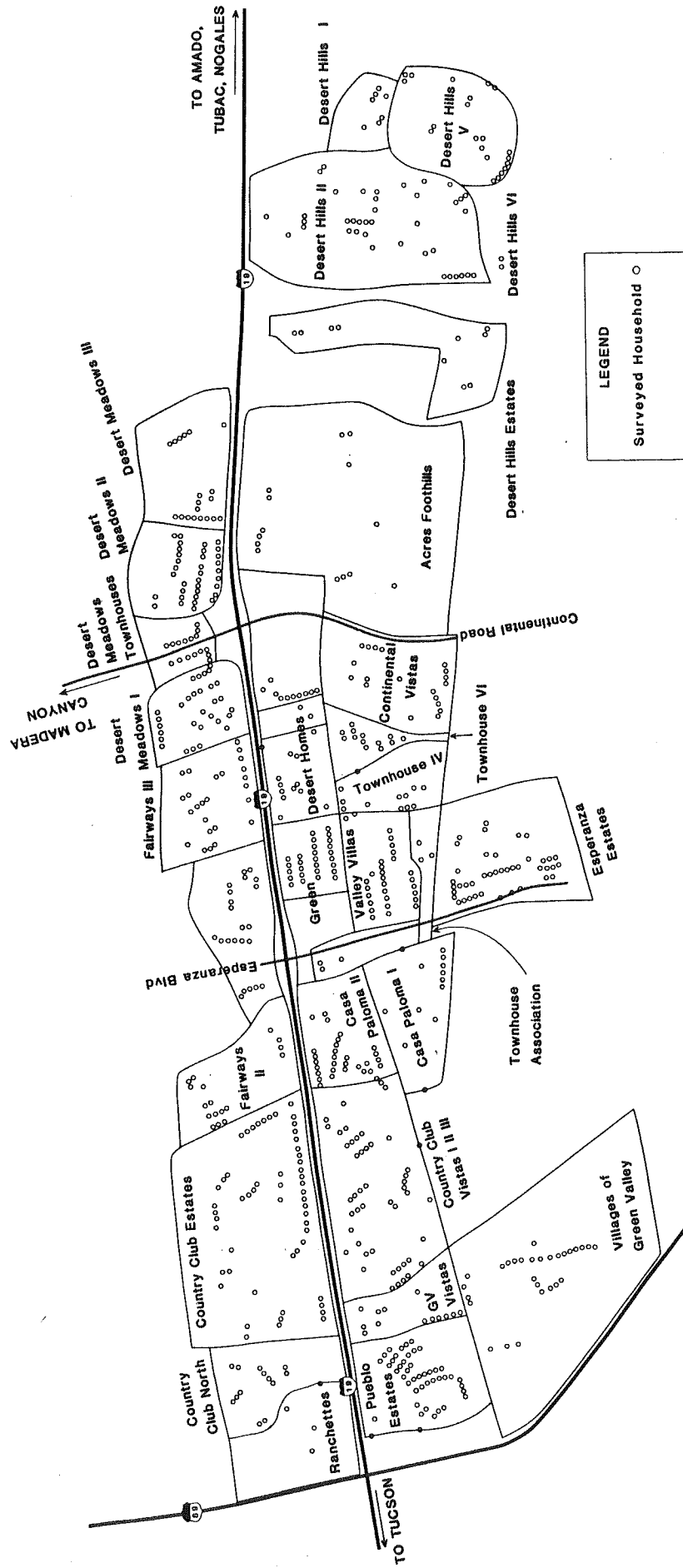
Residents of 676 household or 61 percent of those randomly selected maintained a travel diary. As can be seen in Figure 7, these households were well distributed throughout Green Valley.

#### **SURVEY EDITING**

There were two steps in the editing of the Green Valley Travel Survey data sets. The first was to make corrections to erroneously coded data and the second was to create new variables that could be used to produce useful statistics. The data sets required a great deal of editing to ensure accurate results. A portion of the data had to be edited by hand due to errors in the identification numbers assigned each survey. Due to problems, several household identifiers were assigned twice, resulting in household, person, and trip records from two different households with the same identifier. To solve this problem, it was necessary to refer to the original surveys to determine the correct identifier. These records had to be recoded by hand because there was no pattern to the errors.

Another problem encountered with the data was the coding of the departure and arrival times of trips. In many cases there was no indication of a.m. or p.m. These trip records also had to be recoded manually before converting the times into military time. Once the times were in

Figure 7  
 Green Valley Travel Survey  
 Locations of Households Surveyed



military form, trip durations in minutes were calculated. A number of the trips had durations that were highly infeasible given the reported origins and destinations, and some instances either the departure or arrival time was not reported. In these situations, the duration was coded as unknown.

Many variables had missing values or values that were out of an acceptable range. In many instances, the original survey forms were referenced to determine the correct values, and those that could not be corrected were coded as unknowns.

The remainder of the edits performed to the data sets consisted of creating new variables from reported information. The new variables were then used in cross tabulations to determine trip rates and other characteristics.

The majority of the new variables that were added to the data sets were added to the household records. These household variables included the number of autos and trucks owned, the number of auto and truck trips taken, the total number of trips taken, the number of bicycle trips taken, the number of walking trips taken, the age of the oldest household member, and the income of the oldest household member. Variables were also created to count the number of vehicle driver trips, vehicle person trips, and golf cart trips per household by trip purpose.

Variables added to the trip records were basically trip purpose and destination indicators. These included the outgoing purpose of the trip, the origin and destination of the trip, and the origin and destination purposes of the trip.

Enclosed as Appendix D is the computer code for SAS programs used to edit the survey file.

## STATISTICAL RELIABILITY

The original survey design anticipated travel diaries would be completed for 500 households and that the average trip generation rate would be 3.83 daily person vehicle trips per household. Due to the high level of cooperation by the community, usable travel diaries were completed by 668 households. Furthermore the average trip generation rate was 7.69 person vehicle trips per household. Therefore, instead of including information for 1,900 weekday person trips, the Green Valley data set includes data for over 5,100 weekday person trips--more than two and a half more than was originally expected.

The statistical reliability of the survey results is dependent on the number of households surveyed, the standard deviation of the trip generation rates and the proportion of households with certain characteristics. All these variables were better for the survey results than were originally anticipated. For example, the C value (or standard deviation divided by the mean) was expected to be 1.0 for the overall trip generation rate; however, the results yielded a C value of 0.72.

As a result of the magnitude of the survey response and the better than estimated statistics, the accuracy of the trip generation rate and other characteristics is better than expected.

For example, the overall trip generation rate was anticipated to be accurate within +7.4 percent at the 90 percent confidence level and +8.8 percent at the 95 percent level. Instead, the overall trip generation rate of 7.69 person trips per household is accurate within .pa +4.6 percent at the 90 percent confidence level and +5.5 percent at the 95 percent confidence level.

Table 24 displays the reliability of the trip generation rates for different household types at the 90 percent confidence level. As can be

TABLE 24. RELIABILITY OF TRIP GENERATION ESTIMATES AT  
90 PERCENT CONFIDENCE LEVEL

<u>Variable</u>	<u>Households Responding</u>	<u>Trip Generation Rate</u>	<u>Standard Deviation</u>	<u>Level of Accuracy</u>
Occupants				
1	128	7.88	5.21	<u>+9.6%</u>
2	517	7.64	5.63	<u>+5.3%</u>
3+	21	8.29	5.53	<u>+2.4%</u>
Number of Vehicles				
1	430	7.89	5.70	<u>+5.7%</u>
2+	176	7.53	5.22	<u>+8.6%</u>
Income				
\$10,000	24	3.90	4.79	<u>+41.3%</u>
\$10,000-\$19,999	86	4.90	7.53	<u>+27.3%</u>
\$20,000-\$29,999	122	7.78	4.93	<u>+9.5%</u>
\$30,000-\$39,999	98	8.15	6.85	<u>+11.6%</u>
¶\$40,000	92	9.12	6.85	<u>+12.9%</u>
Overall	668	7.69	5.53	<u>+4.6%</u>



seen in that table, the level of reliability of the trip generation estimation range from +5.7 percent for households owning one vehicle to +41 percent for households with incomes below \$10,000. In general, the trip generation rates for most household categories are accurate within +15 percent.

The reliability of the estimates for other travel characteristics is better than that experienced for trip generation. For example, the finding that 87 percent of the trips made by Green Valley residents stay within Green Valley is accurate to within +0.4 percent at the 99 percent confidence level, a very high statistical reliability.

Therefore, it can be said that, in general, the survey results are statistically reliable well beyond the level anticipated when the survey was designed.

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