# AN INFERENTIAL DESCRIPTIVE ANALYSIS OF THE DEMOGRAPHIC CHARACTERISTICS OF WASTE GENERATION AND RECYCLING IN AUSTIN, TEXAS

THESIS

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By

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# ACKNOWLEDGEMENTS

This research began as I embarked upon an endeavor to learn more about one of the most disgusting things in the world—garbage. Throughout my studies at Southwest Texas State, I have heard more than once that "there is gold in garbage." That one statement having piqued my curiosity, I decided that I would plunge into the world of landfills. And so, I began to wholeheartedly delve into the field of waste management and recycling. There is one—and only one—person I have to thank for turning me on to garbage, and that would be Dr. Robert Larsen. Were it not for his support, motivation, encouragement, patience, and ideas, this thesis would never have come to fruition. The added support of Dr. Susan Macey, reviewing my Turabian, and reminding me that good writing is "a matter of" covering all of your bases, helped to push this thesis onward. My third committee member, Dr. Fred Shelley, helped me to make it through this thesis "race." I appreciate your willingness to work with me, and feel honored that you did. Thank you all for your time, patience, understanding, and caring. You all are truly the best professors I have had in my college career, and have taught me that I really can accomplish my goals. I owe you all an overwhelming debt of gratitude.

This thesis is dedicated to my parents, Don and Alison; without their support, I never would have approached the idea of graduate school. I could not have made it without you two. Dad, thank you for turning me on to Geography—I will never be the same. Mom, thank you for being my best friend. I love you both more than words can describe.

To Charlie—you have been more supportive than even you realize. You really do have the patience of Job when it comes to dealing with me, and thank you for lifting me up when things weren't the greatest. I love you with all my heart.

Last, but not least, I would like to thank all of my friends for grilling me about when I would finish my thesis, and I would like to thank my co-workers in the pit. Were it not for my fellow pitters, I surely would have lost my sanity by now. Thank you for all of the laughs, margaritas, and good times. I love you all dearly.

The Earth breathes in
The Earth breathes out
so long as there's not
too much litter about

--Gary Boswell

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# CHAPTER I

## INTRODUCTION TO THE STUDY

> According to the U.S. Environmental Protection Agency, because the generation of waste is increasing at the same time as capacity to handle it is decreasing, communities face hard choices when weighing trash management options (Reynolds 1993 1).

Waste generation is a major concern throughout the United States. Households, businesses, industries, and schools will continue to generate waste. However, it is up to the individual to decide how much waste will actually go into the waste stream, and how much waste is reused and recycled.

The problem of waste generation is not new; it can be traced back to the days of nomadic activity. Nomads would reside in an area until it became cluttered with enough trash that they would have to disperse to a cleaner area. Although food may have been a more compelling reason for moving to a different area, the litter would eventually become such a big problem that moving became necessary. Archaeologists have found evidence after digging through layers of trash. The solid waste problem continued throughout history as cities developed and people threw their waste out onto the streets, drawing in vectors and creating unsanitary conditions (Ellis et al. 9).

Urban areas will continue to grow in population, and with that growth comes more waste generation. Instead of migrating to a new area as our ancestors once did, we are now faced with one of the greatest problems in the world—what to do with our waste. In the 1990s, Austin experienced significant growth; in fact, the population increased approximately 46.5 percent from 576,407 people in 1990 to 812,280 people in 2000 (Capital Area Planning Council 2001). The Austin metropolitan area ranked the fifth fastest growing city in the nation over the past ten years (Capital Area Planning Council 2001). These increasing figures mean that Austin will not only generate more waste, but that it will have to plan wisely for landfill space as well.

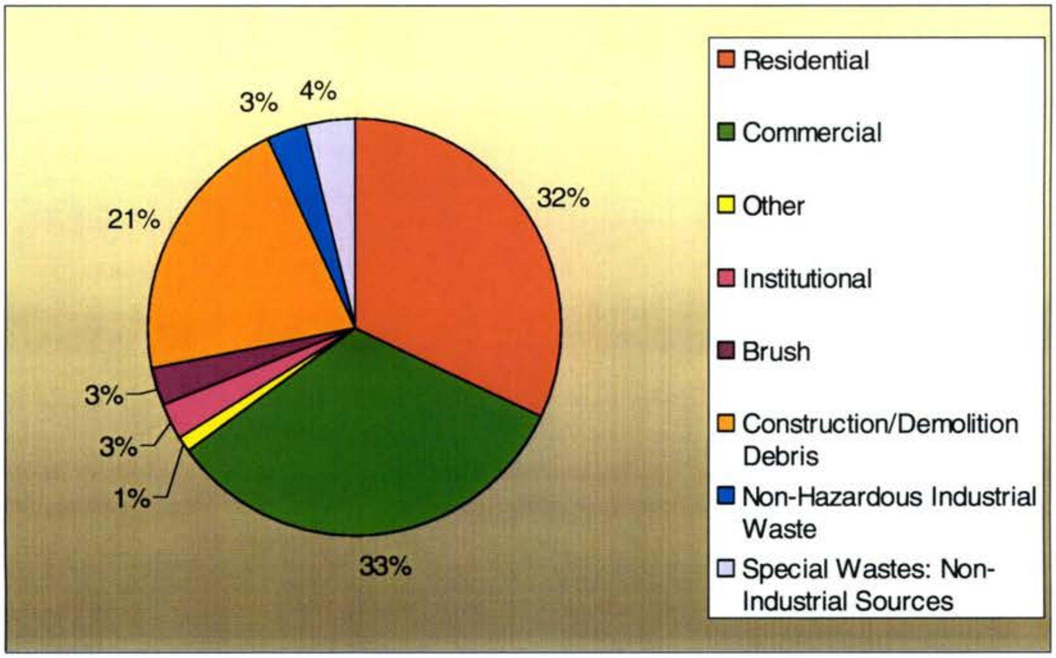
Throughout Texas in 1999, the largest contributor to the municipal solid waste, (MSW), stream was commercial waste at 34.7%, followed by residential waste at 33.2%, and construction and demolition (C&D) waste at 21.6%. In the CAPCO region, which includes 11 different counties in the central Texas area, the largest single contributor to the municipal solid waste stream was residential waste, representing 38.34% in 2000 and 34.87% in 2001 (Capital Area Planning Council 2001). Therefore, it is important for the city of Austin to educate people about the importance of reducing waste and recycling.

Although there are various solutions in the works for the municipal solid waste problem, such as creating new landfills and designating recycling services, many are not without conflict. There are many difficulties involving locations of landfills, funding for educational programs, politics of various solid waste management programs, and legal issues surrounding the management of municipal solid waste.

Texas has one of the highest municipal solid waste generation rates in the United States by definition. According to the Texas Commission on Environmental Quality

(2001), the definition of MSW is found in the Texas Administrative Code (TAC), Title 30, Chapter 330, Subchapter A (General Information). MSW is defined as "solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste" (Texas Commission on Environmental Quality 2002 1). The reason Texas has one of the highest MSW percentages is because Texas is one of the few states that calculates commercial, construction and demolition waste as part of the municipal solid waste stream (Figure 1), whereas other states only include residential and municipal wastes as part of the MSW stream.

**Figure 1: MSW Generation in Texas**



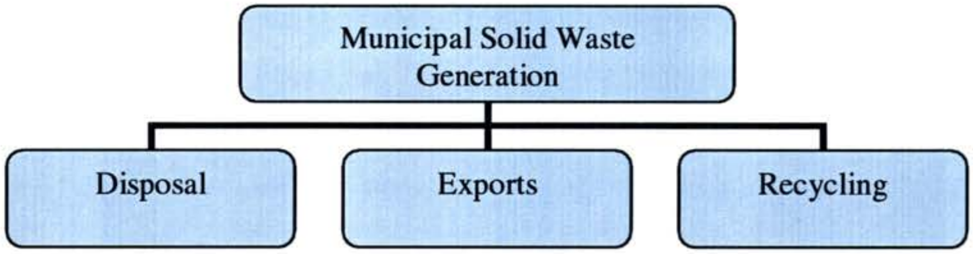

Source: Texas Environmental Profiles 2000

This thesis identifies some of the major issues surrounding waste generation management, and characterizes the types of waste generated in the city of Austin. This research also discusses the areas in Austin that generate the most waste and recycle the least in order to identify where further educational programs and funding should go. Included in this research is a participation study on recycling for the city of Austin (City of Austin 2001). In this research, the participation rates of five neighborhood study areas were discussed. The data obtained on waste generation from the TCEQ, the city of Austin and CAPCO are used to produce an inferential descriptive study of waste characterization and generation for Austin, Texas.

## Objective

There are several objectives in this research, all of which are important parts of a waste management study. The primary objective of this research is to obtain a better understanding of how demographics affect waste generation. A second objective of this research is to identify future areas to place programs for education on waste generation and recycling awareness. A third objective of this research is to characterize types of waste generated and discuss how demographic variables affect waste generation. The final objective of this research is to define the components of the waste generation stream, including recycling, exports, and disposal (Figure 2) in order to better understand which areas of waste generation need to be reduced and managed.

**Figure 2. Hierarchy of MSW Generation**




Source: Texas Commission on Environmental Quality 2002

SPECIFIC OBJECTIVES

1. To discuss five specific neighborhoods of the City of Austin, including their recycling participation rates.
2. To define from these study areas where similar demographic neighborhoods are in Austin
3. To design a profile of what types of people have high recycling participatory rates and high waste generation rates at the residential level

This research was done at the local level because of the environmental awareness throughout Austin, and the willingness to have more education programs for recycling and waste generation. The purpose of this research is to identify what demographic variables most affect recycling participation at the residential level in Austin. Once the recycling rates for the city are identified, waste generation amounts may be better predicted for different areas of the Austin. Through a demographic analysis, areas that are expected to have higher amounts of waste generation can be targeted for educational programs. This thesis includes a discussion of waste characterization, which analyzes the types of municipal solid waste in the national waste stream. The waste characterization study is included because the waste at the local level mirrors that at the national level. This thesis also defines which types of households generate the most waste, and discusses the variables that contribute to waste generation. A demographic analysis for MSW generation is useful in determining which variables contribute most to the waste stream, and helps to pinpoint which households are likely to produce the most waste. The effects of recycling on waste generation are discussed in this thesis. There has been similar research done for the city of Austin. One study has been conducted on social changes, behavior, and solid waste management. A student at the University of Texas compiled a report on the human effects of waste generation and attitudes toward municipal solid waste issues in 1993 (Reynolds 1993).

Background

Throughout the history of solid waste management, there have been hindrances to developing management programs and defining municipal solid waste. These hindrances pose a problem on many levels, including for local, state, and federal governments. One hindrance to designing a strategic management plan is the lack of clear definitions in the field of solid waste management. The EPA is constantly developing clearer definitions and solid waste management strategies at the federal level in order to better assist state and local governments with their management plans. The TCEQ will usually adopt strategies and definitions developed by the EPA; however, there is no clear communication on whether local governments should develop their own definitions and solid waste management strategies, or use the ones provided by the state. Furthermore, larger cities create working plans of their own that better suit their size and may be different from those designed at the state and federal levels. These discrepancies can often lead to confusion and miscommunication among planners. To develop a working plan that management teams can understand, decision makers at the state level should decide on concise definitions and management strategies before a plan is executed.

Another major impediment in developing a good solid waste management plan is a lack of quality data. Over the years, data collected in the field have been obtained from different companies, programs, and people. This causes not only communication problems, but also incomplete, incorrect, and lost information. Due to the fact that there are so many problems with data collection, it is hard for any company or manager to design research projects with concise data (Krieth and Tchobanogolous 2002). The TCEQ, the city of Austin, and CAPCO have been diligently working to update their databases so that the information stored there will be current and accurate.

The problem with developing a reliable waste management program on a local level is that well-structured roles and leadership in federal and state government are also necessary. Waste management is traditionally considered a program that should operate on a local level. Local level governments are more aware of what is going on in their communities, and more responsive to citizens' opinions; because of this, it is easier to manage waste at the local level. However, more state and regional leadership and communication would help the local decision-making process by making sure that local area solid waste managers are in compliance with state policy. This leadership might also help to guide local program designers into more uniform enforcement of government regulations and standards (Krieth and Tchobanogolous 2002).

Exports of MSW from Texas also need to be more clearly defined. It is important to have accurate figures on the annual amounts of waste generated in order to produce a more meaningful generation analysis. Another reason to make sure that these exportation amounts are clearly defined is that exports to Mexico have no clear regulations. The La Paz Agreement between Mexico and the United States allows for the shipment of waste into the U.S. as long as the shippers comply with U.S. regulations (Texas Commission on Environmental Quality 2001). Decision makers need to design a clear route of transportation for all MSW transports, imports, and exports (Krieth and Tchobanogolous 2002). The above problems in current waste generation management present many concerns in designing research on waste generation on state and local levels.

State and local level waste management programs are often modeled on federal management programs. The United States Environmental Protection Agency is a forerunner in defining waste management and municipal solid waste programs. In 1989, the United States Environmental Protection Agency designed a proposed solution to the ongoing waste problem. The solution involved relieving pressure on landfill use through three different means, the last option being to landfill:

1) Source reduction—less waste is created in the first place
2) Recycling and Composting—as much waste as possible is reused for other purposes
3) Combustion of Waste—any waste unable to be recycled is burned in order to be used as a fuel source
4) Landfill—any waste that cannot be handled by the previous means

(Chertow 1989)

This background included state and federal solutions and definitions to a growing problem. To come to a more rapid solution, though, the problem must be addressed at the local level. Waste that is generated must be characterized in order to achieve a better idea of what cities are up against.

# CHAPTER II

## LITERATURE REVIEW

To characterize the generation of waste based on different variables, an understanding of the types of waste entering the waste stream must be achieved. To plan for the future of waste generation, current trends in waste generation first have to be observed and studied. At the municipal end, several different types of waste are added to the waste stream in large quantities on a daily basis (Franklin 2002). Tables one and two display the types of waste that represent the waste stream at the national level, which is similar to the waste generated in the city of Austin.

**Table 1. Types of MSW in the waste stream**

| | |
|---|---|
| Paper and Paperboard | Historically, paper items have been the largest element of the MSW stream, typically more than one-third of waste generation nationally. Paper products can be found in various items, including containers, packaging, office papers, junk mailings, newspapers, and other commercial printings, known as nondurable goods. Containers include corrugated cardboard boxes, and paper bags and sacks. |
| Glass | Glass, including glass containers, makes up approximately six percent of the national municipal waste stream, and is typically considered to be a durable item. Glass containers encompass beer bottles, soda bottles, wine and liquor and food products. |
| Ferrous Materials | This group of materials includes more durable goods. Household appliances, furniture, tires, and steel cans are included in this category. Although these are items are typically disposed of less often than the items in other groups, they still make up 5.6 percent of the waste stream. |
| Aluminum | Aluminum makes up approximately 1.4 percent of the waste stream. Most aluminum is found in packaging, including beverage cans. |
| Plastics | Plastics make up about 10 percent of the entire waste stream. No single type of plastic accounts for the majority of this percentage; however, plastics in durable goods, including appliances and carpet, made up for 3 percent in 1998. Other plastics in nondurable goods include soda bottles, plates and cups, food containers and wrappings. |
| Food Wastes | Food waste also makes up for about 10 percent of the waste stream. Included in this category are spoiled household food wastes, preparation waste from fast food places and restaurants, and food wastes from institutional areas including school lunchrooms, and prison cafeterias. |
| Yard Trimmings | Yard wastes have declined over the last decade to be only 12.6 percent of the waste stream. Yard trimmings include lawn clippings, tree and shrub trimmings, and gardening clippings. As homeowners have become more conscious of yard wastes, they have come up with different methods of management and disposal. |

Source Franklin 2002

**Table 2. Types of MSW in the Waste Stream**

| Type of Waste | Percentage in Waste Stream |
|---|---|
| Paper and Paperboard | 33% |
| Glass | 6% |
| Ferrous Materials | 5.6% |
| Aluminum | 1.4% |
| Plastics | 10% |
| Food Wastes | 10% |
| Yard Trimmings | 12.6% |
| Other | 22% |

Source Franklin 2002

## Waste Generation

Waste generation is characterized based on several different variables. Variables such as recycling percentages, income, ethnicity, age, household size, and owner occupancy rates can affect the amounts and types of materials being thrown into the waste stream (Murphy and Rathje 1992). Some of these variables affecting waste generation go hand in hand, that is, education affects whether or not a person recycles (Reynolds 1993).

According to the literature, the most influential variables affecting waste generation are recycling (composting included) and income, followed by average household size, ethnicity, education and age (Murphy and Rathje 1992). Recycling and composting are important to include in waste characterization studies because they both affect how much waste enters into the waste stream. Composting includes wet household waste (garbage), and green wastes. Green wastes include leaves, grass clippings, prunings, and other natural organic matter discarded from yards and gardens. In neighborhoods, the amount of green wastes generated is more closely correlated with other variables, such as income, ethnicity, home ownership, age, and education. This means that households with a higher annual income may generate more yard waste because they can afford not only to buy a home, but also can afford larger lots and may be able to afford lawn care services. Residents of lower income may rent homes and may not generate as much yard waste. Murphy and Rathje (1992) mention other household factors that add to waste generation, including number and type of pets and number of children under the age of four.

Recycling

> We have only scratched the surface of recycling's potential in the United States. Every day another city achieves cost effective diversion rates well above the national average and new recycling markets, program and processing strategies demonstrate success (Edwards in Grass Roots Recycling Network 2000).

Recycling can have an exponential effect on lessening the amounts of municipal waste that is landfilled. The EPA's definition of municipal solid waste generation is the sum of disposal, recycling, and the net of exports. Exports include the amount of waste transferred out of state (Texas Commission on Environmental Quality 2002).

The EPA calculated that the recycling rate for the United States in 2000 was approximately 30 percent, not including composting (Environmental Protection Agency 2000). More people and states are now participating in local recycling programs than in the past. Recycling is an important element of waste disposal because it can affect how much waste is actually introduced into the waste stream.

Reynolds (1993) reported on behavior and solid waste management in Austin. This research developed characteristics of people who recycle as opposed to those who do not. Through a survey, Reynolds found that non-recyclers view recycling as a nuisance; however, Reynolds also found that economic incentives and rewards were important reasons for recycling. This research showed no differences between non-recyclers and recyclers in gender, household size, occupation, or educational level. The research did show that recyclers tend to be older than non-recyclers (Reynolds 1993).

The Texas Recycling Rate Project

In Texas, the Texas Recycling Rate Project reports the amount of waste that is recycled (Watts 1998). This project began on Earth Day in 1998 as a voluntary reporting program through representatives of the Recycling Coalition of Texas (RCT), the Texas Natural Resource Conservation Commission, (now the Texas Commission on Environmental Quality, TCEQ), the Texas Association of Regional Councils (TARC), and leaders of the private sector recycling industry in Texas.

The Texas Recycling Rate Project was established to help reduce the amount of MSW that needs to be managed and to help calculate the amount of waste that Texas recycles. It also helps to track statewide recycling efforts and identify opportunities for manufacturers who use recycled products. Over 150 businesses and communities, known as "First Rate Recyclers" participate in the Texas Recycling Rate Program by encouraging the cost-effective use of reusing materials. The Texas Health & Safety Code, Section 361.422 set a goal of 40 percent for the reduction of municipal solid waste disposed of in the state, and according to the Texas Recycler Market News, Texas hit its first official recycling rate of 37% in 1998 (Texas Recycler Market News 1998 1). Table 3, however, displays a rate of 35%, which is more accurate for the City of Austin. The reason Table 3 is being used in this research is because the equation was calculated by the Texas Recycling Rate Project.

**Table 3. Texas Recycling Rate Calculation**

| | |
|---|---|
| Tons (of recyclables) reported | 9,915,296 (85%) |
| Tons (of recyclables) estimated | 1,795,114 (15%) |
| Total tons recycled | 11,710,510 |
| Total tons landfilled | 22,064,521 |

Formula: $\frac{\text{tons recycled}}{\text{tons landfilled + tons recycled}} = \frac{11{,}710{,}510}{33{,}760{,}287}$

Recycling rate = **35%** (34.67%)

Source Texas Commission on Environmental Quality 2002

The difference between reduction, reuse, and recycling must be clarified to better understand the goals of the Texas Recycling Rate Project. The primary goal of most recycling programs is the reduction of waste at the source, that is, at the residential level. This begins with the option to reuse certain materials instead of throwing them away. For example, a used plastic soda bottle can be kept, cleaned, and refilled with water. Reusing such items instead of throwing them away is a good way to reduce waste at its source. If such items are not reused, then recycling becomes an option. The City of Austin offers a "pay-as-you-throw" curbside pickup service for many recyclable items. The Texas Recycling Rate Project tracks various items that are recycled (Table 4).

**Table 4. Materials tracked by the Texas Recycling Rate Project**

| | |
|---|---|
| **Paper** | **Plastic** |
| Old newspaper | Plastic bottles |
| Old corrugated cartons | Other plastic |
| Office and high-grade paper | |
| Mixed and other paper | **Compostables** |
| **Glass** | |
| Container glass | Yard trimmings, brush, trees, and |
| Other glass | Other clean wood |
| **Metal** | Food materials |
| Steel cans | Biosolids |
| Other ferrous metal | |
| Aluminum cans | **Construction & Demolition Materials** |
| Other non-ferrous metal | Other Materials |

Note A list of the 17 types of materials that the Texas Recycling Rate Project tracks, based on the constituent fraction of the MSW stream, inclusion in municipal and commercial recycling programs, standard recycling market classifications, and ease of reporting (Watts 1998).

The reduction of municipal waste generation starts at the residential level. Composting is an easy and economical means of reducing the amounts of waste introduced into the stream (Lund 2002). Backyard composting, as it is often called, can be done with little or no cost, it can be kept in a small area, and the end product is beneficial to almost any type of soil (Lund 2002). Composting yard wastes alone can help reduce the volume of the waste stream (Table 5). Large scale composting may be practiced at landfills. The most common material composted at landfills is yard waste because it encompasses approximately 18% of the national residential waste stream (Lund 2001). Waste generation could possibly be reduced greatly if more homeowners were to begin composting in their own backyards.

**Table 5. Density of Yard Waste**

| Material | Condition | Typical Density, $lb/yd^3$ |
|---|---|---|
| Leaves | Loose and dry | 100-260 |
| Leaves | Shredded and dry | 250-350 |
| Leaves | Compacted and moist | 400-500 |
| Green grass | Loose | 300-400 |
| Green grass | Compacted | 500-800 |
| Yard waste | As collected | 350-930 |
| Yard waste | Shredded | 450-600 |
| Brush and dry leaves | Loose and dry | 100-300 |
| Compost | Finished, screened | 700-1200 |

Source: Lund 2002

Income

Income is also a leading factor in the amount of MSW that is generated. It is a surprise how affluence affects the generation of waste. Groups with low-income tend to generate more waste than do their high-income counterparts (Murphy and Rathje 1992). Low-income households will dine out more often at places such as McDonald's where the food packaging is disposable. High-income households tend to dine out in restaurants where there is no food packaging, and items such as cutlery are not disposable. Low-income households tend to buy less expensive appliances, and such items typically have a shorter lifespan than the same appliances that are high-end. This usually leads to a high disposal rate of such household items, whereas in high-income residences, people tend to purchase more expensive items with longer lifespans (Alexander, 1993).

There are a couple of exceptions to the amount of waste generated by both these groups. High-income groups dispose of reading material in much greater quantities than those in low-income groups. The total of magazines, newspapers, and catalogues disposed of on a daily basis in high-income groups adds up to one pound daily. High-income people discard more yard wastes than do their low-income counterparts. Typically, those in high-income neighborhoods tend to take more care of their yards and landscape. High-income people can also afford larger lots and lawn care services, which may lead to higher amounts of yard waste generated than those in low-income areas. (Alexander 1993).

Based on the literature review, income affects the types of waste that are generated, but it does not necessarily affect the amounts of waste that are generated. Both high and low-income groups generate similar amounts of waste.

Household Size

Inherent within this particular variable is family size, which will also be included as a part of this study. Household size includes the number of residents listed as living in the dwelling by the United States Census Bureau. Residents can include family members, whether immediate or not, roommates, and other renters. The literature review or waste generation implied that household size is an important variable because the more people in a residence, the more waste is generated (Murphy and Rathje 1992). Also, it may be harder to control the separation of recyclables in larger households, especially in those that have residents of different educational backgrounds (Reynolds 1993).

## Ethnicity

Ethnicity is an important variable to research when compiling a waste characterization study because it affects the types and amounts of waste that are generated per household (Murphy and Rathje 1992). In The Milwaukee Garbage Project, Murphy and Rathje, studied various patterns of waste discarded in neighborhoods of different ethnicity and income. They discovered that households that are low-income, small family and African American throw away 37 percent more waste than middle-income, small-family Polish neighborhoods (Murphy and Rathje 1992).

The Garbage Project also revealed that ethnicity affects the types of wastes thrown away. Hispanic families tend to eat more candy than do those other ethnicities; they also throw away very little garbage, or wet waste (Murphy and Rathje 1992).

## Education and Age

Education affects waste generation slightly differently than the other variables. The amount of education affects how people dispose of wastes and whether or not they participate in recycling and composting. Those with high levels of education tend to get information from the newspaper whereas people with lower levels of education tend to get their information from the television (Reynolds 1993). Now, people are also getting information from the Internet, which means that in the future newspaper and magazine use may drop. People with higher levels of education (some college or more) are typically more environmentally aware and are more knowledgeable of local recycling programs. People who are more conscious about their local environment tend to take up such practices as composting and recycling (Reynolds 1993). Reynolds (1993), however, concluded that people ages 50-65 were more educated and thus more likely to be environmentally aware. Older age groups that were educated also recycled more than those of other younger groups.

Home Ownership

Whether or not a person, or family, owns or rents their place of residence will make a difference in how much waste is generated. Ownership will also affect recycling participation rates. There is usually much pride in home ownership. Homeowners are usually more concerned with lawn care, thus producing more yard wastes. Homeowners are typically more involved in their cities and communities as well, leading to higher participation rates in recycling. According to the Manitowoc Herald Times Reporter (2003) "Homeowners are more likely to vote, participate in local volunteer organizations, and are generally more aware of what's going on in their community" (2003, 1).

# CHAPTER III

# METHODS

The main focus area for this research is the city of Austin in Travis County (Figure 3). This area is a good locale for this research because citizens of Austin tend to be more environmentally aware, and because Austin is one of the fastest growing areas in the United States, increasing almost 46.5 percent from 1990 to 2001 (Capital Area Planning Council 2001). The city of Austin is the only city in Travis County that provides a curbside recycling program.

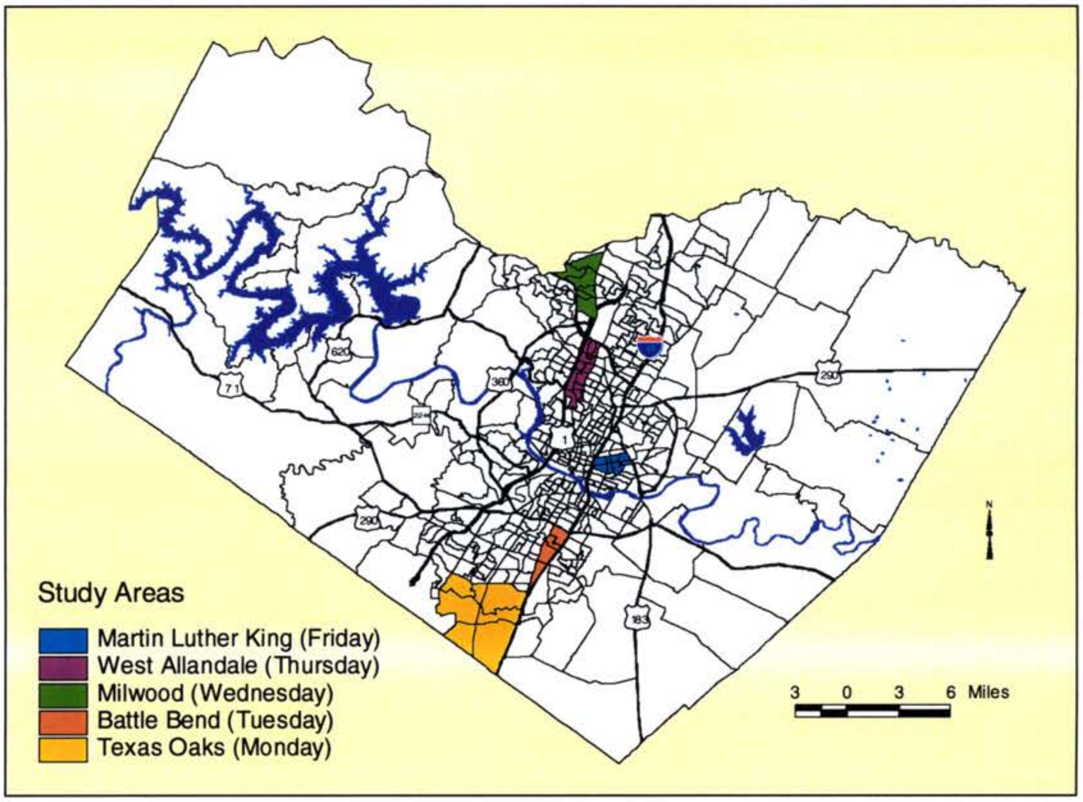



**Figure 3. City of Austin Participation Study Areas (City of Austin 2001)**

Definitions

The definition of disposal is the total of all MSW that is left after exports and recycled products are eliminated from the waste stream (Texas Commission on Environmental Quality 2002). Waste exports include wastes exported to other states; however, there are currently no requirements to track MSW exports from Texas. The TCEQ has adopted a waste generation equation (Table 6) from the Environmental Protection Agency, (EPA) which will assist in developing a better description of the waste generated in the city of Austin.

**Table 6. Calculation of MSW Generation in Texas, 2001**

| Disposal | | Net Exports | | Recycling | | Generation |
|---|---|---|---|---|---|---|
| 27,938,751 tons | + | 452,530 tons | + | 15,287,613 tons | = | 43,678,894 tons |
| (64%) | | (1%) | | (35%) | | (100%) |

Source Texas Commission on Environmental Quality 2002

Table 6 displays different numbers than Table 3. The reason for the difference is the Texas Recycling Rate Project was completed in 1998, which is where the figures in Table 3 originate. The EPA designed the equation in Table 6 in 2001, thus providing updated calculations on waste generation and recycling. TCEQ's current recycling and solid waste figures are based on Table 6; therefore, it is being used in this research. Exports are not included Table 3 because it is displaying the equation based on the EPA's definition of MSW. Based on the literature review, Table 6 is a better fit for the city of Austin because it includes not only disposal and recycling, but also net exports.

Table 7 depicted below displays the types of waste included in the MSW stream that come from different sources. It is included in this thesis to provide a background of where MSW is generated. Table 1 displayed a characterization of wastes from all of the sources identified in Table 7.

**Table 7. Examples of types of MSW that come from different sources**

| Sources and Examples | Example Products |
|---|---|
| Residential (single- and multi-family homes) | Newspapers, clothing, disposable tableware, food packaging, cans and bottles, food scraps, yard trimmings |
| Commercial (office buildings, retail and wholesale establishments, restaurants) | Corrugated boxes, food wastes, office papers, disposable tableware, paper napkins, yard trimmings |
| Institutional (schools, libraries, hospitals, prisons | Cafeteria and restroom trash can wastes, office papers, disposable tableware, paper napkins, yard trimmings |
| Industrial (packaging and administrative; *not* process wastes) | Corrugated boxes, plastic film, wood pallets, lunchroom wastes, office papers |

Source US Environmental Protection Agency 2000

## Data Collection

The solid waste and recycling data for this research were obtained from the City of Austin. The recycling participation study (City of Austin 2001) was obtained from the City of Austin. This research used secondary data from the city which was updated in 2001. Variables from this source include recycling participation rate percentages and extra waste generation percentages. The demographic data for this research were obtained from the U.S. Census Bureau, taken in 2000 (US Census Bureau 2000). The data compiled from the U.S. Census Bureau for this research were measured at the block group level. The demographic variables that are examined include education, age, income, household size, ethnicity, and whether or not the residence is owned.

## Variables

Recycling is an important part of a waste characterization study. The city of Austin released a five-year participation study for recycling, yard trimmings, and garbage. In the participation study, five different socio-economic areas were selected to represent the total population of the city of Austin (City of Austin 2001). These areas included two neighborhoods in south Austin, Texas Oaks and Battle Bend, Martin Luther King in central Austin, and West Allandale and Milwood in north Austin. Each of these neighborhoods were studied for four years (1998 – 2001) by the city of Austin, and for each of those years recycling participation rates and extra waste generation rates were calculated. Recycling participation included those homes that used the curbside pickup service for their plastics, aluminum, glass, and paper. Extra waste included those homes with extra bags outside of the city provided trash cans, and those bags that caused the trash can lid to open at least 8 inches (City of Austin 2001).

The participation study completed by the City of Austin includes the amounts of recyclables, yard waste, and extra garbage left curbside by the study areas. The demographic variables that are represented by the participation study include ethnicity and household income (from the 1990 census). The preliminary census 2000 data showed that ethnic variables were still representative of Austin's make-up; however, it is uncertain whether income, home ownership, and education are still well represented (City of Austin 2001).

Table 8 depicts the measures of the demographic variables from the U.S. census to be used in the descriptive analysis. The descriptive analysis was used to produce GIS maps for each neighborhood in the City of Austin's participation study.

**Table 8. Variables used in the Descriptive Analysis**

| Variable | Unit of Measure |
|---|---|
| Income | Per capita annual income |
| Ethnicity | Nominal |
| Education | Modal level of education per block group |
| Age | Mean years |
| Household Size | Mean household size of residents |
| Owner Occupancy | Percentages |

The demographic variables collected from the U.S. Census Bureau included age, income, ethnicity, education, household size and owner occupancy. The waste generation and recycling data from the city of Austin's participation survey are used to create an inferential descriptive study of waste characterization in Austin. The five survey areas for the city of Austin were analyzed by overlaying maps of each demographic variable in the study using Geographic Information Systems (GIS). The city of Austin was then overlaid with maps depicting the characteristics of each demographic variable. A descriptive analysis of the data for each site was completed using Microsoft Excel. For each of the five areas, the exploratory variables of ethnicity, mode of education, percent home-owner occupancy, mean household size, per capita annual income, and mean age were analyzed by using the literature review of the demographic characteristics that most effect waste generation and recycling.

In each of the study sites, the percentage of people who were White, African-American, and Hispanic were determined. For each ethnic group, the percentage was determined by adding the total number of persons belonging to that ethnic group and dividing that number by the total population of the study site. For example, the total number of Hispanics were added up for each tract in the Battle Bend and then divided by the total population for the neighborhood, providing the equation below:

$$\frac{\text{Hispanics: } 614 + 312 + 1226 + 513}{\text{Population: } 1374 + 495 + 2122 + 1148} \times 100 = 51.85\%$$

This equation produced a percentage of 51.85 for the total number of Hispanics in the Battle Bend group. This was done for each ethnicity in each study group. It was important to note that the U.S. Census Bureau counts Hispanics not as a racial category, but a cultural background. The ethnicity of Hispanic is not a mutually exclusive category; therefore, the percentages of ethnicities in each study area add up to more than one hundred percent. For the analysis in chapter four, two pie charts for each area were designed; one depicts the total ethnicities, and one depicting the percent of Hispanic.

The census data for education were originally grouped by sex, and organized by levels of education received for those over the age of 25. Education data were derived using the total number of men and women from each block group to have received some grade school (no diploma), high school (or GED equivalent), some college (no diploma), bachelors, masters and doctorate degrees. To come to these categories, the education level mode had to be defined from each block group (based on the amount of people per level of education), and then a label was given to each group with the mode of education received. For example, if more men and women in group 1702 had bachelor's degrees than any other categories, that tract was given the label "bachelors". Once all of the labels were applied, the block groups were grouped into neighborhoods. Each neighborhood was then given the identification "high, medium, or low level" education status, solely for the purposes of comparison and contrast. A "high level" education rating for a neighborhood means that each block group has a mode of bachelor's degree or higher. A "medium level" rating for a neighborhood means that the block groups are divided between college degrees and high school degrees, and a "low level" education rating means that the neighborhood has a mode of high school degrees or lower in every block group.

The percentage of home-owner occupancy was acquired for each neighborhood by adding up the total number of residences for each group whether vacant, owned, or rented and dividing the total number owned residences for each group by that number.

Once the percent of owner occupancy for each block group was obtained, the percentages were added up and divided by the total number of groups to produce a total owner occupancy mean for each neighborhood. The equations for this are depicted below using Milwood as an example:

$$\frac{\text{Total Owned in Milwood:}}{\text{Total Vacant, Owned, Rented:}} \quad 100 \times \frac{121}{58 + 121 + 1420} = 7.5\% \text{ Owner Occupancy in Milwood}$$

The average household size was equated through the owner occupancy equation. The total population for each neighborhood was divided by the total number of residences, whether rented, or owned.

Income was one of the most difficult calculations. Mean income, rather than median income, was selected to be used for accuracy purposes. In order to obtain a mean income for each neighborhood, the average household income for each block group had to be multiplied by the population for each block group. Then, the sum of the totals for each group was divided by the total population for the neighborhood. This equation produced a mean income for the neighborhood.

Mean age for each neighborhood was calculated similarly to income. Age was calculated by multiplying the mean age for each group by the population for each group. The sum of the ages was then divided by the total population for the neighborhood, producing a mean age.

The data described above were mapped out for the city of Austin using the software package Geographic Information Systems. Each of the above six variables was mapped and then queries were created based on the literature review's demographic characteristics. Reynolds (1993) stated that age, income, and education may affect whether or not one will participate in recycling. Murphy and Rathje (1992) discussed the fact that people of different ethnicities and incomes will generate different types and amounts of waste. The city of Austin (2001) noted that in their participation study, those neighborhoods that were heavily Hispanic and African American had low participation rates until 2001, when they were notified of the curbside recycling program; however, these neighborhoods still retained the lowest participation rates in the study.

The neighborhoods discussed in this research were originally used in the city of Austin's participation study. The five neighborhoods were chosen to be demographically representative of the city of Austin for 2000. The study areas represent a pick up route by waste services, one for each day of the week, so that waste can be more easily tracked. Monday's route is Texas Oaks, Tuesday's route is Battle Bend, Wednesday's route is Milwood, Thursday's route is West Allandale, and Friday's route is Martin Luther King.

Once the variables were analyzed for each neighborhood, GIS maps were then designed depicting the six variables for each of the five study areas. A GIS analysis of the city of Austin was then designed to represent neighborhoods that have characteristics of recyclers and also to distinguish which neighborhoods are probable high waste generators. These analyses were overlaid with the five study areas, which were shown previously in Figure 3, to determine if there were any matches on demographic characteristics, which will be discussed in chapter four. Using the demographic information in the literature review, a GIS query was built to determine those areas of potential high recycling participation rates and high waste generation rates. The descriptive variables used in the query of recycling rates include age, income, household size and education. The variables used in the query of waste generation rates include age, income, household size, and education.

# CHAPTER IV

# RESULTS AND ANALYSIS

A summary of the demographic characteristics can be seen in Tables 9 and 10. The city of Austin's participation study involved collecting information from each of the five study areas in order to develop a participation and weekly set-out rate for each area. The data from this research are depicted in Table 11. To better understand Table 11, its variables must first be clearly defined. The set-out rate means the number of customers setting out recycling or other types of waste on any given week (City of Austin 2001). The participation rate is the number of households that set out on one or more weeks during a four-week monitoring period (City of Austin 2001). The city also monitored those homes setting out extra garbage, which declined after an excess garbage fee was implemented early in 2001 (City of Austin 2001). The data from the participation study are compared to the demographic analysis to produce areas of expected waste generation and areas of higher recycling participation rates.

**Table 9. A Summary of the Ethnicities in the Participation Study Areas**

| Participation Area | Percent White | Percent African American | Percent Hispanic | TOTAL POP. |
|---|---|---|---|---|
| Texas Oaks (Monday) | 78.7% | 3.7% | 24.0% | **11998** |
| Battle Bend (Tuesday) | 55.1% | 7.0% | 51.8% | **5139** |
| Milwood (Wednesday) | 82.6% | 4.5% | 13.1% | **12742** |
| West Allandale (Thursday) | 88.0% | 2.0% | 11.0% | **11122** |
| Martin Luther King (Friday) | 18.0% | 50.0% | 42.5% | **8137** |
| **TOTAL** | **64.5%** | **13.4%** | **28.5%** | **49138** |

Source: U.S. Census Bureau 2000

**Table 10. A Summary of Demographic Characteristics in the Participation Study Areas**

| Participation Area | Average Household Size | Owner Occupancy Rate | Income | Mode of Education | Median Age |
|---|---|---|---|---|---|
| Texas Oaks (Monday) | 2.68 | 77% | $67,894 | High School Graduate | 34.1 |
| Battle Bend (Tuesday) | 2.28 | 35% | $36,873 | High School Graduate | 29.3 |
| Milwood (Wednesday) | 2.00 | 45% | $56,197 | Bachelors | 32.2 |
| West Allandale (Thursday) | 1.93 | 57% | $54,808 | Bachelors | 39.9 |
| Martin Luther King (Friday) | 2.69 | 37% | $19,004 | High School Graduate | 28.0 |
| AVERAGE | **2.32** | **50%** | **$46,955** | **High School** | **32.7** |

Source: U.S. Census Bureau 2000

**Table 11. Participation and Weekly Set-Out Rates for the Five Neighborhoods**

| | Participation Rate Comparison | | | | Weekly Set-Out Rate | | | |
|---|---|---|---|---|---|---|---|---|
| **Routes** | **2001** | **2000** | **1999** | **1998** | **2001** | **2000** | **1999** | **1998** |
| Texas Oaks | 73.0% | 70.0% | 75% | 79% | 48.6% | 47.1% | 53% | 49% |
| Battle Bend | 75.6% | 66.1% | 71% | 71% | 48.5% | 46.4% | 47% | 47% |
| Milwood | 70.2% | 67.2% | 94% | 77% | 47.1% | 48.7% | 58% | 55% |
| West Allandale | 89.3% | 87.7% | 74% | 80% | 69.7% | 65.4% | 47% | 43% |
| Martin Luther King | 60.0% | 44.1% | 44% | 48% | 25.1% | 24.6% | 26% | 26% |
| **AVERAGE** | **73.6%** | **67.0%** | **72%** | **71%** | **47.7%** | **46.5%** | **46%** | **44%** |

Source: City of Austin 2001

The data compiled from the U.S. Census bureau were quite useful in designing a demographic profile of each neighborhood in the city of Austin's participation study. The descriptive data analysis helped to gain a better understanding of the neighborhood's recycling participation percentages and extra waste generation percentages. A summary of each neighborhood was produced, as were maps representing each of the demographic layers including population, mean age, annual income, average household size, owner occupancy, and education.

Texas Oaks

Texas Oaks is a part of the Monday route, located in southwest Austin. It is West of Interstate 35, and rests just above the Travis County line. This neighborhood has a total population of 11,998, and is primarily white. The ethnicity charts for this area are depicted in Figures 4 and 5. The average household size in Texas Oaks is 2.68, which is the second highest average out of the five participation areas. Surprisingly, Texas Oaks had a relatively low average level of education, with only two groups having a mode of "bachelors" degree. The mean age in this neighborhood was 34.1, with an average income of $67,894, which was the highest average income of any of the study areas. The owner occupancy rate for Texas Oaks is 77%, again, the highest rate of all of the study areas (Table 10). The GIS maps of the demographic variables for this neighborhood are shown in Figures 6 through 11. There are many internal variations in each neighborhood which is why the demographic maps of each study area are included in this research. The recycling participation rates and weekly set-out rates for the Texas Oaks area have been near the average of the five study sites for the last four years. They have been neither high nor low, but they have been relatively consistent (Table 11). The education level in Texas Oaks may be the only variable that is keeping the rates lower than might be expected, because the income, age, and owner occupancy rates for this neighborhood are all relatively high. Texas Oaks is different from the other study areas in that it has the largest home lots, from one to five acres in size. Therefore, this area may produce more yard waste than the other areas.

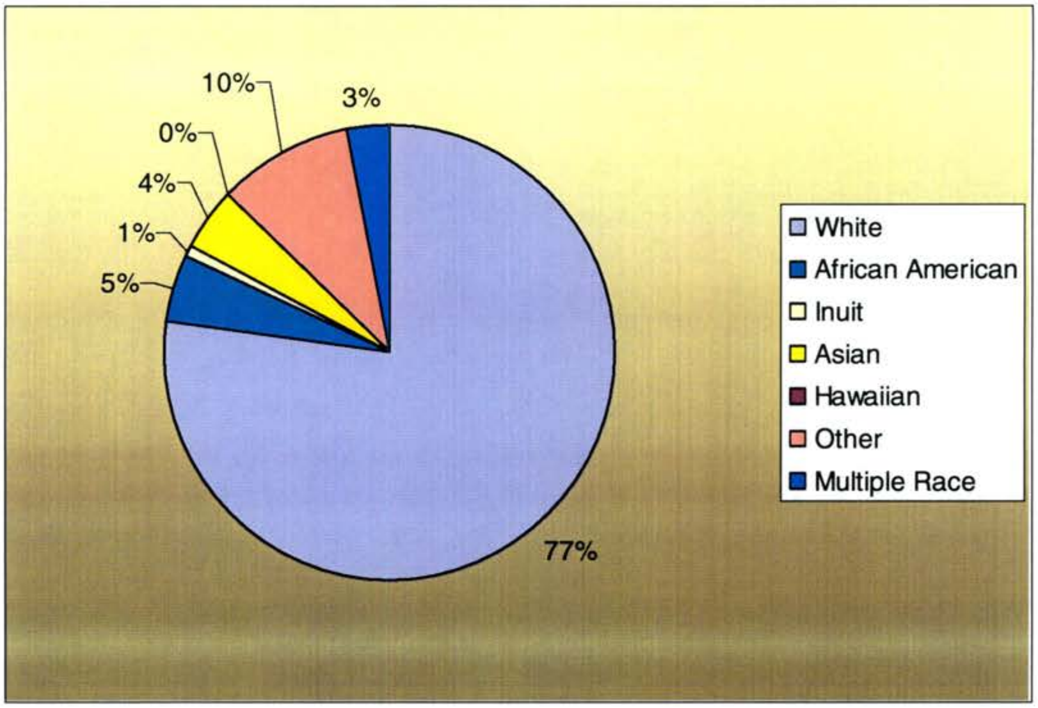



**Figure 4. Ethnicity of Texas Oaks (U.S. Census Bureau 2000)**

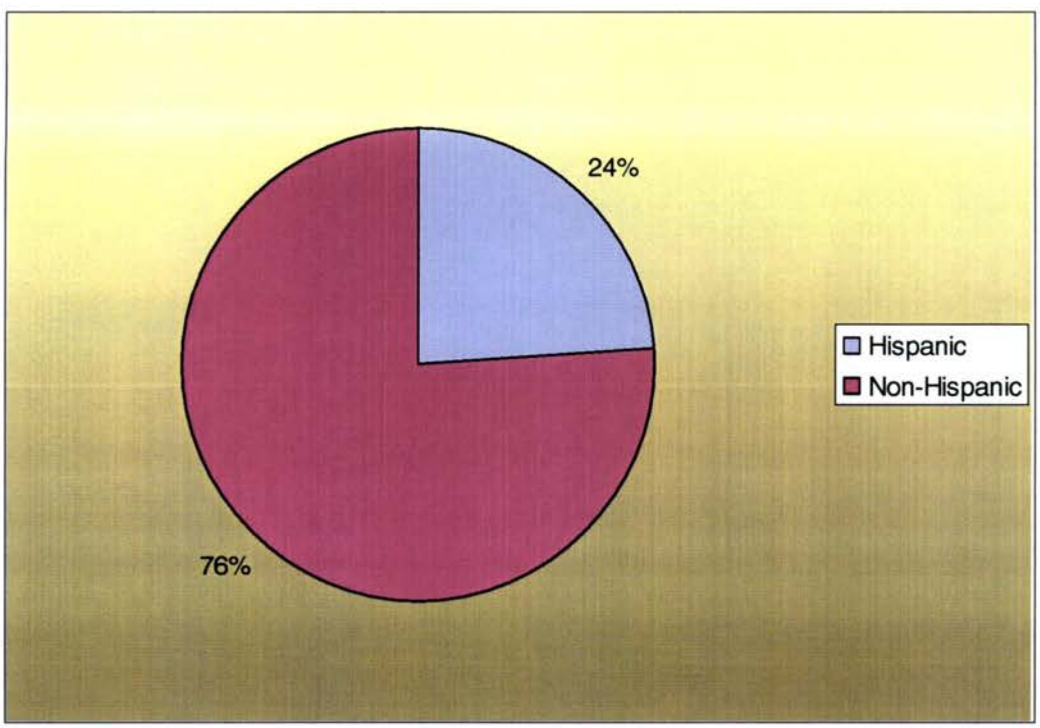



**Figure 5. Percent Hispanic in Texas Oaks (U.S. Census Bureau 2000)**

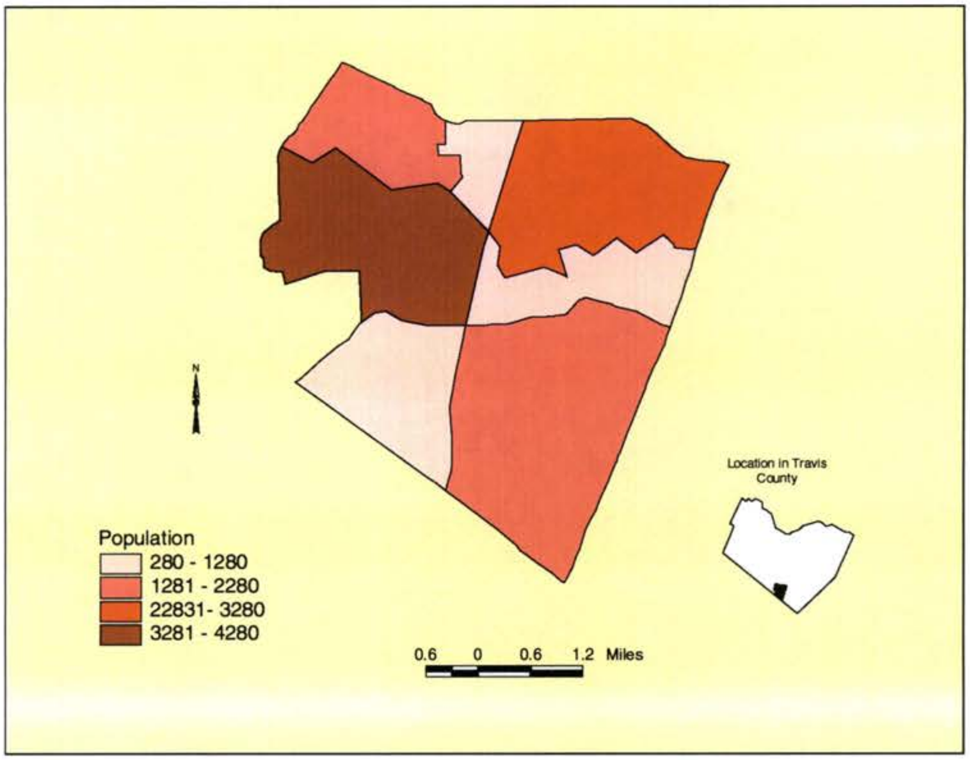



**Figure 6. Population of Texas Oaks (U.S. Census Bureau 2000)**

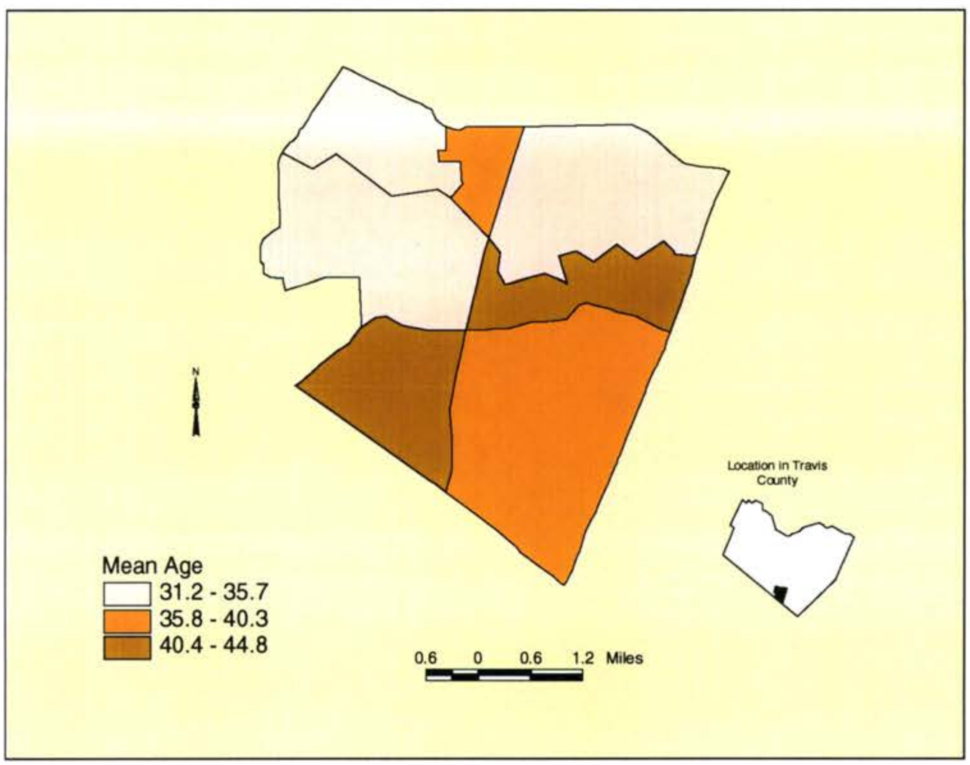



**Figure 7. Mean Age of Texas Oaks (U.S. Census Bureau 2000)**

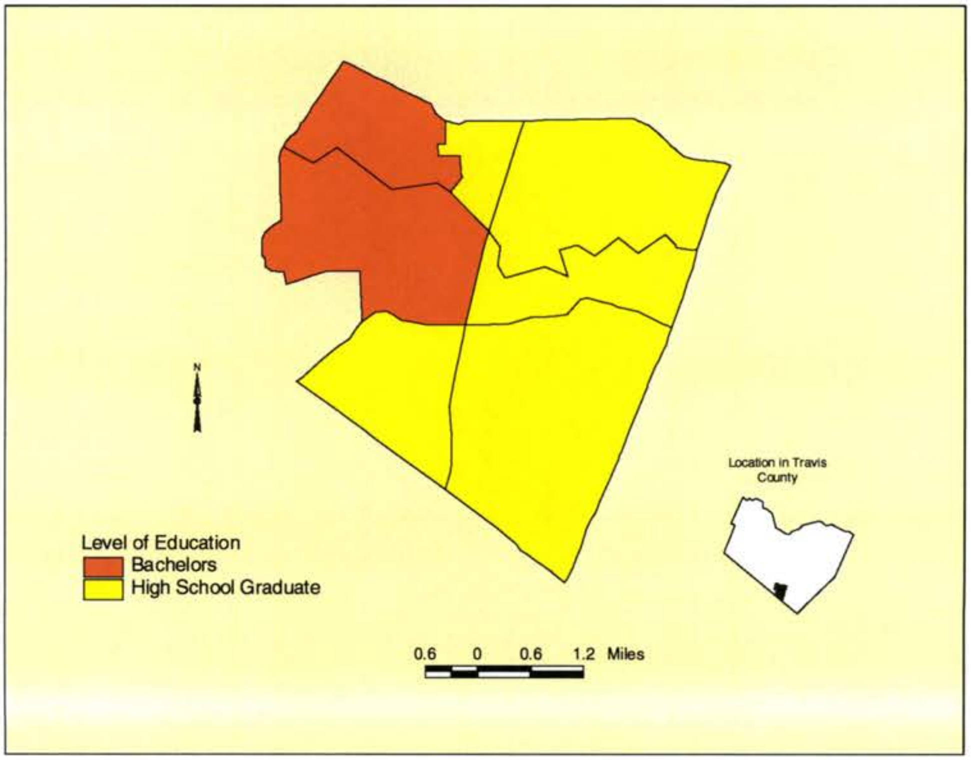



**Figure 8. Education Levels of Texas Oaks (U.S. Census Bureau 2000)**

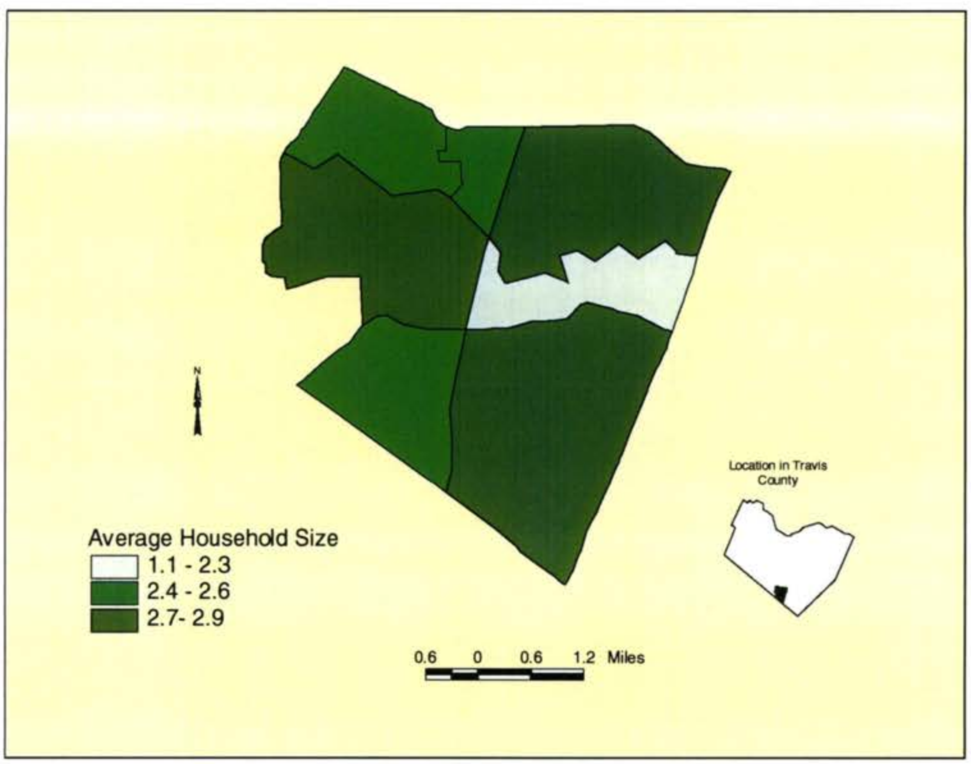



**Figure 9. Average Household Size of Texas Oaks (U.S. Census Bureau 2000)**

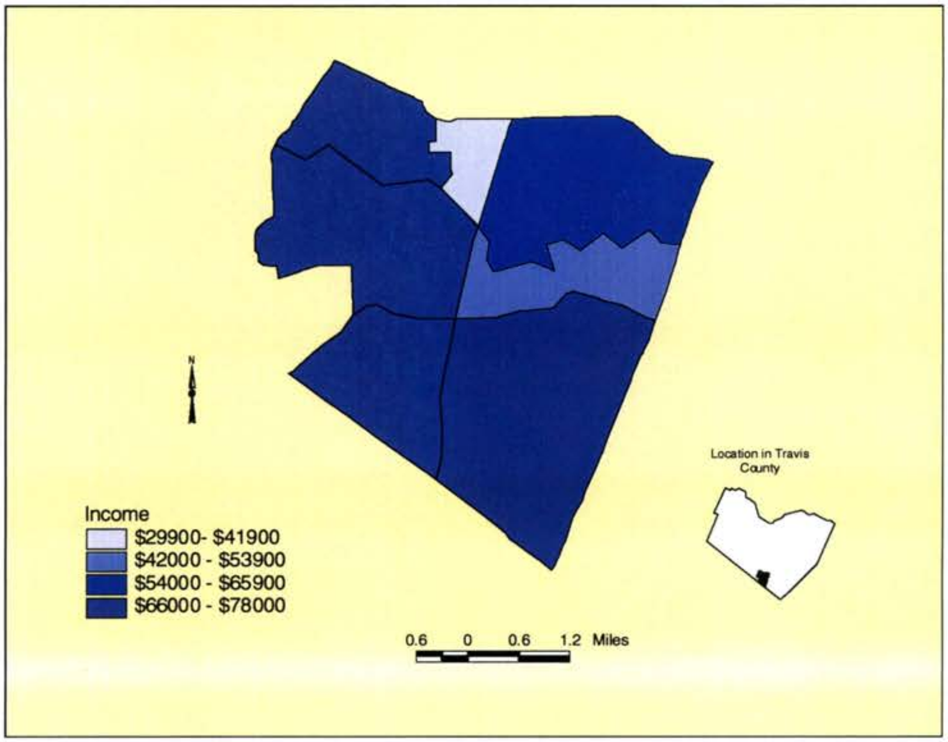



**Figure 10. Annual Income of Texas Oaks (U.S. Census Bureau 2000)**

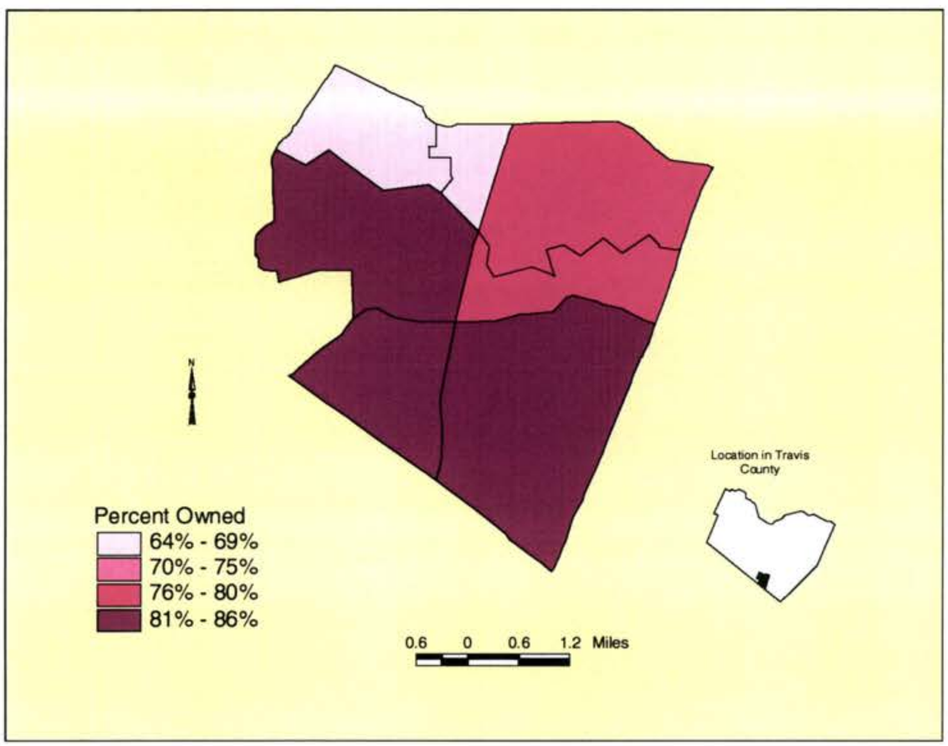



**Figure 11. Owner Occupancy of Texas Oaks (U.S. Census Bureau 2000)**

Battle Bend

Battle Bend is located in east central Austin, and is part of the Tuesday route. It was the smallest group (in size) with only four tracts. The total population for the area is 5,139 and is approximately half white and one third Hispanic (Table 9). The average household size for Battle Bend is 2.28, which is also the median for all five neighborhoods. This study area has a mid-level education rating, divided evenly between college and high school educations. The total owner occupancy mean for the area is 35 percent, ranging from only 8 percent to 64 percent. The mean age for Battle Bend is only 29.3 (Figure 15), while the mean income is $36,873 (Figure 18), approximately half that of Texas Oaks. The maps for Battle Bend can be seen in Figures 14 through 19. In the year 2001, Battle Bend had the second highest recycling participation rate; however, it had been the second lowest for the three years previous. This area also had consecutively low percentages in weekly set-out rates (Table 11). The reasons behind these low weekly set-out rates may be because of low annual household income and a young mean age. Set-out rates may also be lower because the owner occupancy rate is only 35% for this area. Yet another reason set-out rates may be lower is because there is only one small neighborhood in the central part of this area, meaning there may not be as many homes to measure recycling participation rates as in the other study areas.

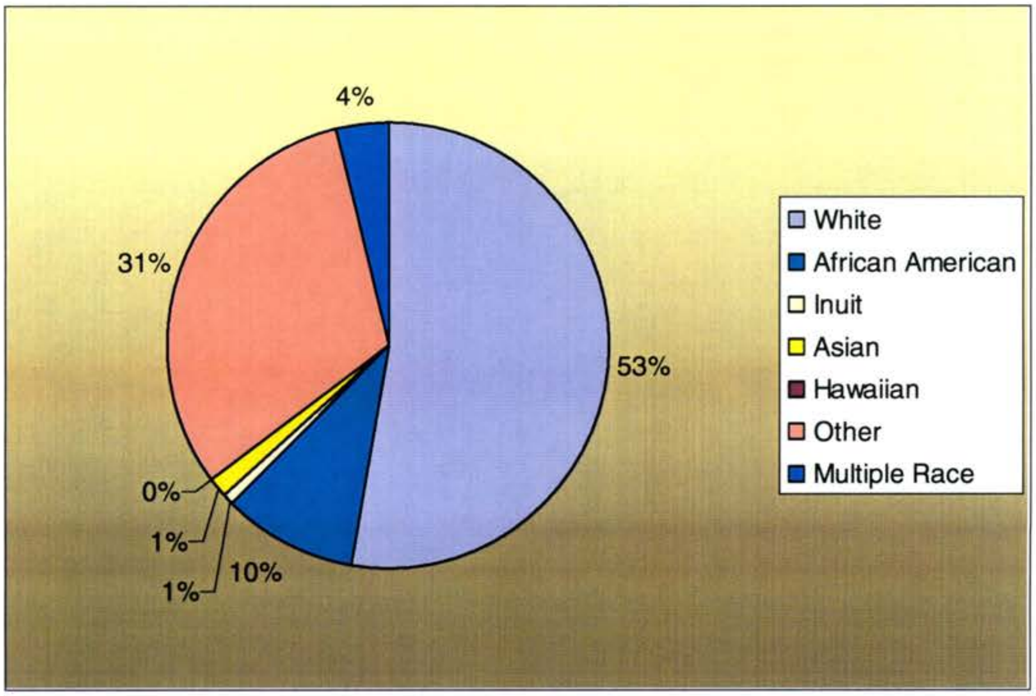



**Figure 12. Ethnicity of Battle Bend (U.S. Census Bureau 2000)**

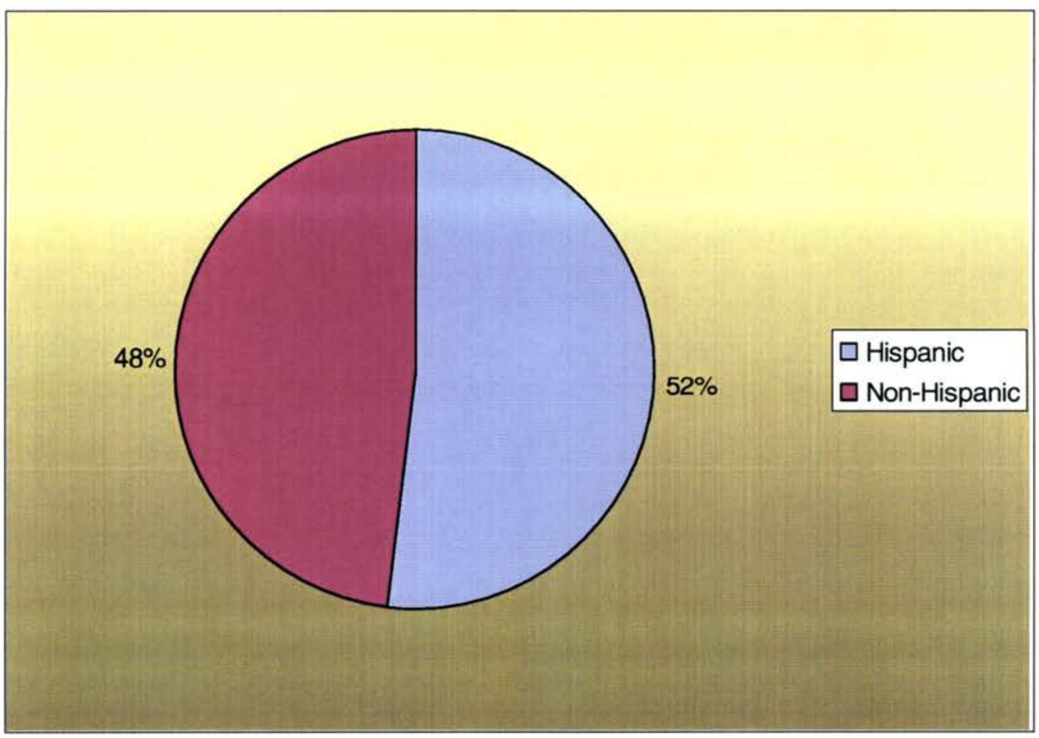



**Figure 13. Percent Hispanic in Battle Bend (U.S. Census Bureau 2000)**

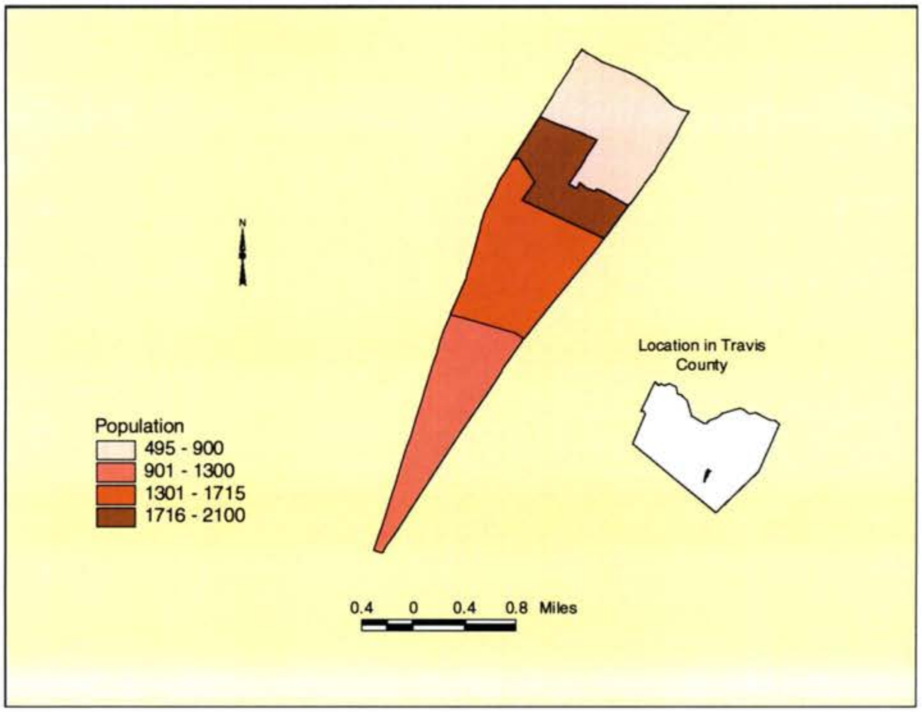



**Figure 14. Population of Battle Bend (U.S. Census Bureau 2000)**

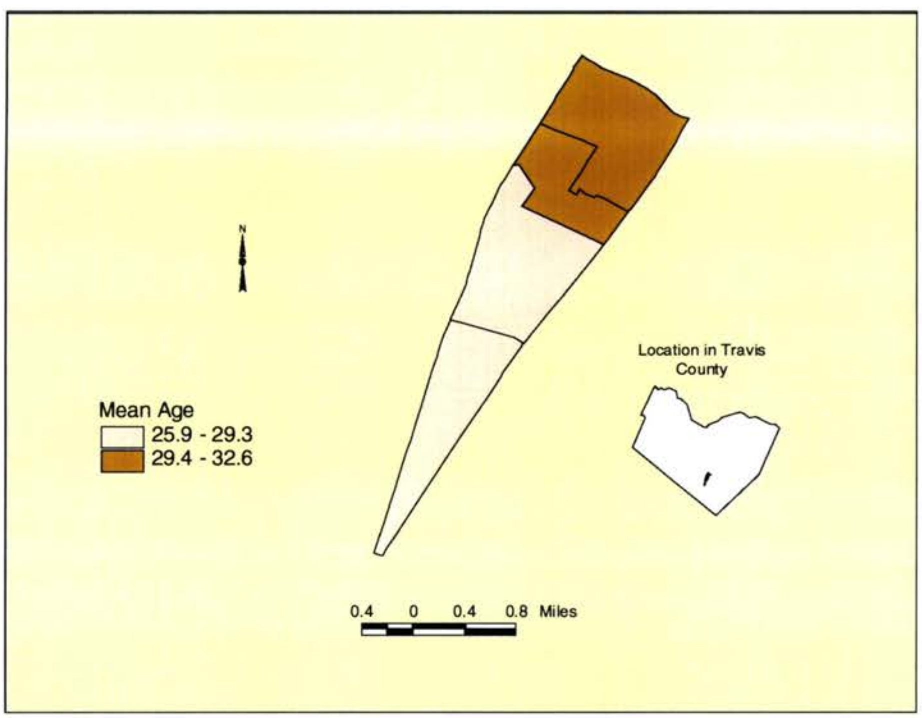



**Figure 15. Mean Age of Battle Bend (U.S. Census Bureau 2000)**

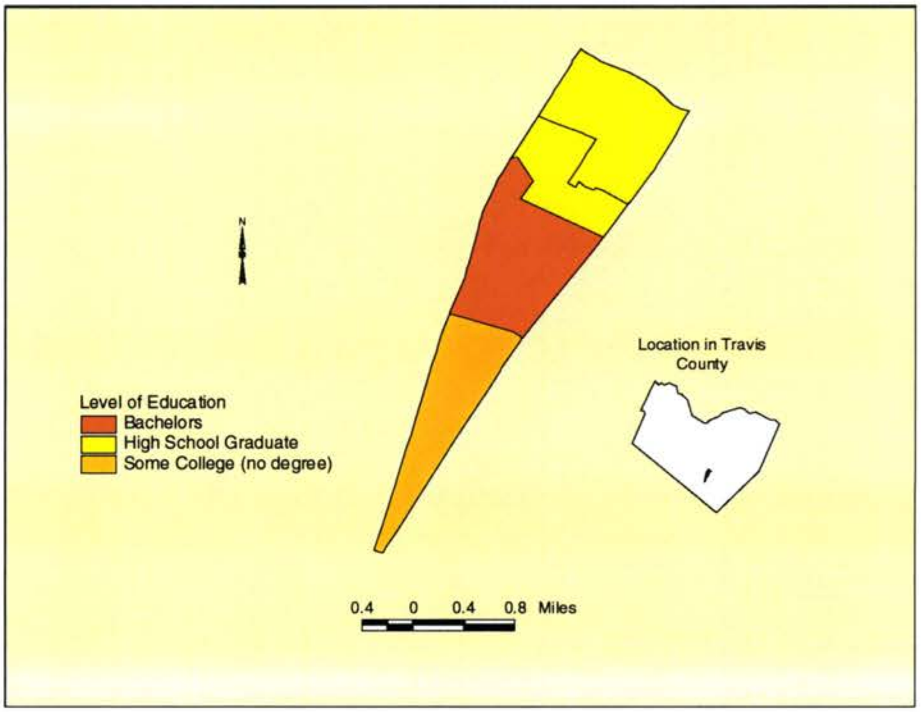



**Figure 16. Education Level of Battle Bend (U.S. Census Bureau 2000)**

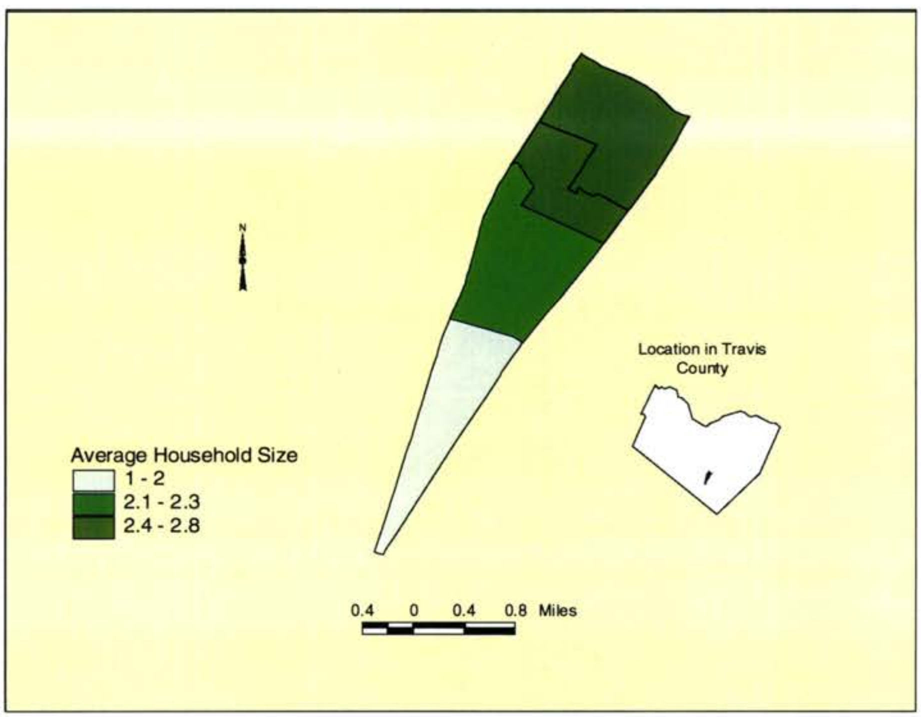



**Figure 17. Average Household Size of Battle Bend (U.S. Census Bureau 2000)**

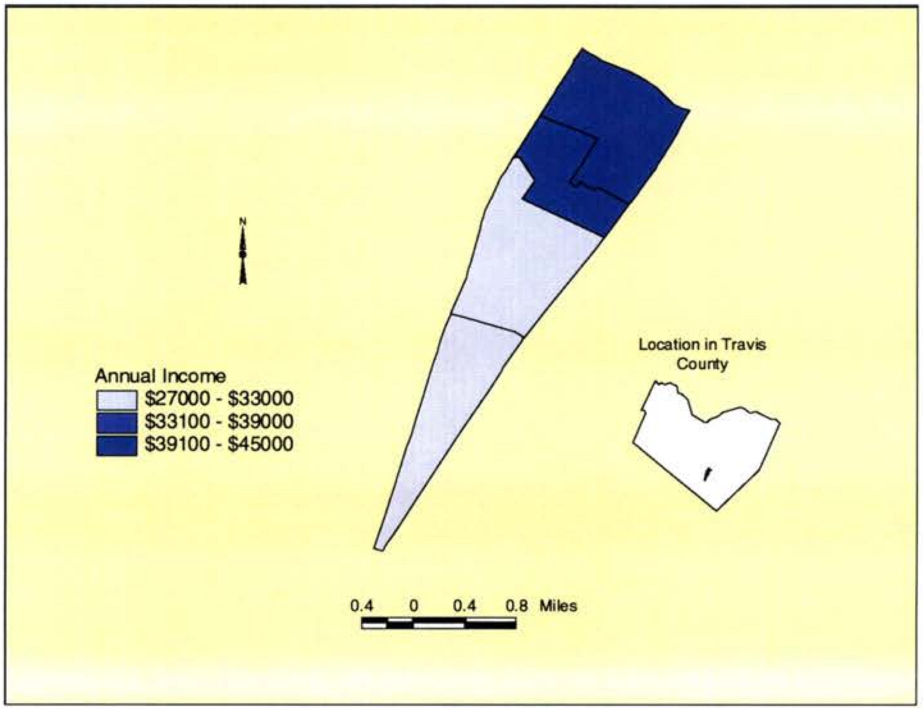



**Figure 18. Annual Income of Battle Bend (U.S. Census Bureau 2000)**

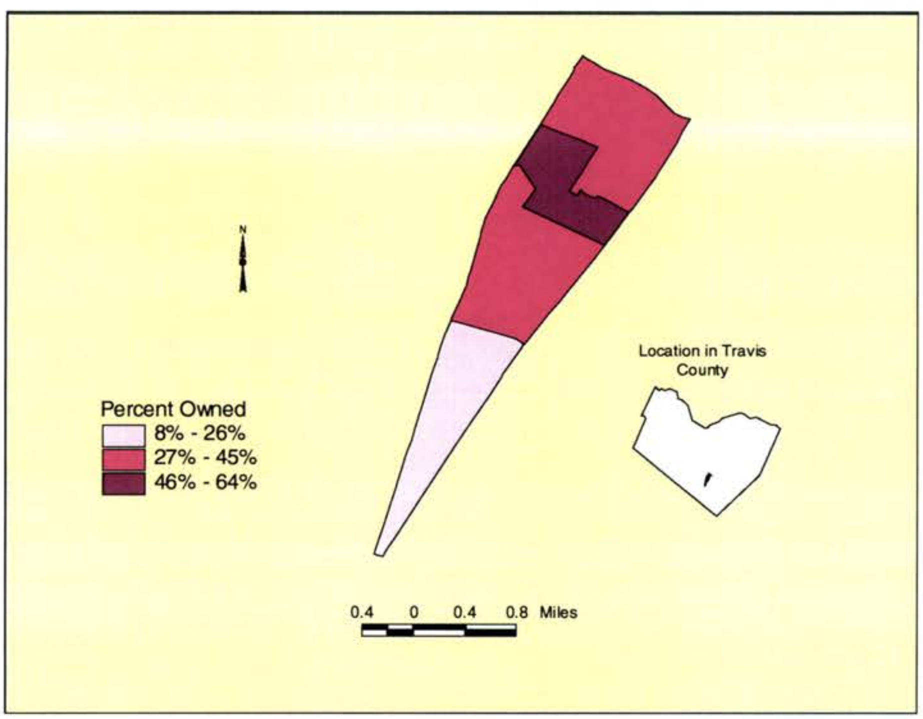



**Figure 19. Owner Occupancy of Battle Bend (U.S. Census Bureau 2000)**

Milwood

Milwood is part of the Wednesday route and is located in north Austin on the Travis County border between Highway 183 and Loop 1. It has a total population of 12,742, and is 83% white (Figure 20). The average household size in Milwood is 2, and the education level is high, with all six tracts having a mode of bachelor's degrees. The total owner occupancy mean is lower than expected, at only 45%. One reason the owner occupancy rate is lower may be because there are many specialty communities in this area, including new apartment complexes. The income in Milwood is the second highest of all the study areas, $56,197. The median age in this study area is 32.2. The maps depicting this information are shown in Figures 22 through 27. In the city of Austin's participation study, Milwood has been neither the lowest nor highest for 2000 and 2001. 1999, Milwood also had the highest weekly set-out rates (Table 11). In 2000 and 2001, Milwood's participation rates were neither high nor low. The education level and mean annual income for this area is high, which does not draw a parallel with its median participation rates. An explanation for the participation rate may be the fact that most of the homes in this study area are rented rather than owned. Another explanation may yet be that the mean age is low as well.

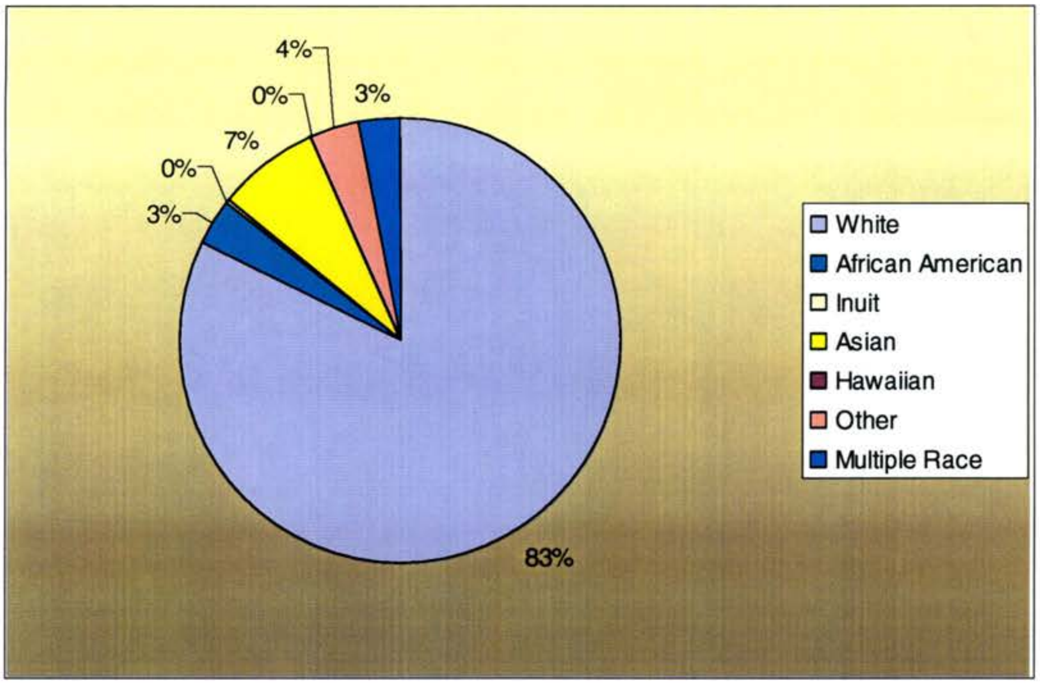



**Figure 20. Ethnicity of Milwood (U.S. Census Bureau 2000)**

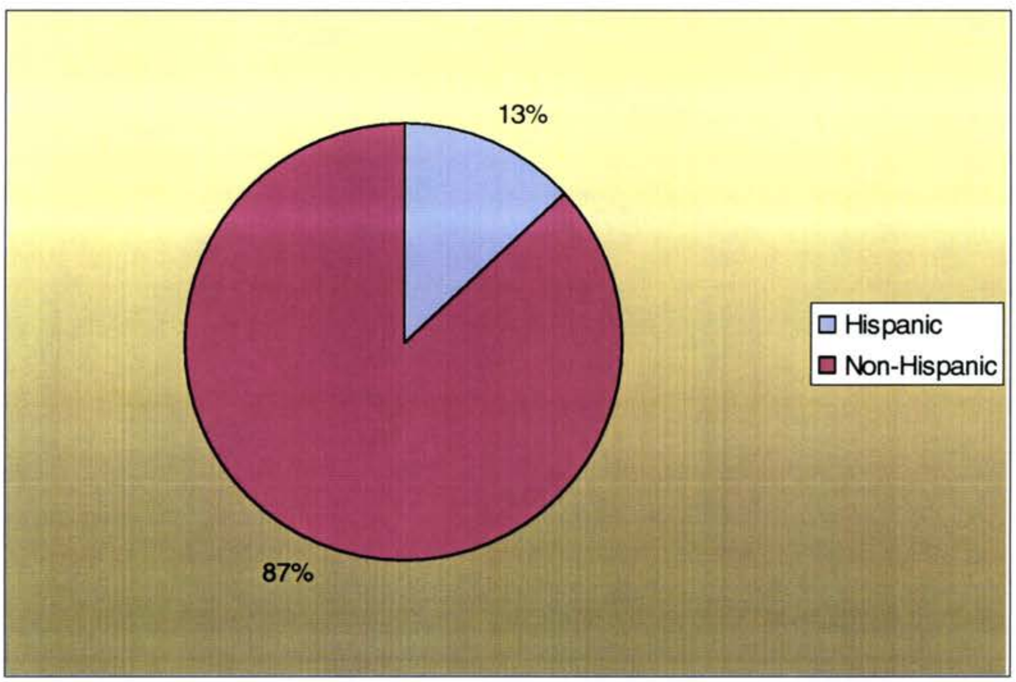



**Figure 21. Percent Hispanic in Milwood (U.S. Census Bureau 2000)**

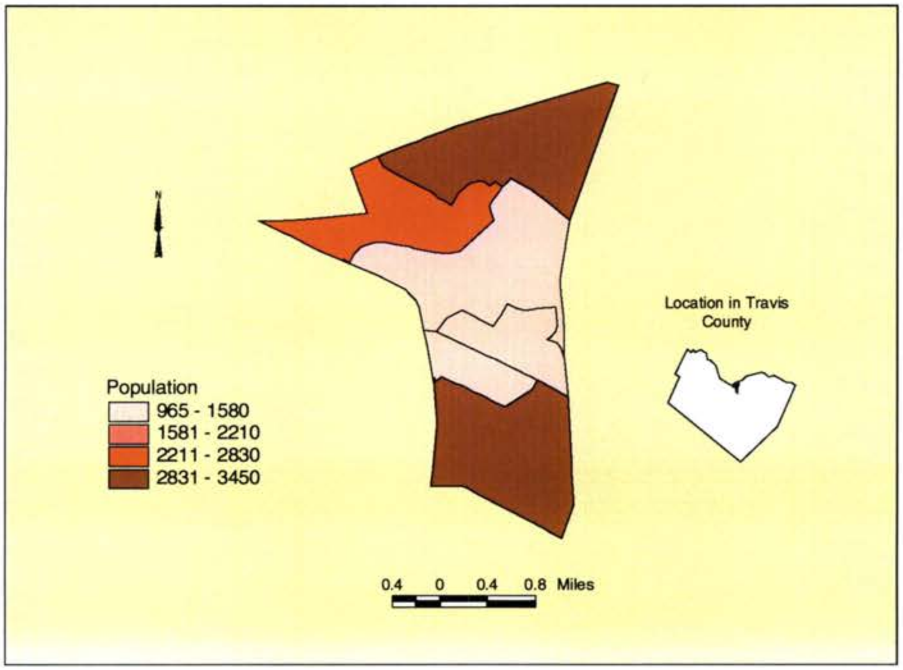



**Figure 22. Population of Milwood (U.S. Census Bureau 2000)**

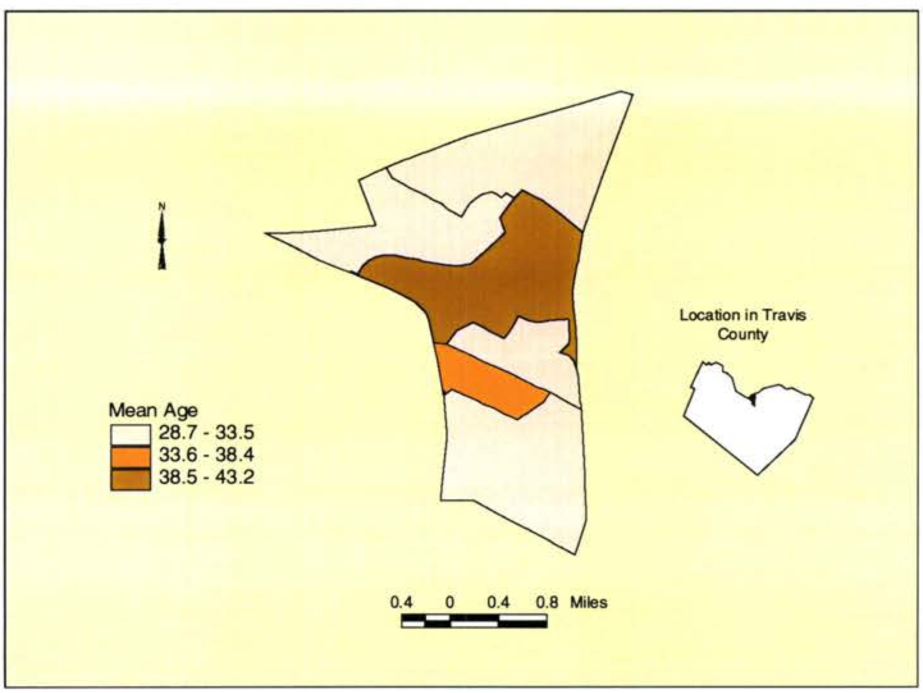



**Figure 23. Mean Age of Milwood (U.S. Census Bureau 2000)**

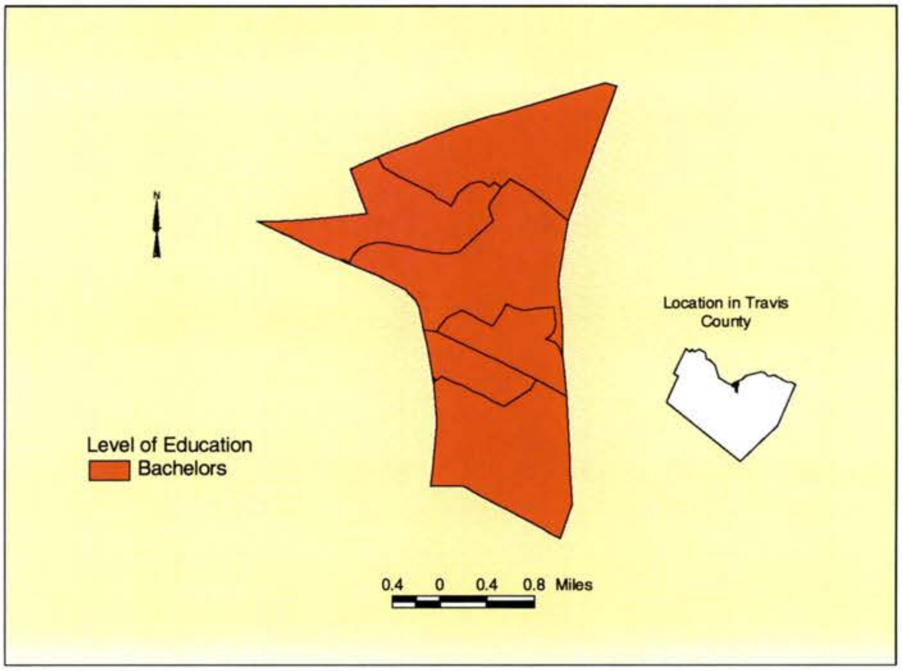



**Figure 24. Education Level of Milwood (U.S. Census Bureau 2000)**

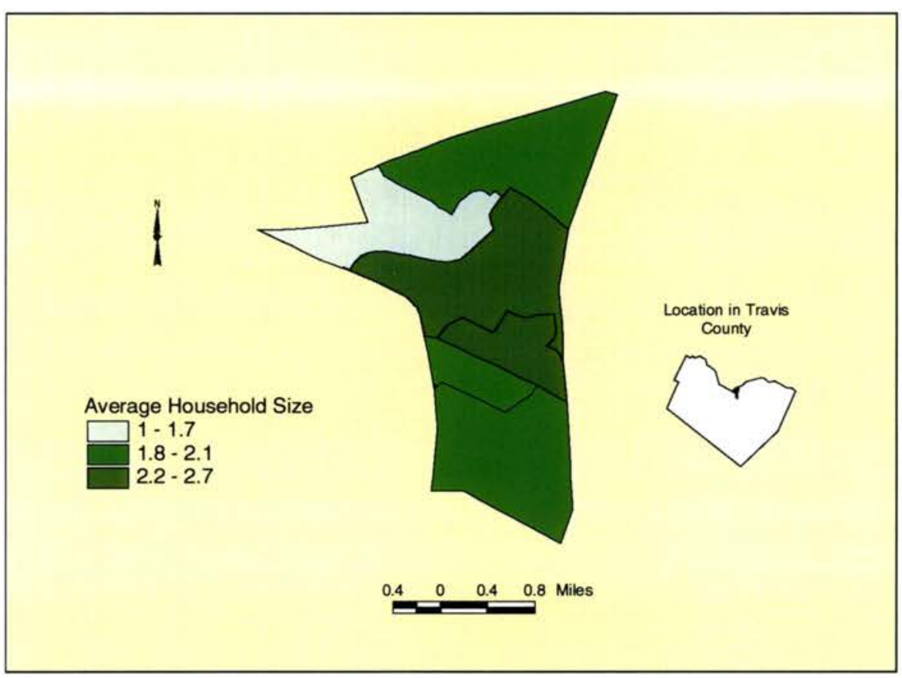



**Figure 25. Average Household Size of Milwood (U.S. Census Bureau 2000)**

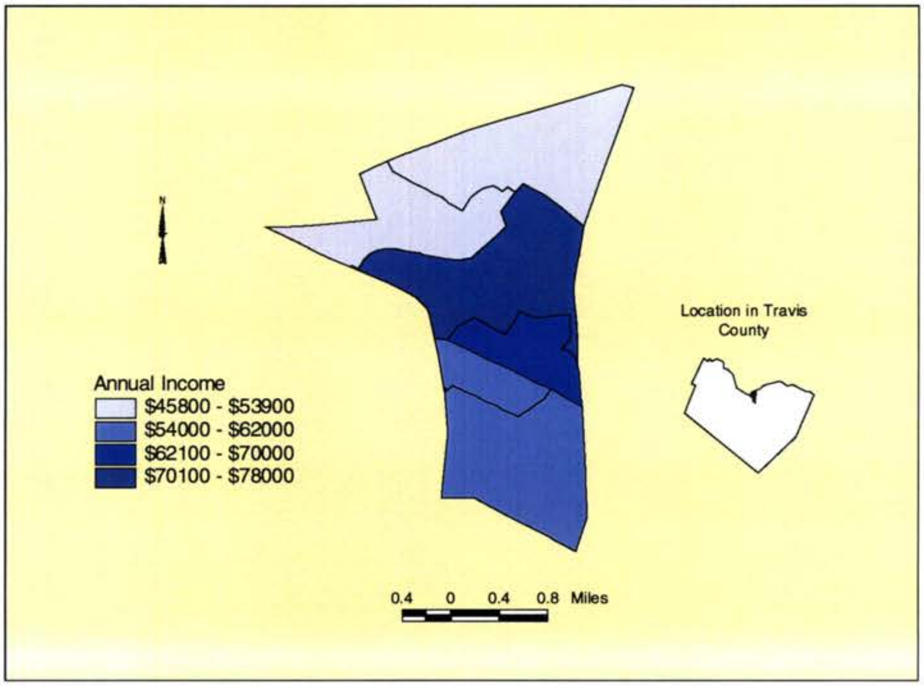



**Figure 26. Annual Income of Milwood (U.S. Census Bureau 2000)**

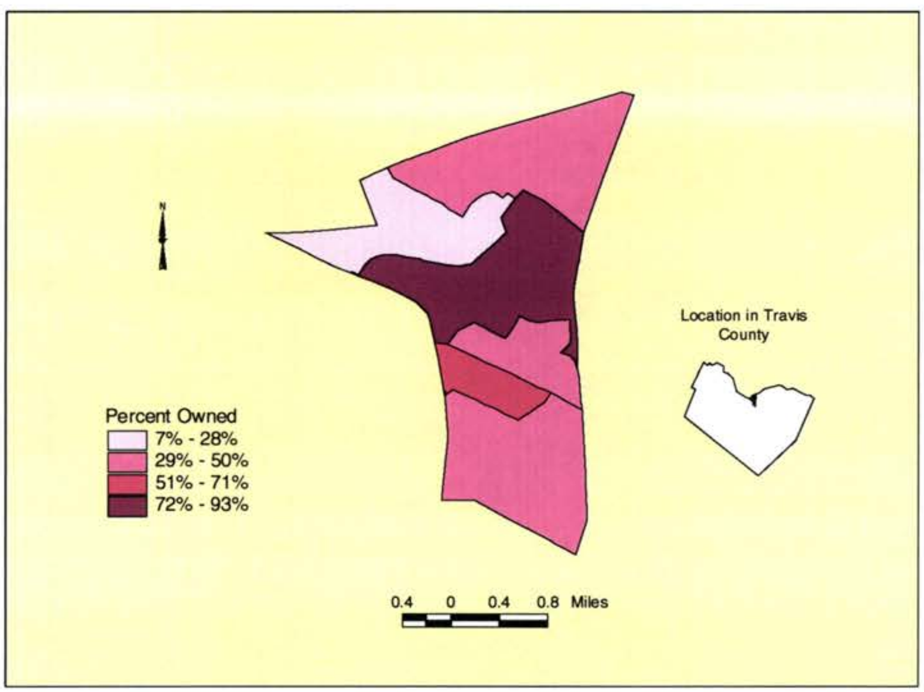



**Figure 27. Owner Occupancy of Milwood (U.S. Census Bureau 2000)**

West Allandale

Located in west central Austin, West Allandale is a part of Thursday's route. It has the highest percentage of whites, 96%, and a total population of 11,122. The average household size in West Allandale is the smallest of the study groups at 1.93, and it also has a high level of education, with only one tract having a mode of high school education, and the rest having the mode of bachelor's degree. West Allandale's owner occupancy mean is 57%, and its range varies from 8% to 86%. There are a lot of families in this area, and many of the homes are older. The mean income for this area is $54,808, and the mean age is the highest out of all the study areas at 39.9 years. This information can be seen in Figures 30 through 35. West Allandale had the highest recycling participation rate for three of the four years in the City of Austin's participation study (Table 11). This neighborhood's high participation rate is most likely a product of its age and education, although higher income is another characteristic that may also promote a high participation rate.

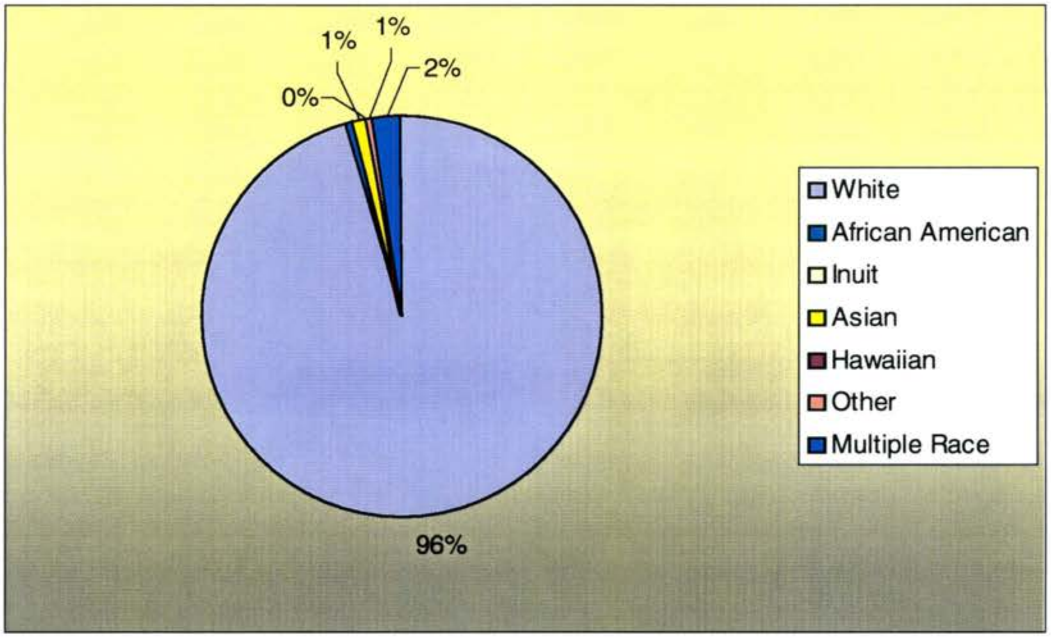



**Figure 28. Ethnicity of West Allandale (U.S. Census Bureau 2000)**

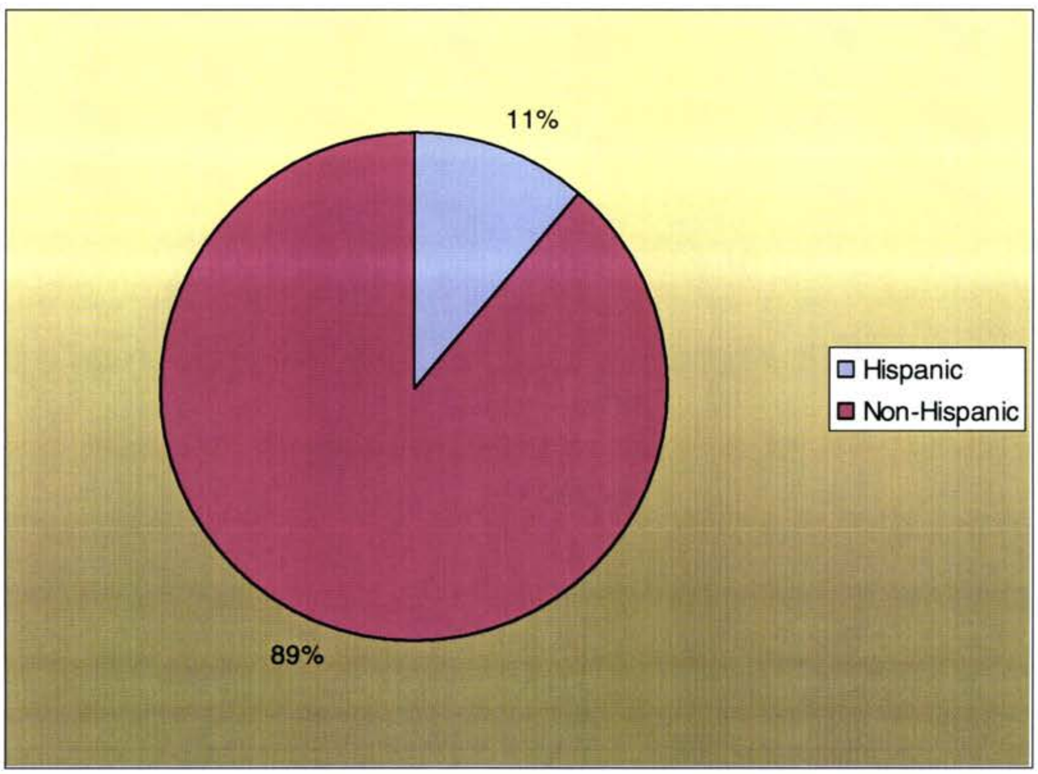



**Figure 29. Percent Hispanic of West Allandale (U.S. Census Bureau 2000)**

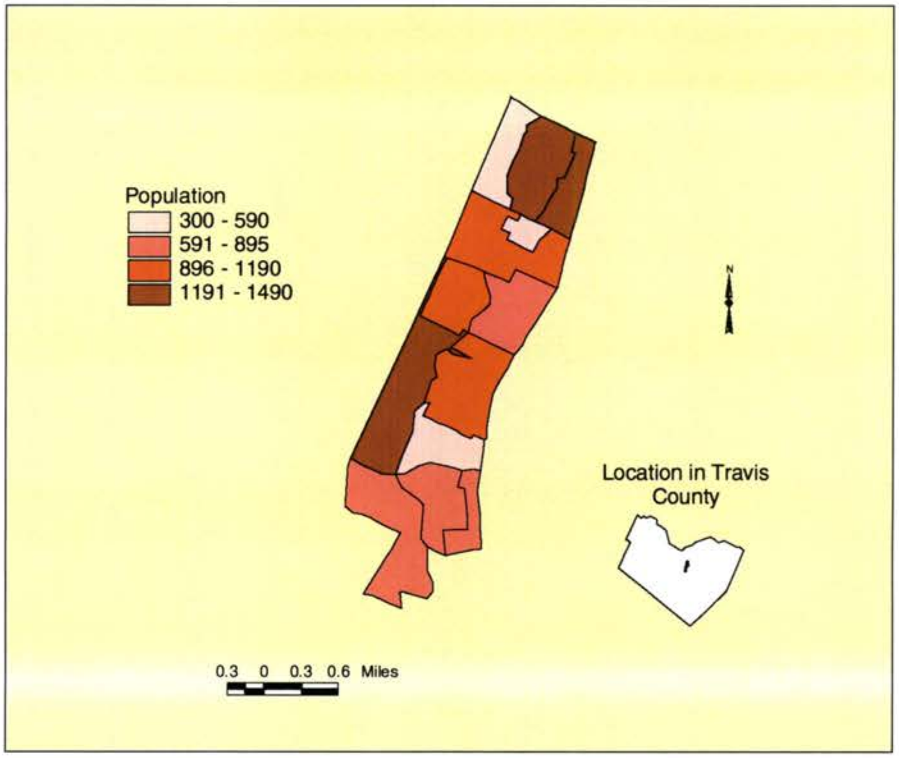



**Figure 30. Population of West Allandale (U.S. Census Bureau 2000)**

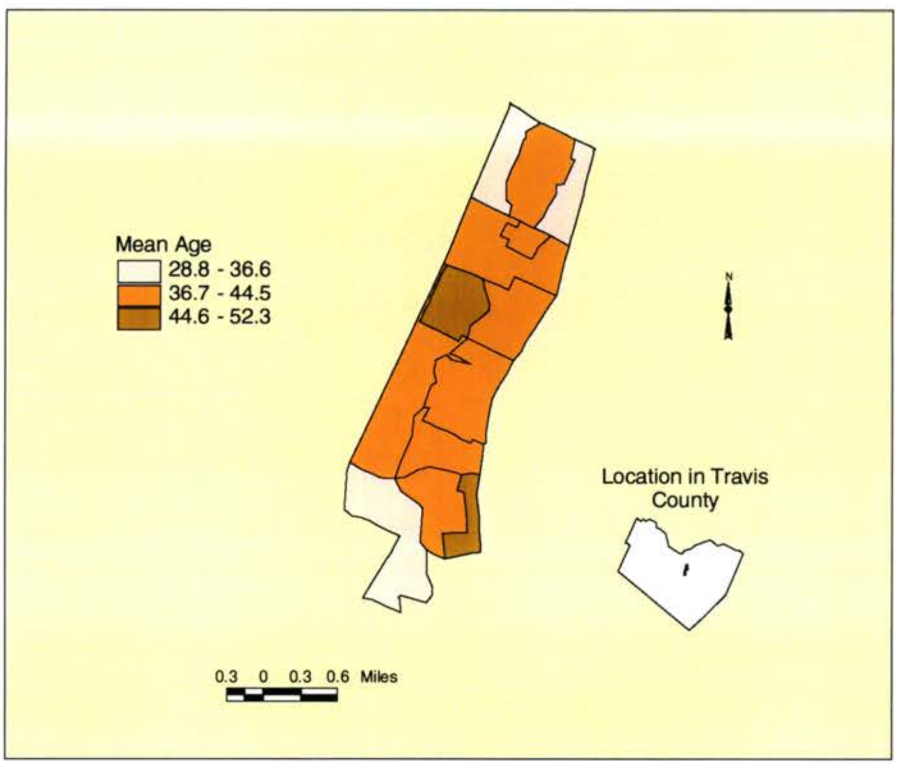



**Figure 31. Mean Age of West Allandale (U.S. Census Bureau 2000)**

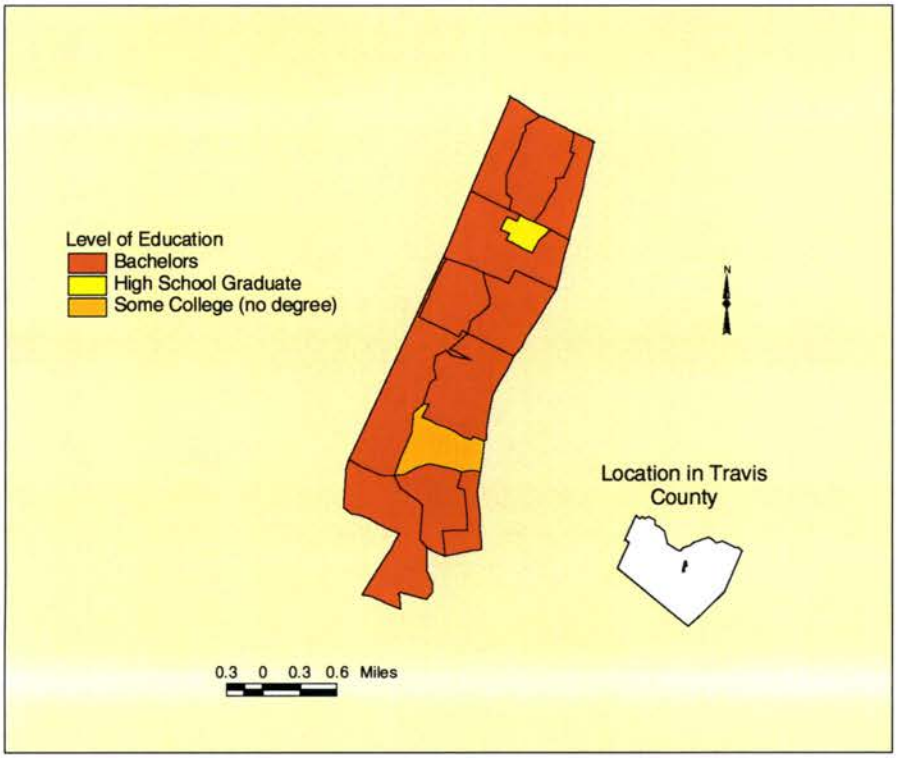



**Figure 32. Education Levels of West Allandale (U.S. Census Bureau 2000)**

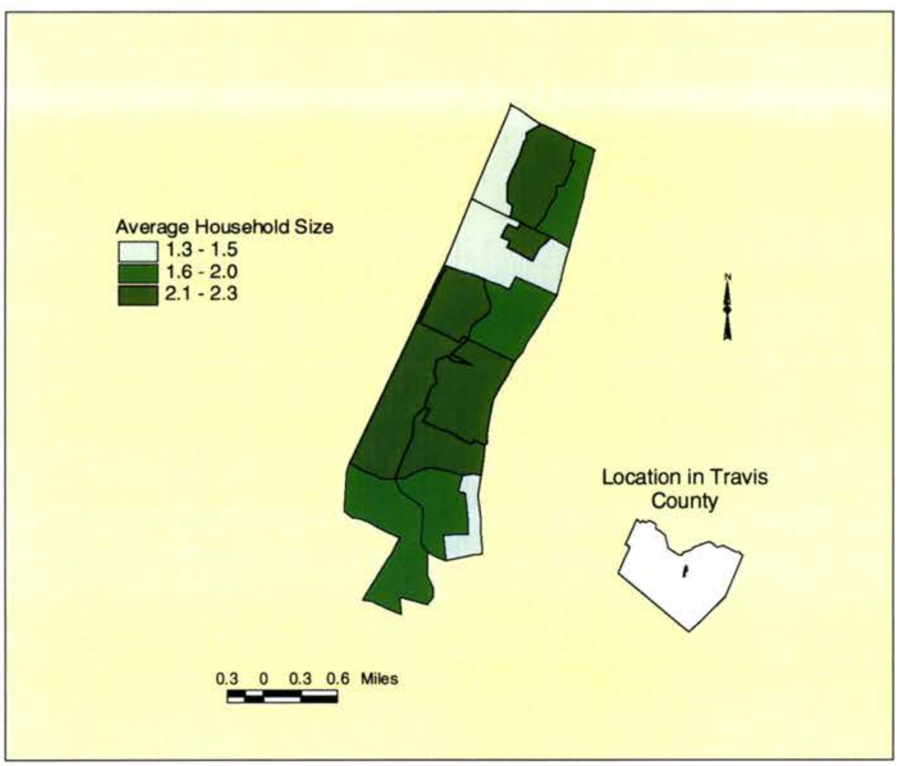



**Figure 33. Average Household Size of West Allandale (U.S. Census Bureau 2000)**

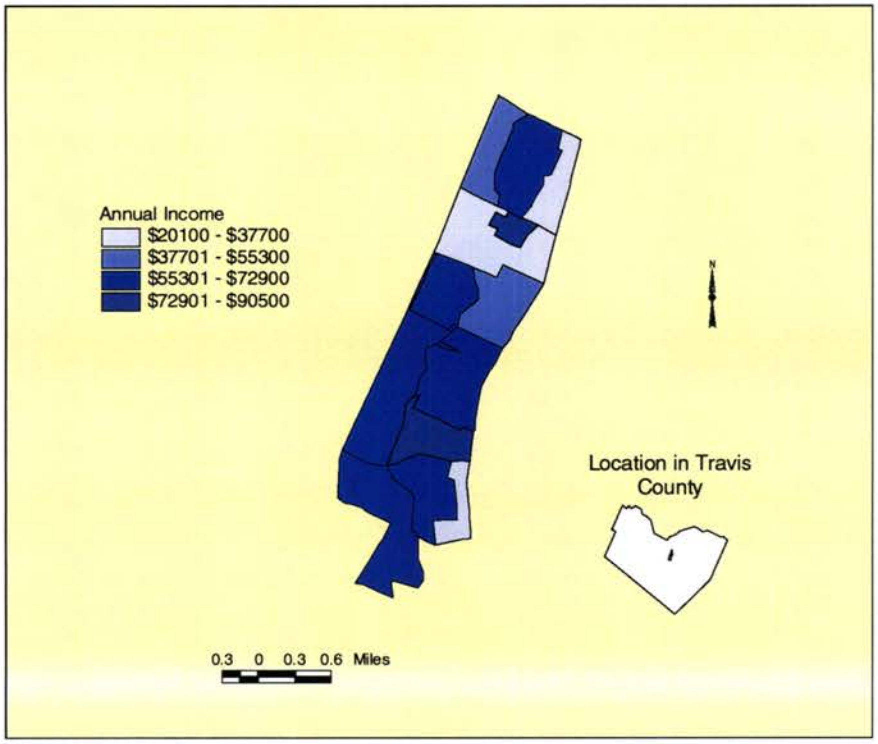



**Figure 34. Annual Income of West Allandale (U.S. Census Bureau 2000)**

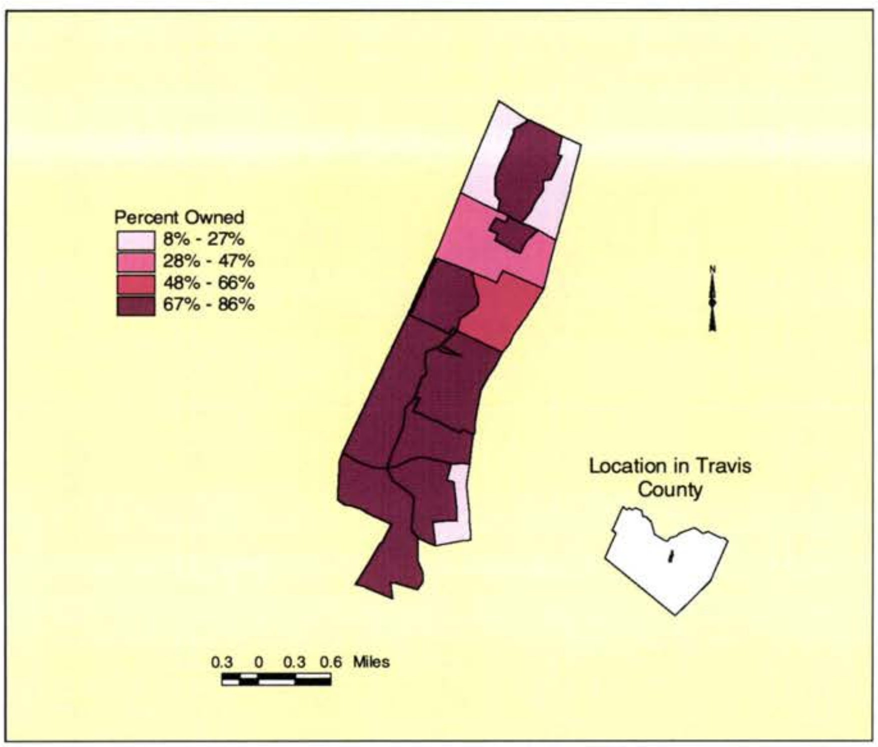



**Figure 35. Owner Occupancy of West Allandale (U.S. Census Bureau 2000)**

Martin Luther King

Martin Luther King neighborhood is the Friday group, and is located in east central Austin. Its total population is 8,137, and it is 50% black and 42.5% Hispanic. The average household size is 2.69, the highest out of all of the study areas. The education for this area is ranked low-level, with only one tract out of eight having a mode of bachelor's degree. The owner occupancy for this area is 37%, the second lowest. The mean income, $19,004, is the lowest out of all of the study areas. The median age is also the lowest at 28. These maps are depicted in Figures 38 through 43. In the participation study completed by the city of Austin, Martin Luther King neighborhood had the lowest recycling participation rates and weekly set-out rates for all four years in comparison to the other study areas (Table 11). The low recycling participation rate could have many reasons: first, this neighborhood is extremely low income. The city of Austin (2001) noted that household income is strongly correlated to recycling participation, and that more affluent neighborhoods tend to recycle more. Other reasons the Martin Luther King study area may have the lowest participation rate are because the education is extremely low, and the median age is quite young. The people who are expected to recycle more often are generally older and more educated (Reynolds 1993). A third reason this area may have low rates is because there is no real community established, meaning that the residents are less involved and less aware of what is going on in their neighborhood. Thus the relatively low participation rate is consistent with what would be expected according to the literature.

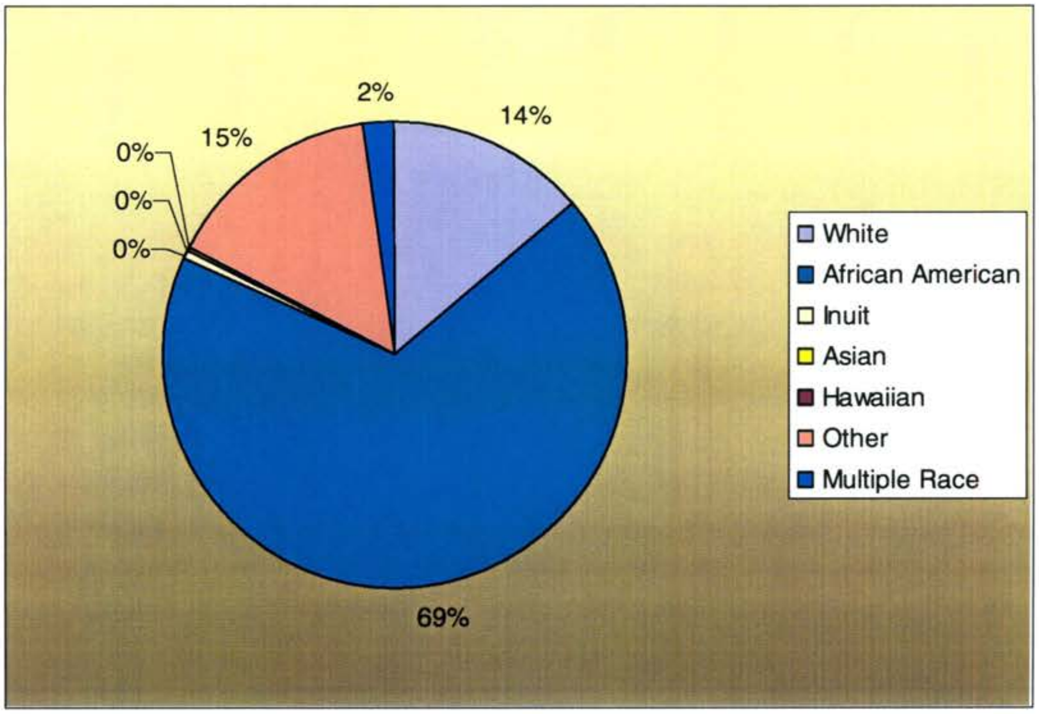



**Figure 36. Ethnicity of Martin Luther King (U.S. Census Bureau 2000)**

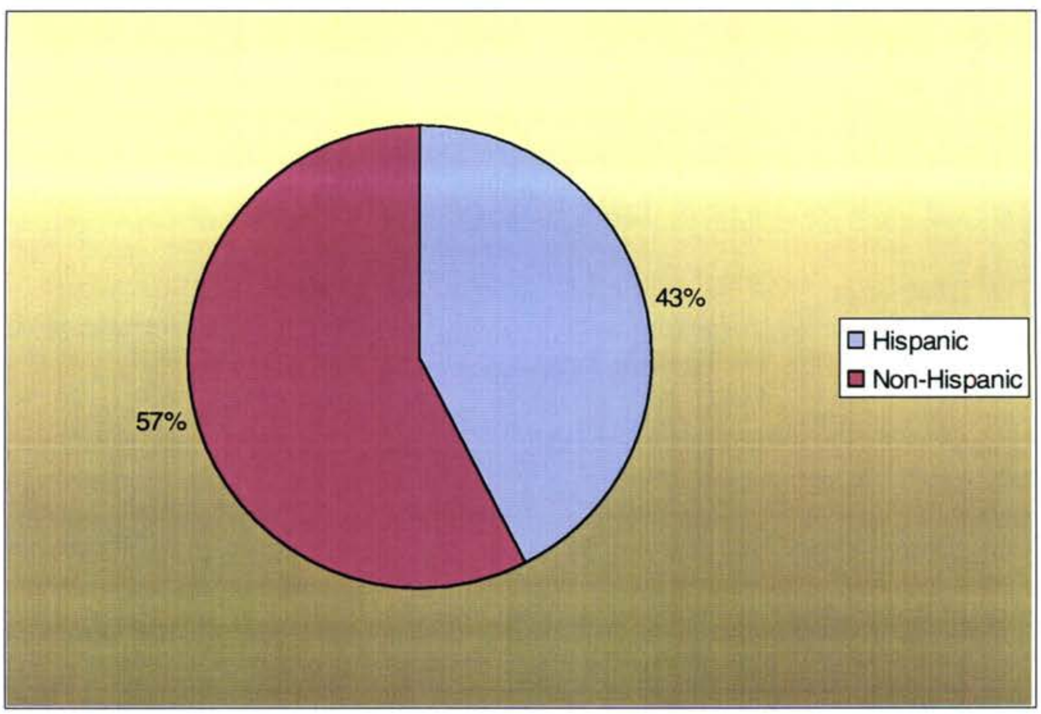



**Figure 37. Percent Hispanic in Martin Luther King (U.S. Census Bureau 2000)**

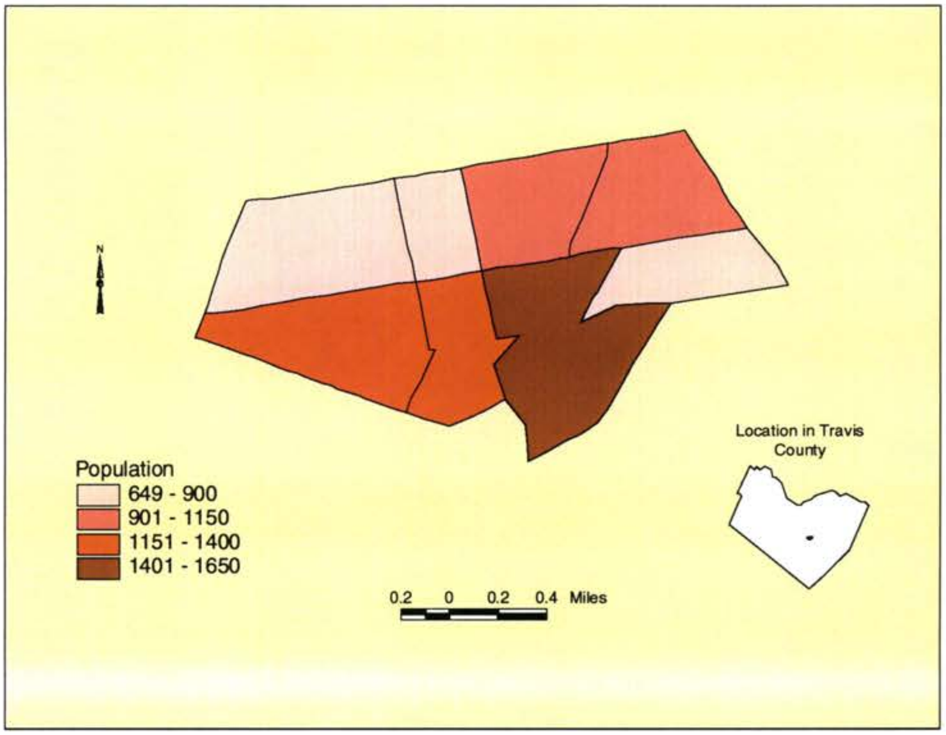



**Figure 38. Population of Martin Luther King (U.S. Census Bureau 2000)**

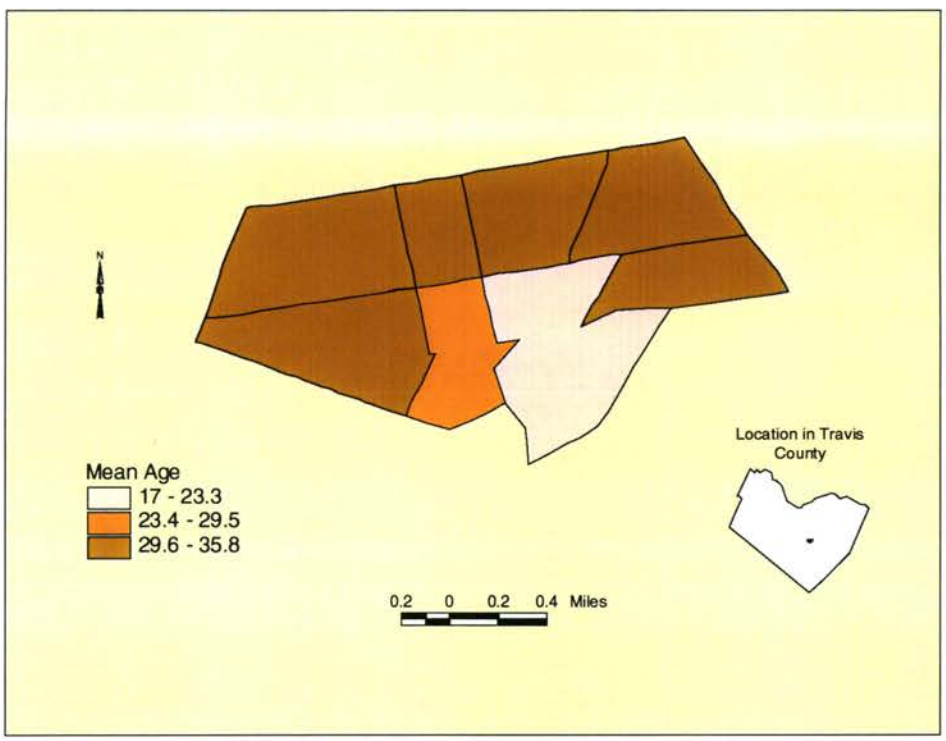



**Figure 39. Mean Age of Martin Luther King (U.S. Census Bureau 2000)**

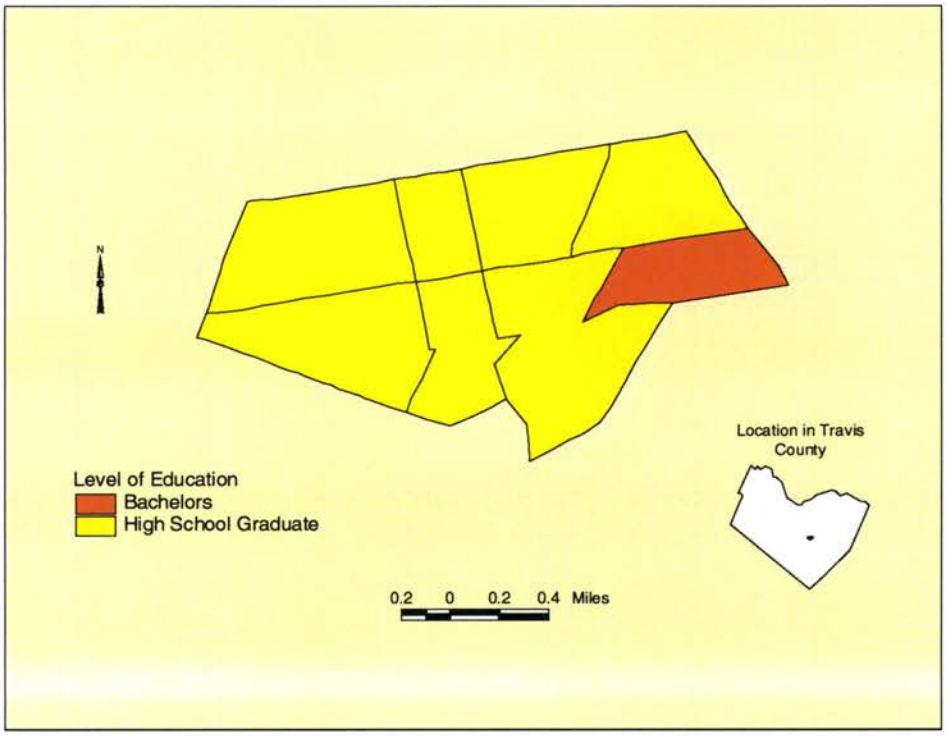



**Figure 40. Education Levels of Martin Luther King (U.S. Census Bureau 2000)**

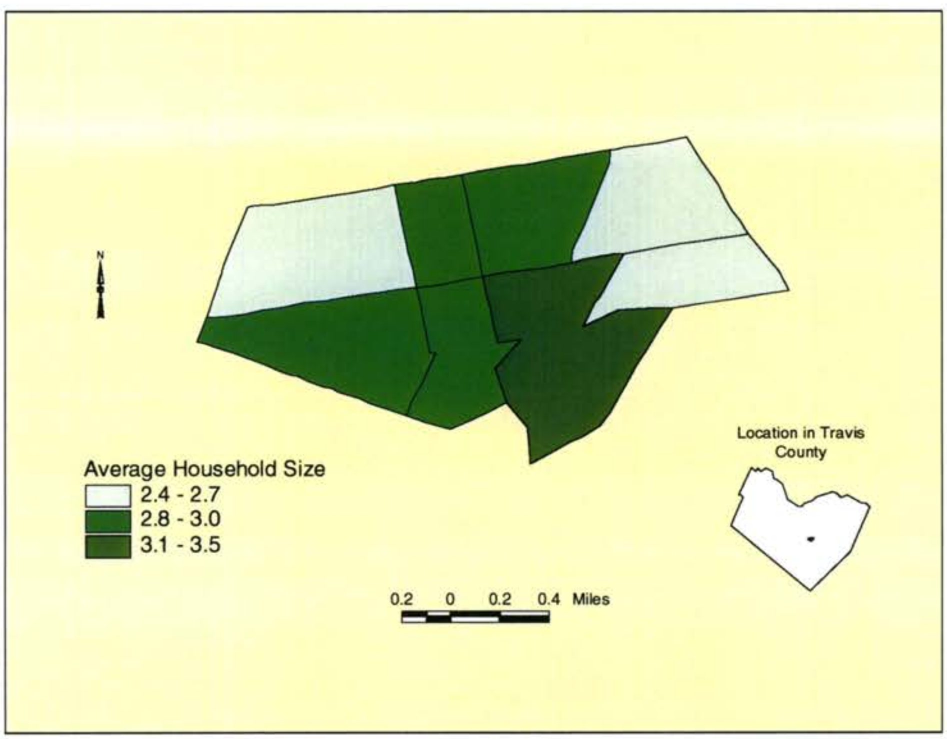



**Figure 41. Average Household Size of Martin Luther King (U.S. Census Bureau 2000)**

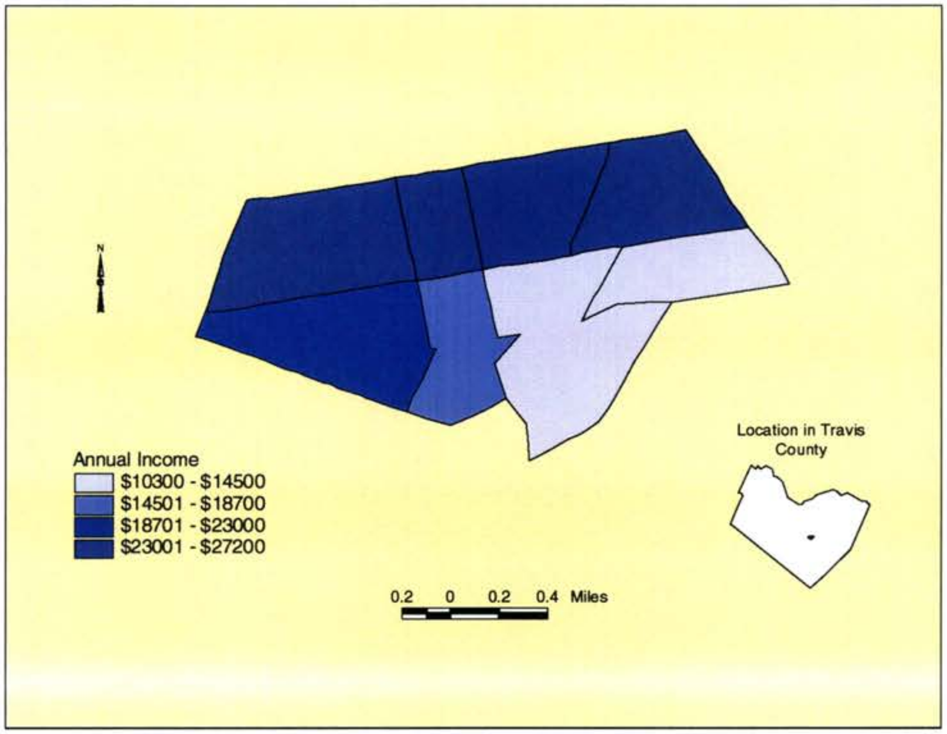



**Figure 42. Annual Income of Martin Luther King (U.S. Census Bureau 2000)**

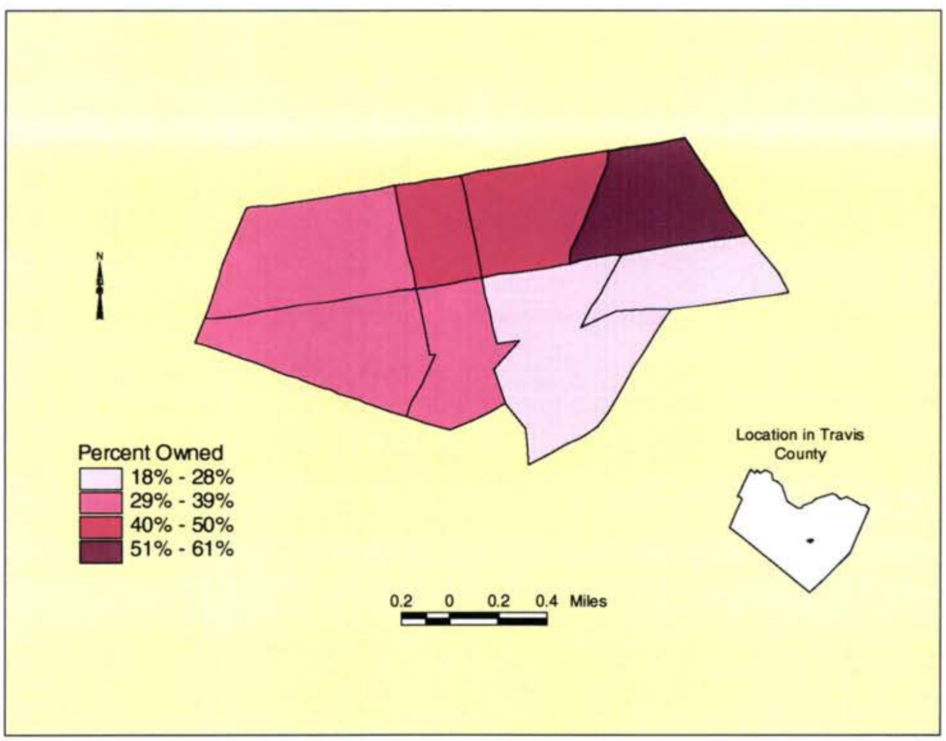



**Figure 43. Owner Occupancy of Martin Luther King (U.S. Census Bureau 2000)**

GIS Analysis

The variables were queried to identify neighborhoods of Austin that are expected to have high recycling participation rates and also to identify those areas that are expected to generate more waste. Once the areas of expected recycling and waste generation are distinguished, they were overlaid with each of the five study areas to determine if there are any matches. Inference can be made to other demographically similar areas of Austin as to how much waste is generated and how often the area participates in recycling.

Using GIS, overlays were created for areas of expected high recycling participation rates and probable municipal waste generator areas for the city of Austin. According to the literature, expected recyclers were educated (having a bachelors degree or higher), had a relatively high income, a smaller household size, and an older mean age (approximately 40+ years of age) (Reynolds 1993). The variables that were used for the expected recyclers overlay include an education level of bachelor's degree or higher, a mean age of 40 or higher, an average household size of 2.3 or lower, and an income of $35,000 or higher. Using these qualifications in a query of the block groups in the city of Austin, thirty-two groups were identified as having all of the above. When overlaid with the five neighborhoods in the participation study, a match appeared. Through the query, West Allandale displayed most of the characteristics, and had the highest participation rate in 2001, according to the city of Austin (City of Austin 2001).

The variables that were queried for probable high waste generator areas for the city were those opposite of high recycling participation rates. These variables were defined in the literature and included those with an income of $34,900 or less, and education of some college (no degree) or less, a median age of 39 or younger, and an average household size of 2.4 or higher (Reynolds 1993). Fifty-one tracts in the city of Austin were an exact match to all of these qualifications; however, there was not a large enough correlation with the City of Austin's participation study to label one study area a match to the queried demographics. The demographic maps that were used in the GIS overlay are depicted in Figures 44 through 49.

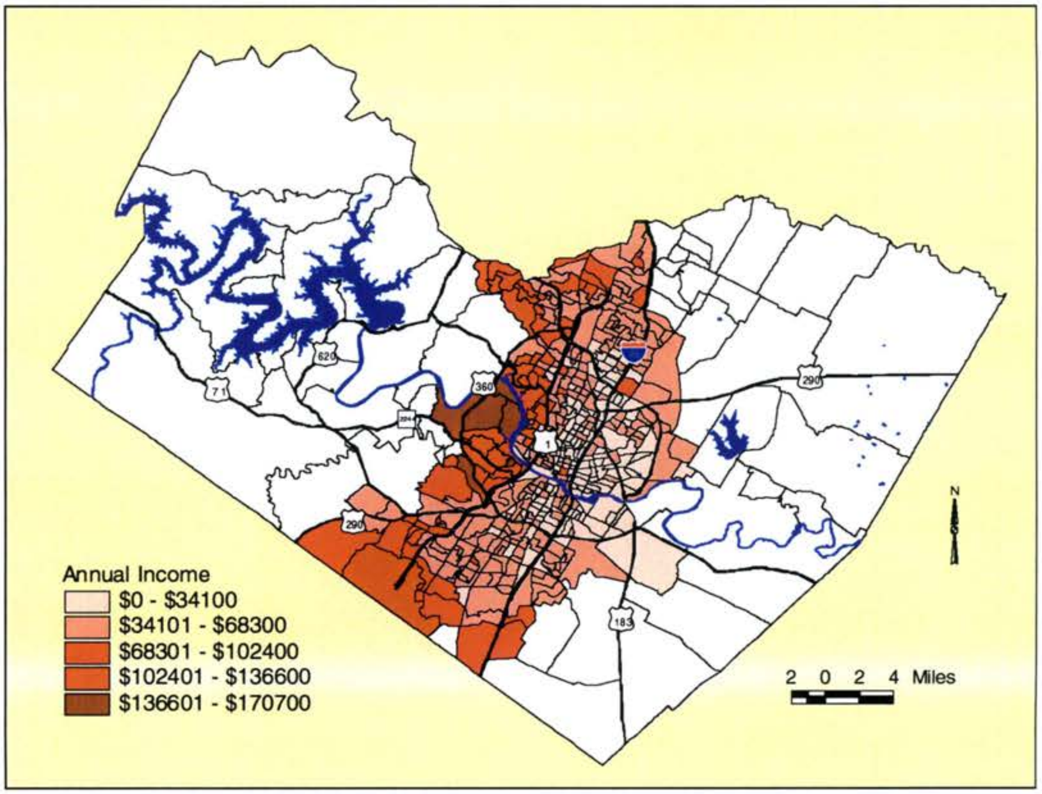



**Figure 44. Annual Income for the City of Austin (U.S. Census Bureau 2000)**

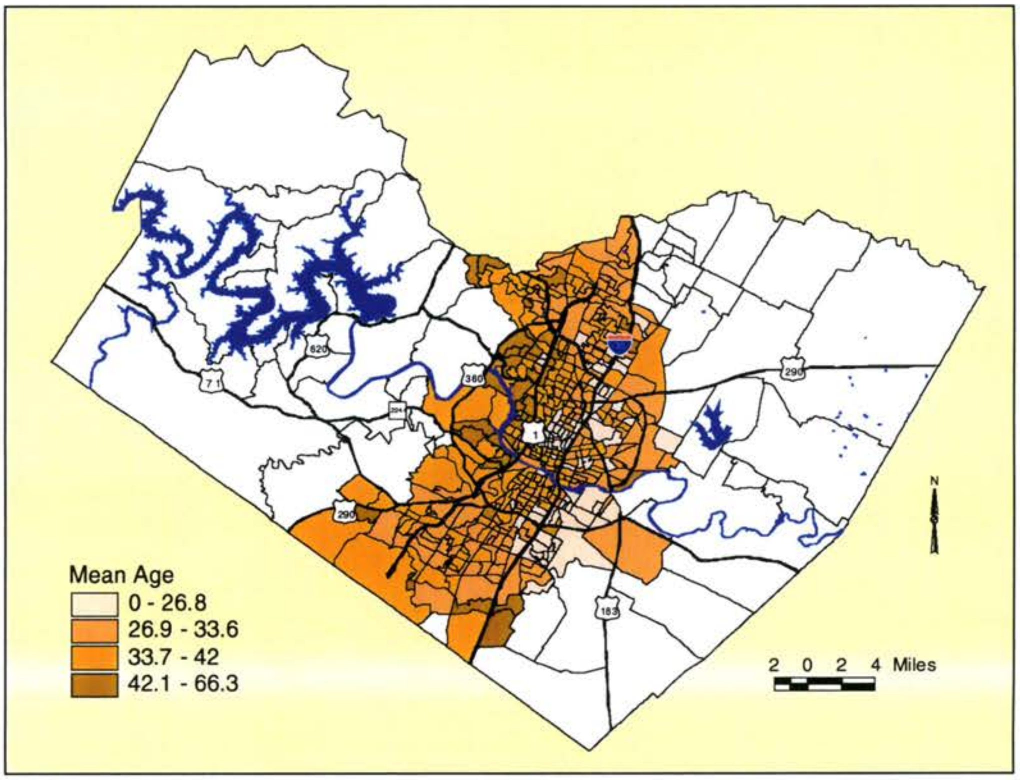



**Figure 45. Mean Age for the City of Austin (U.S. Census Bureau 2000)**

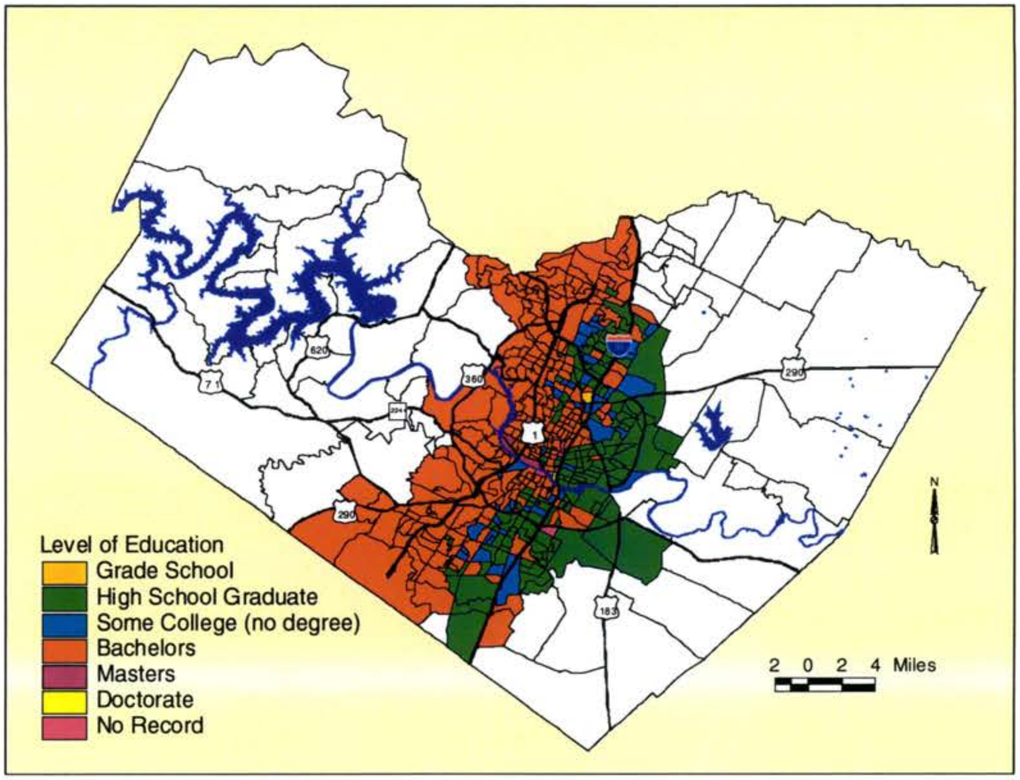



**Figure 46. Education Levels for the City of Austin (U.S. Census Bureau 2000)**

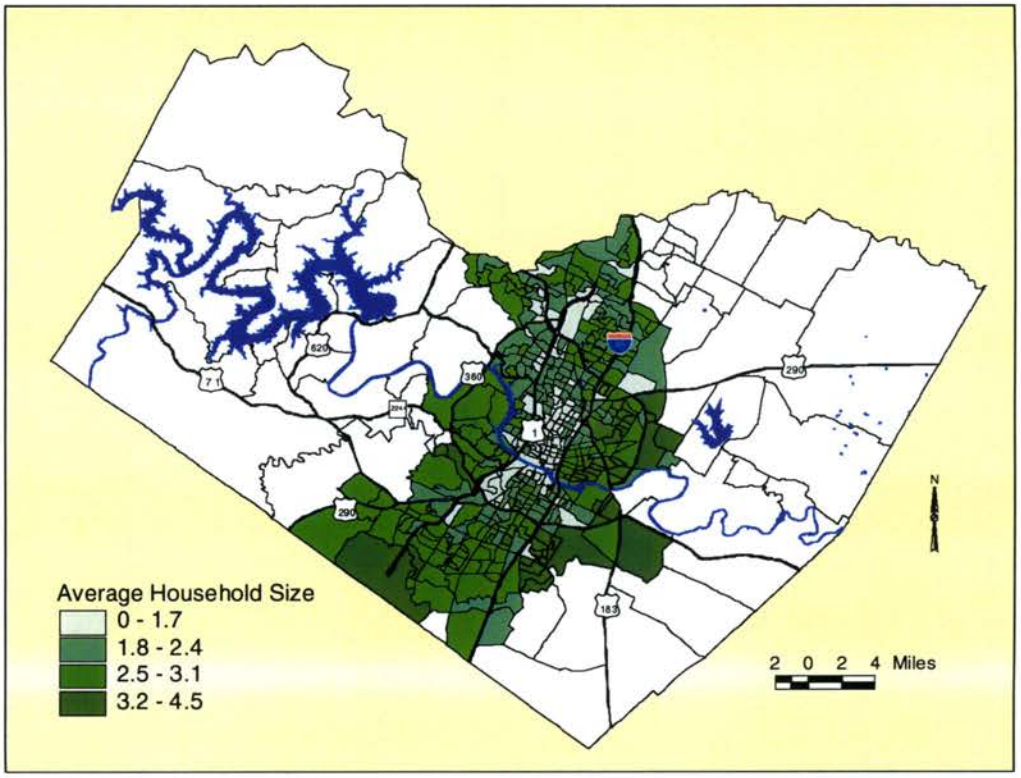



**Figure 47. Average Household Size for the City of Austin (U.S. Census Bureau 2000)**

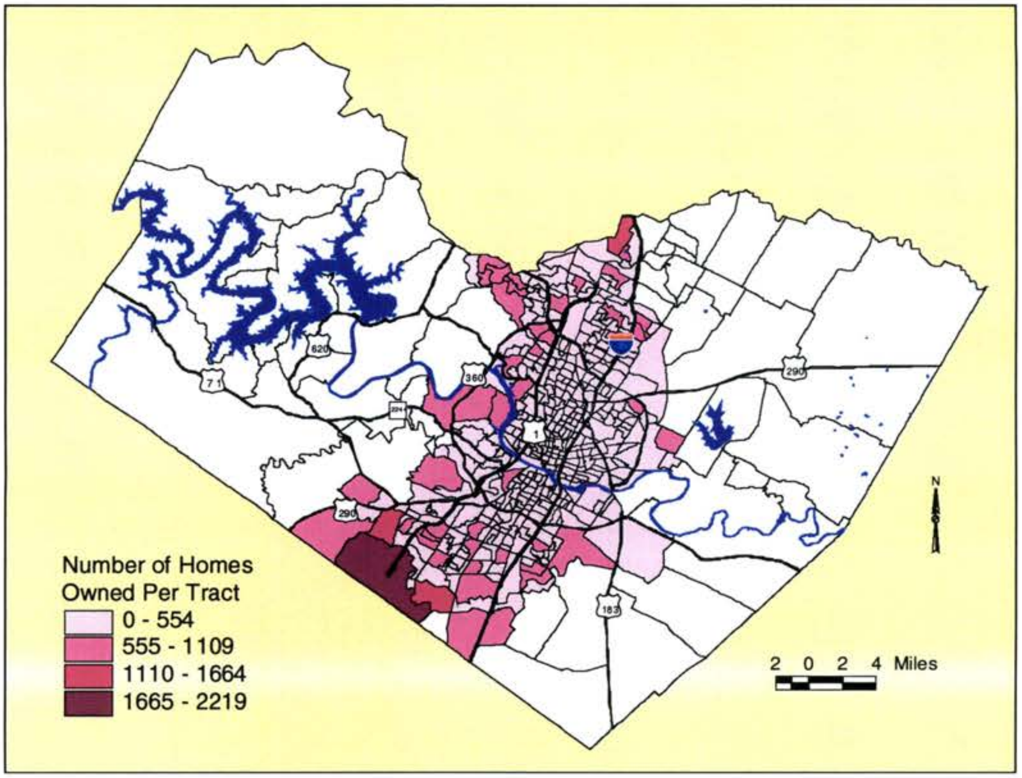



**Figure 48. Owner Occupancy for the City of Austin (U.S. Census Bureau 2000)**

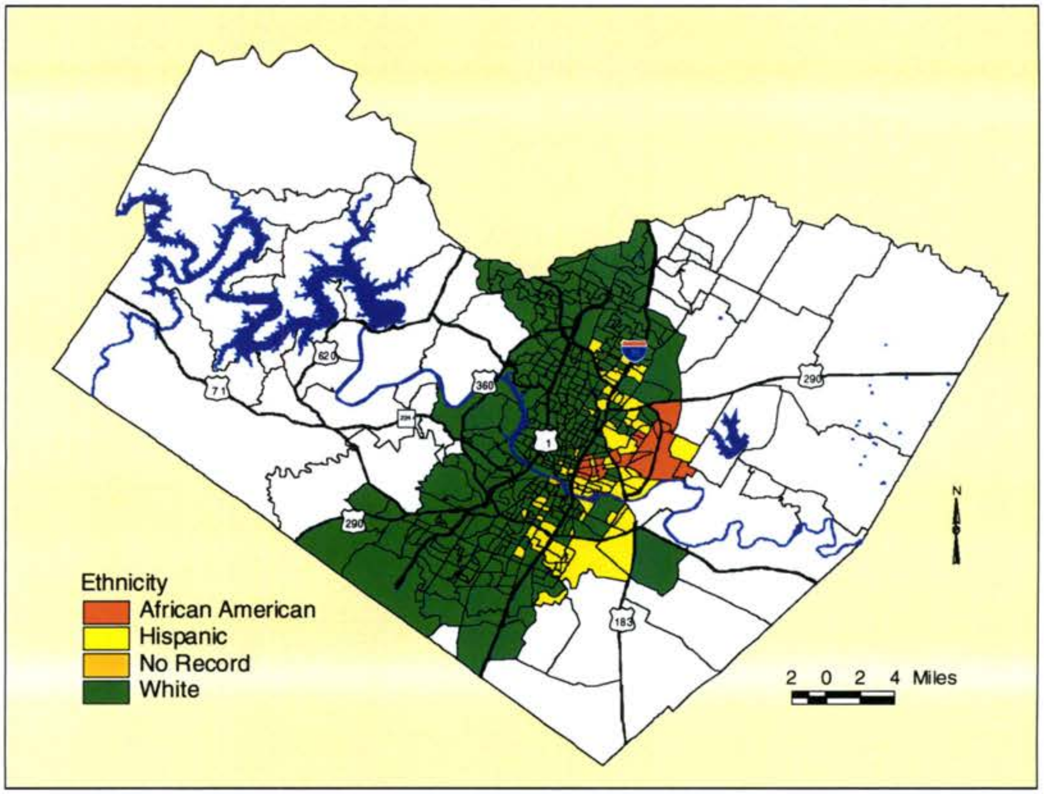



**Figure 49. Ethnicity for the City of Austin (U.S. Census Bureau 2000)**

Once these variables were queried, two GIS data layers were created for both potential high recycling areas and potential high waste generator areas (Figure 50). These layers were then overlaid with the five areas from the city of Austin's participation study. This new map depicted some very interesting information. The neighborhood of West Allandale appeared in the expected recycling area, which correlated with the data from the City of Austin in that it had the highest recycling percentage rate for 2001 (City of Austin 2001). The neighborhood of Martin Luther King came up in the expected waste generator area, which correlated with the city of Austin's study; it had the lowest weekly set-out rates in the study and higher amounts of extra garbage bags (City of Austin 2001). The map with the overlays of the expected groups and neighborhoods is shown in Figure 51.

From this GIS analysis, other areas of Austin can be targeted for recycling and waste generation education programs. Neighborhoods in the green areas of the overlay, for example, may generate more waste than other areas of the city. Neighborhoods in the green area that are expected to have low recycling rates and high waste generation rates include Montopolis, East Downtown, and South Austin. Recycling participation rates may be raised in these three areas if recycling was promoted more by the city. The city of Austin has a few solutions to help areas of likely high waste generation. It send out mailings to residents notifying them of the curbside recycling program, its purpose, and how it helps to eliminate potential recyclables from the waste stream. The city can also sponsor educational programs that promote environmental awareness, such as the importance of recycling and wise use of landfill space. The city could help by providing programs that encourage neighborhood and community awareness. If more residents of the city of Austin were involved in their communities, recycling might become more commonplace. Neighborhoods with the potential to have high recycling participatory rates include Spicewood Springs, Tarrytown, East Allandale, and Great Hills. The City of Austin could learn from those neighborhoods of high participation rates, and use that knowledge to promote recycling around the capital.

This analysis helped to design demographic profiles of the types of people who generate extra waste and the types of people who have high participatory rates. A summary table of the demographics of each neighborhood and their participation and extra waste generation percentages is pictured below. Generally, the people who are probable recyclers include those who are in their 40s and above, have mid to high incomes, are well educated, and own their homes. These types of people tend to be more established, involved in their community, and environmentally educated. People that are expected to generate high amounts of waste include those who are young (early 30s and younger), have large household sizes, rent their homes, have low income, are uneducated, and often ethnic minorities.

**Table 12. Summary of Results for Each Neighborhood Study Area**

| Study Area | Participation Rate* | Extra Waste Average (in bags)* | Primary Ethnicity | Annual Income | Education Level | Avg. Household Size | Owner Occ. Rate | Mean Age |
|---|---|---|---|---|---|---|---|---|
| Texas Oaks | 74% | 29 | White **78%** | High | Low | Large | High | High |
| Battle Bend | 70% | 37 | White **55%** | Mid-Range | Mid-Level | Mid-size | Low | Low |
| Milwood | 77% | 39 | White **82%** | High | High | Mid-size | Mid-Range | Mid-Range |
| West Allandale | 82% | 33 | White **88%** | High | High | Small | Mid-Range | High |
| Martin Luther King | 49% | 47 | African American **50%** | Low | Low | Large | Low | Low |

*Note: The participation rates are averaged over a study of four years (1998-2001), and the extra waste is averaged over a study of three years (1999-2001), and is measured by bags per week per neighborhood (City of Austin 2001).

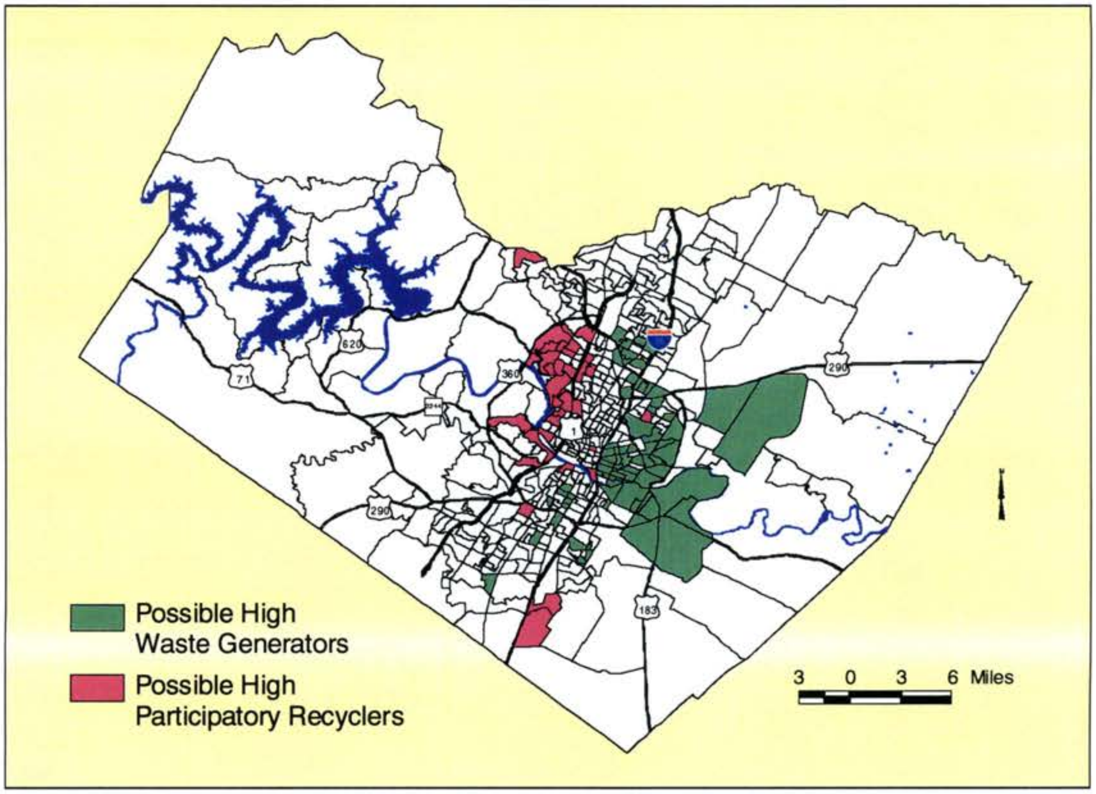



**Figure 50. Areas in Austin of Potential High Recycling Participation Rates and High Waste Generation Rates (City of Austin 2001)**

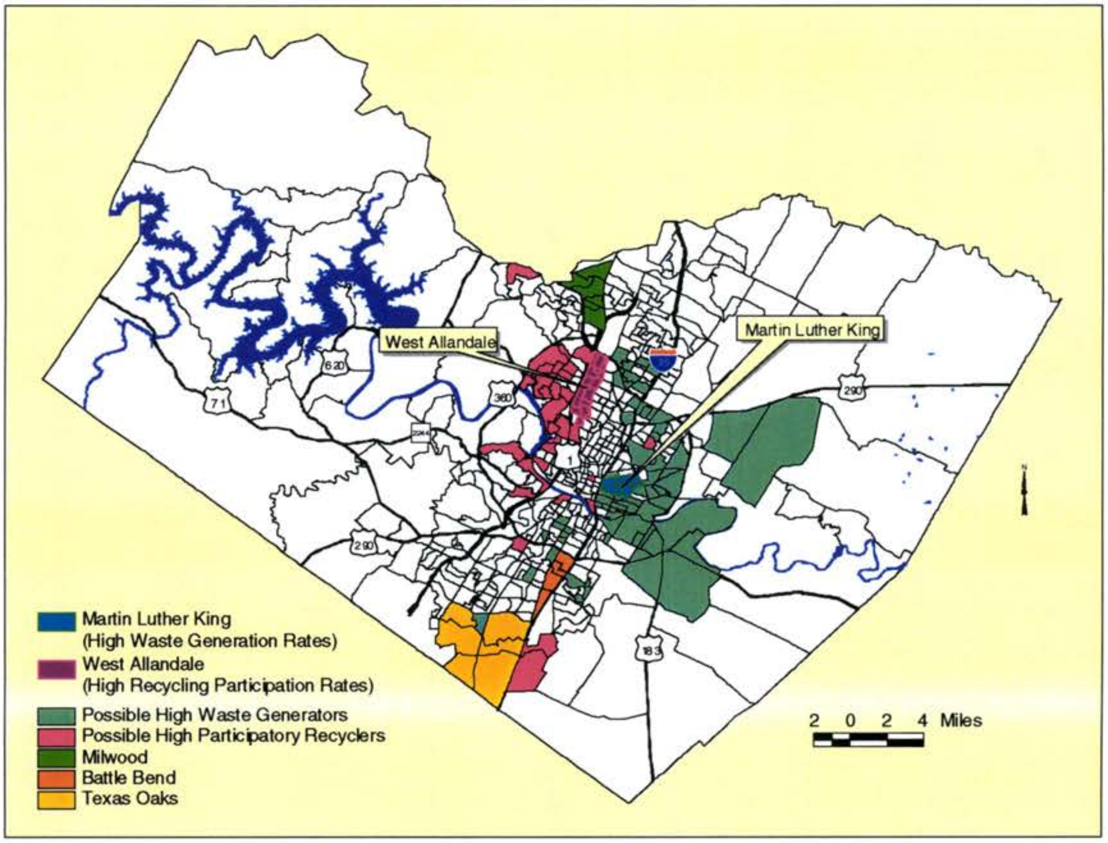



**Figure 51. Overlay of Participation Areas with Potential Recycling and Waste Generation Areas (City of Austin 2001)**

# CHAPTER V

# CONCLUSION

In summary, there are many variables that can affect recycling participation rates and waste generation rates. The literature review pointed out that income is a major factor in the amount of waste generated. However, this research showed that it is not the only factor. Other variables, including owner occupancy, ethnicity, age, education and household size may affect the amounts of waste recycled per household. This research also showed that age and education are important factors in recycling participation; and income, home-owner occupancy, and household size may affect which households recycle.

This descriptive analysis provided many important points in our understanding of the demographic variables behind waste generation and recycling. It helped to discern the differences between the attributes of recycling in the literature review and the results of the participation study for the city of Austin. This research also helped to target the major differences between recycling and waste generation rates of specific areas in Austin. According to Reynolds (1993) people who are older and more educated tend to recycle more. This proved to be the case in the study of the five Austin neighborhoods.

The city of Austin (2001) stated that income does make a difference in recycling participation. This also was true for the descriptive analysis of the participation areas.

However, the analysis also showed that income may not be the only factor as to whether or not one will recycle. Other variables such as education and age may play a role in recycling participation. This may be because older and more educated people are more environmentally aware and more involved in their communities. Now more than ever, community involvement, age, and education may play a role in recycling participation (Reynolds 1993). Although income does make a difference in the types of waste that the five study areas generate, it is not an indicator of the amounts of waste an area will produce.

In the city of Austin, recycling does help to eliminate much of the waste that would otherwise enter into the waste stream. However, it is crucial to continue such participation studies and monitor areas of low participation. It is important to teach people in those areas of low recycling participation the significance of recycling and how it can eliminate waste from the waste stream.

In the future, a way to find recycling participation rates would be to survey the neighborhoods of low participation, or distribute informational fliers through the mail. One explanation for low recycling participation rates among the low-income households may also be because they characteristically do not own their own homes. Therefore, the residents may not have as much community involvement as those in high owner occupancy areas, and may not be aware of curbside recycling programs. Much of recycling depends on education level, which is lower in low-income areas.

The GIS-based analysis of the five neighborhoods aided in identifying other neighborhoods in the city that have similar recycling and waste generation percentages. Murphy and Rathje (1992) stated that ethnicity has an effect on how much waste is generated in certain areas. The analysis of the five neighborhoods showed that recycling was more prevalent among white neighborhoods. However, it was only more prevalent among white neighborhoods with high home-owner occupancy rates. This suggests that the more important variables include age, home-owner occupancy, income, and education which infers that ethnicity has nothing to do with recycling. Two neighborhoods with equal median age, owner occupancy, income, and education should have similar recycling levels regardless of the ethnic background of the residents; however, this research did show that areas of low recycling participation also had high minority populations.

Some residents of the city of Austin may simply be uninformed that a curbside recycling program exists, especially in areas of low participation. As a future objective, the city should target those areas of expected high waste generation and low recycling participation, and encourage those areas to recycle. One means of doing this is by distributing informational fliers through the mail. Another way information can be shared is by airing television commercials about the city's recycling programs. Apartment complexes can also become involved by encouraging their residents to recycle and provide easy access recycling containers near dumpsters.

This analysis assists in locating educational programs for recycling and waste generation. The GIS-based analysis was also useful in predicting potential recycling and waste generation around the city, so that Austin can plan for future landfill space. The descriptive analysis helped to confirm that there are differences in those households that recycle and those that do not.

In the future, it will be important to include the entire city in a participation study of recycling and waste generation. It would help to better predict how much waste is actually being generated and it will help to predict how much future landfill space for the city of Austin is necessary. In future research, it is also crucial to have detailed recycling and waste generation information at smaller scales, such as block group for entire cities, so that more accurate analyses can be produced.

Other cities in the state of Texas could use research similar to this to determine their participation rates and inform citizens of the importance of recycling and minimizing amounts of waste generated. If data were acquired at smaller scales, such as block group, it would be possible for other cities such as Dallas, San Antonio, and Houston to create studies of their cities' waste generation and recycling rates.

The city of Austin has a good recycling percentage rate, but it could be better. By encouraging people to recycle more, and providing education to those who are unaware of the recycling program, this rate could be raised significantly. In the future, it is vital for the city to collect more waste generation and recycling data at the local level, so that efficiently targeted educational endeavors may be made possible.

**Recycling makes the world more clean,**

**And it makes the grass and trees more green.**

**You can recycle glass and cans,**

**But it's hard work so you'll need a fan.**

**You could give your old to a charity shop if they don't fit you anymore.**

**In the shop they have clothes galore!!**

**Kids or adults can recycle,**

**Oh yes you can recycle your old bicycle.**

***By Nora***

# APPENDIX I
# GLOSSARY OF TERMS

| | |
|---|---|
| Biodegradable | Waste material, which is capable of being broken down into simper compounds by microorganisms or other decomposers such as fungi. |
| Combustibles | Various materials in the waste stream that are burnable, such as paper, plastic, lawn clippings, leaves, and other organic materials. |
| Combustion | The chemical combining of oxygen with a substance that results in the production of heat and usually light. |
| Commercial Waste | Waste materials originating in wholesale, retail, or service establishments such as office buildings, stores, markets, theaters, hotels and warehouses. |
| Compost | Relatively stable mixture of organic wastes partially decomposed by aerobic or anaerobic conditions. |
| Composting | The controlled biological decomposition of organic solid waste materials under aerobic or anaerobic conditions. |
| Discards | Refers to the MSW remaining after recovery. The discards are generally combusted or landfilled, but they could be littered, stored, or disposed on-site, particularly in rural areas. |
| Durable goods | These are goods that typically have a lifetime of three years or longer. |
| Food Waste | Animal or vegetable wastes resulting from the handling, storage, sale, preparation, cooking and serving of foods; commonly called garbage. |
| Garbage | Solid waste consisting of putrescible animal and vegetable waste materials resulting from the handling, preparation, cooking, and consumption of food, including waste materials from markets, storage facilities, handling and sale of produce, and other food products. Generally defined as *wet food waste.* |
| Generation | Refers to the amount (weight, volume, or percentage of the overall waste stream) of materials and products as they enter the waste stream and before material recovery, composting, or combustion takes place. |
| Generator | Any person, by site or location, whose act or process produces a solid waste; the initial discarding of a material. |
| Green Waste | See yard waste. |
| Industrial Waste | Those waste materials generally discarded from industrial operations or derived from industrial operations or the manufacturing processes, all nonhazardous wastes other than residential, commercial, and institutional. |
| Landfill, sanitary | Engineered method of disposing of solid wastes on land in a manner that protects human health and the environment. Waste is spread in thin layers, compacted to the smallest practical volume, and covered with soil or other suitable material at the end of each working day, or more frequently, as necessary. |
| Municipal Solid Waste (MSW) | Includes all of the wastes that are generated from residential households and apartment buildings, commercial and business establishments, institutional facilities, construction and demolition activities, municipal services, and treatment plant sites. |

| | |
|---|---|
| Nondurable Goods | These are items with a lifetime of three years or less. |
| Participation Rate | A measure of the number of people participating in a recycling program compared to the total number that could be participating. |
| Recovery | Refers to the removal of materials from the waste stream for recycling and composting. Recovery does not automatically equal recycling. |
| Recycling | Separating a given waste material (e.g., glass) from the waste stream and processing it so that it may be used again as a useful material for products that may not be similar to the original. |
| Refuse | All solid materials that are discarded as useless. |
| Reduction, Waste | The prevention or restriction of waste generation at its source by redesigning products or the patterns of production and consumption. |
| Rubbish | General term for solid wastes—excluding food wastes and ashes—taken from residences, commercial establishments, and institutions. |
| Trash | Wastes that usually do not include food wastes but may include other organic materials, such as plant trimmings. Generally defined as dry waste material, but in common usage it is a synonym for *rubbish* or *refuse*. |
| Yard Waste | Leaves, grass clippings, prunings, and other natural organic matter discarded from yards and gardens. Yard wastes may also include stumps and brush, but these materials are not normally handled at composting facilities. |

(Krieth and Tchobanoglous 2002)

# APPENDIX II
# DATA TABLES FOR BATTLE BEND

| Block Group | Total Population | White | African American | Inuit | Asian | Hawaiian | Other | Multiple Race | Hispanic |
|---|---|---|---|---|---|---|---|---|---|
| 002402 | 1374 | 725 | 133 | 12 | 18 | 0 | 432 | 54 | 614 |
| 002403 | 495 | 281 | 18 | 2 | 4 | 0 | 177 | 13 | 312 |
| 002403 | 2122 | 1159 | 104 | 29 | 17 | 1 | 734 | 78 | 1226 |
| 002422 | 1148 | 668 | 108 | 6 | 37 | 0 | 298 | 31 | 513 |
| **TOTAL** | **5139** | **2833** | **363** | **49** | **76** | **1** | **1641** | **176** | **2665** |
| | Percent | **55.10%** | **7.06%** | **0.95%** | **1.47%** | **0.00%** | **31.93%** | **3.42%** | **51.85%** |

| Block Group | Vacant Homes | Owned Homes | Rented Homes | Total | Percent Owned |
|---|---|---|---|---|---|
| 002402 | 53 | 185 | 423 | 661 | 27% |
| 002403 | 18 | 93 | 101 | 212 | 43% |
| 002403 | 17 | 498 | 258 | 773 | 64% |
| 002422 | 23 | 49 | 529 | 601 | 8% |
| TOTAL | 111 | 825 | 1311 | 2247 | 142% |
| | | **Total Owner Occupancy Mean 35%** | | | |

| Block Group | Income | Income * Population | Mean Age | Age * Population |
|---|---|---|---|---|
| 002402 | 30744 | 42242256 | 25 9 | 35586 6 |
| 002403 | 45000 | 22275000 | 32 6 | 16137 0 |
| 002403 | 44241 | 93879402 | 31 8 | 67479 6 |
| 002422 | 27089 | 31098172 | 27 5 | 31570 0 |
| TOTAL | 147074 | 189494830 | 29 30 | 150773 |
| Mean Income | | **36873** | | |

| Block Group | Average Household Size | Education Level |
|---|---|---|
| 002402 | 2 26 | bachelors |
| 002403 | 2 55 | high school graduate |
| 002403 | 2 81 | high school graduate |
| 002422 | 1 99 | some college, no degree |
| TOTAL | **2.28** | **Medium Level** |

# DATA TABLES FOR MILWOOD

| Block Group | Population | White | African American | Inuit | Asian | Hawaiian | Other | Multiple Race | Hispanic |
|---|---|---|---|---|---|---|---|---|---|
| 001744 | 2586 | 2127 | 81 | 12 | 191 | 0 | 92 | 80 | 271 |
| 001744 | 3006 | 2238 | 236 | 13 | 268 | 1 | 165 | 86 | 495 |
| 001745 | 965 | 885 | 20 | 3 | 17 | 3 | 22 | 18 | 108 |
| 001745 | 1428 | 1177 | 78 | 6 | 78 | 1 | 54 | 35 | 200 |
| 001754 | 1302 | 1112 | 59 | 6 | 39 | 1 | 71 | 14 | 211 |
| 001754 | 3455 | 2997 | 100 | 15 | 183 | 1 | 100 | 57 | 390 |
| **TOTAL** | **12742** | **10536** | **574** | **55** | **776** | **7** | **504** | **290** | **1675** |
| **Percent** | | **82.60%** | **4.50%** | **0.43%** | **6.00%** | **0.01%** | **3.90%** | **2.20%** | **13.10%** |

| Block Group | Vacant Homes | Owned Homes | Rented Homes | Total | Percent Owned |
|---|---|---|---|---|---|
| 001744 | 58 | 121 | 1420 | 1599 | 7 5% |
| 001744 | 23 | 451 | 969 | 1443 | 31 0% |
| 001745 | 4 | 343 | 18 | 365 | 93 0% |
| 001745 | 11 | 295 | 277 | 583 | 50 0% |
| 001754 | 3 | 291 | 258 | 552 | 52 0% |
| 001754 | 95 | 719 | 990 | 1804 | 39 0% |
| **TOTAL** | **194** | **2220** | **3932** | **6346** | **272.5%** |
| | | **Total Owner Occupancy Mean 45%** | | | |

| Block Group | Income | Income* Population | Mean Age | Age* Population |
|---|---|---|---|---|
| 001744 | 53015 | 137096790 | 28 7 | 74218 2 |
| 001744 | 45825 | 137749950 | 29 2 | 87775 2 |
| 001745 | 78192 | 75455280 | 43 2 | 41688 0 |
| 001745 | 66103 | 94395084 | 32 8 | 46838 4 |
| 001754 | 54539 | 71009778 | 36 7 | 47783 4 |
| 001754 | 57992 | 200362360 | 32 5 | 112287 5 |
| **TOTAL** | **355666** | **716069242** | **32.20** | **410590.7** |
| **Mean Income** | **56197** | | | |

| Block Group | Average Household Size | Education Level |
|---|---|---|
| 001744 | 1 67 | bachelors |
| 001744 | 2 12 | bachelors |
| 001745 | 2 66 | bachelors |
| 001745 | 2 36 | bachelors |
| 001754 | 2 15 | bachelors |
| 001754 | 2 02 | bachelors |
| **TOTAL** | **2.00** | **High Level** |

# DATA TABLES FOR MARTIN LUTHER KING NEIGHBORHOOD

| Block Group | Population | White | African American | Inuit | Asian | Hawaiian | Other | Multiple Race | Hispanic |
|---|---|---|---|---|---|---|---|---|---|
| 000802 | 965 | 133 | 656 | 4 | 4 | 0 | 147 | 21 | 291 |
| 000802 | 737 | 129 | 475 | 10 | 0 | 0 | 105 | 18 | 215 |
| 000802 | 1654 | 184 | 701 | 12 | 16 | 0 | 670 | 71 | 866 |
| 000803 | 917 | 142 | 481 | 0 | 0 | 0 | 277 | 17 | 397 |
| 000803 | 649 | 134 | 339 | 4 | 0 | 0 | 157 | 15 | 262 |
| 000803 | 681 | 224 | 321 | 11 | 2 | 1 | 107 | 15 | 177 |
| 000804 | 1257 | 312 | 486 | 13 | 0 | 0 | 409 | 37 | 701 |
| 000804 | 1277 | 247 | 612 | 15 | 3 | 0 | 375 | 25 | 557 |
| **TOTAL** | **8137** | **1505** | **4071** | **69** | **25** | **1** | **2247** | **219** | **3466** |
| **Percent** | | **18.00%** | **50.00%** | **0.80%** | **0.30%** | **0.00%** | **27.60%** | **2.60%** | **42.50%** |

| Block Group | Vacant Homes | Owned Homes | Rented Homes | Total | Percent Owned |
|---|---|---|---|---|---|
| 000802 | 35 | 243 | 120 | 398 | 61% |
| 000802 | 19 | 57 | 232 | 308 | 18% |
| 000802 | 10 | 127 | 348 | 485 | 26% |
| 000803 | 28 | 171 | 152 | 351 | 48% |
| 000803 | 18 | 101 | 105 | 224 | 45% |
| 000803 | 42 | 113 | 163 | 318 | 35% |
| 000804 | 42 | 138 | 268 | 448 | 30% |
| 000804 | 36 | 173 | 281 | 490 | 35% |
| **TOTAL** | **230** | **1123** | **1669** | **3022** | **298%** |
| | | **Total Owner Occupancy Mean 37%** | | | |

| Block Group | Income | Income* Population | Mean Age | Age* Population |
|---|---|---|---|---|
| **000802** | 27250 | 26296250 | 35 8 | 34547 0 |
| **000802** | 10313 | 7600681 | 33 6 | 24763 2 |
| **000802** | 10791 | 17848314 | 17 0 | 28118.0 |
| **000803** | 25625 | 23498215 | 31 7 | 29068 9 |
| **000803** | 23162 | 15032318 | 30 0 | 19470 0 |
| **000803** | 26971 | 18367251 | 30 9 | 21042 9 |
| **000804** | 16563 | 20819691 | 25 2 | 31676 4 |
| **000804** | 19716 | 25177332 | 30 7 | 39203 9 |
| **TOTAL** | **160391** | **154640052** | **28.00** | **227890.3** |
| **Mean Income** | **19004** | | | |

| Block Group | Average Household Size | Education Level |
|---|---|---|
| **000802** | 2 66 | hıgh school graduate |
| **000802** | 2 40 | bachelors |
| **000802** | 3 48 | hıgh school graduate |
| **000803** | 2 84 | hıgh school graduate |
| **000803** | 2 96 | hıgh school graduate |
| **000803** | 2 46 | hıgh school graduate |
| **000804** | 3 05 | hıgh school graduate |
| **000804** | 2 81 | hıgh school graduate |
| **TOTAL** | **2.69** | **Low Level** |

# DATA TABLES FOR TEXAS OAKS

| Block Group | Population | White | African American | Inuit | Asian | Hawaiian | Other | Multiple Race | Hispanic |
|---|---|---|---|---|---|---|---|---|---|
| **001732** | 4281 | 3309 | 201 | 31 | 189 | 1 | 422 | 128 | 1049 |
| **001732** | 334 | 296 | 0 | 3 | 2 | 2 | 26 | 5 | 40 |
| **001748** | 2009 | 1691 | 65 | 10 | 17 | 0 | 177 | 49 | 381 |
| **001748** | 283 | 254 | 3 | 1 | 2 | 1 | 21 | 1 | 50 |
| **002407** | 382 | 338 | 0 | 0 | 2 | 0 | 33 | 9 | 55 |
| **002407** | 1983 | 1664 | 39 | 6 | 17 | 1 | 194 | 62 | 456 |
| **002421** | 2726 | 1896 | 147 | 10 | 67 | 1 | 524 | 81 | 937 |
| **TOTAL** | **11998** | **9448** | **455** | **61** | **296** | **6** | **1397** | **335** | **2968** |
| **Percent** | | **78.7%** | **3.7%** | **0.5%** | **2.4%** | **0.0%** | **11.6%** | **2.7%** | **24.0%** |

| Block Group | Vacant Homes | Owned Homes | Rented Homes | Total | Percent Owned |
|---|---|---|---|---|---|
| **001732** | 113 | 1373 | 99 | 1585 | 86% |
| **001732** | 3 | 108 | 18 | 129 | 83% |
| **001748** | 14 | 500 | 257 | 771 | 64% |
| **001748** | 6 | 79 | 28 | 113 | 69% |
| **002407** | 9 | 134 | 24 | 167 | 80% |
| **002407** | 30 | 620 | 71 | 721 | 85% |
| **002421** | 21 | 774 | 192 | 987 | 78% |
| **TOTAL** | **196** | **3588** | **689** | **4473** | **545%** |
| | **Total Owner Occupancy Mean 77%** | | | | |

| Block Group | Income | Income* Population | Mean Age | Age*Population |
|---|---|---|---|---|
| **001732** | 78010 | 333960810 | 31 2 | 133567 2 |
| **001732** | 66250 | 22127500 | 41 7 | 13927 8 |
| **001748** | 70417 | 141467753 | 34 2 | 68707 8 |
| **001748** | 29940 | 8473020 | 36 2 | 10244 6 |
| **002407** | 50972 | 19471301 | 44 8 | 17113 6 |
| **002407** | 70721 | 140239743 | 39 6 | 78526 8 |
| **002421** | 54606 | 148855956 | 32 3 | 88049 8 |
| **TOTAL** | **420916** | **814596083** | **34.10** | **410137.6** |
| **MEAN INCOME** | **67894** | | | |

| Block Group | Average Household Size | Education Level |
|---|---|---|
| **001732** | 2 91 | bachelors |
| **001732** | 2 65 | high school graduate |
| **001748** | 2 62 | bachelors |
| **001748** | 2 64 | high school graduate |
| **002407** | 2 42 | high school graduate |
| **002407** | 2 86 | high school graduate |
| **002421** | 2 80 | high school graduate |
| **TOTAL** | **2.68** | **Low Level** |

# DATA TABLES FOR WEST ALLANDALE

| Block Group | Population | White | African American | Inuit | Asian | Hawaiian | Other | Multiple Race | Hispanic |
|---|---|---|---|---|---|---|---|---|---|
| 000101 | 825 | 788 | 4 | 1 | 8 | 0 | 5 | 19 | 42 |
| 000201 | 675 | 637 | 8 | 5 | 7 | 0 | 13 | 5 | 43 |
| 000201 | 725 | 586 | 63 | 8 | 9 | 0 | 39 | 20 | 99 |
| 001501 | 695 | 598 | 13 | 6 | 15 | 0 | 49 | 14 | 106 |
| 001501 | 942 | 896 | 5 | 8 | 9 | 0 | 12 | 12 | 60 |
| 001501 | 530 | 514 | 0 | 0 | 2 | 0 | 7 | 7 | 25 |
| 001501 | 1492 | 1417 | 9 | 6 | 9 | 1 | 27 | 23 | 95 |
| 001501 | 936 | 893 | 1 | 3 | 23 | 0 | 4 | 12 | 36 |
| 001817 | 1324 | 925 | 87 | 15 | 66 | 2 | 191 | 38 | 363 |
| 001817 | 1285 | 1145 | 35 | 6 | 28 | 0 | 44 | 27 | 147 |
| 001817 | 299 | 249 | 4 | 1 | 11 | 0 | 31 | 3 | 46 |
| 001817 | 1045 | 885 | 18 | 2 | 35 | 2 | 70 | 33 | 154 |
| 001817 | 349 | 325 | 3 | 0 | 7 | 0 | 7 | 7 | 31 |
| **TOTAL** | **11122** | **9858** | **250** | **61** | **229** | **5** | **499** | **220** | **1247** |
| **Percent** | | **88.00%** | **2.00%** | **0.50%** | **2.00%** | **0.01%** | **4.00%** | **1.90%** | **11.00%** |

| Block Group | Vacant Homes | Owned Homes | Rented Homes | Total | Percent Owned |
|---|---|---|---|---|---|
| 000101 | 10 | 295 | 105 | 410 | 71 0% |
| 000201 | 6 | 253 | 69 | 328 | 77 0% |
| 000201 | 9 | 56 | 456 | 521 | 10 0% |
| 001501 | 16 | 172 | 158 | 346 | 49 0% |
| 001501 | 9 | 349 | 62 | 420 | 83 0% |
| 001501 | 9 | 206 | 31 | 246 | 83 0% |
| 001501 | 9 | 538 | 128 | 675 | 79 0% |
| 001501 | 5 | 374 | 51 | 430 | 86 0% |
| 001817 | 20 | 66 | 661 | 747 | 8 0% |
| 001817 | 8 | 391 | 168 | 567 | 68 0% |
| 001817 | 1 | 36 | 148 | 185 | 19 0% |
| 001817 | 21 | 271 | 432 | 724 | 37 0% |
| 001817 | 1 | 121 | 31 | 153 | 79 0% |
| **TOTAL** | **124** | **3128** | **2500** | **5752** | **749%** |
| | **Total Owner Occupancy Mean 57%** | | | | |

| Block Group | Income | Income* Population | Mean Age | Age* Population |
|---|---|---|---|---|
| **000101** | 63542 | 52422150 | 36 3 | 29947 50 |
| **000201** | 57500 | 38812500 | 38 5 | 25987 50 |
| **000201** | 20114 | 14582650 | 52 3 | 37917 50 |
| **001501** | 47750 | 33186250 | 39 3 | 27313 50 |
| **001501** | 66848 | 62970816 | 40 5 | 38151 00 |
| **001501** | 77114 | 40870420 | 38 2 | 20246 00 |
| **001501** | 61394 | 91599848 | 43 4 | 64752 80 |
| **001501** | 72045 | 67434120 | 46 8 | 43804 80 |
| **001817** | 36703 | 48584772 | 28 8 | 38131 20 |
| **001817** | 61838 | 79461830 | 37 4 | 48059 00 |
| **001817** | 54219 | 16211481 | 36 1 | 10793 90 |
| **001817** | 30476 | 31847420 | 43 3 | 45248 50 |
| **001817** | 90538 | 31597762 | 39 3 | 13715 70 |
| **TOTAL** | **740081** | **609582019** | **39.9** | **444068.90** |
| **MEAN INCOME** | **54808** | | | |

| Block Group | Average Household Size | Education Level |
|---|---|---|
| **000101** | 2 06 | bachelors |
| **000201** | 2 10 | bachelors |
| **000201** | 1 42 | bachelors |
| **001501** | 2 09 | bachelors |
| **001501** | 2 29 | bachelors |
| **001501** | 2 24 | some college, no degree |
| **001501** | 2 22 | bachelors |
| **001501** | 2 20 | bachelors |
| **001817** | 1 82 | bachelors |
| **001817** | 2 30 | bachelors |
| **001817** | 1 63 | bachelors |
| **001817** | 1 49 | bachelors |
| **001817** | 2 30 | high school graduate |
| **TOTAL** | **1.93** | **High Level** |

# REFERENCES


Alexander, Judd H. 1993. *In defense of garbage.* Westport, CT: Praeger Publishers.

Capital Area Planning Council. 2002. *Solid waste management plan.* Austin, TX: Capital Area Planning Council.

City of Austin. 2001. *Participation survey 2001: Recycling, yard trimmings and garbage program participation.* Austin, TX: Solid Waste Services, Research and Planning.

Chertow, Marian R. 1989. *Garbage solutions. A public official's guide to recycling and alternative solid waste management technologies.* The United States Conference of Mayors. National Resource Recovery Association.

Ellis, H.M., W.E. Gilbertson, O. Jaag, D.A. Okun, H.I. Shuval, and J. Sumner. 1969. *Problems in community wastes management.* Belgium. World Health Organization.

Environmental Protection Agency. 2000. *Municipal solid waste in the United States: 2000 Facts and figures executive summary.* Office of Solid Waste and Emergency Response. June.

______."First Official Texas Recycling Rate: 37 Percent!" *Texas recycler market news* [on-line]. November 1998; available from http://www.tnrcc.state.tx.us/admin/topdoc/pd/008; Internet; accessed 1 March 2003.

Grass Roots Recycling Network. 2000. Wasting and recycling in the United States 2000. Washington, DC: Institute for Local Self-Reliance.

Krieth, Frank and George Tchobanoglous, ed. 2002. *Handbook of solid waste management. Solid waste stream characteristics,* by Marjorie A. Franklin. New York: NY McGraw-Hill.

Lund, Herbert F, ed. 2001. *The McGraw-Hill recycling handbook. Processing yard waste,* by Richard J. Hlavka. New York: NY McGraw-Hill.

Manitowoc Herald Times Reporter. 2003. "Home ownership still a strong investment" [on-line]. Manitowoc, WI: Manitowoc Herald Times Reporter; available from http://www.wisinfo.com/heraldtimes/news/archive/biz_9882106.shtml; Internet. Accessed on 21 May 2003.

Murphy, Cullen and William Rathje. 1992. *Rubbish!* New York: NY Harper Collins.

Reynolds, Mary Ann. 1993. *Social change and solid waste management: A study of social attitudes and behavior*. Austin, TX: University of Texas at Austin.

Texas Environmental Profiles. 2000. *Municipal Solid Waste in Texas*. Second Edition. Austin, TX. University of Texas Press.

Texas Commission on Environmental Quality. 2001. International Waste [on-line]. February 2001. Available at: http://www.tnrcc.state.tx.us/permitting/wasteperm/ihwperm/int_wast.html; Internet; accessed 27 March 2003.

Texas Commission on Environmental Quality. 2002. *Municipal solid waste in Texas: A year in review, 2001 data summary and analysis*. Austin, TX: TCEQ

Watts, Allan. 1998. *The Texas recycling rate project*. Texas Commission on Environmental Quality. Austin, TX: TCEQ

US Census Bureau. 2000. American Fact Finder. *Census 2000 data sets* [on-line]. Available at: http://factfinder.census.gov; Internet; accessed 20 March 2003.

## VITA

Meredith Kathryn Greene was born in Norman, Oklahoma, on June 11, 1979, the daughter of Alison Joan Greene and Donald Miller Greene. After graduating in 1997 from Robinson High School, Waco, Texas, she entered into Sam Houston State University in Huntsville, Texas. She attended SHSU until August of 2000, when she transferred to Texas Tech University, Lubbock, Texas. Meredith graduated with a Bachelor of Arts Geography in 2001. In the fall of 2001, she studied at San Diego State University and completed preparatory graduate work in downtown gentrification. She entered into Southwest Texas State University, San Marcos, Texas, in the spring of 2002. Meredith worked for three semesters as a graduate assistant, instructing undergraduate geographic information science and field methods labs. In the summer of 2002, she worked an internship as an Engineering Technician for the Texas Commission on Environmental Quality. Meredith now plans to continue learning more about landuse planning and hopes to join a private consulting firm while continuing her travels.

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