Recycling and Solid Waste Management in Montes de Oca, San José, Costa Rica

Patricia Adamson ~ Emily Allietta ~ Melissa King

July 6, 2006

Dr. Ronald Arrieta Calvo
School of Chemistry
University of Costa Rica
San José, Costa Rica

Dear Dr. Arrieta,

We have included our report entitled "Improved Waste Management in Montes de Oca, San José, Costa Rica." This document was written in Costa Rica from May 13 to July 6 of 2006 with the preliminary work being completed in Worcester, Massachusetts from March 14 to May 2 of 2006. Copies of this report are being submitted simultaneously to Professors Mello, DiBiasio and Salazar for evaluation. Upon faculty review, the original will be catalogued in the Gordon Library of Worcester Polytechnic Institute. We appreciate the time that you and Mr. Gerardo Madrigal Aguilar have devoted to our team. We hope that our project will help with the institution of a permanent program within the community.

Sincerely,

Patricia Adamson

Emily Allietta

Melissa King

Recycling and Solid Waste Management in Montes de Oca, San José, Costa Rica

Report Submitted to:

Professor Natalie Mello

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Professor David DiBiasio

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Professor Guillermo Salazar

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Costa Rica, Project Center

By

Patricia Adamson _____

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In Conjunction with

Dr. Ronald Arrieta Calvo, Professor of Chemistry at the University of Costa Rica

July 6, 2006

This Interactive Qualifying Project Report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the opinions of Dr. Ronald Arrieta or Worcester Polytechnic Institute.

This report is the product of an education program and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

While working with Dr. Arrieta from the School of Chemistry at the University of Costa Rica in San José, we researched previous recycling programs in Costa Rica, surveyed residents of the area, conducted interviews with community officials in Montes de Oca, began a pilot recycling program in this community. This project established possible reasons for previous programs' successes and failures, provided a socio-economic breakdown of community opinion towards solid waste disposal and recycling, and provided suggestions for best practices in recycling.

Authorship

All parts of the writing, editing and execution of this project were completed equally by all members of the project team.

Acknowledgements

We would like to thank our sponsor, Dr. Ronald Arrieta Calvo from the School of Chemistry at the University of Costa Rica, and Gerardo Madrigal Aguilar, from the Municipality of Montes de Oca, for their help in completing our project. We would also like to thank the Municipality of Montes de Oca for their help and cooperation with the solid waste collection.

Thanks also are extended to our advisors, Professors Natalie Mello, David DiBiasio, and Guillermo Salazar for steering us in the right direction and consistently helping with improvements on our report.

We would also like to extend our gratitude to Susan Vernon-Gerstenfeld and James and Marcela Music for the coordination of our project.

Lastly, we would like to thank the residents of Barrios Sinaí, Urbanización El Rodeo, and Barrio La Granja for their cooperation and participation throughout the project.

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Executive Summary

Throughout the world, solid waste management has become a growing environmental concern. In San José, Costa Rica, the problem has been recognized. The municipality of Montes de Oca has examined their solid waste management program, and determined the different factors affecting the increase in solid waste. Being an environmentally conscious country, Costa Rica would prefer to conserve land for parks or recreational areas than create new landfills (Baker, 2006). This has inspired the government to promote recycling within its communities. For our project, we worked in conjunction with Dr. Ronald Arrieta Calvo, a professor in the School of Chemistry, at the University of Costa Rica, to improve the solid waste management methods in Montes de Oca, a cantón of San José. The government of Montes de Oca is attempting to reduce the abundance of solid waste by promoting a reuse and recycle program. Our project was to determine the feasibility of a recycling program in Montes de Oca.

For the project we developed several objectives:

- Conduct a survey to determine the community's interest in recycling based on socio-economic factors in addition to identifying factors of a recycling program that would encourage greater levels of participation.
- Conduct a trial recycling program in three barrios to determine the total volume and mix of reusable materials that an average household in Montes de Oca produces in an typical week;
- Determine the market value of different recycled materials (including paper, plastic, glass and aluminum) in the region.
- Determine the investment necessary to start a recycling program, including labor and materials (such as informational brochures, recycling bins, etc.).

In order to attain the objectives listed above we employed several methods including interviews with personnel from other recycling programs in Costa Rica, identified representative households to begin the trial program, conducted an in-person survey with

the representative households, and collected solid waste from those households for three consecutive weeks.

We interviewed personnel from the Santa Ana recycling center to determine what makes a recycling program successful. They provided us with information about which campaigning tactics worked for their community as well as which recyclable companies purchased their recyclables.

Our team used three different socio-economic levels, represented by different barrios in Montes de Oca, to conduct the in-person surveys and the trial recycling program. The levels ranged from poor to medium to wealthy.

. We used the information gathered through the project to determine how socio-economic levels affect the participation in recycling. After finding which neighborhoods we would use, we helped Dr. Arrieta to design an in-person survey; this was conducted throughout the different barrios to receive a higher return rate from the residents and increase the participation rate in the trial recycling program that followed the surveys. The trial recycling program was conducted for three weeks in three barrios. During this time, the residents separated their solid waste into three groups (reusable (recyclable), non-usable and biodegradable materials) so our team could determine the average number of recyclables produced weekly.

We distributed the in-person survey to ten households in each barrio for a total of 30 surveys. We were able to receive a seventy seven percent return rate on the survey that left us with 23 surveys in total to use for our analysis. From the data collected with the surveys we were better able to understand the residents' thoughts and interests towards the current solid waste management system, what improvements they would like to see made and their opinions on a future recycling system.

While conducting the survey, we moved into the next phase of the project, waste collection. The data that we received from the collection and separation of the materials in the barrios was recorded into a matrix to better understand and analyze the data.

The data that we received from both parts of our field research showed that there is a connection between recycling participation and socio-economic levels. Although we found that the medium and wealthy levels produced more recyclable material, we also

found that the poor socio-economic level was more willing to participate in the trial program, any future recycling program or educational program in Montes de Oca.

From the determination of the common practices and opinions of the residents we were able to compile possible recommendations for improvements to the current waste management system. We determined that a recycling program is feasible from the data gathered about the economics of the program and the participation rates of the community. Therefore, our team recommends the integration of a permanent recycling program in Montes de Oca.

We also found that there is a lack of recycling education in Montes de Oca. For this reason we have recommended that recycling educational materials, such as a pamphlet, be available to residents. We recommend a pamphlet, a visual aid, which would contain detailed information about the types of recyclables and services available, along with other types of waste management options.

The implementation of a permanent recycling program will be a huge step in reduction of solid waste in Montes de Oca, while keeping in mind the needs and wants of the residents in the community.

1 Introduction

This report was prepared by members of Worcester Polytechnic Institute Costa Rica Project Center. The relationship of the University of Costa Rica, Escuela de Quimica and the relevance of the topic to the University of Costa Rica, Escuela de Quimica are presented in Appendix A.

Throughout the world, solid waste management has become a growing environmental concern. In San José, Costa Rica, the problem has been recognized. The municipality of Montes de Oca has examined their solid waste management program, and determined the different factors affecting the increase in solid waste. Over the past twenty years, Costa Rican's population has doubled from 2,723,111 in 1986 to 4,075,261 in 2006 (http://www.census.gov/). With population increases and doubled rainfall, solid waste disposal has become a major problem. In July 2005, Costa Rica produced 16,869 tons of solid waste per week, the majority of which was sent to landfills (http://www.ifam.go.cr/PaginaIFAM/docs/estadodesituaciondesechossolidos..pdf). Costa Rica declared inviolate 27.27 percent of its land area for places such as forest reserves, buffer zones, wildlife refuges, and Indian reserves (Baker, 2006). Costa Rica is quickly expending the remaining land with landfills. Being an environmentally conscious country, Costa Rica would rather use the land for parks or recreational areas (Baker, 2006). This has inspired the government to promote recycling within its communities. A handful of cities in Costa Rica, such as Santa Ana, have begun implementing recycling programs as early as 1998.

For our project, we worked in conjunction with Dr. Ronald Arrieta Calvo, a professor in the School of Chemistry, at the University of Costa Rica, and COOPEMUJER, a women's cooperative, to improve the solid waste management methods in Montes de Oca, a cantón of San José shown in Figure 1. The government of Montes de Oca is attempting to reduce the abundance of solid waste by promoting a reuse and recycle program. After meeting with Dr. Arrieta and Sonia Montero, the Mayor of Montes de Oca, we found that the previous attempt at a recycling program in Montes de

Oca failed due to a political struggle that resulted in the withdrawal of governmental support forcing the program to end (Personal Communication, May 25 and 26, 2006).

Figure 1: Map of San José
Source: http://www.1-costaricalink.com/costa_rica_images/costa_rica_san_jose/san_jose_costa_rica_map.gif

Through research we found that there are several factors which lead to successful recycling program implementation. The most important aspects of these programs are an emphasis on community education as well as incentives and penalties to encourage recycling. Costa Rica has implemented several recycling programs employing these tactics in many cantons including Nosara, Escazú, Santa Ana and Heredia. Two communities in which these techniques have also been proven effective in the United States are Seattle, Washington and Clearwater, Florida.

Our project goal was to determine the feasibility of a successful recycling program in Montes de Oca. In order to achieve this goal we identified five objectives.

The project's objectives are:

- Conducted a recyclable inventory to determine the total volume and mix of recyclable materials that typical households in the Montes de Oca community generated in an average week;

- Determined the market value per kilogram of different recycled materials (including paper, plastic, glass and aluminum) in the region.
- Conducted a survey that:
    - Determined the degree of interest within the community toward recycling, which indicated the likely rates of community participation in the new program;
    - Evaluated the role socio-economic factors are likely to play in participation rates.
- Determined the amount of recyclables that must be collected in order to make a profit.
- Determined the investment necessary to establish a recycling program, including labor and material costs (such as informational brochures, recycling bins, etc.).

The project team estimated the amount of recyclables that were likely to be collected in a typical month, and calculated the net profit as a function of total revenues according to the prevailing prices for recyclables and the total monthly program costs. The revenue and cost projections allowed us to determine the feasibility of a recycling program in Montes de Oca. In addition, we presented a set of recommendations for Dr. Arrieta and COOPEMUJER to consider in designing the proposed program. We hope that through this research, our project assisted our sponsor in establishing a successful, self-sustaining recycling program in Montes de Oca.

2 Background

Waste management is a growing concern in many countries around the world, including Costa Rica. As of July 2005, Costa Rica's population of 4,016,173 produced 16,869 tons of solid waste per week, most of which was deposited into landfills and incinerators as shown in Figure 2. Environmental factors, such as increases in both rainfall and population (has doubled from 2,723,111 in 1986 to 4,075,261 in 2006 (http://www.census.gov/)), have increased waste management concerns in San José, Costa Rica. These environmental issues lead to the clogging of sewer drains. Sewer drains are expensive to clean and repair and also create health concerns (Personal Communication, May 15, 2006). In order to promote better waste management practices, such as recycling, we must first evaluate the current waste management program.

REGION	P.D.S Municipales (ton/sem)	% Cobertura
Región Central	11,839	79
Región Chorotega	1,368	58
Región Huetar Norte	781	65
Región Huetar Atlántica	1,119	68
Región Brunca	721	45
Región Pacífico Central	1,041	76
	16,869	72

Figure 2: Weekly Solid Waste Production in Costa Rica
Source: http://www.ifam.go.cr/PaginaIFAM/docs/estadodesituaciondesechossolidos..pdf

This section will discuss:

- General solid waste management methods;
- Benefits of recycling; and
- Waste management programs in the United States.

2.1 Solid Waste Management Methods

Solid waste management systems consist of three major aspects of management methods: generation, collection, and disposal (Powell, 1996). Nearly 100% of solid waste produced is deposited into landfills or incinerators with very little of the solid

waste composted or recycled. As shown in Figure 3, found in Waste Management in Costa Rica and the United States, 90% of the solid waste generated is usable through biodegrading, directly reusing, or recycling.

Waste removal is an expensive process and has created many environmental problems; therefore, many communities in Costa Rica, such as Nosara, Escazú and Santa Ana, have transferred their methods for waste reduction into reuse and recycling programs according to Sonia Montero, the Mayor of Montes de Oca (Personal Communication, May 15, 2006). In order to decrease illegal dumping and increase community participation in a recycling program, a cheap, effective, and efficient program must be established.

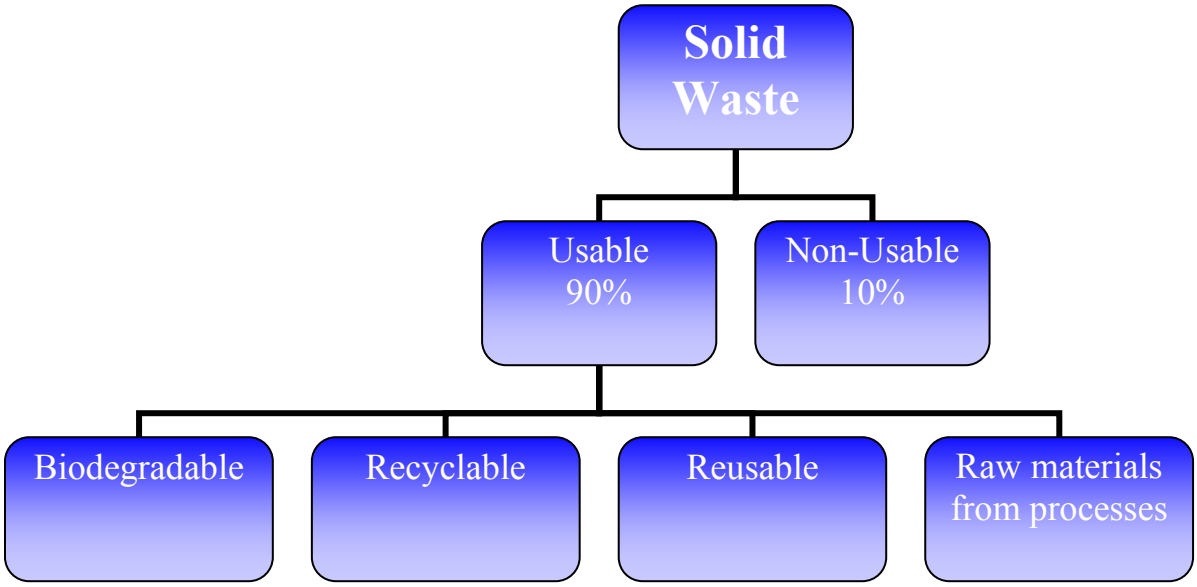


Figure 3: Arrieta's Model for the Categories of Solid Waste in Costa Rica
Source: *Solid Waste Management in Costa Rica and the United States.*

2.1.1 Landfills

As of 2000, there were 50 landfills located in Costa Rica (www.netsalud.sa.cr/ms/ministe/memoria/me2000/prote.htm). A major landfill located in La Unión de Cartago of San José is Río Azul. This landfill receives about 700 metric

tons of solid waste per day from 10 metropolitan cantons. Among these cantons are Montes de Oca, Tibás, Escazú and Moravia who pay 5,500 colones for the treatment of one metric ton of solid waste. Recently, legislation was passed to permanently close Río Azul in November of 2006 because of a lack of treatment to the solid waste that is being deposited there (Villegas, 2006). The 10,000 metric tons of solid waste that are uncovered and exposed to the air are generating environmental contamination in addition to the proliferation of rodents, flies and buzzards in the area.

The solid waste that is deposited every day should be covered with 10 centimeters of soil every day to discourage the existence of bad odors and animals. There were previous attempts to close Río Azul; however, the landfill remained open because there was no other landfill in which to deposit the solid waste (Villegas, 2006).

The two other major landfills located in the country are La Carpio and Los Mangos (Guide for Economic Sustainability and Quality Life of San José, 2003). The municipalities are responsible for solid waste collection and disposal (http://www.paho.org/Spanish/SHA/prflCOR.htm). The main benefit of a landfill in the short term is that it is less expensive than an incinerator or a recycling program (http://www.abetterearth.org/article.php/871.html). However, negative affects on the environment such as leaks and the release of green house gases greatly outweigh the reduction in cost (http://www.physicalgeography.net/fundamentals/7h.html).

A landfill is composed of several different parts; each protects the environment if they work properly. Unfortunately these components are vulnerable to material failure. For example, clay liners have natural cracks and crevices that permit environmental pollution. Benzene, along with other organic molecules, can diffuse through the clay, or even decompose the liner. In recent years, benzene, which is an organic molecule, has been found as a carcinogen. (http://www.osha.gov/SLTC/benzene/index.html). Recently various landfills began using humus, as described in Composting, the next section, as a cover to effectively reduce methane gas emissions by 100 percent.

2.1.2 Composting

Composting is the decomposition of organic materials, such as food and yard wastes, that after time become humus which is used as a natural fertilizer (http://vegweb.com/composting/). A benefit of composting is that many materials may be used. Some of these materials are food waste, yard waste, manure, and woodchips or sawdust. After breaking down, the humus is used to fertilize agriculture and other areas because of its benefits that include an increase in solid organic matter, water holding capacity, and nutrients in the soil such as: nitrogen, magnesium and sulfur which are slowly released into the surrounding soil (http://www.compost.me.uk/html/compost_use_in_agriculture.html). Because of its fibrous texture, compost is able to hold more water which prevents erosion (http://www.compost.me.uk/html/compost_use_in_highway_schemes.html), making it useful on road sides in addition to agriculture.

Composting has disadvantages because of the amount of time that it takes for the organic materials to break down into humus. Aeration is required to maintain the proper percentage of nitrogen, oxygen and nutrients throughout the compost heap (http://journeytoforever.org/compost_make.html). There is evidence that composting the wrong materials, such as pressure treated wood, may leach arsenic or chromium that is poisonous for the soil. Chromium has been proven to instigate lung cancer (http://www.atsdr.cdc.gov/tfacts7.html#bookmark06).

EARTH, la Escuela de Agricultura de al Región Tropical Húmeda, opened in Guacimo, Limón in Costa Rica in 1990. EARTH teaches and promotes the benefits and uses of composting in addition to offering a professional education in natural resources and the agricultural sciences (http://www.earth.ac.cr/ing/index.html). The methods EARTH uses attempt to change the common agricultural chemicals to methods such as composting. Costa Rica is known for their agricultural harvesting, such as coffee and bananas, which are the most exported goods. Both the environment and production are promoted by using the methods taught at EARTH. In this way Costa Rica uses composting to help improve its country's economy. (http://www.emro.co.jp/english/library/gallery/2001panels/panelcostarica.html)

2.2 Benefits of Recycling

Recycling is the process by which materials are collected and remanufactured into new products (www.recyclethis.org/QP_Res_dictionary.html). Some types of materials that are classified as recyclables are aluminum and other metals, glass, paper, cardboard and plastics. Recycling and composting prevent reusable materials from being deposited into landfills and incinerators. For example in the United States, 64 million tons of materials were redirected from landfills and incinerators in 1999 (http://www.epa.gov/epaoswer/non-hw/muncpl/recycle.htm).

Communities use a variety of recycling methods such as curbside pick-up, drop-off centers, and deposit or refund programs. After collection, the recyclables are cleaned and separated, and then the materials are broken down to be reassembled into other products (http://www.epa.gov/epaoswer/non-hw/muncpl/recycle.htm#Process). According to the Environmental Protection Agency in the United States (EPA), by reusing these products, natural resources are conserved, energy used for manufacturing is decreased and the environmental impacts from extracting raw materials are reduced (1995).

An economical benefit of recycling is that as more people use a recycling program there is a decrease in the fuel costs, maintenance, and labor costs per truckload (Brower, Leon, 1999). Environmental benefits of recycling include a decrease in pollution emissions and energy (Brower, Leon, 1999). In a study done by the Franklin Associates, a typical curbside recycling program eliminates 620 pounds of carbon dioxide, 30 pounds of methane, and 5 pounds of carbon monoxide per ton of material processed. That same study found that it takes less than 25 percent of energy to produce aluminum cans from recycled cans than from virgin ore (Brower, Leon, 1999).

2.3 Does recycling pay?

There are still some skeptics who do not believe that recycling is beneficial to the economy. However, most data that shows recycling costs more money is from the beginning of the program. After the recycling program is established and more residents are participating in the program, generally the costs of recycling decline. According to Brower and Leon, the average in the United States for the cost of curbside recycling

programs is $173 per ton including the collection, separation and processing of the recyclable materials (1999).

Another aspect that is sometimes overlooked is that recyclable materials can pay for themselves. This is because the recyclables that are collected can be sold as raw materials that will be made into new products. The price of the materials depends on the economy and the demand on the product. For example in 1993 the average selling price of paper was $46 per ton. However, just two years later in 1995 there was an increase in the demand for recycled paper and the price rose to an average of $165 per ton (Brower, Leon, 1999).

When recycling programs become successful and are running smoothly they often are able to lower the cost of other solid waste disposal. The amount that the cost is lowered by varies on the location and the use of the recycling program. The average reduction of regular solid waste disposal is $31 per ton of material. However, there are exceptions where there are greater reductions such as in Seattle, Washington which saw a reduction in cost of $70 per ton (Brower, Leon, 1999).

From the study, "*Municipal Recycling Performance: A Public Sector Environmental Success Story,"* there is proof of further success from recycling programs as opposed to regular solid waste collection. From the study, on average regular solid waste collection costs were $131 per ton of material versus $85 per ton of material to recycle. The study also showed that the average costs for normal solid waste disposal were higher than those of recycling even if the revenue from the sale of the materials was not included (Folz, 1999).

2.4 Current Solid Waste Management in the United States

To reduce the amount of solid waste deposited in landfills and incinerators, the United States encourages different types of recycling and solid waste management programs. According to Figure 4 the United States has been able to increase its recycling percentage of solid waste and decrease the overall percentage of solid waste disposed in landfills. This decrease has evolved from the implementation of successful recycling

programs. The following sections will describe a few selected cities and their recycling programs.

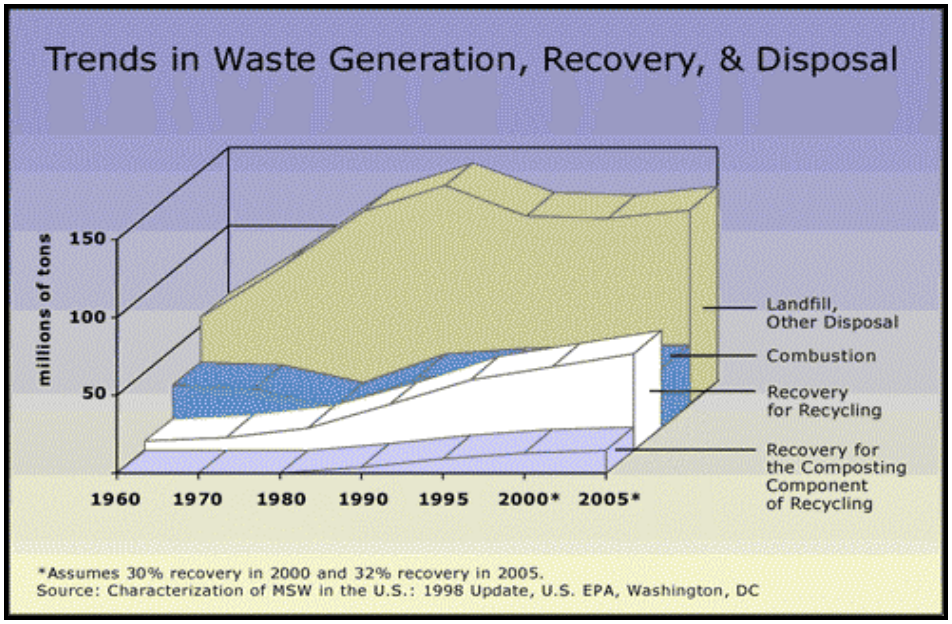


Figure 4: Waste Trends in the United States from 1960
Source: http://www.zerowasteamerica.org

2.4.1 Pay As You Throw

The Pay-As-You-Throw (PAYT) program was promoted by the United States Environmental Protection Agency as early as 1990. As of 2006 PAYT was used throughout communities in 45 out of the 50 states, shown in

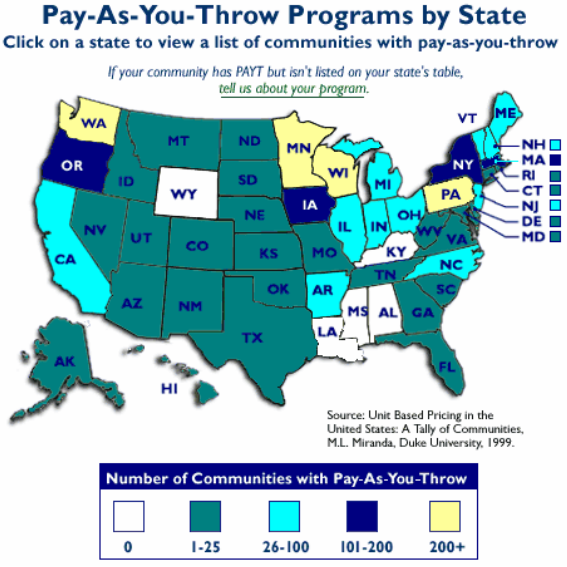


Figure 5.

Figure 5: Pay As You Throw by State
Source: http://www.epa.gov/epaoswer/non-hw/payt/comm-2.htm

PAYT programs charge residents based on the amount of solid waste being disposed of as opposed to paying for traditional disposal methods. This is accomplished because the residents buy predetermined bags, tags or stickers that allow them to dispose of certain amounts of waste. For example the bags often come in different gallon sizes such as 20 or 30 gallons. The residents are motivated to recycle more to reduce the amount they pay for waste disposal.

In communities without the PAYT program, solid waste disposal is an extra expense included in residential property taxes or is a standard fixed fee. PAYT encourages residents to use the program with the incentive of controlling a normal fixed expense. Residents not only save money, but help conserve the environment.

2.4.1.1 Worcester, Massachusetts

Worcester, Massachusetts began the PAYT program in 1992. Before the program was implemented, the recycling rate in Worcester was 3%. Immediately after the program was implemented, the city saw that the recycling rate became 36% (Canterbury, December 1998). Since the implementation of the program the City of Worcester has seen a total savings of 1.2 million dollars.

2.4.1.2 South Kingstown, Rhode Island

In 1994 South Kingstown, Rhode Island initiated a PAYT program. The Rose Hill Regional Transfer Station (RHRTS) noticed a decrease in the disposal of solid waste by the residents from fiscal year 1991 to 1994. The estimated amount of solid waste disposed of in 1991 was 7,608 tons. After the program was implemented in 1994, RHRTS estimated that the residents disposed 2,175 tons of solid waste (Canterbury, October 1997). The residents have reduced their waste to an average of one tagged bag and one bag of recyclables per week. Because of this they have been able to save forty dollars per month per household over the previous program, instead of paying for a sticker to use the town's landfill (Canterbury, October 1997).

2.4.1.3 Mount Vernon, Iowa

The PAYT program started in 1991 in Mount Vernon, Iowa in collaboration with a curbside recycling program. The project's goal was a 50% reduction in solid waste disposal by 2000. The project exceeded the expectations of the city by reducing the solid waste disposal over 50%. The city estimated that the amount of solid waste deposited into landfills decreased by 40% from 1990 to 1995. The total waste per person was 45 pounds per week in 1990. There was a reduction of the solid waste per person to 27 pounds per week in 1995 (Canterbury, October 1997).

2.4.2 Seattle, Washington

In Seattle, Washington legislation was passed on January 1, 2005 that banned residents and businesses from throwing away more than 10 percent by volume of recyclables as waste. If there are more than 10 percent recyclables with the other types of solid waste, the city is able to take action to encourage the residents' use of the program. The three steps that the city enacts are:

- a refusal to pickup the solid waste,
- a warning tag to remind residents to recycle. The warning tag is used as an educational device to explain to the resident how to separate the solid waste
- the residents are fined $50.

After a one year adjustment period, the city began enforcing the law. According to preliminary research, it is possible for the residents of Seattle to save two million dollars per year and reduce future garbage collection costs (http://www.ci.seattle.wa.us/util/About_SPU/Recycling_System/History_&_Overview/Ban_on_Recyclables_in_Garbage/index.asp). The residents were informed of the new legislation and also received recycling education to help promote the program. For example, the city uses a recycling pamphlet shown in Figure 23: Recycling Guide-Seattle, Washington. The guide states which items are acceptable for recycling and where they should be placed.

The curbside recycling collection is free for single-family homes and apartment houses but the recyclables are also accepted for free at recycling centers. Residents

subscribe to curbside yard debris collection in addition to backyard composting. The city charges less for trimmings compared to solid waste.

There are a few reasons for the institution of the recycling legislation. A main reason is that the solid waste in Seattle contains approximately 25 percent of paper, cardboard, aluminum cans, plastic bottles and yard debris which could have been composted or recycled (http://www.seattle.gov/util/About_SPU/Recycling_System/History_&_Overview/Ban_on_Recyclables_in_Garbage/index.asp). The city wants these recyclables to be sorted for placement into correct facilities, not placed into landfills. Another reason for the new legislation was because of the decline in recycling rates in Seattle from 1995. According to the *Seattle Daily Journal of Commerce*, possible reasons for the decline in the recycling program were a flat resale market for recyclables, the maturing of residential curbside pick-up programs and weak participation by businesses (2001).

2.4.3 Clearwater, Florida

As part of the team's research, we contacted officials in Clearwater, Florida because of its great success with recycling. Andy Fairbanks, the Pinellas County Waste Reduction Coordinator, over the years helped to drastically increase recycling in the county. Mr. Fairbanks explained how residents are encouraged to use available programs (personal communication, April 25, 2006). Clearwater makes recycling 'fun' by educating its residents and encouraging them to participate in different events (personal communication, April 25, 2006).

Clearwater's management methods have received awards because of their integrated solid waste management approach (personal communication, April 25, 2006). For example Clearwater received an award from The AF&PA Community Paper Recycling Awards for successful implementation of a recycling program (http://www.americanrecycler.com/0805af.shtml). In order to achieve such awards, the county processed different methods regarding how much they are willing to budget for a recycling program. In order to make the program successful, the county found ways to

encourage the residents to use the program. Clearwater educates the community through campaigns using newspapers, websites, radio, television, and school systems.

According to Mr. Fairbanks, recycling programs are market dependent; the program coordinator must know the audience and be able to reach the outside community (personal communication, April 25, 2006). Maintaining a recycling program consists of costs such as transportation, bins, and collection methods. Profitability is calculated through the difference of the amount recycled and investment costs.

In order to create interest among the residents you need to encourage them to use the program that is available (http://www.clearwater-fl.com/gov/depts/_solid waste/PDF/Solid wasteOrdinance10-99.pdf). For example, Clearwater holds a "Recycling Regatta" each year to encourage the residents to participate in recycling. The residents build boats out of recyclables, as shown in, which are then raced. After the race, the boats are dismantled and the materials are recycled. This year the Regatta was held on April 22, Earth Day with a total of 200 entrants and 67 boats.

2.5 Recycling in Costa Rica

As many other countries, Costa Rica is attempting to reduce the amount of solid waste generated by promoting reuse and recycle programs. The following sections describe several recycling programs that exist in Costa Rica.

2.5.1 Nosara

Currently there is a recycling program in Nosara, an area in the northwest region of Costa Rica on the Pacific coast. This program was established by the Micro Empresa para el Saneamiento Ambiental de Nosara (Arnulfo, 2005). This organization schedules solid waste collection for every Monday and Thursday. However, in order to participate in this program, there are many regulations which need to be followed. Before collection the recyclables must be separated from the non-usable materials. They must also be separated by the type of recyclable (e.g. aluminum, paper, etc.).

Residents aided in the success of this program by helping to fund the program and control their solid waste. The residents help to fund the program by paying a monthly fee to Micro Empresa para el Saneamiento Ambiental de Nosara on the last Sunday of every month. The residents are charged a service fee of ¢1,000 or $2.02 USD (June 29th, 2006), which pays for their solid waste collection and the exportation of the recyclables (http://www.oanda.com/convert/classic). This fee is either collected door-to-door or residents can pay at the local grocery store, Super Nosara.

They export their recyclables to Nicoya, a southern province on the Pacific coast in Costa Rica, and to Nicaragua because they are able to obtain a higher price for the recyclables.

2.5.2 San José

The current waste management program in the city of San José was developed by the Sección Urbana del Planeamiento y el Departamento del Saneamiento del Ambiente (The Urban Planning Section and the Environment Sanitation Department) (Guide for Economic Sustainability and Quality Life of San José, 2003). They handle the disposal of solid waste from residential, commercial and industrial communities. San José produces approximately 1400 tons of solid waste daily. In Costa Rica 47 percent of the municipalities dispose of their solid waste into landfills including San José (Costa Rica, n.d.). The three most known landfills in the country are Río Azul, La Carpio and Los Mangos (Guide for Economic Sustainability and Quality Life of San José, 2003). In addition, 60 percent of this waste is composed of food and organic materials. However, currently composting programs are not widespread in the city of San José.

2.5.3 Escazú

Escazú is a cantón located in the northern section of the province of San José. In 2002, 54,000 residents of Escazú produced 12,700 tons of solid waste per week, costing the city ¢213,610,046 ($435,352 USD) (June 29, 2006) for solid waste disposal (http://www.oanda.com/convert/classic). The cantón uses a biweekly curbside recycling program that has six trucks; five of which are used for solid waste disposal and one that is

used for the collection of recyclables. This curbside program is run by El Departamento de Obras Públicas de Escazú (The Escazú Department of Public Works) (Levesque et al. 2003). The program is managed by nineteen employees, hired in 2003, who offer curbside solid waste collection. The solid waste is then delivered to Río Azul, the local landfill. The department pays ¢3,400 ($6.92 USD) (June 29, 2006) per ton of solid waste disposed of into the landfill (http://www.oanda.com/convert/classic). The residents are also offered a recycling service that passes once a week to collect plastics, aluminum, paper, and glass. These recyclables are bought by recycling agencies for further processing by the department (Levesque et al. 2003).

2.5.4 Santa Ana

Santa Ana, is a cantón located directly west of the cantón of Escazú and has a population of 39,476 (Levesque *et al* . 2003). The specific areas of economic production in Santa Ana include farming, the food and industry and structural product manufacturing. The residents fund this program buy paying 1,200 colones ($2.43) monthly (June 29, 2006, http://www.oanda.com/converter/classic). In 2002, the municipality produced 10,000 tons of waste, costing 168, 545,698 colones ($343,508 USD) (June 29, 2006) for removal and disposal (http://www.oanda.com/converter/classic). However, Santa Ana experienced a 31% shortage in removal costs, obtaining only 117,000,000 colones ($238,454 USD) (June 29, 2006) from the community (http://www.oanda.com/converter/classic).

The recycling center in Santa Ana began in 1998 by the municipality in cooperation with parents of mentally handicapped children. The program was begun to provide mentally handicapped with job experience and opportunities. The program also provides the employees with other opportunities such as learning other skills a few times a week. (Personal Communication, June 6, 2006).

The center currently employ's 25 people including Liliana Umaña, the manager of the program. The recycling center's services are available throughout Santa Ana which has about 35,000 residents. The program has increased community interest through pamphlets in addition to door to door campaigning which is shown by the increase in

participation in the program. Residents have even started to bring their recyclables directly to the center. The project has become very successful throughout the years and is capable of handing 40,000 metric tons of recyclables per month (personal communication, June 6, 2006).

2.5.5 Alfaro Ruiz

In September 2005 the Municipality of Alfaro Ruiz began a cantón wide recycling program. By initiating the recycling program, the cantón is able to reduce their solid waste by 30 metric tons per month. The revenue from the sale of the materials directly benefits a women's cooperative, la Asociación de Mujeres Ambientalistas de Alfaro Ruiz (AMAR). AMAR is run by five women who collect all of the recyclables, including glass, cardboard, aluminum, paper and plastic, from the residents in the cantón every Wednesday. The women were given 12 million colones to buy a collection truck which they adapted so that there would be a compartment for each type of recyclable material.

The community was informed by surveys throughout the community as well as an educational program in the schools. There were informative lectures given in the schools about the importance of recycling. The children were encouraged to pass on this information back into the community (Rita Mora, 2006).

2.6 Waste Management Legislation in Costa Rica

In 1981 legislation in Costa Rica was passed to regulate waste management within the country. These laws dictate who is responsible for the pick up of the waste and appropriate facilities for waste disposal. An excerpt of this legislature is Article 270 states: "All persons, natural or legal are prohibited from throwing or accumulating solid waste in places not authorized for that effect, to use inadequate means for transportation of solid waste, accumulation and behavior to its use, treatment or final disposition by means of systems not approved by the Ministry." However, this legislation is not strictly enforced as shown below in Figure 6.

Figure 6: Solid Waste Disposed Near the University of Costa Rica

3 Methodology

The goal of our project was to help Dr. Ronald Arrieta, from the University of Costa Rica, establish a recycling program in the Cantón of Montes de Oca as a method to reduce solid waste within that community. By assessing community practices we identified key concerns and solutions to help ease the integration of a recycling program into their waste management system.

The project had six objectives. They were to:

- determine the level of willingness for participation in a recycling program and the residential knowledge of the current solid waste management in Montes de Oca;
- discuss the importance of recycling with the residents of Montes de Oca and show them how to separate their solid waste into three groups (biodegradable, reusable and non-reusable).
- To determine the amount of recyclable material available in Montes de Oca for the use in a recycling program.
- determine the Costa Rican market value for different types of recyclables; and
- conduct a financial analysis to determine the economic feasibility of the project.

The methods that we implemented to accomplish these objectives were to:

- identify key attributes of successful waste management and recycling practices in the United States and Costa Rica;
- interview waste management officials in Costa Rica concerning the current waste management system and their opinion towards a cantonal recycling program;
- survey 23 households in Montes de Oca to determine their current waste management practices and to ascertain their opinions towards a recycling program;
- collect and analyze solid waste from 23 houses for three weeks; and

- contact possible buyers for the recyclables to determine prices for the types of materials recycled.
- Extrapolate the amount of recyclables that we received to determine the possible income that could be gained from a recycling program.

By determining common practices and opinions of the residents we compiled possible suggestions for improvements to the current waste management system and the facilitation of the integration of a recycling program in Montes de Oca. Also from the data gathered about the economics of the program we were able to determine the feasibility of a recycling program within this community.

3.1 Success in the United States and Costa Rica

Through research we compiled a matrix of waste management practices within the United States. This matrix identified several cities' programs' attributes and the reduction of solid waste after the implementation of the project. In several of these programs fines were implemented or incentives were given to encourage recycling. For example, most states in the U.S. use the Pay-As-You-Throw system for solid waste collection that encourages residents to recycle (http://www.epa.gov/epaoswer/non-hw/payt/intro.htm).

We enhanced the matrix in Costa Rica by continuing to research recycling programs already in place and which characteristics led to their success. To determine the successful practices of these recycling programs we conducted an interview the manager of the recycling center in Santa Ana, Liliana Umaña Morales. The interview supplemented the findings of our literature review and completed research. From the research of the United States and Costa Rica we proposed the implementation of some aspects of these recycling programs that may help to increase the success of a recycling program in Montes de Oca. The complete matrix is shown in Table 1.

The matrix breaks down cities in the United States and in Costa Rica and the different methods of waste reduction. One example is the disposal of solid waste before and after implementation of a program. This shows how much solid waste has reduced from implementing a variety of programs and whether they've had success. Also, this

Solid Waste Data Matrix breaks down recycling within different cities. Another classification in the data matrix is the Bottle Bill, or if cities have similar methods such as businesses returning bottles in order to receive more, a method used throughout Costa Rica. The most important aspect of this data matrix is whether cities have a curbside recycling program.

Solid Waste Data Matrix of Target Communities

City	Year Implimented	Size of Operation	Solid Waste Collection		Recycling			Cost to Dispose of Solid Waste	Waste Disposal		Solid Waste Disposal	
			Curbside	Direct to Landfill	Curbside	PAYT	Bottle Bill	Yearly	Landfills	Export	Before Implementation (Yearly)	After Implementation (Yearly)
Worcester, MA	1993	173,000 Residents (Approx. 60,000 Households)	Yes	Yes	Yes	Yes	Yes	Residents pay for usage of bins, bags and tags	Yes	No	Information Unavailable	Information Unavailable
South Kingston, RI	1994	28,000 Residents (Approx. 9,000 Households)	Yes	Yes	Yes	Yes	No	Residents are required to buy $10.00 for 10 tags	Yes	No	7,000 Metric Tons (In 1991)	2,000 Metric Tons (In 1995)
Mount Vernon, IA	1994	3,700 Residents (Approx. 1,200 Households)	Yes	Yes	Yes	Yes	Yes	($84 +$1.75 per tag) / Household	Yes	No	1,000 Metric Tons (In 1990)	600 Metric Tons (In 1995)
Seattle, WA	2005	563,000 Residents (Approx. 180,000 Households)	Yes	Yes	Yes	Yes	No	$122-$589 / Household	Yes	Recyclables to Oregon	695,500 Metric Tons	Undetermined as of June 2006
Clearwater, FL	Information Unavailable	109,000 Residents (Approx. 30,000 Households)	Yes	Yes	Yes	No	No	Information Unavailable	Yes	No	Information Unavailable	Information Unavailable
Nosara, CR	Information Unavailable	Information Unavailable	Yes	Yes	Yes	No	*	¢12,000 ($24) / Household	Yes	Nicargua & Costa Rica	Information Unavailable	Information Unavailable
Escazú, CR	Information Unavailable	18,000 Residents (Approx. 6,000 Households)	Yes	Yes	Yes	No	*	¢3,400 ($7.00) / Metric Ton	Yes	Not Known	12,700 Metric Tons	Information Unavailable
Santa Ana, CR	1998	35,000 Residents (Approx. 12,000 Households)	Yes	Yes	Yes	No	*	¢14,500 ($30) / Household	Yes	Guanacaste, CR and Nicaragua	¢168.5 Million (in 1997) [$430,000]	¢117 Million (in 1999) [$300,000]
San Isidro de Heredia, CR	Information Unavailable	Approx. 2000 Residents (500 Households)	Yes	Yes	Yes	No	*	Information Unavailable	Yes	Information Unavailable	Information Unavailable	Information Unavailable
Montes de Oca, CR	2006	50 Households	Yes	Yes	Yes	No	*	¢3,500 ($7.00)/ Household	Yes	Information Unavailable	Information Unavailable	Information Unavailable

*** Means that it is assumed you will return glass bottles to the place where they were purchased but there is no formal "bottle bill"**

**** Means that it imports waste from other communities, approximately 60% of their solid waste is imported.**

Table 1: Solid Waste Data Matrix of Target Communities

3.2 Interviews

We conducted interviews with waste management officials to gather more information. These interviews identified the current waste management program in

Montes de Oca and its effectiveness within the community. By asking a set of questions about how the program functioned we generated possible suggestions to improve the program.

A few example questions are:

- When was the program started?
- Why was the program started?
- Is waste management a problem?
    - Are the residents aware of this problem?

In addition to interviewing officials from Montes de Oca, we interviewed an administrator from the recycling program in Santa Ana, Liliana Umaña. From that interview we established the effectiveness of the program, why and how it was implemented. A few examples of those questions are:

- What type of program is it?
- Are there incentives or fines that encourage the use of the program?
- How much recyclable material can be processed in a month?

By learning about the implementation of the program we extracted practices that can be used to improve the waste management program within Montes de Oca.

3.3 Recycling Interest in Montes de Oca

To establish a recycling program within the community it is required that there be a high level of involvement throughout the neighborhood (Noehammer & Byer, 1997). Therefore determining the level of interest in a recycling program in Montes de Oca was paramount to our project. Before we began to determine the interest level in a recycling program we first needed to determine which houses we would survey and collect solid waste from. The next sections will describe how the neighborhoods and houses were chosen and how the survey was conducted.

3.3.1 Choosing representative houses

The first step of the project was to choose representative houses in three socio-economic groups. The socio-economic levels were determined by Dr. Arrieta and

Gerardo Madrigal, the previous director of the municipality. They were condensed from a set of nine levels determined by data from a census in 1999. The original nine levels were determined by the housing construction, the surrounding area and the average monthly household income.

For our project, Dr. Arrieta and Gerardo Madrigal decided to use three socio-economic levels for a survey and the same three levels for solid waste collection. Due to time constraints, we chose to use ten houses from each socio- economic level for an appropriate representation of the total population in Montes de Oca. We chose ten households in hopes of getting over a fifty percent rate of return. We were lucky enough that in total eighteen out of the thirty households participated in our three week recycling trial. Each level was represented by a barrio, or neighborhood, within Montes de Oca. The barrios are shown below in Table 2.

Socio- Economic Levels		
Barrio	Monthly Income (colones)	Monthly Income (US dollars)
Barrio Sinai	80000 or less	160 or less
Urbanizacion El Rodeo	150,000 -200000	200-400
Barrio la Granja	300,000-400,000	600-800

Table 2: Socio-Economic Levels

3.3.2 Survey Distribution

The second step in our project was to conduct a survey with selected residents of the Montes de Oca community. Through the survey of the residents, shown in Appendix L – Survey in English, we were able to gather information about the perceptions of the current waste management practices and the interest level toward a recycling program in the community. The content of the survey included questions regarding residents' knowledge of waste reduction and the opinion towards the current waste management system.

A few example questions are listed below:

- Do you think that the waste that you produce contaminates the environment?
- What can you do to reduce the contamination that is produced from the solid waste?
- How would you rate the collection services? Why?

After determining which neighborhoods in Montes de Oca we would be working in, we distributed an in-person survey.

The survey used open ended questions to allow the residents to express their opinions and concerns freely. Although this structure made interpretation of the data complicated, it was important to fully understand the knowledge and concern of the residents. After analyzing the data our team produced visual representations of the data collected regarding interest level amongst the residents in a recycling program.

3.3.3 Distribution of Recycling Information to the Residents

After conducting the survey, we spoke to the residents of the houses about recycling and separation of solid waste. We explained which materials were biodegradable, reusable, and non-reusable types of solid waste. We also provided the residents with a recycling pamphlet that they used as a reference when separating their solid waste. The pamphlet that was created by Dr. Arrieta to help inform the community of the three classifications of solid waste is shown in Appendix E – Montes de Oca .

3.4 How many recyclables are there?

Another aspect of our project was to determine the amount of recyclables in the community that were disposed of through traditional waste disposal methods. We achieved this through our three week trial program in which solid waste was sorted by the residents into the three types of waste: biodegradable, reusable (recyclable) and non-reusable.

Every household that was participating in the solid waste collection received three different colored bags. These bags were specified for the three different types of waste: grey for biodegradable waste, green for reusable (recyclables) and black for non-usable

materials. The bags were collected on Thursday mornings for three weeks and brought to the COOPEMUJER recycling center.

At the cooperative recycling center, the waste was further sorted and weighed to record data about the percentages and types of waste. We opened bags containing the non-usable material to determine if there were reusable materials that had not been properly sorted. The non recyclable remainder of the material was weighed and recorded and then transferred to the Río Azul landfill along with the weighed biodegradable bag. The biodegradable material was brought to the landfill because there is currently no composting program available and to return the materials to the residents who were composting was unsanitary. The bag containing reusable material was separated by material type, such as aluminum cans, paper, glass bottles and cardboard. These materials were then weighed and recorded in preparation for sale to buyers.

From this trial we estimated the amount of reusable material that may be recovered with a successful recycling program. It also provided first hand knowledge as to which reusable materials were most prevalent in the solid waste of Montes de Oca and which materials might bring a higher profit to help sustain the program.

3.5 Determining Value for Recyclables

Through our research, we found that a main factor in determining the feasibility of a recycling program was to establish the market value of recyclable materials. To do this Gerardo Madrigal provided the team with a list of possible recyclable buyers. We conducted phone interviews with the companies to gather updated price lists and compiled them into a matrix as shown in Table 3. We created the matrix to serve as a tool for COOPEMUJER to use as a guide of average recyclable prices.

3.6 Solid Waste per Person in Montes de Oca

In addition to the other objectives, we calculated the approximate amount of waste produced per person. To do this we first found how many people resided in each of the target households. After collecting the solid waste data over the three week period in each house, we found the average daily solid waste per household and then divided by the

average number of residents in each neighborhood. Through this method we were able to determine a rough estimate for the average amount of daily solid waste per resident in the three barrios. Next we used the population data of Montes de Oca to determine an estimation of the solid waste produced in the entire cantón per day.

We used this same method described above to obtain a rough estimate of the average number of recyclables that could be produced in the Cantón of Montes de Oca weekly.

Recyclable Purchasing Companies								
Business	Contact	Material						
		Aluminum	Cardboard	Glass		Paper	Plastic	
				Broken	Whole		Bottles	Bags
AMANCO Fábrica	551-0866					¢25/Kg		
Euroaméria Fábrica	843-0632					¢10-¢25/Kg		
P.R.E Cervecería Costa Rica	443-2222	¢130/Kg					¢380 / Kg	
Romaldo Reutilización	238-5857						¢30 Each	
Francolor Reuitilización	282-1684						¢40 Each	
Intermediario	237-6098						¢50 Each	
VICESA Fábrica	550-3200			¢14.5 / Kg				
Intermediario	252-4016		¢15-¢50/ Box		¢10-¢40/ Bottle			
Reutilización	380-5959		¢15-¢70/ Box		¢3-¢6 Each		¢3 Each	¢350/Kg
PRODUCOL Fábrica	848-9412							¢15-¢40/Kg
Cajas Quirós y Retana Reutilización	233-0210		¢40/Box					
Destiladora Centroamericana Reutilización	235-7890				¢30/ Bottle			
Tecniplast S.A. Fabrica	293-8072							¢25/Kg
Empaques Universal Fabrica	374-8887							¢40-¢120/Kg
Kimberly Clark	298-3100					¢10-¢20/Kg		

Table 3: Recyclable Purchasing Companies

3.7 Financial Analysis

The final part of our project was to determine the feasibility of a permanent recycling program in Montes de Oca. As described in section 3.6, our team extrapolated the amount of recyclable material that we collected from the households in our trial program to determine how much recyclable material might be collected from all of Montes de Oca. Using the table of prices the team was able to determine how much revenue COOPEMUJER could make in an average week from collection of the recyclable materials.

4 Results

We obtained four main results throughout our project. Our project results were based on interviews with solid waste management officials and personnel from a recycling program in Costa Rica, surveying 23 households in the community, and collecting solid waste from 18 households in Montes de Oca.

4.1 Solid Waste Management Officials

We conducted interviews with Gerardo Madrigal, Director of the Municipality of Montes de Oca, regarding current waste management practices in the community as well as potential community involvement with the program. Señor Madrigal gave us a tour of the neighborhoods in which we would be conducting surveys, and collecting solid waste. He helped us conduct our project by driving us through the different barrios for the in-person surveys and also helped us to inform the residents about the program.

After meeting with Gerardo Madrigal, we met with Marvin Quesada, the head of sanitation in Montes de Oca. Señor Quesada schedules the collection of solid waste by the municipality. In order to keep the system working, he must adapt to changes such as the lack of functioning collection trucks. He schedules the different pick-up times for solid waste for the different parts of the municipality and also insures that the trucks are repaired. Also, Señor Quesada is responsible for the collection of the fees that are assessed to each household for solid waste collection. However, the barrio with the lowest socio-economic level, Sinaí, is not billed because they do not own the land (personal communication, June 30, 2006).

The next interview that we conducted was with the Alcaldesa (mayor) of Montes de Oca, Sonia Montero, to determine the political support that the proposed program might have. The Alcaldesa was elected in December of 2002 and has since then been trying to improve the waste management practices within Montes de Oca. She explained that solid waste management is not only a problem in Montes de Oca, but in all of Costa Rica. She believes that the institution of recycling programs throughout Costa Rica will benefit the environment and preserve the country for future generations.

4.2 Recycling Program Officials

We conducted an interview with the manager of the Santa Ana recycling program, Liliana Umaña. From this interview we better understood the reasons behind implementing programs in Costa Rica, how many employees are needed to maintain a recycling program, what aspects of the community are needed to support the program, and how solid waste within the communities is reduced.

The program was begun in 1998 by the municipality as a means to reduce solid waste. The program provides service to the entire municipality of 34,507 inhabitants. They found that the community responded best to door to door advertising including the distribution of pamphlets. The recycling center in Santa Ana can handle up to 40,000 metric tons of recyclables per month. Because of the implementation of the program, their yearly solid waste decreased from 50,000 metric tons to 34,000 metric tons within the three year span from 1997-1999.

4.3 Surveying residents of Montes de Oca

We successfully completed 23 in-person, open-ended surveys in the three barrios. From the results that we obtained we conducted a first level content analysis to determine the most frequent results of all neighborhoods. As we did not receive an equal number of surveys from every neighborhood we decided to normalize the results in order to ensure that every resident's response was equal and did not carry more weight than other responses. The normalized results were used to find the overall opinion in respect to many survey questions. After speaking in detail with our sponsor we determined that we should also qualify the survey results by barrio in order to see the difference in opinion in the socio-economic levels. The survey analysis is further described in the following sections.

4.3.1 Survey Analysis

We received a 77 percent return rate on our surveys in the barrios of Montes de Oca. After reviewing the completed surveys we found that there were five main themes that could be used to more easily understand the survey results:

- General Knowledge
- Solid Waste Management Knowledge
- Solid Waste Management Opinion
- Recycling Knowledge
- Willingness to Collaborate in a Recycling Campaign

After speaking with our advisors and sponsor we determined that the survey results needed to be analyzed through two different methods. The first was through normalization of results to find the over all opinion of all residents; the second was by a comparison of the barrios.

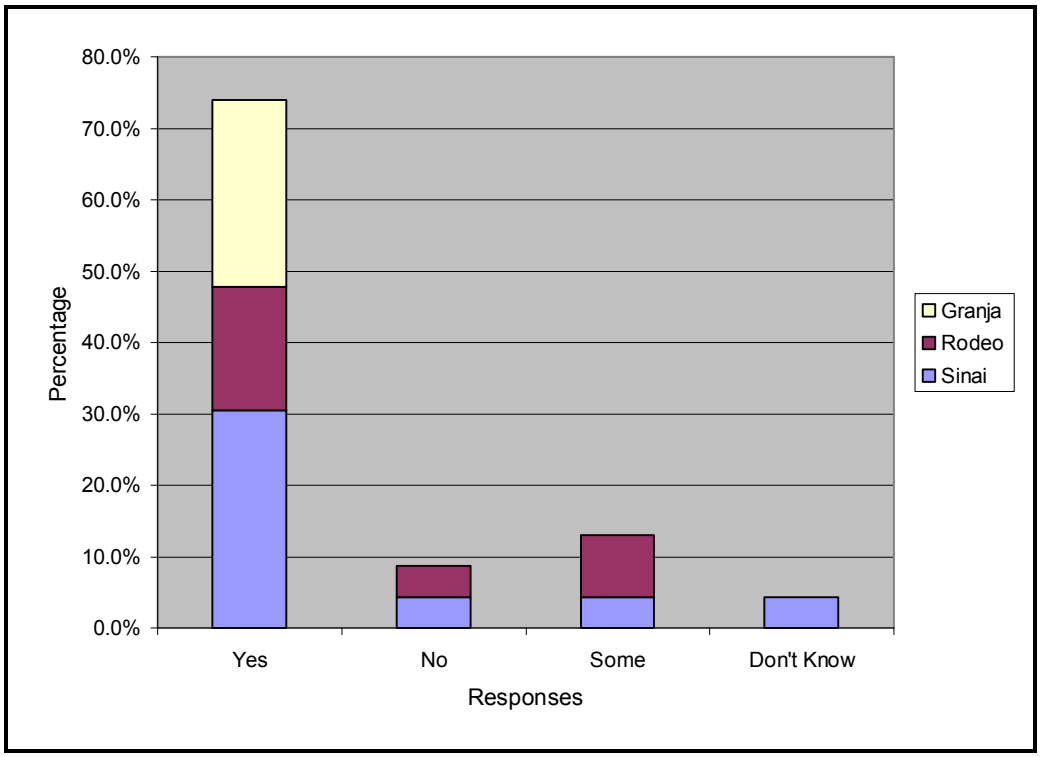
4.3.1.1 Survey Analysis – Normalization

We determined that it was necessary to analyze the survey results by normalizing the data collected in order to determine the overall opinion of all residents and also to ensure that the opinions of every surveyed resident was equal. The normalized survey results by theme can be found in .

These are our findings for each theme from the normalized data:

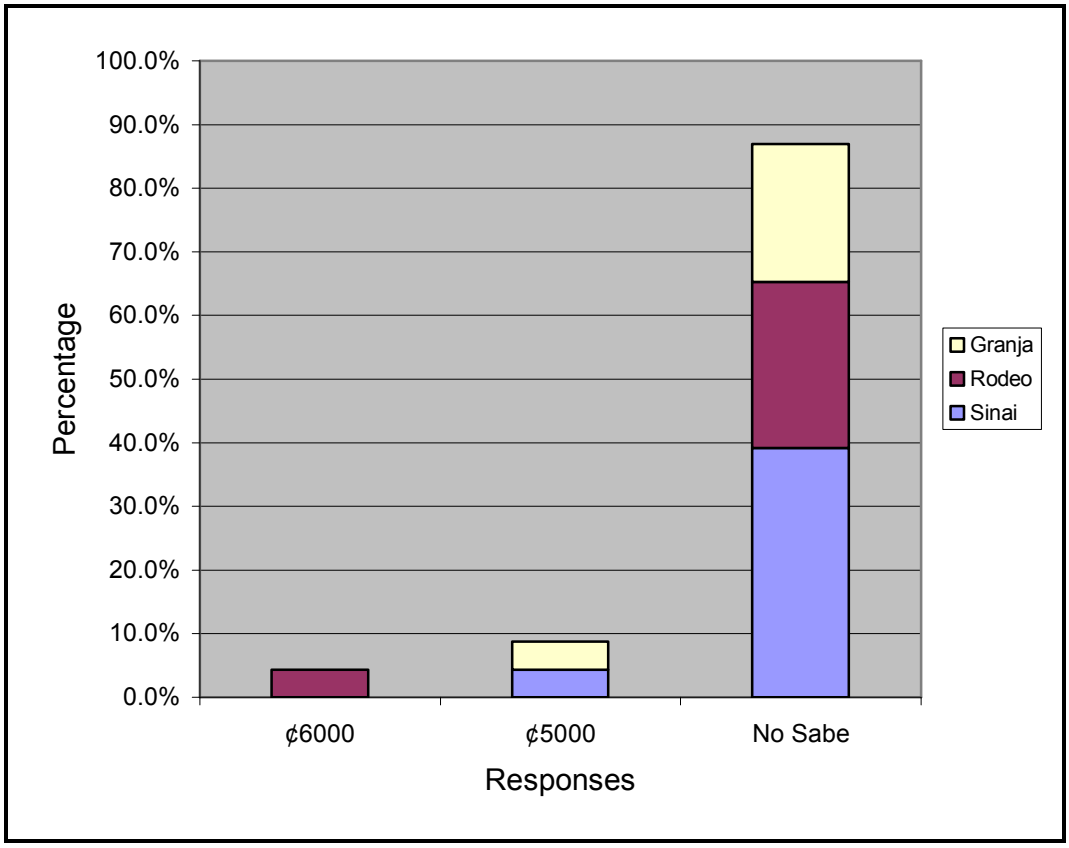
- General Knowledge showed the team that there is an overall lack of knowledge of how solid waste affects the environment within the community. For example some of the residents were unaware that the solid waste that they produced contaminated the environment. The graph shown below, Figure 7, was the first question that was asked of the residents. The graph illustrates that more than a quarter of the residents (25.9 percent) responded that they either did not believe, had no knowledge or only thought that the solid waste that they produced slightly contaminated the environment.

Figure 7: Do you believe that the solid waste that you produce contaminates the environment?



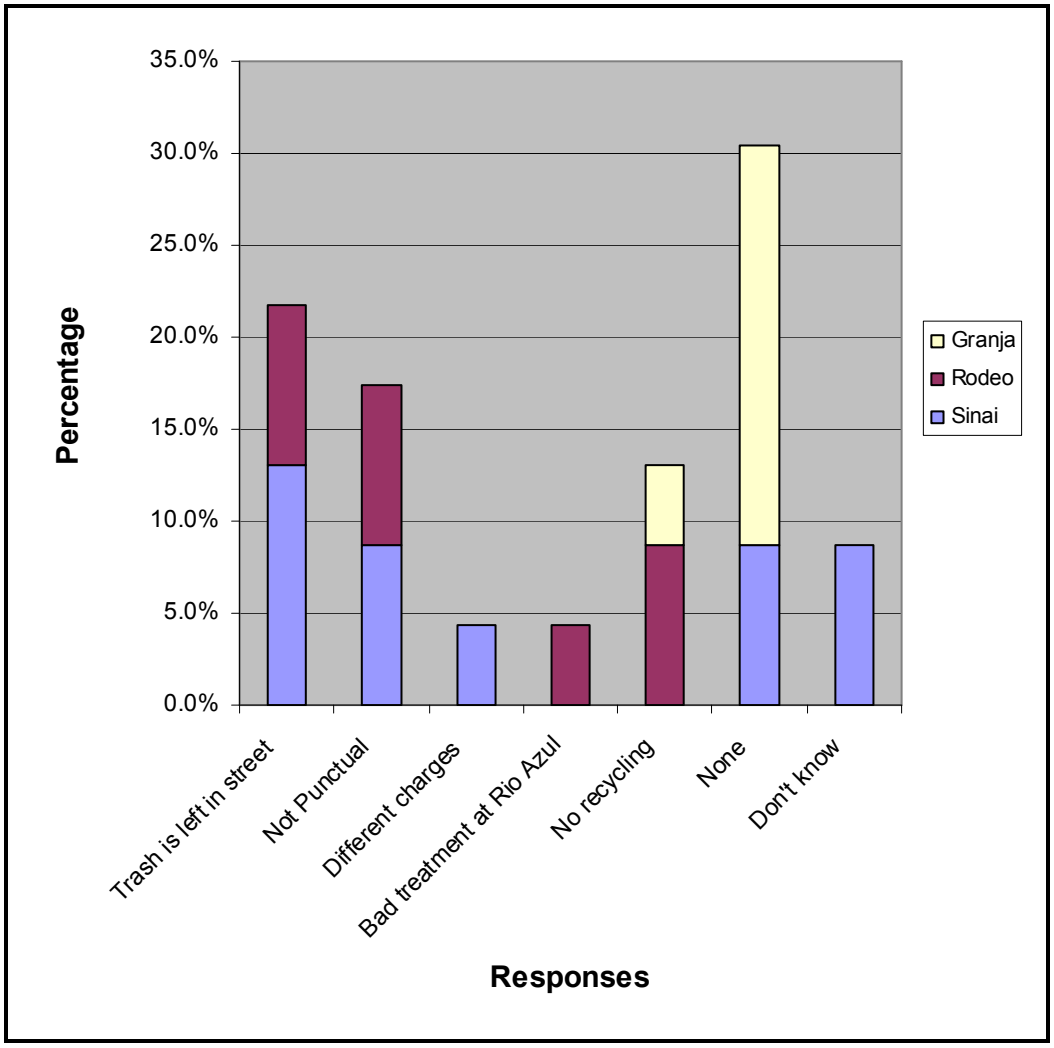
- The **Solid Waste Management Knowledge** theme illustrated to the team that there was not enough information provided to the residents about the specifics of the solid waste management in each barrio. None of the residents were aware of the actual cost of the solid waste collection services provided by the municipality. The graph shown below, Figure 8, shows the responses from the residents. Most of the residents did not know how much the services cost. The actual cost of the services provided are 3,500 colones every four months, however, this did not appear in any of the responses.

Figure 8: How much does the solid waste collection cost?



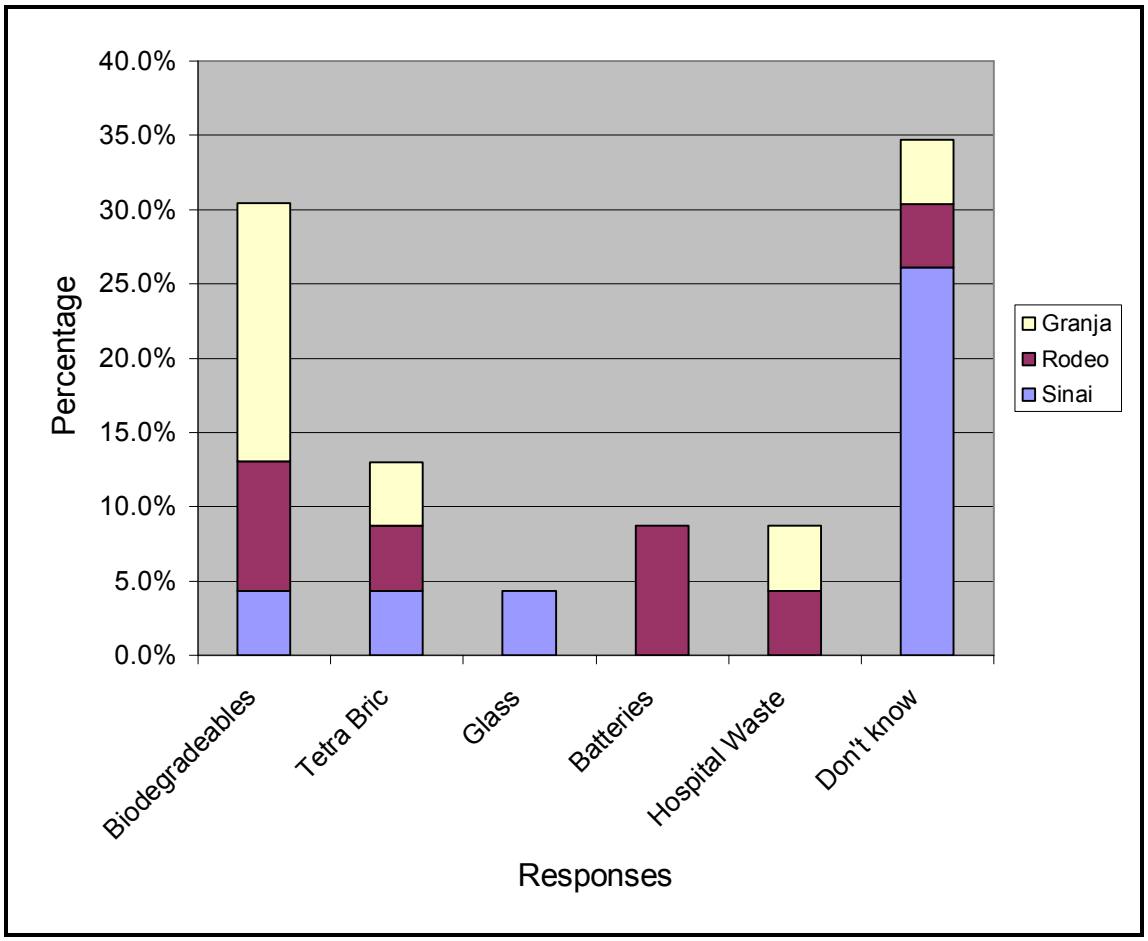
- **Solid Waste Management Opinion** made plain to the team that there was an overall negative opinion about the current solid waste management services provided to the barrios. The general opinion of the residents was that the services were not punctual and that they charge different residents different amounts for the services. This data is shown in the graph below, Figure 9.

Figure 9: What negative aspects do you see in the solid waste collection services?



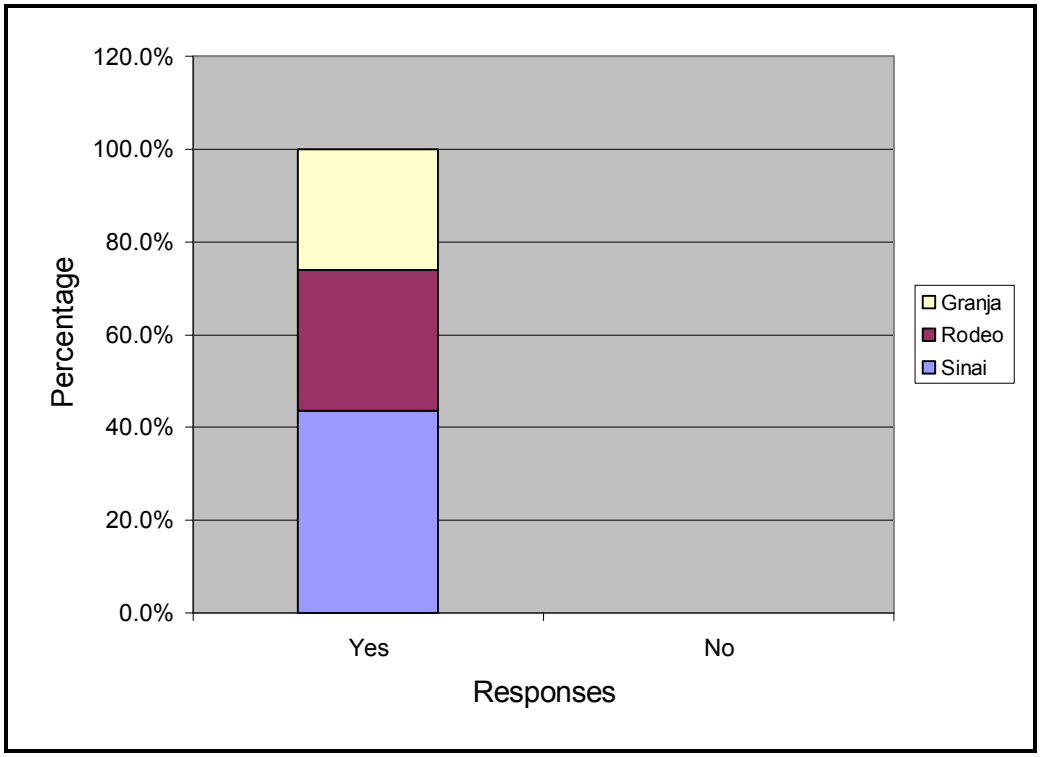
- **Recycling Knowledge** showed the team that there has been very little information provided to the residents about recycling and its benefits. Many residents did not know what types of materials are not reusable in Costa Rica as shown by Figure 10.

Figure 10: What materials are not reusable in Costa Rica?



- And finally, **Willingness to Collaborate in a Recycling Program** gave very positive results. Many residents were interested in a permanent recycling program. For example, when asked if the residents would be willing to separate their solid waste there was a 100 percent positive response (Figure 11).

Figure 11: Would you be willing to separate your solid waste into three groups: usable, non- usable and biodegradable?



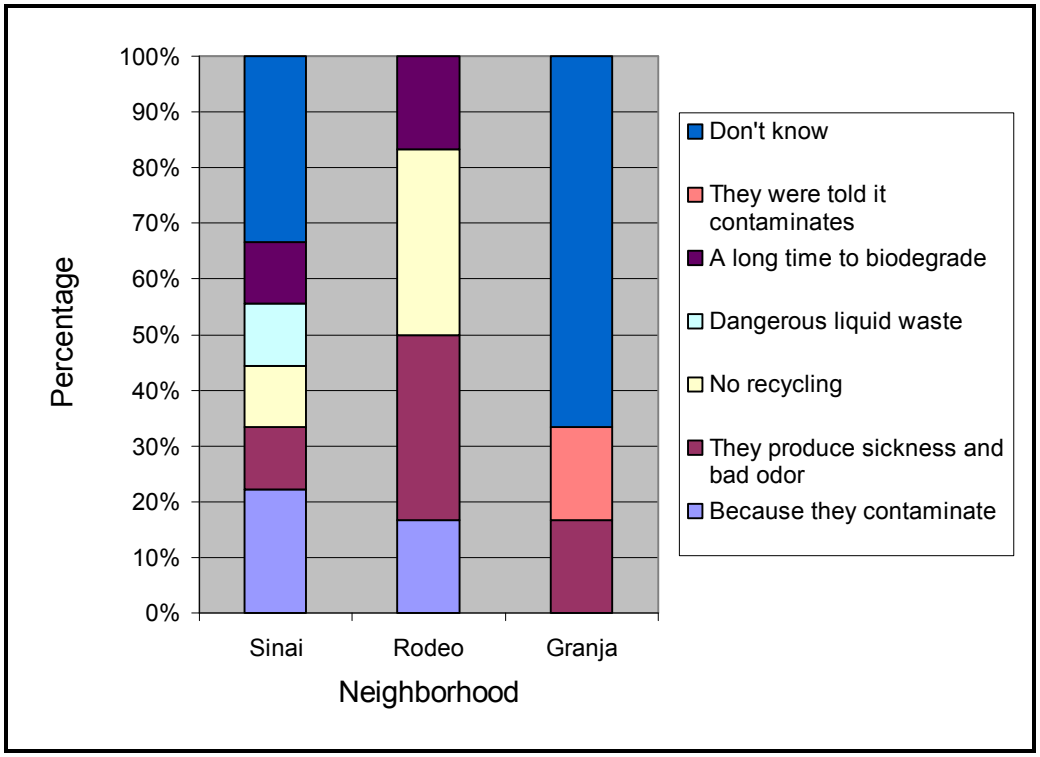
4.3.1.2 Survey Analysis – By Barrio

Our next analysis was by barrio. We believed that it was important to understand the data collected by barrio to see if there is a difference in responses by socio-economic level. The complete results by barrio are shown in Appendix O.

These are our findings by theme by barrio:

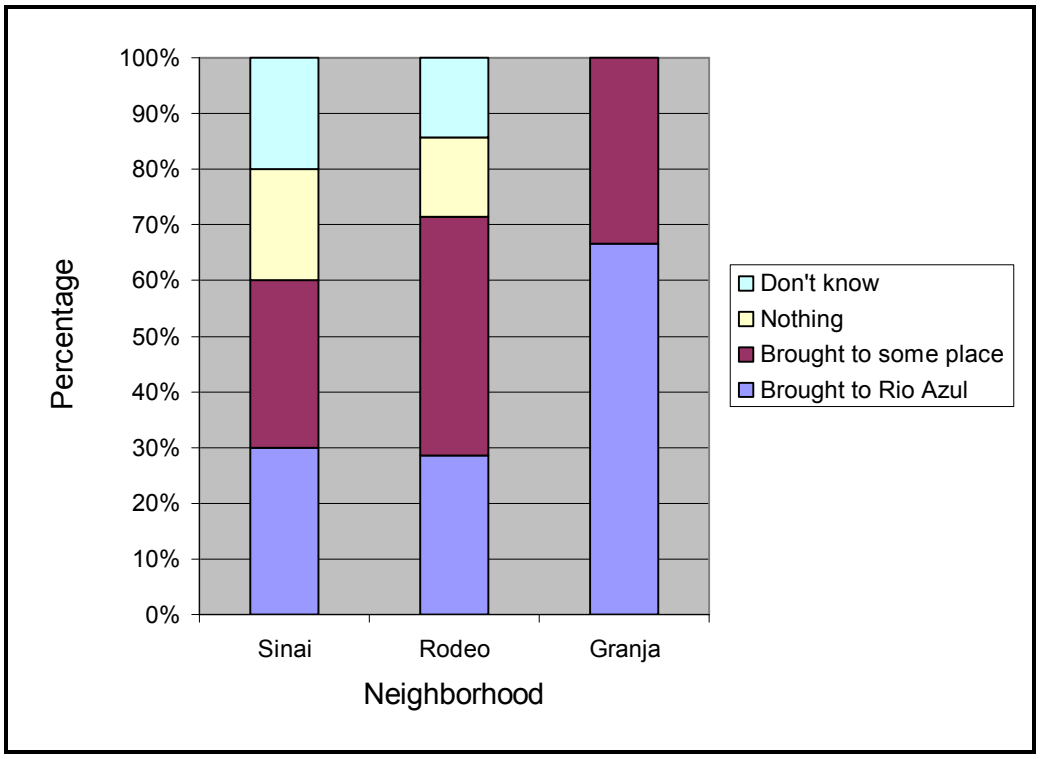
- From **General Knowledge** we found that there is less knowledge about how solid waste affects the environment in the lower socio-economic level, Sinaí. For example, while 70 percent of the residents surveyed knew that their solid waste contaminated the environment, 33.3 percent did not know why or how it contaminated the environment. The distribution of responses for how the environment is contaminated is shown below in Figure 12.

Figure 12: Why does your solid waste contaminate the environment?



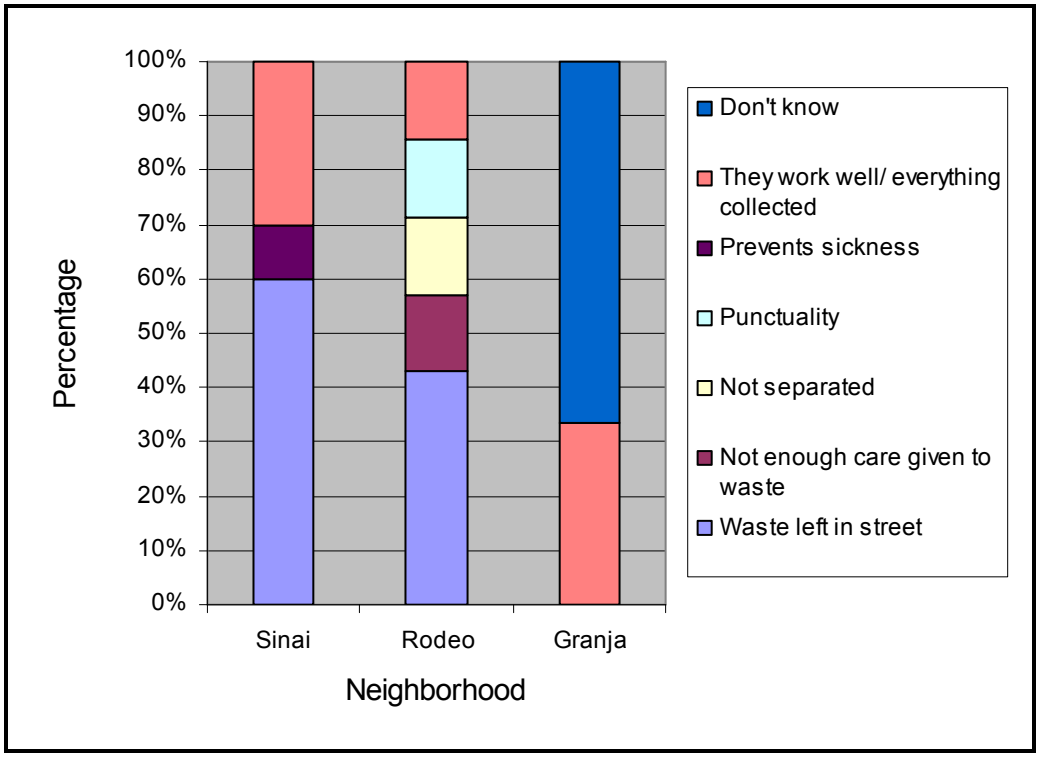
- The analysis of the questions from the theme **Solid Waste Management Knowledge** showed that the lower and middle socio- economic levels had less information than the highest barrio. For example, 67 percent of Granja knew that the solid waste produced is sent to Río Azul. However, from Sinaí and El Rodeo only 30 percent and 29 percent, respectively, knew that the solid waste is brought to Río Azul. This is shown in Figure 13.

Figure 13: What does the municipality do with the solid waste?



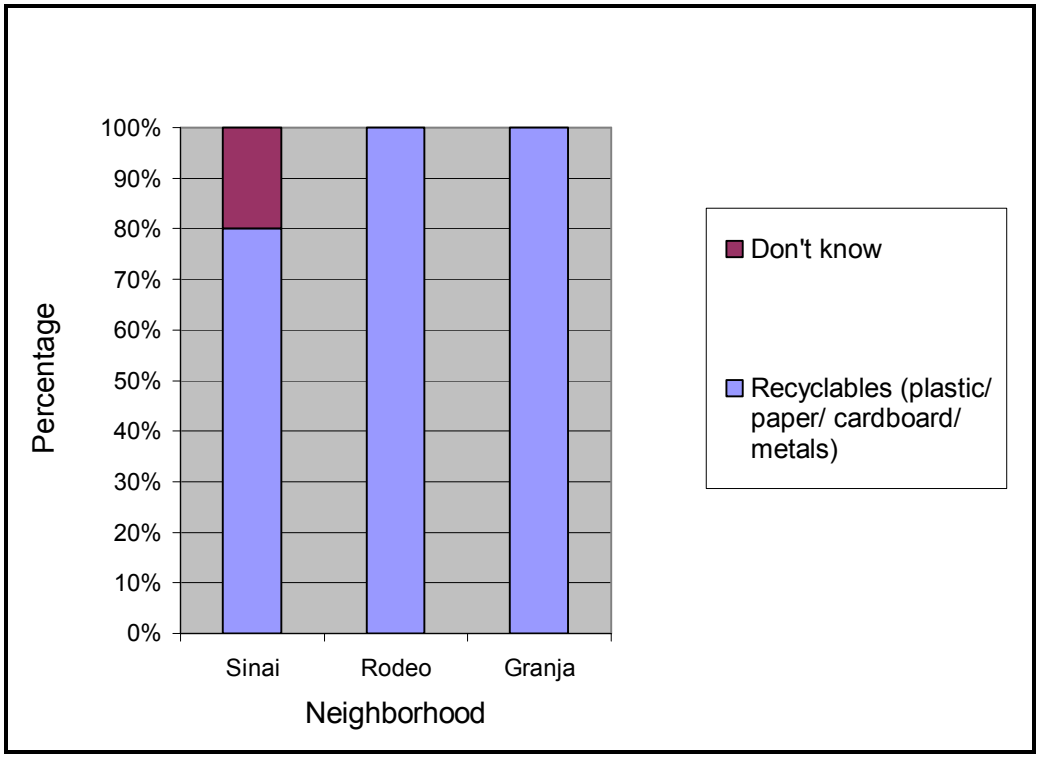
- **Solid Waste Management Opinion** showed a higher negative response towards the current solid waste management program in Sinaí than in the other two barrios. There was a total of 40 percent of the residents in Sinaí who said that the collection services were very bad. From the reasons that were given 60 percent said that there is often solid waste left in the streets or it is not collected at all. As the socio- economics levels increased, there was an increase in the positive response towards the solid waste management. In Granja 84 percent of the residents said that the collection services were good to very good and that all of the solid waste was picked from the streets. These results are shown below.

Figure 14: Why did you rate the solid waste collection as you did?



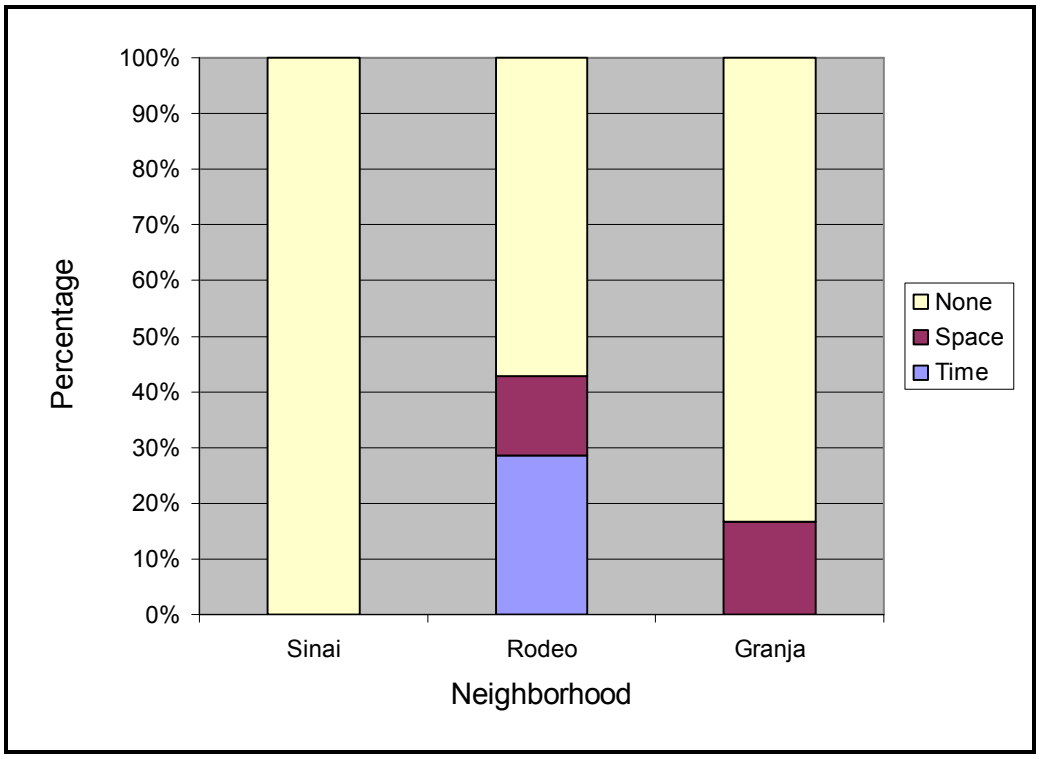
- **Recycling Knowledge** further showed the team that there is a differentiation in the barrios. Figure 15 shows that the lower socio-economic level, Sinaí, had less knowledge of what materials were recyclable (from El Rodeo and La Granja 100 percent of the answers gave at least one type of recyclable material, while there was only 80 percent from Sinaí) than El Rodeo or La Granja.

Figure 15: What types of materials are reusable?



- In the final theme, **Willingness to Collaborate in a Recycling Campaign**, our team found an interesting result from the responses in the barrios. Sinaí, the lower barrio, was more responsive to the idea of the initiation of a permanent recycling program in Montes de Oca. The residents from Sinaí believed that there were no disadvantages to recycling. However, in El Rodeo and La Granja some of the residents believed that time and space were disadvantages to participation in a recycling program. These results are shown below in Figure 16.

Figure 16: What disadvantages are there to recycling?



4.4 Solid Waste Collection

For three weeks solid waste was collected from twenty-three households within the community of Montes de Oca. Three bags were collected, one specifically for reusable materials or recyclables, one for biodegradable material, and one for non-reusable material. The bags for biodegradable material were weighed and then sent to the Río Azul landfill. The bag containing non-reusable material was weighed and then opened to determine if the residents were improperly disposing of recyclables. The reusable materials, if any, were removed and the remainder was sent to the Río Azul landfill. The bags containing reusable materials were sorted and weighed to be sold as a profit for the COOPEMUJER, the women's cooperative. The following sections describe the results that we obtained from the three weeks of our collection.

4.4.1 Week One

In the first week we encountered a few problems. An example of one that we came across in the first week was that some residents who had previously committed to the program could not participate. Another problem that we encountered with the first week's collection was that some paper materials were contaminated by bottles that had not been rinsed prior to being placed in the recyclable bag, thereby making the material unusable because wet paper of any sort is not a recyclable in Costa Rica. We also found that there were a few sorting mistakes which were due to the print quality of the pamphlet that was distributed. The original pamphlet was in color, but was in black and white when it was distributed to the residents. When we returned to the households to collect the solid waste, many of the residents had questions about what was allowed for recycling and what was not in addition to more questions about what materials were biodegradable or non-usable.

The amount of biodegradable material we received from some barrios was limited because some of the residents were already using their biodegradable material for their own personal composting.

The residents that participated in the program, however, sorted and separated their solid waste into the separate bags. They followed the pamphlet, shown in Appendix E – Montes de Oca which indicated the proper disposal of materials. Some residents had extra reusable materials in their homes that they donated to the recycling center in the first week. The extra material was not included in our data analysis. After picking up the first collection, residents seemed enthusiastic about future waste removal.

In the first week in Barrio Sinaí, we received only three bags of non-reusable materials from the whole barrio. The average weight in each of these bags was 1.08 kilograms. From two of the houses in Barrio Sinaí we received bags of biodegradable material which averaged out to be 1.625 kilograms per bag. There were more houses that gave us reusable material than biodegradable and non-reusable materials. The types of materials that we found that were in each of these houses were plastic bottles, aluminum cans, newspapers and cardboard.

Figure 17: House in the Barrio Sinaí

The houses in Barrio Sinaí that participated in the trial program all contributed something to the collection and measurement process during the first week, even though we did not receive all three types of waste from all of the participating houses. An example of this is that one of the residents already collects her aluminum cans as well as some of those from other houses in the barrio, and sells them to a recycling center. Therefore, in this barrio there may be fewer aluminum recyclables received in the future program compared to other barrios. The types of materials that we found that were in each of these houses were plastic bottles, aluminum cans, newspapers and cardboard. Table 4 indicates the households participating and the amount of solid waste produced per member of the household.

Barrio Sinai- Week 1						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total solid waste (kg)	Residents per household	Waste produced per resident (kg)
1	1	0.5	0	1.5	3	0.5
2	0	0	0	0	5	0
3	0	0	0	0	2	0
4	0	0	0	0	4	0
5	1	0.15	1	2.15	4	0.54
6	0	0	0	0	4	0
7	1.25	0	2.25	3.5	3	1.17
8	0	0.5	0	0.5	5	0.1
9	0	0	0	0	6	0
10	0	2.5	0	2.5	5	0.5
Totals	**3.25**	**3.65**	**3.25**	**10.15**	**20**	**0.51**

Table 4: Waste Chart-Barrio Sinaí-Week One

In Barrio Sinaí during the first week of collection, there was a total of 10.15 kg of solid waste produced. Most of this solid waste was composed of recyclable material that was used to help the development of COOPEMUJER. After calculating the number of members per household, each resident who participated in the collection during the first week produced approximately 0.51 kg of solid waste.

In the first week's collection from Urbanización El Rodeo, we received only three bags of non-reusable materials from the residents. There was an average of 1.67 kilograms in each of these bags. We collected biodegradable material from three houses with an average weight in each of these bags was 2.33 kilograms. From these houses we also collected reusable materials. The majority of those materials were plastics, glass, and cardboard.

Figure 18: House in the Barrio El Rodeo

As in Barrio Sinaí, we received some type of waste from the participating houses in El Rodeo. In El Rodeo we encountered a family that has been recycling and composting for several years. This is similar to the situation from Barrio Sinaí. As shown in Table 5 below, more residents from this neighborhood were unable to participate in the recycling program for various reasons.

El Rodeo Week 1						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	1	0	4	5	3	1.67
14	0	0.35	0	0.35	5	0.07
15	0	0	0	0	0	0
16	0	1	0.5	1.5	2	0.75
17	1.75	0	0	1.75	5	0.35
18	0	0	0	0	6	0
19	0	0	0	0	0	0
20	1.75	1.6	2.5	5.85	2	2.93
Total	**4.5**	**2.95**	**7**	**14.45**	**17**	**0.85**

Table 5: Waste Chart-El Rodeo-Week One

In Urbanización El Rodeo five households participated in the collection of solid waste. The community produced 14.45 kg of solid waste. Most of this solid waste was composed of non-reusable materials. After calculating the number of members per household, each resident who participated in the collection during the first week produced approximately 0.85 kg of solid waste.

In our final barrio, Granja, we collected bags from five households. The average weight per bag was 1 kilogram. There was no biodegradable material collected from these households. We were able to collect reusable materials from five households. Most of these materials were plastics, glass and cardboard.

Figure 19: House in the Barrio Granja

As shown below in Table 6 during the first week only five houses participated in the collection of solid waste. More recyclables were collected than solid waste. Residents were willing to sort through their materials and separate to help our program. During the first week of collection, the participating households of Barrio Granja produced 18.75 kg of solid waste. After calculating the number of members per household, each resident who participated in the first week of collection produced approximately 0.89 kg of solid waste.

Granja Week 1						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
21-24	4	7.25	0	11.25	8	1.41
25	0	0	0	0	3	0
26	0	7.5	0	7.5	2	3.75
27	0	0	0	0	0	0
28	0	0	0	0	5	0
29	0	0	0	0	3	0
30	0	0	0	0	0	0
Total	**4**	**14.75**	**0**	**18.75**	**21**	**0.89**

Table 6: Waste Chart-Barrio La Granja- Week One

In Barrio Granja there were no biodegradable materials collected from the households. We did collect reusable materials from five households. Most of these materials were plastics, glass and cardboard. In Barrio Granja the most contributions of

recyclables came from an apartment building where four apartments (houses 21-24) participated in trial program. Most of these reusable materials in Barrio Granja were paper products, newspapers and loose paper and glass bottles. An observation from the data is that this neighborhood collected more glass bottles than other neighborhoods. Most of these bottles were wine or liquor bottles. Because of the difference in weight between plastic and glass we found that there was a larger weight of reusable materials found in Barrio Granja than either Barrio Sinaí or El Rodeo.

4.4.2 Week Two

Because of the complications our team had with the Municipality waste collection in the first week, we began the second week's collection with El Rodeo. From El Rodeo we continued to Barrio Sinaí and then Barrio Granja. In the first week, residents of El Rodeo placed their solid waste outside and the Municipality accidentally collected the trial household's waste.

The second week ran more smoothly as residents were waiting for their bags to be picked up. Also, residents had a better understanding of the separation process. We collected more material from more houses in each of the barrios the second week. During the first week residents only had a pamphlet to aid in the separation of materials. However, we answered their questions when collecting the first week's solid waste, but a greater understanding of separation was obvious during the second week. Another reason that the number of participating households was greater is because we collected the materials before the Municipality in El Rodeo the second week of our trial program. Shown below are the waste charts from the data collected in the second week.

Sinai Week 2						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
1	2.00	0.70	0.00	2.70	3	0.90
2	0.00	0.00	0.00	0.00	5	0.00
3	0.00	0.00	0.00	0.00	2	0.00
4	0.00	0.00	3.75	3.75	4	0.94
5	2.00	0.15	1.35	3.50	2	0.88
6	3.00	0.00	2.00	5.00	4	1.25
7	0.80	2.78	3.50	7.08	3	2.36
8	1.50	1.98	0.00	3.48	5	0.70
9	0.00	0.00	0.00	0.00	6	0.00
10	0.00	0.23	0.00	0.23	5	0.05
Total	**9.30**	**5.84**	**10.60**	**25.74**	**28**	**0.92**

Table 7: Waste Chart-Barrio Sinaí-Week Two

In Barrio Sinaí, six households participated in the collection during the second week. Out of the six households, five participated in the collection of reusable materials. Also, four households participated in the collection of biodegradable material. Table 7 above shows comparisons between the households. In total, during the second week of collection Barrio Sinaí produced 25.74 kg of solid waste. After calculating the number of members per household, each resident who participated in the collection during the second week produced approximately 0.92 kg of solid waste.

Table 8: Waste Chart- El Rodeo- Week 2 below shows the comparison between households and residents in regards to how much solid waste each produced in El Rodeo. This table summarizes the second week of collection and which households participated during this time period. As seen below, El Rodeo created the most biodegradable material and solid waste during the second week of collection in comparison to Barrios Sinaí and Granja.

During the second week of collection, El Rodeo as a whole produced 32.78 kg of solid waste. After calculating the number of members per household, each resident who participated in the collection during the second week produced approximately 1.56 kg of solid waste.

El Rodeo Week 2						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00
13	2.10	1.50	8.00	11.60	3.00	3.87
14	1.10	1.28	1.75	4.13	5.00	0.83
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	2.00	0.00
17	0.00	5.60	1.15	6.75	5.00	1.35
18	1.05	0.00	2.00	3.05	6.00	0.51
19	0.00	0.00	0.00	0.00	0.00	0.00
20	2.05	1.55	3.65	7.25	2.00	3.63
Total	**6.30**	**9.93**	**16.55**	**32.78**	**21.00**	**1.56**

Table 8: Waste Chart- El Rodeo- Week 2

In El Rodeo, four households participated in the collection of solid waste during the second week. More households, however, participated in disposal of their biodegradable materials. Also, four households participated in the collection of recyclables. Some households that participated in the first week of collection were not home when we went to collected their solid waste; therefore they were not calculated in the second week of collection.

In Barrio Granja, six households participated in the second week of solid waste collection. Unfortunately, only one household participated in the collection of biodegradable materials. We also collected recyclables from three of the households.

Table 9: Waste Chart- Barrio La Granja- Week 2 demonstrates the amount of solid waste produced by Barrio Granja. During the second week of collection, the target households of Barrio Granja produced a total of 15.87 kg of solid waste. Most of the solid waste was biodegradable material. After calculating the number of members per household, each resident who participated in the collection during the second week produced approximately 0.99 kg of solid waste.

Granja Week 2						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
21-24	0.95	1.25	0.00	2.20	8.00	0.28
25	2.15	0.00	0.00	2.15	3.00	0.72
26	0.00	0.50	14.25	0.50	2.00	0.25
27	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	5.00	0.00
29	0.35	10.67	0.00	11.02	3.00	3.67
30	0.00	0.00	0.00	0.00	0.00	0.00
Total	**3.45**	**12.42**	**14.25**	**15.87**	**16.00**	**0.99**

Table 9: Waste Chart- Barrio La Granja- Week 2

4.4.3 Third Week

The third and final week of collection was the most efficient and successful. Residents were waiting for our collection with their bags at their gates and with the help from the Municipality of Montes de Oca the collection was completed quickly. Solid waste collection began with Barrio Sinaí, El Rodeo, and finished in Barrio Granja. It was obvious during this last collection that residents had a better understanding of separating the materials into their proper marked bags.

During the last week of collection five households from Barrio Sinaí participated. Four out of five households participated in both collections of reusable materials and non-reusable materials. Two out of the five households participated in the collection of biodegradable material. In total, the five households in Barrio Sinaí produced approximately 22.1 kg of solid waste. Most of the solid waste was composed of recyclable material, 10.10 kg. After calculating the number of members per household, each resident who participated in the collection during the third week produced approximately 0.29 kg of solid waste. Table 10 shows the amount of solid waste produced, including biodegradable material, recycling and non-usable materials per household as well as resident.

Sinai Week 3						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
1	1.8	1	0	2.8	3	0.93
2	0	0	0	0	5	0.00
3	0	0	0	0	2	0.00
4	0	0	0	0	4	0.00
5	0	0	0	0	4	0.00
6	3	0	2.25	5.25	4	1.31
7	0.75	1.8	3.5	6.05	3	2.02
8	0	1.5	0	1.5	5	0.30
9	0	0	0	0	6	0.00
10	0.7	5.8	0	6.5	5	1.30
Totals	**6.25**	**10.1**	**5.75**	**22.1**	**20**	**0.29**

Table 10: Waste Chart-Barrio Sinaí-Week Three

House #10 produced the most amount of solid waste at 6.50 kg. Not only did they produce the most amount of solid waste, but most of that solid waste was recyclable material, 5.8 kg. House #7 accumulated the most amount of biodegradable material at 3.5 kg.

We then collected solid wasted from Urbanización El Rodeo. The participating households produced a total of 30.15 kg of solid waste during the third week. The majority of this solid waste was biodegradable material (14.10 kg). After calculating the number of members per household, each resident who participated in the collection during the third week produced approximately 0.41 kg of solid waste.

El Rodeo Week 2						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00
13	2.10	1.50	8.00	11.60	3.00	3.87
14	1.10	1.28	1.75	4.13	5.00	0.83
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	2.00	0.00
17	0.00	5.60	1.15	6.75	5.00	1.35
18	1.05	0.00	2.00	3.05	6.00	0.51
19	0.00	0.00	0.00	0.00	0.00	0.00
20	2.05	1.55	3.65	7.25	2.00	3.63
Total	**6.30**	**9.93**	**16.55**	**32.78**	**21.00**	**1.56**

Table 11: Waste Chart- El Rodeo- Week Three

House#13 produced the most quantity of biodegradable material as well as waste. In total, House #13 produced the most solid waste at 11.60 kg in El Rodeo. Most of this solid waste was composed of biodegradable material (8.00 kg). House #17 accumulated the 5.60 kg of recyclable material, which was the most for any household in this community.

In the third week's collection we received solid waste from seven households in Barrio Granja. We collected a total of 41.6 kg of solid waste; 28.85 kg was composed of recyclable material. The remaining material was composed of 7.4 kg of biodegradable material and 5.35 kg of waste. After calculating the number of members per household, each resident who participated in the collection during the third week produced approximately 0.72 kg of solid waste. Table 12 shows the amount of solid waste per household as well as per resident. We calculated the average solid waste per household, by dividing the sum of solid waste by the amount of residents within each household.

Granja Week 3						
Household	Waste produced (kg)	Recyclables produced (kg)	Biodegradables produced (kg)	Total Solid Waste (kg)	Residents per household	Waste produced per resident (kg)
21-24	4.7	13.1	0	17.8	8	2.23
25	0	0.5	7.4	7.9	3	2.63
26	0	7.85	0	7.85	2	3.93
27	0	0	0	0	0	0.00
28	0	0	0	0	0	0.00
29	0.65	7.4	0	8.05	3	2.68
30	0	0	0	0	0	0.00
Total	**5.35**	**28.85**	**7.4**	**41.6**	**16**	**0.72**

Table 12: Waste Chart-Barrio Granja-Week Three

The twenty-three households who participated in our program helped to begin the process of implementing a future recycling program in the cantón of Montes de Oca. Hopefully from the research we conducted during the three weeks, the Municipality can use the information we collected as a reference for future recycling programs.

4.5 Financial Analysis

After completing the three week trial recycling program we were able to find the aver amount of recyclables produced per resident and from those results we were able to extrapolate to determine the amount of recyclables that could be expected to be produced in the canton of Montes de Oca, this chart can be found in Appendix T- Average Weekly Recyclables per Resident. We then combined the expected amount of recyclables with the average recyclable prices we obtained to find the total amount that COOPEMUJER could expect to receive from a week's collection. That data can be found in Appendix U – Possible Recyclable Profits. According to our calculations the women of COOPEMUJER could receive approximately ¢4,270,000 for the recyclables received in one week.

After speaking with Gerardo Madrigal we found that COOPEMUJER will be subsidized by the municipality for the first four years of the program. Because of this, the only costs to be covered by COOPEMUJER will be the tags or bags that they supply to the residents. As explained in the next section we are recommending the use of tags which will cost approximately ¢68,000 a week, allowing for ¢4,200,000 to go directly to

the women of COOPEMUJER.

5 Recommendations

After completing our field research and analyzing the data collected, we developed several recommendations that we believe can improve the solid waste management program in Montes de Oca. These methods were developed through our background research conducted on recycling programs throughout Costa Rica and the United States in addition to field research in Montes de Oca. The next sections will discuss our recommendations for the implementation of a permanent recycling program, and educational pamphlet and finally a financial analysis of the future costs of the program.

5.1 Implementation of a Permanent Program

Because of the significant waste management problem in Costa Rica, we believe that the implementation of a permanent recycling program in the community of Montes de Oca would help to reduce their solid waste in addition to providing income for COOPEMUJER. As shown in the background research, communities such as Mount Vernon, Iowa in the United States are capable of decreasing their solid waste by 50 percent through the use of a recycling program.

5.1.1 Options for a Recycling Program

There are several options for recycling programs within the community of Montes de Oca. Below are listed two types of programs that our team has researched. Each program also lists advantages and disadvantages to the implementation and running of the program.

5.1.2 Curbside Recycling

Our team recommends that Montes de Oca implement a curbside recycling program. A curbside program would be most beneficial to the residents of the community because it would minimally change their waste management habits as the residents would need only to place their recyclables outside of their doors for

COOPEMUJER to collect. As seen in our study of waste management habits of the residents, some are unable to participate in solid waste separation because of physical restraints, such as age or disability. With a curbside recycling program, it would be more convenient for such residents and therefore they would be more likely to separate their solid waste. Also, this would be easiest for the residents of the community because they would not have to transport their own materials to a recycling center.

5.1.3 Containers, Bags, or Tags

A concern that occurred to our team was how the recyclables would be contained after separation from other waste materials. We determined that there are three options for the residents.

These are:

- containers,
- bags or
- tags

The first option for the collection of recyclables is to use container which would be an ideal choice for a few reasons. For long term use containers would be the better choice because they would be the most cost efficient method for COOPEMUJER and the Municipality of Montes de Oca. By using containers, COOPEMUJER would save ¢12,666,171 ($23,751 USD) (http://www.oanda.com/convert/classic). Although the initial expense of supplying and distributing all 11,310 houses in Montes de Oca with containers would be large, these containers last more than a year which means they do not need to be replaced as often as other methods such as bags do. The expense to supply each household with a container is shown in Table 13: Cost Chart for Bags and Containers. For an average 12.50 gallon container, as show in Figure 20: Example Recycling Bin. The rates vary from $13.50 to $25.00 depending on the retailer that the containers are bought from.

Figure 20: Example Recycling Bin
Source:
http://www.bettymills.com/shop/product/view/Rubbermaid%20Commercial/RCP571206BLU.html

When researching this method our team came across several advantages and disadvantages. One of the advantages is that it would be easier for COOPEMUJER to separate the recyclables out of containers. Another benefit of containers is that they could have a cover to prevent animals from going through the recyclables.

There are also disadvantages of the use of containers for the collection of recyclable materials. If the recycling program were only to be run short term, a great disadvantage would be the cost to supply and distribute a collection bin to each household Montes de Oca. Another disadvantage is that most residents would not be willing to use the containers as a method for reusable waste disposal; the residents would find another use for the containers, for example, as a method of storage in their household.

Cost chart for COOPEMUJER					
Item	Number of households	Amount per household	Cost per item	Total Weekly Costs for households	Total Yearly Costs for households
Bags	11310	2	$0.30	$3,393.00	$176,436.00
Containers	11310	1	$13.50	N/A	$152,685.00

Table 13: Cost Chart for Bags and Containers

The second method for collection of reusable materials is bags. For short term use, as in a six month trial, bags would be the most cost efficient method for

COOPEMUJER and the Municipality of Montes de Oca. However, if the program implemented is not a short term program, the expense of bags would be greater than that of the containers. The total cost for the use of bags for a year is shown in Table 13: Cost Chart for Bags and Containers. Each household would be provided with two bags for their recyclables. If there was a need for more bags, the residents would purchase more from COOPEMUJER.

Our team also found advantages and disadvantages for the use of bags for the collection of recyclable materials. The greatest advantage is that in the short term bad would be less expensive to supply to the residents. Another advantage is that the residents could separate their recyclables from each other. For example, they would be able to separate paper and cardboard from bottles and cans. By separating these materials, there would be no contamination of the paper and cardboard increasing the amount of useable material to be sold to companies. In Costa Rica, companies do not accept contaminated materials; this system would limit the amount of rejected recyclables. The disadvantage of using bags for the collection of the materials is that the destruction of the bags by animals is possible. But if the materials are properly cleaned and separated there is a low chance of odors attracting animals.

The third option for the collection of recyclable materials is the use of different colored tags (shown in Figure 21: Bag Tag). The expense to supply all households in Montes de Oca with tags is far less than the other two methods of collection. The expense to supply the households with three tags every week for a year is much less than either bags or containers (shown below in Table 14: Cost Chart for Tags). An advantage to this system is that the solid waste management habits of the residents would not be affected as greatly as other methods. Most residents in Montes de Oca reuse the bags that they receive in the grocery store to dispose of their solid waste. Therefore, they would buy the tags from the Municipality, the local grocery store or from COOPEMUJER. In the future the tags could also be used for the collection of biodegradable material for a composting program.

Tags	Amount per pack	Households	Cost of tags	Price Per Month	Yearly Price
$3.83	100	11310	$436.62	$5,239.44	$68,112.72
$3.83	100	11310	$436.62		
$3.83	100	11310	$436.62		
			Weekly Price		
			$1,309.86		

Table 14: Cost Chart for Tags

In conclusion, the most cost efficient method for COOPEMUJER and the Municipality of Montes de Oca in the long term would be containers. However, there is the obstacle of getting residents to use the containers for the collection of recyclable materials. The use of bags would be the most cost efficient for a short term program, but if the program were to continue longer than six months the expense of bags would be too great for COOPEMJUER and the Municipality. Therefore, our team recommends that the system of tags be used for the collection of recyclables and other types of solid waste.

Figure 21: Bag Tag
Source: http://www.city.sault-ste-marie.on.ca/wastemanagement/wastem2.jpg

5.1.4 Bimonthly Collection

One option for the curbside recycling program is a bimonthly collection by COOPEMUJER. The day of collection would be specified for each barrio, preferable on the same day as the collection of solid waste. However, the collection day could be on a different day than this collection. The weeks that the reusable materials will be recycled

also need to be specified for the residents to make it easy for them to remember; for example the second and fourth weeks of the month.

Bimonthly Curbside Recycling Collection				
Collection Day	Cost Effective for COOPEMUJER	Confusion Among the Residents	Recyclables to Landfill	Reduction in Truck Usage
Same Day	♦		♦	♦
Different Day	♦	♦	♦	♦

Table 15: Bimonthly Curbside Recycling Collection

Table 15 above outlines some advantages and disadvantages of bimonthly collection for either the same day or a different day. The diamonds signify which aspects of the program each has. The team believes that the same day collection would be more so COOPEMUJER because the services provided will still allow revenue for the cooperative. This characteristic includes lower transportation costs for the collection of the materials and fewer hours required of each employee for the collection of the materials. Both the same day and different day collection service have this characteristic, however, the same day service might bring in slightly more revenue because there would not be any confusion among the residents as to which day to place their reusable materials out for collection. Both the same day service and different day service would reduce the truck usage (transportation costs would be lower, less gasoline used, etc.) because the service would only be twice a month. A disadvantage to bimonthly collection is that there would be more reusable material and the same storage space between pickups. This might increase the chances that some of the reusable material would be sent to a landfill instead of the recycling center.

5.1.5 Weekly Collection

As another option our team suggests that the recyclables be collected weekly. This would increase the convenience for the residents and potentially increase the cost effectiveness for COOPEMUJER. Each of the neighborhoods should have a designated

day for collection. Once again, the collection day could correspond to the day currently in place. Shown below in Table 16 are some of the characteristics of this type of recycling collection service.

Weely Curbside Recycling Collection				
Collection Day	Cost Effective for COOPEMUJER	Confusion Among Residents	Increase in Man Hours	Increase in Recyclables
Same Day	♦		♦	♦
Different Day	♦	♦	♦	♦

Table 16: Weekly Curbside Recycling Collection

Some of the advantages of weekly collection are that there would be an increase in the recyclables collected each week because the residents would not need as much storage space for the recyclables before they are collected. This would lead to an increase in revenue for COOPEMUJER which would make this method more cost effective, either on same day service or different day service. A disadvantage of the different day program there might be some confusion among the residents in the initiation of the program. Another disadvantage to the weekly pickup is that there would be an increase in man hours needed for the collection of the materials. This would also increase the usage of the service truck.

5.1.6 Recycling Center

After completing our research we found that there are many communities in the United States that have recycling centers where the residents can bring their materials. Our team encountered a household in which this method was already in use in Urbanización El Rodeo. However, our team believes that this method is less effective than that of the curbside recycling. Listed below are several reasons for the ineffectiveness of this type of recycling program.

- Transportation issues for residents in the community.

    - Not every household has a vehicle capable of transporting.
    - Traffic and roads are difficult.
- Inconvenience of bringing the recyclables to the recycling center.
    - This takes time and planning on the part of each resident to transport their materials.
    - More convenient to include the recyclables in other waste collection and not recycle.
- Time constraints on recycling centers and residents.
    - The recycling center may only be open during certain hours during the week.
    - Residents may have previous commitments, such as work and family obligations.

Our team suggests that the recycling center began in Montes de Oca should accept the various recyclables brought to the center by residents in addition to those collected by COOPEMUJER. Also, there should be contact numbers available for the residents if they have questions or suggestions for the recycling program.

5.2 Other Waste Management Options

Our team decided to suggest more options for waste management than just a curbside recycling program. In the following sections, we have described two other waste management options and how they would be beneficial to the COOPEMUJER, the Municipality and most importantly, the residents of Montes de Oca.

5.2.1 Pay-As-You-Throw

A method described in the background section that has been found to be effective in the United States is Pay As You Throw. We suggest that a similar type of program be started within Montes de Oca to ensure that all of the residents are charged the same amount for the service that they receive.

The system that our team recommends is the use of tags to distinguish types of solid waste. The residents of Montes de Oca are all provided with their own bags,

reusing bags grocery bags or purchasing their own. However, the Municipality would be responsible for making the tags available to the residents. Similar to our three week trial program, the tags would be available in different colors depending on the material in the bag. The residents would mark their bags with a tag either signifying reusable material (recyclables) or waste (non-reusable material). The tags could be purchased by residents at specified locations such as the local supermarket or Municipal buildings. The residents would be able to control their solid waste expense by controlling how much they dispose of in addition to recycling. This type of program would be easy to enforce with the bags without tags being left behind at the time of collection. Unfortunately this method could also promote illegal disposal of solid waste as some residents may be resistant to the program. Therefore we suggest that if the municipality decides to implement such a program they should follow the example of Seattle, Washington and give the residents a grace period before enforcing the program.

In the future this method could be expanded to include a tag for biodegradable materials if a composting program were to be started in the cantón. It would be simple to add another color to distinguish biodegradable materials.

With this program, the residents would not pay an extra cost for recycling. The cost to recycle would be built into the cost of the tags for collection. In this way the Municipality would receive the profit from the sale of the tags, therefore, effectively replacing the current trimester billing system. The program would also benefit COOPEMUJER through the promotion of recycling which would increase their income.

5.2.2 Bottle Bill

Our team recognized the need for incentives in different types of waste management programs. In the United States there are a few programs in which residents can decide not to recycle but are then required to pay more for their products. One example of such a program is the Bottle Bill. We believe that the implementation of such a program would provide incentives to the residents and no other regulations would be necessary. A fixed rate of 20 colones would be placed on plastic bottles and cans providing the residents with an incentive to return them as they would be reimbursed for

the deposit upon return. No other regulations would be necessary because the residents have already paid the deposit on the bottles which would be returned to the recycling program for its further financial support. Our team made the recommendation for this program because residents would be likely to respond to the accumulation of 20 colones per bottle or can.

Advantages:

- Increased awareness among the residents because of the accumulation of the bottle deposit.
- Decrease in littering of bottles and cans.
- Bottles and cans collected from the street could be returned to stores for their cash value.
    - More convenient to residents as recycling bottles currently involves taking them to a recycling facility, whereas stores are conveniently located near homes.

Disadvantages:

- Bottle bill may be difficult to implement;
    - Would require the cooperation and supervision of businesses.
- Space limitations within the businesses.
    - Would need space to store returned materials
- Some businesses may refuse to refund the bottle deposit if it is not in use in their store.
    - Would make return of material inconvenient.

5.3 Package of Programs

Because any one of these programs will not be effective on its own, our team suggests that the Municipality of Montes de Oca implement two or more of the above mentioned programs. For example, implementing a PAYT program in cooperation with a curbside recycling program, funded by the municipality of Montes de Oca and run by COOPEMUJER, would encourage the use of the recycling program and reduce solid

waste effectively. If these two programs were implemented simultaneously, it would be possible for the curbside recycling to be free of charge.

We believe that the implementation of a package of programs would be the best investment for COOPEMUJER, the Municipality and the residents for a few reasons:

- Decrease in the solid waste within the community.
- Recyclables would be able to be sold for a profit by COOPEMUJER.
- Decrease in solid waste costs for the residents of the community.

5.4 Educational Program

To insure an effective implementation of a recycling program or a package of programs, it is critical that the community be aware of how such a project works. Therefore, it is a main recommendation of our team to implement an educational program in the community.

Our research, both in the field and in our background, suggests that recycling programs are more effective if the residents are aware of the benefits for themselves and the environment. Therefore our team suggests proactive educational campaign about the implementation of a recycling program. There are several types of campaigns: ads on television, radio and in the newspaper. As our team learned from the program begun in Santa Ana, door to door campaigning and pamphlets were very effective methods of advertising about the recycling program. Another suggested method to reach the residents is through recycling educational programs in the schools. This would bring the importance of recycling to the attention of the parents through talking to their children.

COOPEMUJER will be aided by the government for four years, during which the government will pay for any of the costs sufficient to the program as well as the residents of Montes de Oca. After four years, the government feels that COOPEMUJER will have a substantial income where they can now afford for the costs of their program.

5.4.1 Educational Pamphlet

The method suggested by our team is an educational pamphlet to help inform the residents of Montes de Oca of proper reusable and non reusable materials. This pamphlet

would provide a detailed explanation as to what is and is not recyclable in Costa Rica. To increase the effectiveness of the pamphlet there should be clear pictures or representations describing the types of materials that are or are not recyclables. Also, this pamphlet should include what types of materials are considered biodegradable in Costa Rica and how these materials might be used by the residents for their own benefit. A sample pamphlet created by our team for this recommendation is located in Appendix Y - Example of Sample Pamphlet Because COOPEMUJER would be collecting the recyclable materials, they should be responsible for the producing and updating the information in the pamphlet. The cost of pamphlet production would be paid by the income received from the resale of recyclable materials collected.

Our team believes that the educational pamphlet would be more effectively distributed to the residents of Montes de Oca by door to door campaigning. However, it could also be available at local supermarkets, gas stations and other stores.

The pamphlet should contain contact numbers to the Municipality in addition to COOPEMUJER. This would make these resources more available to the residents in case of questions about or any suggestions the residents might have for the program.

6 Conclusions

The main goal of our project was to determine the feasibility of a recycling program in the Cantón of Montes de Oca, San José, Costa Rica and to recommend improvements to the proposed program. This project required our team to keep in mind the needs of the residents in addition to the needs of the Municipality. Through research and analysis our team made recommendations for improvements to the waste management system in Montes de Oca.

From the data collected, our team found that many residents of Montes de Oca were willing to participate in a recycling program. In fact some of the residents were already recycling and composting to reduce their amount of solid waste. From these encouraging results, our team compiled recommendations for the community of Montes de Oca.

Our team's primary recommendation was to implement a permanent recycling program in the Cantón of Montes de Oca. From our research we found that recycling programs are most effective when executed in conjunction with another waste management program, such as Pay-As-You-Throw (PAYT). PAYT improves the effectiveness of a recycling program because it encourages residents to recycle by making them aware of a physical and monetary reduction in solid waste management. Also, PAYT allows for residents to control their solid waste management expense. As the curbside recycling program would be provided free of charge, the residents would be able to reduce solid waste costs in addition to maintaining a cleaner environment through recycling.

To integrate these recommendations into the system already in place and improve the trial system, an educational recycling program should be implemented to inform the community of the changes taking place in the waste management program. From our research and data collection, the most beneficial educational program would be the distribution of a detailed recycling pamphlet.

In conclusion, by integrating a recycling program into the current waste management program within the Cantón of Montes de Oca, the community would effectively reduce their solid waste production and help to control environmental contamination. Our team

hopes that the recommendations from the completion of this project will encourage changes to the trial program and make it more effective as a permanent program.

Glossary of Terms

Alcalde/Alcaldesa: The Spanish equivalent of mayor.

Barrio: The Spanish equivalent of a neighborhood.

Biodegradable: Materials that can be decomposed by biological agents such as bacteria.

Biodegrade: Biological process that breaks down materials into basic components.

Cantón: A subdivision of a province; equal to a county in the United States of America.

Compost: A blend of decaying organic matter (such as food waste, leaves and yard clippings), that can be used to improve the soil structure and provide nutrients to the soil.

Composting: The controlled biological decomposition of organic solid waste.

Decompose: To break down into basic components or elements; to decay.

Dispose: To discard; to throw away.

Environment: Everything that surrounds living things and has an effect on them; examples of environment are people, animals, plants, soil, water, buildings, weather, etc.

Garbage: See **Solid Waste**, more specifically household solid waste.

HDPE: High Density Polyethylene; a type of plastic that includes containers such as milk jugs, bottled water jugs and detergent bottles.

Incinerate: To burn solid waste.

Landfill: A site where solid waste may be disposed by compacting and covering with soil.

MSW: Municipal Solid Waste; includes non- hazardous waste that is generated by households and commercial establishments; does not include industrial wastes, agricultural wastes and sewage sludge.

Methane: A gas that is odorless, colorless and flammable. It is the major constituent of natural gas that is used as fuel. It is formed from the decomposition of materials in landfills.

Natural Resource: Materials that are naturally occurring and have some value, such as trees, water and minerals.

Non-usable Material: See **Waste**.

Organic: Materials or compounds that contain carbon that are often derived from living organisms. Organic wastes include food waste, yard clippings and leaves.

Pollution: The contamination of air, soil and water with harmful chemicals or substances.

Recyclable: Materials that can be used again to create new materials; recyclable materials include cardboard, paper, plastics, metals, etc.

Recycle/recycling: The process of reusing materials to create new products.

Recycling Center: A site where recyclable material is brought so the materials can be collected and resold.

Solid Waste: All types of solid waste; these are classified into three categories: reusable (or recyclable), non-reusable (or garbage), and biodegradable material (organic material).

Trash: See **Waste**.

Usable Material: See **Recyclable**.

Waste: Any non-reusable, non-biodegradable material.

Appendix A - Sponsor Description

Our sponsor, Dr. Ronald Arrieta Calvo, a professor of Chemistry at the University of Costa Rica, has been working on various recycling programs since 1991. He believes that recycling will be a difficult but a necessary addition to Costa Rican society because of their pressing solid waste management problem. Costa Ricans, he believes, do not feel responsible for the maintenance of their environment, and that is the reason why recycling programs have faced so much adversity in the past. According to Dr. Arrieta, Costa Rica's unique culture and history makes it difficult to translate methods that have worked for other countries. He is hoping that through his efforts he will be able to design a protocol that any Costa Rican city or town will be able to use to create their own recycling program.

In the past, Dr. Arrieta has worked in conjunction with the Centro en Investigación de Contaminación Ambiental to establish recycling programs in Costa Rica. Centro en Investigación de Contaminación Ambiental (CICA) is a small government funded non-profit organization that researches methods to reduce environmental pollution in Costa Rica. CICA was established by the University of Costa Rica in 1982 with these three main objectives:

1. To be able to the measure the amount of environmental pollution;
2. To be able to control the environmental contamination and;
3. To become the best research and investigative institution in the country.

It was also founded to help consolidate the analysis of various different types of environmental pollutants, including aquatic pollutants as well as recyclable materials, into one research institution. An additional objective in creating CICA was to encourage Costa Ricans to minimize their impact on the environment by promoting reuse and recycling. During our project we worked with students from CICA at the University of Costa Rica to conduct a survey of residents of Montes de Oca.

Our project also employed the help of COOPEMUJER, a women's cooperative in Montes de Oca, into our project. COOPEMUJER was created in 2003 by single mothers in Montes de Oca to create jobs that would provide them with sufficient income to

provide for their families without requiring them to work while their children were at home. We worked with them on this project because any future recycling program in Montes de Oca will be run by COOPEMUJER. The women of COOPEMUJER were also involved in a previous trial recycling program with Dr. Arrieta in 2003. Because of their previous experience they already had knowledge of recyclable purchasing companies as well as which recyclable materials were useable in Costa Rica. They were also helpful in determining the target households as they are from Montes de Oca and knew many residents in the barrios that were willing to participate.

Appendix B- Original Sponsor Letter to WPI

UNIVERSIDAD DE COSTA RICA
ESCUELA DE QUÍMICA
Dr. Ronald Arrieta Calvo
rarrieta@cariari.ucr.ac.cr
207 5038 355 81 33

Señora
Profesor Susan Vernon-Gerstenfeld
Dir. Academic Programs and Planning

Estimada Señora,

Con respecto a su solicitud de proponer un proyecto a ser realizado por estudiantes de la WPI en mayo próximo, me permito comunicarle que un proyecto adecuado es el de realizar un estudio de factibilidad económica y social para determinar la viabilidad de un centro de acopio para comercializar desechos aprovechables en el Cantón de Montes de Oca.

Este centro de acopio será operado por la cooperativa COOPEMUJER qué han firmado un convenio con la Municipalidad de este Cantón en el cual se prevee ceder un espacio para instalar el centro de acopio.

El objetivo principal será:
Determinar la factibilidad económica y social para un centro de comercialización de desechos aprovechables.

Los objetivos específicos son:

Conocer las características del Cantón de Montes de Oca
Conocer la legislación costarricense sobre manejo y aprovechamiento de desechos sólidos
Seleccionar muestras representativas de tres sectores socioeconómicos del Cantón
Educar a los vecinos de los sectores a estudiar para que separen los desechos en tres grupos: biodegradables, aprovechables y no aprovechables.
Cuantificar los diferentes tipos de desechos durante cuatro semanas
Determinar los precios qué se pagan en el mercado costarricense
Determinar los costos de inversión y operación de un centro de acopio cantonal
Determinar mediante una encuesta el grado de disponibilidad de los vecinos para separar los desechos en tres grupos.
Realizar un análisis financiero para determinar la viabilidad económica del proyecto

Quedo a su disposición y a la de los estudiantes y profesores para atender cualquier consulta qué consideren pertinente.

Atentamente,

Dr. Ronald Arrieta Calvo

Appendix C - Sponsor Letter (English)

Patricia Adamson, Emily Allietta, Melissa King
Worcester Polytechnic Institute
100 Institute Rd. Box 118
Worcester, MA, 01609
Phone: 720-840-6782
CICA06@wpi.edu

Ronald Arrieta
CICA
San José, Costa Rica
Office: 506-207-5038
Cell: 506-355-8133
rarrieta@cariari.ucr.ac.cr

Dear Professor Arrieta,

We would like to take a moment to introduce ourselves to you. We are currently sophomores at Worcester Polytechnic Institute and we are looking forward to working with you this summer. At WPI we are studying a variety of majors, ranging from Mechanical Engineering, Biochemistry, and Management Engineering. With this variety of majors, we believe that our unique backgrounds will benefit our project.

After looking through the project opportunities of Costa Rica, we found this project to be the most meaningful to us and are delighted to be working with you and for such a great organization. This project looks to have the most impact on the community of Montes de Oca and will help future generations to recycle. Our advisors, Natalie Mello, Professor Guillermo Salazar, and Professor David DiBiasio believe that we have found the perfect project because we have all had experience in our communities with similar undertakings and we feel passionate about this project.

If possible we would like to set up a conference call in which we would thoroughly discuss the scope and content of our proposed project and what exactly you would like for us to accomplish for your organization. Our advisors have given us a rough description of the project, but if possible we would like some more clarity. We also would like to discuss with you the materials you would like us to consider for recycling in this project.

We are anxious to move ahead with our background research, and we would appreciate if you could let us know by email as soon as possible in regards to which days and times work the best and are the most convenient for you. Wednesdays are the best day for the conference call, preferably after 12pm EST. Feel free to contact us at anytime via email

at cica06@wpi.edu or by phone at +1-720-840-6782 and ask for Patricia. We thank you for your time and cooperation.

Sincerely,
Patricia Adamson
Emily Allietta
Melissa King

Cica06@wpi.edu

Appendix D - Sponsor Letter (Spanish)

Patricia Adamson, Emily Allietta, Melissa King
Worcester Polytechnic Institute
100 Institute Rd. Box 118
Worcester, MA, 01609
Phone: 720-840-6782
CICA06@wpi.edu

Profesor Ronald Arrieta
Centro en Investigación de Contaminación Ambiental
Escuela De Química
Universidad de Costa Rica
San José, Costa Rica
Office: 506-207-5038
Cell: 506-355-8133
rarrieta@cariari.ucr.ac.cr

Estimado Profesor Arrieta,

Por medio de la presente nos estamos presentando a usted. Somos las estudiantes Patricia Adamson, Emily Allietta y Melissa King. Estamos estudiando el segundo año de universidad en el Instituto Politécnico de Worcester, WPI y estaremos trabajando con usted en el semestre de verano en el proyecto que examinara las políticas de reciclaje en la población de Montes de Oca en el área de San José de Costa Rica. En el WPI estudiamos una variedad de especialidades. Patricia está estudiando ingeniería mecánica, Melissa está estudiando bioquímica y Emily está estudiando administración en la ingeniería. Creemos qué la diversidad de nuestras áreas de concentración le serán benéficas a nuestro proyecto.

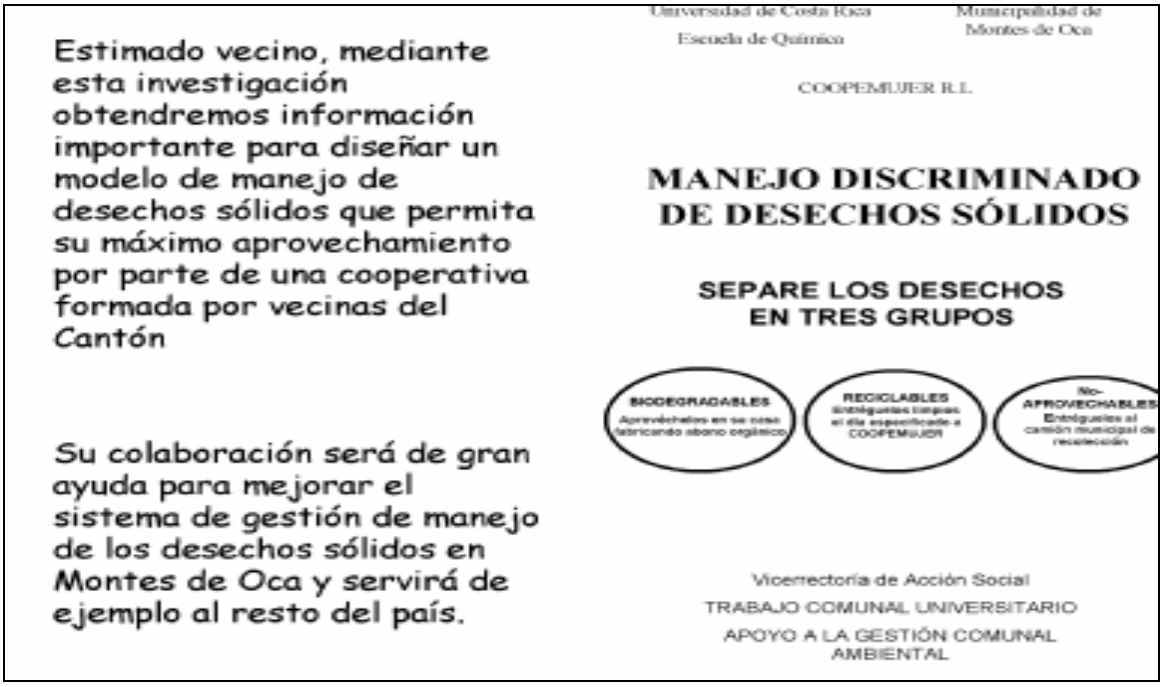
Nuestros profesores, Natalie Mello, Guillermo Salazar y David DiBiasio piensan que este proyecto es ideal para nosotros puesto qué nosotras hemos tenido experiencia en nuestras comunidades con proyectos similares y estamos muy entusiasmadas de tener la oportunidad de poder contribuir sobre este tema. Estamos muy emocionadas con la idea de trabajar con usted durante el verano.

Sí es posible nos gustaría hacerle una llamada telefónica lo mas pronto posible para discutir el objetivo del proyecto en mas detalle ya que por el momento la descripción qué tenemos es muy general y queremos prepararnos lo mejor posible recabando información al respecto antes de viajar a Costa Rica por lo cual apreciaríamos mucho si nos podría contactar cuanto antes por correo electrónico mencionando los días y las horas qué son más convenientes para usted. Los miércoles son los mejores días para nuestro grupo después de 12pm EST, pero es posible tener la llamada los martes a las 2pm EST. Por

favor, háganos saber su respuesta por correo electrónico a cica06@wpi.edu. Muchas gracias por su tiempo. Esperamos pronto poder estar trabajando con usted.

Atentamente,
Patricia Adamson, Emily Allietta, Melissa King
Worcester Polytechnic Institute
100 Institute Rd. Box 118
Worcester, MA, 01609
Teléfono: 720-840-6782
CICA06@wpi.edu

Appendix E – Montes de Oca Pamphlet



Estimado vecino, mediante esta investigación obtendremos información importante para diseñar un modelo de manejo de desechos sólidos que permita su máximo aprovechamiento por parte de una cooperativa formada por vecinas del Cantón

Su colaboración será de gran ayuda para mejorar el sistema de gestión de manejo de los desechos sólidos en Montes de Oca y servirá de ejemplo al resto del país.

Universidad de Costa Rica
Escuela de Química

Municipalidad de Montes de Oca

COOPEMUJER R.L.

MANEJO DISCRIMINADO DE DESECHOS SÓLIDOS

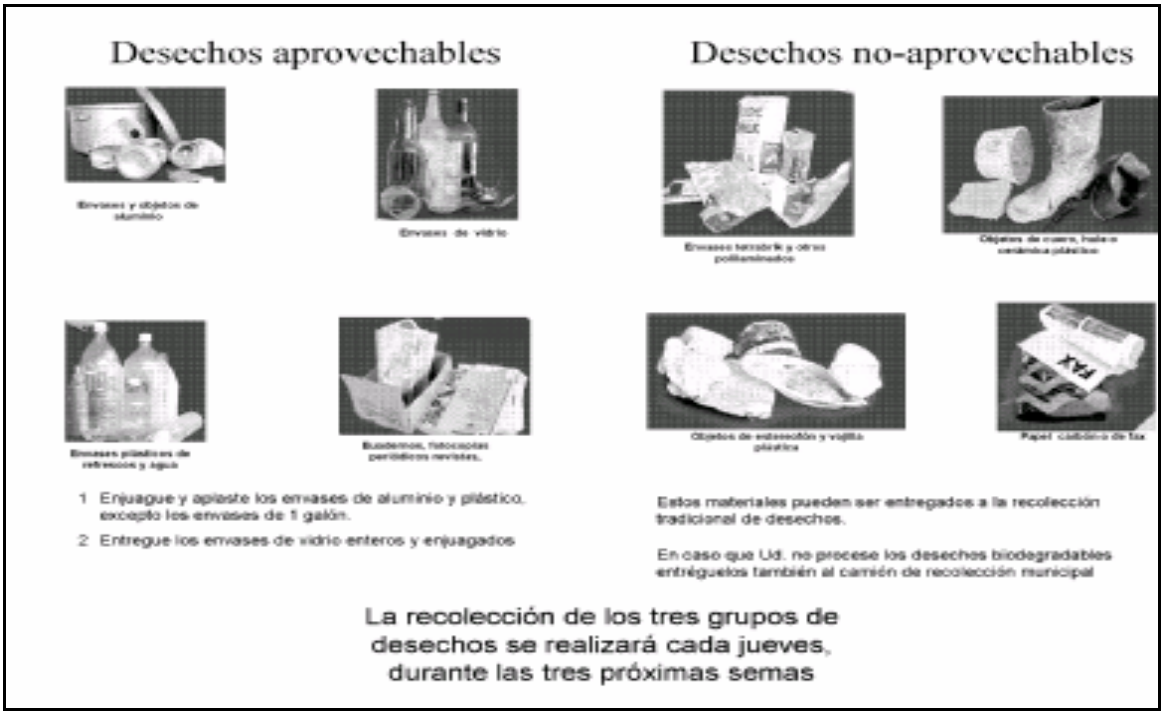
SEPARE LOS DESECHOS EN TRES GRUPOS

BIODEGRADABLES

RECICLABLES

No-APROVECHABLES

Vicerrectoría de Acción Social
TRABAJO COMUNAL UNIVERSITARIO
APOYO A LA GESTIÓN COMUNAL AMBIENTAL



Desechos aprovechables

Desechos no-aprovechables

1 Enjuague y aplaste los envases de aluminio y plástico, excepto los envases de 1 galón.

2 Entregue los envases de vidrio enteros y enjuagados

Estos materiales pueden ser entregados a la recolección tradicional de desechos.

En caso que Ud. no procese los desechos biodegradables entréguelos también al camión de recolección municipal

La recolección de los tres grupos de desechos se realizará cada jueves, durante las tres próximas semas

Figure 22: Recycling flyer for Montes de Oca provided by Dr. Arietta

Appendix F – Seattle, Washington Recycling Guide

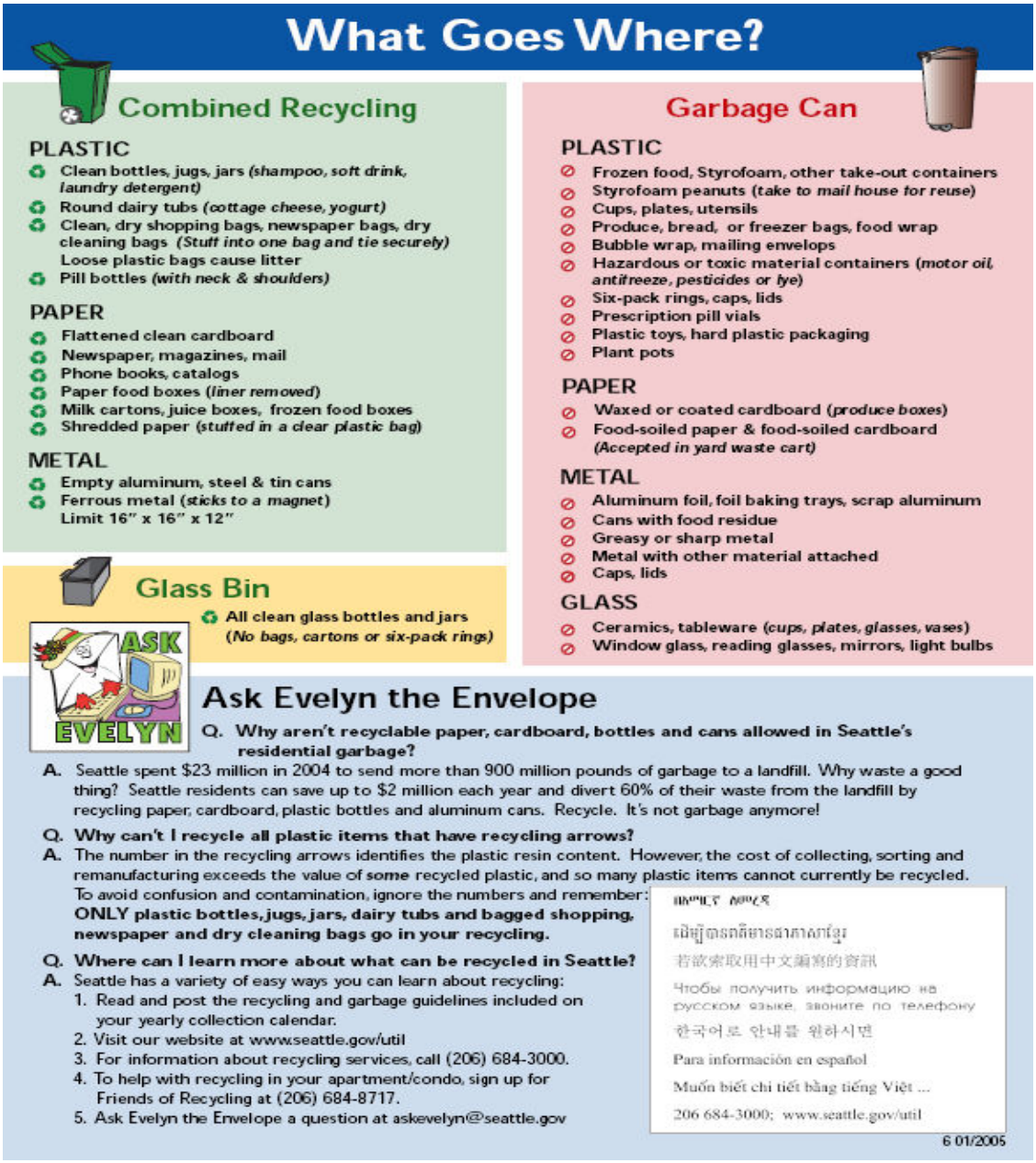


Figure 23: Recycling Guide- Seattle, Washington
Source:
http://www.ci.seattle.wa.us/util/stellent/groups/public/@spu/@csb/documents/webcontent/recyclable_2003120207594812.pdf

Appendix G- Clearwater Recycling Regatta

Figure 24: Clearwater Recycling Regatta

Appendix H - Project Timeline

Action	15-May	22-May	29-May	5-Jun	12-Jun	19-Jun	26-Jun	3-Jul
Archival and Background Research								
Learn the characteristics of the Cantón of Montes de Oca								
Learn the legislation regarding waste management in Costa Rica								
Select representative houses from five socio-economic levels in the Cantón								
Design a Survey								
Survey the Community								
Train the residents of Montes de Oca to separate their solid waste into three groups: biodegradable, reusable, and non-reusable materials								
Solid waste collection and separation for three weeks								
Determine market value for recycables								
Determine the costs for investment and operation of a recycling center for the canton								
Financial analysis to determine the economic feasibility of the project								
Write the final presentation								

Table 17: Project Timeline

Appendix I- Interview with the Santa Ana Recycling Center

1. What is your full name?

Liliana Umaña

2. Who is the head of the program?

There is no head of the program, it is run by an association, but Liliana is the manager of the recycling center.

3. When was the program started?

The program was begun in 1998.

4. Why was the program started?

The program was started because many parents of mentally handicapped children were worried because their children were unable to find jobs. They wanted to start a program that would teach their children skills that they could use to find work. At the same time, the municipality of Santa Ana wanted to start a recycling program to reduce the amount of solid waste produced by the community. They were able to combine both programs into one, and created a unique recycling center that employs mentally handicapped youth while also teaching them trades, such as basket weaving and pottery, a few days a week. Unfortunately, the job market is still prejudiced against mentally handicapped people, and the jobs that were supposed to be temporary for the youth have become permanent.

5. How many employees are there?

There are 25 people working at the recycling center.

6. How many houses/residents are served by the recycling company?

There is a survey being conducted at the moment to determine exactly how many residents are using the program, but we currently service the entire community of Santa Ana.

7. Do people in the community use the program?

Yes, many people have become very involved in the program and even go as far as bring recyclables directly to the center.

8. How were they informed of the program?

There was a recycling campaign that included the use of pamphlets and door to door campaigning.

9. Are there incentives or fines?

No there are no incentives or fines.

10. If so, what types?

In 1999 a law was passed that stated residents who recycle can receive a discount on their solid waste disposal costs as well as fining those who do no participate in recycling programs. Unfortunately there is not enough political support to enforce the law.

11. What types of recyclables are collected by the recycling center?

The recycling center currently collects: aluminum, plastics 1 and 2, all types of paper, cardboard and sometimes car batteries.

12. Where do they go?

Each type of recyclable goes to a different company.

13. Are the recyclables sold?

The recyclables are sold to the companies that receive the material.

14. How much are they sold for?

I don't currently know. The prices for recyclable materials change constantly.

15. How much material can the recycling center process in a month?

The recycling center can process about 25,000 tons of material in a month.

Appendix J - Alcaldesa Interview

1. **When were you elected into office?**

I was elected in December of 2002 in the 1st popular vote in all of Costa Rica for the Alcaldesa position. Before the popular vote, Alcaldesa positions were filled by political parties and it created instability in the municipalities. The municipality of Montes de Oca decided to have a popular vote because in the 4 years previous to the vote they had had 14 different Alcaldesa's.

2. **Is there a solid waste problem in Montes de Oca? And if so, why?**

All of Costa Rica is experiencing a solid waste crisis. The cities and rivers are dirty and there is no set way for people to deal with garbage disposal. The municipalities that have a solid waste management program in place do not have the necessary funding and are badly organized. As there has never been a political force to organize nationwide garbage collection or to create an educational program in Costa Rica, the country is experiencing a solid waste crisis.

3. **How do you believe this problem can be corrected?**

We need to create recycling programs throughout Costa Rica and promote the use of recycled materials. One way that I believe we can promote the use of recycled materials is to make goods that use recycled materials equal in price, or less expensive. The government also needs to create a plan with every municipality to determine the funding necessary to create a functional recycling program.

4. **In speaking with Liliana Umaña, we found that many recycling companies are saturated and cannot receive any more recyclable materials. What steps do you believe are necessary to correct that problem?**

The government must start to support the recycling companies because they are in the business of recycling to make a profit and at the moment recycled goods are too expensive for them to do so.

5. How did you become concerned with recycling?

I worked as a private consultant to solid waste companies for five years and saw the problem first hand.

6. Why do you believe it is important to recycle?

I believe it is important to recycle in order to achieve an environmental equilibrium. The more that we recycle, the better off future generations will be.

7. What are you future plans for solid waste management in Montes de Oca?

I would like to unite all of Costa Rica and work together to enforce laws to help municipalities improve their individual systems. Ideally I would like for each municipality to receive 40,000,000 colones/ year for education and maintenance of solid waste practices.

Appendix K – Survey in Spanish

Barrio _____
Entrevistador(a) _____
Identificación de la casa #, color, otra característica
_____
_____
_____

1	¿Considera que los desechos que usted produce contaminan el ambiente?	
2	¿Por que?	
3	¿Qué hace la municipalidad con los desechos que usted produce?	
4	¿Contaminan esos desechos el sitio al que los llevan?	
5	¿Qué se puede hacer para reducir la contaminación que producen los desechos?	
6	¿Qué calificación le da usted al servicio de recolección?	
7	¿Por que?	
8	¿En los últimos tres meses considera usted que el servicio ha mejorado, se ha mantenido igual o ha desmejorado con respecto al plazo anterior?	
9	¿Qué aspectos positivos destacaría usted del servicio de recolección?	
10	¿Qué aspectos negativos destacaría usted del servicio de recolección?	
11	¿A que cree usted que se deban las deficiencias?	
12	¿Cada cuanto pasa por aquí el camión recolector?	
13	¿Cuáles días?	
14	¿Cuanto paga usted por trimestre?	

15	¿Cuanto cree usted que cuesta el servicio?	
16	¿Cuanto cree usted que le costaría enviar por su propia cuenta los desechos a un relleno sanitario?	
17	¿En Montes de Oca, el servicio de recolección y tratamiento de los desechos cuesta ¢3500. Considera que es barato, justo o caro?	
18	¿Ese monto es insuficiente para cubrir los costos de un buen servicio de recolección y tratamiento. Será necesario aumentarlo?	
19	¿Qué se puede hacer para que el costo del servicio de recolección y tratamiento no aumente en forma exorbitante?	
20	¿Cuales desechos se pueden aprovechar actualmente en Costa Rica?	
21	¿Cuales desechos no se pueden aprovechar actualmente en Costa Rica?	
22	¿Estaría usted dispuesta a clasificar los desechos en biodegradables u orgánicos, aprovechables y en no aprovechables?	
23	¿Esta usted de acuerdo que una cooperativa de mujeres colecte esos desechos?	
24	¿Qué desventajas tiene clasificar y aprovechar los desechos?	
25	¿Qué ventajas tiene?	
26	¿Le gustaría colaborar en una campana educativa?	
27	¿En caso positivo, a que teléfono le podemos avisar?	
28	¿Alguna observación?	

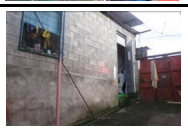
Appendix L – Survey in English

Neighborhood _____
Surveyor _____
Identification of the house (#, color, other characteristic)
_____
_____
_____

1	Do you believe that the waste you produce contaminates the environment?	
2	Why?	
3	What does the municipality do with the waste that you produce?	
4	Does the waste contaminate the place where the municipality takes it?	
5	What can be done to reduce the contamination that the waste produces?	
6	What rating would you give the municipal waste collection service?	
7	Why?	
8	In the past three months do you believe that the waste collection service has gotten better, stayed the same, or gotten worse?	
9	What are the positive aspects of the waste collection service?	
10	What are the negative aspects of the waste collection service?	
11	Who do you believe is at fault for the waste collection service deficiencies?	
12	How often is waste collected in your neighborhood?	
13	Which days?	
14	How much do you pay for waste removal per trimester?	

15	How much do you believe that the service is worth?	
16	How much do you believe that it would cost to bring the waste you produce to a landfill on your own?	
17	In Montes de Oca the waste service costs ¢3500. Do you think that it is expensive, okay, or inexpensive?	
18	This amount is insufficient to provide an adequate waste collection and treatment service. Should it be raised?	
19	What can be done to prevent the waste collection and treatment service from becoming more expensive?	
20	Which waste products can be reused at this time in Costa Rica?	
21	Which waste products cannot be reused at this time in Costa Rica?	
22	Would you be willing to classify your waste into three bags: biodegradeable or organic waste, recyclables and non-reusable waste?	
23	Are you in agreement that a women's cooperative would collect the separated bags?	
24	What disadvantages does separating waste have?	
25	What advantages does separating waste have?	
26	Would you like to participate in an educational program?	
27	If so, at which telephone number can we contact you?	
28	Comments?	

Appendix M – List of Project Participant Households

Household Trial Number Key						
Neighborhood	#	# of Residents	Description	Picture	Comments	Survey
Sinaí	1	3	House with Taxi		They compost	Yes
Sinaí	2	5	House with Diamond		None first week	Yes
Sinaí	3	2	House down hill		None first week	Yes
Sinaí	4	4	House Across From Doña Blanca		None first week	Yes
Sinaí	5	4	Doña Blanca		Good at separating	Yes
Sinaí	6	4	Doña Blanca's Daughter		None first week	Yes
Sinaí	7	3	Garden House		Very good at separating. Collects cans and resells them	Yes
Sinaí	8	5	Store		Is a store but will try to keep store waste out of the bags	Yes
Sinaí	9	6	House in front of the store		None first week	Yes
Sinaí	10	5	Wooden House		Had a lot of saved newspapers the first week. Very receptive to program	Yes

Household Trial Number Key						
Neighborhood	#	# of Residents	Description	Picture	Comments	Survey
Rodeo	11	X	#24 Orange with Green Gate		None first week	
Rodeo	12	2	#25 Yellow with Wooden Gate		Trash accidentally took their bags the first week	
Rodeo	13	3	#26 Green with White Gate		Has worked with Ronald in the past. Had a lot of previously saved recyclables that were not counted for our study. The next two weeks will be counted.	
Rodeo	14	5	#29 Green Gate with Mesh		Very good at separating.	Yes
Rodeo	15	X	#30 White with White Bars		Decided not to participate after the first collection	No
Rodeo	16	2	#31 Green with Black Bars		Very good at separating.	Yes
Rodeo	17	5	#33 Green with Black Bars and White Roof		None first week	
Rodeo	18	6	No Number Pink with Black Bars		None first week	
Rodeo	19	X	No Number but long front yard		Decided not to participate after the first collection	No
Rodeo	20	3	#87 Light Blue with White Bars	**NO PICTURE**	Has worked with Ronald in the past	

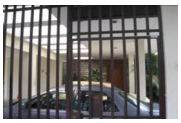
Household Trial Number Key						
Neighborhood	#	# of Residents	Description		Comments	Survey
Granja	21-24	8	Apartments		Was initially going to be 4 separate collections but the building manager separated all 4 apartments garbage together so now it will be counted as one collection	
Granja	25		White House with Black Bars and Red Bricks (Across from Apartments)		Trash accidentally took their bags the first week	
Granja	26	4	White House with White Bars and Purple Flowers		Good at separating	
Granja	27	X	#129 Huge House		Decided not to participate after the first collection	No
Granja	28		#80 Peach Colored House with White Gate		Trash accidentally took their bags the first week	
Granja	29		Brown House with Grey Bars		Trash accidentally took their bags the first week	
Granja	30		Blacked Out Gate	NO PICTURE ALLOWED	Did not participate	

Table 21: List of Household Participants

Appendix N – Survey Results by Theme Normalized

A General Knowledge

		Barrio	Yes	No	Some	DK
1	Do you believe that the solid waste you produce contaminates the environment	Sinai	30.4%	4.3%	4.3%	4.3%
		Rodeo	17.4%	4.3%	8.7%	0.0%
		Granja	26.1%	0.0%	0.0%	0.0%
		Total	73.9%	8.7%	13.0%	4.3%

		Barrio	Because they contaminate	They produce bad smells and sickness	No recycling program	Dangerous liquids	Takes a long time to biodegrade	Because people say they contaminate	DK
2	Why?	Sinai	9.5%	4.8%	4.8%	4.8%	4.8%	0.0%	14.3%
		Rodeo	4.8%	9.5%	9.5%	0.0%	4.8%	0.0%	0.0%
		Granja	0.0%	4.8%	0.0%	0.0%	0.0%	4.8%	19.0%
		Total	14.3%	19.0%	14.3%	4.8%	9.5%	4.8%	33.3%

		Barrio	Yes	No	DK
4	Does the solid waste contaminate the place it is taken to?	Sinai	34.8%	0.0%	8.7%
		Rodeo	26.1%	4.3%	0.0%
		Granja	26.1%	0.0%	0.0%
		Total	87.0%	4.3%	8.7%

		Barrio	Recycle / Separate	Educate the people	Burn it	Better management and treatment	Better maintenance of the landfill	DK
5	What can be done to reduce the contamination that it produces?	Sinai	26.1%	0.0%	4.3%	0.0%	0.0%	13.0%
		Rodeo	17.4%	4.3%	0.0%	4.3%	4.3%	0.0%
		Granja	21.7%	0.0%	0.0%	4.3%	0.0%	0.0%
		Total	65.2%	4.3%	4.3%	8.7%	4.3%	13.0%

		Barrio	The Government	Educate the people	A fixed price for everyone	Better management and treatment of solid waste	Produce less solid waste	Recycle	DK
19	What can be done to ensure that the waste collection and treatment service does not become very expensive?	Sinai	0.0%	4.3%	4.3%	4.3%	0.0%	0.0%	30.4%
		Rodeo	0.0%	0.0%	4.3%	8.7%	8.7%	4.3%	4.3%
		Granja	4.3%	21.7%	0.0%	0.0%	0.0%	0.0%	0.0%
		Total	4.3%	26.1%	8.7%	13.0%	8.7%	4.3%	34.8%

B Knowledge of Solid Waste Management System

		Barrio	They take it to Rio Azul	Take them somewhere	Nothing	DK
3	What does the municipality do with the solid waste you produce?	Sinai	13.0%	13.0%	8.7%	8.7%
		Rodeo	8.7%	13.0%	4.3%	4.3%
		Granja	17.4%	8.7%	0.0%	0.0%
		Total	39.1%	34.8%	13.0%	13.0%

		Barrio	Correct	Incorrect
12	How often is solid waste collected?	Sinai	43.5%	0.0%
		Rodeo	30.4%	0.0%
		Granja	26.1%	0.0%
		Total	100.0%	0.0%

		Barrio	Correct	Incorrect
13	Which days?	Sinai	39.1%	4.3%
		Rodeo	30.4%	0.0%
		Granja	21.7%	4.3%
		Total	91.3%	8.7%

		Barrio	¢6000	¢5000	¢4800	DK
14	How much do you pay for solid waste collection each trimester?	Sinai	0.0%	0.0%	8.7%	34.8%
		Rodeo	4.3%	0.0%	0.0%	26.1%
		Granja	0.0%	4.3%	0.0%	21.7%
		Total	4.3%	4.3%	8.7%	82.6%

		Barrio	¢6000	¢5000	DK
15	How much do you believe the service is worth?	Sinai	0.0%	4.3%	39.1%
		Rodeo	4.3%	0.0%	26.1%
		Granja	0.0%	4.3%	21.7%
		Total	4.3%	8.7%	87.0%

		Barrio	A Lot	DK
16	How much do you believe it would cost to bring your solid waste to a landfill by yourself?	Sinai	26.1%	17.4%
		Rodeo	26.1%	4.3%
		Granja	26.1%	0.0%
		Total	78.3%	21.7%

C Opinion of the Solid Waste Management System

		Barrio	Very Bad	Bad	Normal	Good	Very Good
6	What rating would you give the solid waste management system	Sinai	17.4%	4.3%	17.4%	4.3%	0.0%
		Rodeo	0.0%	0.0%	8.7%	17.4%	4.3%
		Granja	0.0%	0.0%	4.3%	17.4%	4.3%
		Total	17.4%	4.3%	30.4%	39.1%	8.7%

		Barrio	Leave trash on the street / Sometimes don't come	Don't treat the solid waste sufficiently	Don't separate	Are punctual	Prevent sickness	Work well / Pick up everything	DK
7	Why?	Sinai	26.1%	0.0%	0.0%	0.0%	4.3%	13.0%	0.0%
		Rodeo	13.0%	4.3%	4.3%	4.3%	0.0%	4.3%	0.0%
		Granja	0.0%	0.0%	0.0%	0.0%	0.0%	8.7%	17.4%
		Total	39.1%	4.3%	4.3%	4.3%	4.3%	26.1%	17.4%

		Barrio	Better	Same	Worse
8	In the last three months do you believe that the solid waste management system has gotten better, stayed the same, or gotten worse?	Sinai	13.0%	26.1%	4.3%
		Rodeo	13.0%	17.4%	0.0%
		Granja	0.0%	26.1%	0.0%
		Total	26.1%	69.6%	4.3%

		Barrio	Curbside pickup	Clean the streets	Are punctual	Other	None
9	What positive aspects do you see in the solid waste collection service?	Sinai	4.3%	4.3%	4.3%	8.7%	21.7%
		Rodeo	8.7%	0.0%	13.0%	8.7%	0.0%
		Granja	0.0%	0.0%	26.1%	0.0%	0.0%
		Total	13.0%	4.3%	43.5%	17.4%	21.7%

		Barrio	Leave trash on the street	Are not punctual	Don't charge the same to everyone	Bad treatment of waste at Rio Azul	Don't recycle	None	DK
10	What negative aspects do you see in the solid waste collection service?	Sinai	13.0%	8.7%	4.3%	0.0%	0.0%	8.7%	8.7%
		Rodeo	8.7%	8.7%	0.0%	4.3%	8.7%	0.0%	0.0%
		Granja	0.0%	0.0%	0.0%	0.0%	4.3%	21.7%	0.0%
		Total	21.7%	17.4%	4.3%	4.3%	13.0%	30.4%	8.7%

		Barrio	The government	Employees don't do their job	Broken Trucks	Prejudice against the poor people	Bad organizatio n	DK
11	Who do you believe is at fault for the deficiencies	Sinai	4.3%	4.3%	13.0%	4.3%	0.0%	8.7%
		Rodeo	8.7%	8.7%	4.3%	0.0%	8.7%	0.0%
		Granja	8.7%	0.0%	0.0%	0.0%	17.4%	0.0%
		Total	21.7%	13.0%	17.4%	4.3%	26.1%	8.7%

		Barrio	Inexpensive	Okay	Expensive	DK
17	In Montes de Oca each household is charged ¢3500 per trimester. Do you believe this is inexpensive, okay or expensive?	Sinai	13.0%	21.7%	4.3%	4.3%
		Rodeo	4.3%	21.7%	0.0%	4.3%
		Granja	17.4%	8.7%	0.0%	0.0%
		Total	34.8%	52.2%	4.3%	8.7%

		Barrio	Yes	No	DK
18	This amount is insufficient to fund a good collection and treatment service. Should it be augmented??	Sinai	17.4%	17.4%	8.7%
		Rodeo	17.4%	8.7%	4.3%
		Granja	26.1%	0.0%	0.0%
		Total	60.9%	26.1%	13.0%

D **Recycling Knowledge**

		Barrio	Recyclables (plastic/paper/cardboard/metals)	DK
20	Which solid waste products can be reused in Costa Rica at this time?	Sinai	34.8%	8.7%
		Rodeo	30.4%	0.0%
		Granja	26.1%	0.0%
		Total	91.3%	8.7%

		Barrio	Biodegradable	Tetra Brick	Glass	Batteries	Hospital Waste	DK
21	Which solid waste products cannot be reused in Costa Rica at this time?	Sinai	4.3%	4.3%	4.3%	0.0%	0.0%	26.1%
		Rodeo	8.7%	4.3%	0.0%	8.7%	4.3%	4.3%
		Granja	17.4%	4.3%	0.0%	0.0%	4.3%	4.3%
		Total	30.4%	13.0%	4.3%	8.7%	8.7%	34.7%

E **Willingness to Collaborate in a Recycling Program**

		Barrio	Yes	No
22	Would you be willing to separate your solid waste in to biodegradable materials, recyclables and waste?	Sinai	43.5%	0.0%
		Rodeo	30.4%	0.0%
		Granja	26.1%	0.0%
		Total	100.0%	0.0%

		Barrio	Yes	No
23	Are you okay with a women's cooperative collecting the recyclables?	Sinai	43.5%	0.0%
		Rodeo	30.4%	0.0%
		Granja	26.1%	0.0%
		Total	100.0%	0.0%

		Barrio	Time	Space	None
24	What disadvantages does separating and reusing solid waste have?	Sinai	0.0%	0.0%	43.5%
		Rodeo	8.7%	4.3%	17.4%
		Granja	0.0%	4.3%	21.7%
		Total	8.7%	8.7%	82.6%

		Barrio	Many	Cleaner Environment	Reuse	Conserve nature	Work for Ticos	Money	DK
25	What advantages does it have?	Sinai	30.4%	4.3%	4.3%	0.0%	0.0%	0.0%	4.3%
		Rodeo	0.0%	8.7%	8.7%	4.3%	4.3%	4.3%	0.0%
		Granja	0.0%	8.7%	0.0%	17.4%	0.0%	0.0%	0.0%
		Total	30.4%	21.7%	13.0%	21.7%	4.3%	4.3%	4.3%

		Barrio	Yes	No
26	Would you like to participate in an educational campaign?	Sinai	43.5%	0.0%
		Rodeo	26.1%	4.3%
		Granja	26.1%	0.0%
		Total	95.7%	4.3%

Table 22: Normalized Survey Results by Theme

Appendix O – Survey Results by Theme by Barrio

A General Knowledge

		Barrio	Yes	No	Some	DK	Total
1	Do you believe that the solid waste you produce contaminates the environment?	Sinai	70.0%	10.0%	10%	10%	100%
		Rodeo	57.1%	14.3%	29%	0%	100%
		Granja	100%	0%	0%	0%	100%

		Barrio	Because they contaminate	They produce bad smells and sickness	No recycling program	Dangerous liquids	Take a long time to biodegrade	Because people say they contaminate	DK	Total
2	Why?	Sinai	22.2%	11.1%	11.1%	11.1%	11.1%	0.0%	33.3%	100%
		Rodeo	16.7%	33.3%	33.3%	0.0%	16.7%	0.0%	0.0%	100%
		Granja	0.0%	16.7%	0.0%	0.0%	0.0%	16.7%	66.7%	100%

		Barrio	Yes	No	DK	Total
4	Does the solid waste contaminate the place where it is taken to?	Sinai	80%	0%	20%	100%
		Rodeo	86%	14%	0%	100%
		Granja	100%	0%	0%	100%

		Barrio	Recycle / Separate	Educate the people	Burn it	Better management and treatment	Maintain the landfill better	DK	Total
5	What can be done to reduce the contamination that they produce?	Sinai	60%	0%	10%	0%	0%	30%	100%
		Rodeo	57%	14%	0%	14%	14%	0%	100%
		Granja	83%	0%	0%	17%	0%	0%	100%

		Barrio	The Government	Educated the people	A fixed price for everyone	Better service	Produce less waste	Better Treatment	Recycle	DK	Total
19	What can be done to ensure that the waste collection and treatment service does not become very expensive?	Sinai	0%	10%	10%	10%	0%	0%	0%	70%	100%
		Rodeo	0%	0%	14%	0%	29%	29%	14%	14%	100%
		Granja	17%	83%	0%	0%	0%	0%	0%	0%	100%

B Knowledge of Solid Waste Management System

3 What does the municipality do with the solid waste you produce?

Barrio	Take them to Rio Azul	Take them somewhere	Nothing	DK	Total
Sinai	30%	30%	20%	20%	100%
Rodeo	29%	43%	14%	14%	100%
Granja	67%	33%	0%	0%	100%

12 How often is solid waste collected?

Barrio	Correct	Incorrect	Total
Sinai	90%	10%	100%
Rodeo	100%	0%	100%
Granja	83%	17%	100%

13 Which days?

Barrio	Correct	Incorrect	Total
Sinai	100%	0%	100%
Rodeo	100%	0%	100%
Granja	100%	0%	100%

14 How much do you pay for solid waste collection per trimester?

Barrio	¢6000	¢5000	¢4800	DK	Total
Sinai	0%	0%	20%	80%	100%
Rodeo	14%	0%	0%	86%	100%
Granja	0%	17%	0%	83%	100%

15 How much do you believe the service is worth?

Barrio	¢6000	¢5000	DK	Total
Sinai	0%	10%	90%	100%
Rodeo	14%	0%	86%	100%
Granja	0%	17%	83%	100%

16 How much do you think it would cost to bring your solid waste to a landfill by yourself

Barrio	A lot	DK	Total
Sinai	60%	40%	100%
Rodeo	86%	14%	100%
Granja	100%	0%	100%

C Opinion of the Solid Waste Management System

6 How would you rate the solid waste collection service?

Barrio	Very Bad	Bad	Normal	Good	Very Good	Total
Sinai	40%	10%	40%	10%	0%	100%
Rodeo	0%	0%	29%	57%	14%	100%
Granja	0%	0%	17%	67%	17%	100%

7 Why?

Barrio	Leave trash on the street	Don't treat the solid waste enough	Don't separate	Are punctual	Prevent sickness	Work well / Pickup everything	DK	Total
Sinai	60.0%	0.0%	0.0%	0.0%	10.0%	30.0%	0.0%	100%
Rodeo	42.9%	14.3%	14.3%	14.3%	0.0%	14.3%	0.0%	100%
Granja	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%	100%

8 In the last three months do you believe that the solid waste collection service has gotten better, stayed the same or gotten worse?

Barrio	Better	Same	Worse	Total
Sinai	30%	60%	10%	100%
Rodeo	43%	57%	0%	100%
Granja	0%	100%	0%	100%

9 What positive aspects do you see in the solid waste collection service?

Barrio	Curbside Pickup	Clean the Streets	Are punctual	Other	None	Total
Sinai	10%	10%	10%	20%	50%	100%
Rodeo	29%	0%	43%	29%	0%	100%
Granja	0%	0%	100%	0%	0%	100%

10 What negative aspects do you see in the solid waste collection service?

Barrio	Leave trash on the street	Are not punctual	Don't charge the same to everyone	Bad treatment of waste at Rio Azul	Don't recycle	None	DK	Total
Sinai	30%	20%	10%	0%	0%	20%	20%	100%
Rodeo	29%	29%	0%	14%	29%	0%	0%	100%
Granja	0%	0%	0%	0%	17%	83%	0%	100%

11 Who do you believe is at fault for the deficiencies?

Barrio	The Government	Employees don't do their job	Broken Trucks	Prejudice against the poor	Bad Organizatio n	DK	Total
Sinai	10%	10%	30%	10%	0%	20%	100%
Rodeo	29%	29%	14%	0%	29%	0%	100%
Granja	33%	0%	0%	0%	67%	0%	100%

17 In Montes de Oca each household is charged ¢3500 per trimester. Do you believe this is inexpensive, okay or expensive?

Barrio	Inexpensive	Okay	Expensive	DK	Total
Sinai	30%	50%	10%	10%	100%
Rodeo	14%	71%	0%	14%	100%
Granja	67%	33%	0%	0%	100%

18 This amount is insufficient to fund a good collection and treatment service. Should it be augmented?

Barrio	Yes	No	DK	Total
Sinai	40%	40%	20%	100%
Rodeo	57%	29%	14%	100%
Granja	100%	0%	0%	100%

D Recycling Knowledge

		Barrio	Recyclables (plastic/paper/card board/metals)	DK	Total
20	Which solid waste products can be reused in Costa Rica at this time?	Sinai	80%	20%	100%
		Rodeo	100%	0%	100%
		Granja	100%	0%	100%

		Barrio	Biodegradable	Tetra Brick	Glass	Batteries	Hospital Waste	DK	Total
21	Which solid waste products cannot be reused in Costa Rica at this time?	Sinai	10%	10%	10%	0%	0%	60%	100%
		Rodeo	29%	14%	0%	29%	14%	14%	100%
		Granja	67%	17%	0%	0%	17%	17%	100%

E Willingness to participate in a recycling program

		Barrio	Yes	No	Total
22	Would you be willing to separate your solid waste in to biodegradable materials, recyclables and waste?	Sinai	100%	0%	100%
		Rodeo	100%	0%	100%
		Granja	100%	0%	100%

		Barrio	Yes	No	Total
23	Are you okay with a women's cooperative collecting the recyclables?	Sinai	100%	0%	100%
		Rodeo	100%	0%	100%
		Granja	100%	0%	100%

		Barrio	Time	Space	None	Total
24	What disadvantages does separating and reusing solid waste have?	Sinai	0%	0%	100%	100%
		Rodeo	29%	14%	57%	100%
		Granja	0%	17%	83%	100%

		Barrio	Many	Cleaner Environment	Reuse	Conserve Nature	Work for Ticos	Money	DK	Total
25	What advantages does it have?	Sinai	70%	10%	10%	0%	0%	0%	10%	100%
		Rodeo	0%	29%	29%	14%	14%	14%	0%	100%
		Granja	0%	33%	0%	67%	0%	0%	0%	100%

		Barrio	Yes	No	Total
26	Would you like to participate in an educational campaign	Sinai	100%	0%	100%
		Rodeo	86%	14%	100%
		Granja	100%	0%	100%

Table 23: Barrio Survey Results by Theme

Appendix P - Recyclable Purchasing Companies

Recyclable Purchasing Companies

Business	Contact	Material						
		Aluminum	Cardboard	Glass		Paper	Plastic	
				Broken	Whole		Bottles	Bags
AMANCO Fábrica	551-0866					¢25/Kg		
Euroaméria Fábrica	843-0632					¢10-¢25/Kg		
P.R.E Cervecería Costa Rica	443-2222	¢130/Kg					¢380 / Kg	
Romaldo Reutilización	238-5857						¢30 Each	
Francolor Reuitilización	282-1684						¢40 Each	
Intermediario	237-6098						¢50 Each	
VICESA Fábrica	550-3200			¢14.5 / Kg				
Intermediario	252-4016		¢15-¢50/ Box		¢10-¢40/ Bottle			
Reutilización	380-5959		¢15-¢70/ Box		¢3-¢6 Each		¢3 Each	¢350/Kg
PRODUCOL Fábrica	848-9412							¢15-¢40/Kg
Cajas Quirós y Retana Reutilización	233-0210		¢40/Box					
Destiladora Centroamericana Reutilización	235-7890				¢30/ Bottle			
Tecniplast S.A. Fabrica	293-8072							¢25/Kg
Empaques Universal Fabrica	374-8887							¢40-¢120/Kg
Kimberly Clark	298-3100					¢10-¢20/Kg		

Table 24: Table of Recyclable Purchasing Companies

Appendix Q – Artículos de Costa Rica

Artículo 278.-
Todos los desechos sólidos qué provengan de las actividades corrientes personales, familiares o de la comunidad y de operaciones agrícolas, ganaderas, industriales o comerciales, **deberán ser separados, recolectados, acumulados, utilizados cuando proceda** y sujetos a tratamiento o dispuestos finalmente, por las personas responsables a fin de evitar o disminuir en lo posible la contaminación del aire, del suelo o de las aguas.

Article 278. -
All the solid waste that comes from the people of the community and agricultural, cattle, industrial or commercial operations, must be separated, collected, accumulated, used when it arrives and subject to treatment or final sorting by the responsible people in order to avoid or diminish the possible contamination of the air, ground or waters.

Artículo 279.-
Queda prohibido a toda persona, natural o jurídica arrojar a acumular desechos sólidos en lugares no autorizados para el efecto, utilizar medios inadecuados para su transporte y acumulación y proceder a su utilización, tratamiento o disposición final mediante sistemas no aprobados por el Ministerio.

Article 279. -
All persons, natural or legal are prohibited to throw or accumulate solid waste in places not authorized for that effect, to use inadequate means for transportation of solid waste, accumulation and behavior to its use, treatment or final disposition by means of systems not approved by the Ministry.

Artículo 280.-
El servicio de recolección, acarreo y disposición de basuras así como la limpieza de caños, acequias, alcantarillas, vías y parajes públicos estará a cargo de las municipalidades las cuales podrán realizarlo por administración o mediante contratos con empresas o particulares, que se otorgarán de acuerdo con las formalidades legales y qué requieran para su validez la aprobación del Ministerio.

Toda persona, **queda en la obligación de utilizar dicho servicio público** y de contribuir económicamente a su financiamiento de conformidad con las disposiciones legales y reglamentarias pertinentes.

Article 280. -
The service of collection, transport and disposition of sweepings as well as the cleaning of sewers, drains, culverts, routes and places public will be the responsibility of the municipalities which will be able to, through administration or by means of contracts with companies or individuals, will be granted in agreement with the legal formalities required to prove validity for the approval of the Ministry.

All persons are obligated to use this public service and to contribute economically to it's financing in accordance with pertinent the legal and prescribed dispositions.

Artículo 281.-
Las empresas agrícolas, industriales y comerciales, deberán disponer de un sistema de separación y recolección, acumulación fina de los desechos sólidos provenientes de sus operaciones, aprobado por el Ministerio cuando por la naturaleza, o cantidad de éstos, no fuere sanitariamente aceptable el uso del sistema público o cuando éste no existiere en la localidad.

Article 281. -
The agricultural, industrial and commercial companies must have a system of separation, collection, and accumulation of the originating solid waste from their operations, approved by the Ministry when by the nature, or amount of these, will not be sanitarily acceptable for the use of the public system or when this one does not exist in the locality.

Artículo 282.-
Los propietarios de terrenos desocupados en áreas urbana están obligados a mantenerlos cerrados y en buenas condiciones higiénicas.

Quedarán obligados, asimismo, a realizar las prácticas u obras, dentro del plazo qué autoridad de salud les ordene, cuando tales terrenos constituyen un foco de contaminación ambiental.

Article 282. -
The owners of unoccupied land in urban areas are required to keep them locked and in good hygienic condition.

They are also obligated to ensure when such lands constitute an environmental focus of infection that any practices or works are done within the term of the health authority,.

Artículo 283.-
Queda prohibida la recuperación de desechos y residuos sólidos en **lugares no aprobados por la autoridad de salud para tales efectos.**

Las personas, naturales o jurídicas, que se ocupen de la recuperación, aprovechamiento, comercio o industrialización de tales materias, deberán solicitar permiso previo a la autoridad de salud y ésta podrá otorgarlo, cuando se compruebe qué los trabajos de selección, recolección y aprovechamiento de los desechos y residuos no impliquen el peligro de contaminación del ambiente o riesgos para la salud de las personas que trabajan en tales faenas o de terceros.

Article 283. -
It is prohibited to recover waste and solid waste in places not approved of by the authority of health.

The people, natural or legal, who take care of the recovery, advantage, commerce or industrialization of solid waste, must ask for permission from the health authority which will be granted when it is verified that the works of selection, recollecting and reuse of the waste, so long as the waste does not imply the danger of contamination of the atmosphere or risks for the health of the people who work with such tasks.

Artículo 284.-
La autorización a qué se refiere el artículo anterior **durará un año y podrá** ser cancelada en cualquier tiempo, cuando el titular no cumpliere las disposiciones reglamentarias pertinentes o no realizare las prácticas y obras especiales qué la autoridad de salud le imponga como requisitos necesarios para resguardar la salud de las personas, o el saneamiento de la operación.

Article 284. -
The authorization that the previous article refers to will last a year and can be cancelled at any time if the holder does not abide by the pertinent rules or does not make the special practices and works that the health authority imposes on them as required to protect the health of the people, or the cleaning of the operation.

Appendix R – Solid Waste Collection Results by Barrio

RI- Barrio Sinaí

Sinai Three Week Waste Collection in Kilograms																
Household	Week One			Week Two			Week Three			Average			Total Average	Daily Solid Waste Average	Daily / Household	Daily / Resident
	R	W	B	R	W	B	R	W	B	R	W	B				
1H	2.50	1.00	0	0.70	2.00	0	1.00	1.80	0	1.40	1.60	0	3.00	0.43	0.43	
1R	0.83	0.33	0	0.23	0.67	0	0.33	0.60	0	0.47	0.53	0	1.00	0.14		0.14
2H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2R	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
3H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3R	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
4H	0	0	0	0	0	3.75	0	0	0	0	0	1.25	1.25	0.18	0.18	
4R	0	0	0	0	0	0.94	0	0	0	0	0	0.31	0.31	0.04		0.04
5H	0	1.00	0	0.15	2.00	1.35	0	0	0	0.15	1.50	0.45	2.10	0.30	0.30	
5R	0	0.25	0	0.04	0.50	0.34	0	0	0	0.04	0.38	0.11	0.53	0.08		0.08
6H	0	0	0	0	3.00	2.00	0	3.00	2.25	0	3.00	2.13	5.13	0.73	0.73	
6R	0	0	0	0	0.75	0.50	0	0.75	0.56	0	0.75	0.53	1.28	0.18		0.18
7H	0	1.25	2.25	2.78	0.80	3.50	1.80	0.75	3.50	2.29	0.93	3.08	6.31	0.90	0.90	
7R	0	0.42	0.75	0.93	0.27	1.17	0.60	0.25	1.17	0.76	0.31	1.03	2.10	0.30		0.30
8H	0.75	0	0	1.98	1.50	0	1.50	0	0	1.41	1.50	0	2.91	0.42	0.42	
8R	0.15	0	0	0.40	0.30	0	0.30	0	0	0.28	0.30	0	0.58	0.08		0.08
9H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9R	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
10H	2.50	0	0	0.38	0	0	5.80	0.70	0	2.89	0.70	0	3.59	0.51	0.51	
10R	0.50	0	0	0.08	0	0	1.16	0.14	0	0.58	0.14	0	0.72	0.10		0.10
Total H	1.92	1.08	2.25	1.20	1.86	2.65	2.53	1.56	2.88	1.63	1.54	1.73	3.47	0.50	0.50	
Total R	0.49	0.33	0.75	0.33	0.50	0.74	0.60	0.44	0.86	0.43	0.40	0.50	0.93	0.13		0.13

Table 25: Waste Collection Results from Sinaí

RII- La Urbanización El Rodeo

Rodeo Three Week Waste Collection in Kilograms																
Household	Week One			Week Two			Week Three			Average			Total Average	Daily Solid Waste Average	Daily / Household	Daily / Resident
	R	W	B	R	W	B	R	W	B	R	W	B				
11H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11R	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
12H	0	0	0	0	0	0	3.00	0	0	1.00	0	0	1.00	0.14	0.14	
12R	0	0	0	0	0	0	1.50	0	0	0.50	0	0	0.50	0.07		0.07
13H	0	1.00	4.00	1.50	2.10	8.00	0.70	3.60	4.60	0.73	2.23	5.53	8.50	1.21	1.21	
13R	0	0.33	1.33	0.50	0.70	2.67	0.23	1.20	1.53	0.24	0.74	1.84	2.83	0.40		0.40
14H	0.80	0	0	1.55	1.10	1.75	0	3.50	0	0.78	1.53	0.58	2.90	0.41	0.41	
14R	0.16	0	0	0.31	0.22	0.35	0	0.70	0	0.16	0.31	0.12	0.58	0.10		0.10
15H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15R	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
16H	1.30	0	0.50	0	0	0	5.70	0	0	2.33	0	0.17	2.50	0.36	0.36	
16R	0.65	0	0.25	0	0	0	2.85	0	0	1.17	0	0.08	1.25	0.09		0.09
17H	0	1.75	0	5.60	0	1.15	0	0	1.80	1.87	0.58	0.98	3.43	0.49	0.49	
17R	0	0.35	0	1.12	0	0.23	0	0	0.36	0.37	0.12	0.20	0.69	0.16		0.16
18H	0	0	0	0	1.05	2.00	0	2.80	3.70	0	1.28	1.90	3.18	0.45	0.45	
18R	0	0	0	0	0.18	0.33	0	0.47	0.62	0	0.21	0.32	0.53	0.09		0.09
19H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
19R	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
20H	2.00	1.75	2.50	1.60	2.05	3.65	0	0.90	4.00	1.20	1.57	3.38	6.15	0.88	0.88	
20R	0.67	0.58	0.83	0.53	0.68	1.22	0	0.30	1.33	0.40	0.52	1.13	2.05	0.18		0.18
Total H	1.37	1.50	2.33	2.56	1.58	3.31	3.13	2.70	3.53	1.32	1.44	2.09	3.95	0.56	0.56	
Total R	0.49	0.42	0.81	0.62	0.44	0.96	1.53	0.67	0.96	0.47	0.38	0.61	1.20	0.16		0.16

Table 26: Waste Collection Results from Urbanización El Rodeo

RIII- Barrio La Granja

Granja Three Week Waste Collection in Kilograms																
Household	Week One			Week Two			Week Three			Average			Total Average	Daily Solid Waste Average	Daily / Household	Daily / Resident
	R	W	B	R	W	B	R	W	B	R	W	B				
21-24H	7.26	4.00	0	1.35	0.95	0	13.10	4.70	0	7.24	3.22	0.00	5.23	0.75	0.75	
21-24R	0.91	0.50	0	0.17	0.12	0	1.64	0.59	0	0.90	0.40	0.00	0.65	0.09		0.09
25H	0	0	0	0	2.15	0	0.50	0	7.40	0.25	2.15	7.40	3.27	0.47	0.00	
25R	0	0	0	0	0.72	0	0.17	0	2.47	0.08	0.72	2.47	1.09	0.16		0.00
26H	7.50	0	0	0.50	0	0	7.85	0	0	5.28	0.00	0.00	5.28	0.75	0.75	
26R	3.75	0	0	0.25	0	0	3.93	0	0	2.64	0.00	0.00	2.64	0.38		0.38
27H	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	
27R	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00		0.00
28H	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	
28R	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00		0.00
29H	0	0	0	10.70	0.35	14.30	7.40	0	0	9.05	0.35	14.30	7.90	1.13	0.00	
29R	0	0	0	3.57	0.12	4.77	2.47	0	0	3.02	0.12	4.77	2.63	0.38		0.00
30H	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	
30R	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00		0.00
Total H	7.38	4.00	0	4.18	1.73	14.30	7.21	4.70	7.40	5.46	1.91	10.85	5.42	0.77	1.50	
Total R	2.33	0.50	0	1.33	0.48	4.77	2.05	0.59	2.47	1.66	0.41	7.23	1.75	0.25		0.47

Table 27: Waste Collection Results from Barrio La Granja

Appendix S – Average Weekly Recyclables by Barrio

Average Weekly Household Recyclables

Material		Sinai		Rodeo		Granja		Average	
		Unit	Kg	Unit	Kg	Unit	Kg	Unit	Kg
Plastic	Plastic Bottles	4.17	0.28	3.08	0.15	3.50	0.13	3.58	0.19
	Plastic Bags	5.58	0.06	0.00	0.00	0.44	0.02	2.01	0.03
	Plastic Gallons	0.33	0.13	0.50	0.03	0.17	0.01	0.33	0.05
	Other Plastic	0.00	0.00	0.08	0.06	0.00	0.21	0.03	0.09
Paper	Loose Paper	0.00	0.77	0.00	0.51	0.00	2.05	0.00	1.11
	Newspaper	0.00	0.00	0.00	0.54	0.00	0.32	0.00	0.29
Cardboard	Whole Cardboard Box	0.33	0.10	0.17	0.01	0.00	0.00	0.17	0.04
	Broken Cardboard	3.58	0.39	0.00	0.09	0.00	0.08	1.19	0.19
Glass	Whole Wine Bottle	0.00	0.00	0.83	0.32	0.78	0.17	0.54	0.16
	Whole Liquor Bottle	0.17	0.08	0.08	0.04	0.06	0.00	0.10	0.04
	Whole Glass Beer Bottle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Whole Glass Soda Bottle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Broken Glass	0.08	0.00	0.00	0.00	0.00	0.00	0.03	0.00
	Glass Baby Food	0.00	0.00	1.67	0.03	0.00	0.00	0.56	0.01
Metal	Aluminum Cans	0.50	0.02	0.08	0.01	8.61	0.14	3.06	0.06
Total	Total	15.08	1.82	6.67	2.01	11.44	3.12	11.06	2.32

Table 28: Average Weekly Recyclables by Barrio

Appendix T- Average Weekly Recyclables per Resident

Average Weekly Recyclables Per Resident

Material		Sinai		Rodeo		Granja		Average	
		Unit	Kg	Unit	Kg	Unit	Kg	Unit	Kg
Plastic	Plastic Bottles	1.02	0.07	0.83	0.04	1.50	0.05	1.12	0.05
	Plastic Bags	1.36	0.01	0.00	0.00	0.19	0.01	0.52	0.01
	Plastic Gallons	0.08	0.03	0.13	0.01	0.07	0.00	0.10	0.01
	Other Plastic	0.00	0.00	0.02	0.02	0.00	0.09	0.01	0.04
Paper	Loose Paper	0.00	0.19	0.00	0.14	0.00	0.88	0.00	0.40
	Newspaper	0.00	0.00	0.00	0.15	0.00	0.14	0.00	0.09
Cardboard	Whole Cardboard Box	0.08	0.02	0.04	0.00	0.00	0.00	0.04	0.01
	Broken Cardboard	0.87	0.09	0.00	0.02	0.00	0.03	0.29	0.05
Glass	Whole Wine Bottle	0.00	0.00	0.22	0.09	0.33	0.07	0.19	0.05
	Whole Liquor Bottle	0.04	0.02	0.02	0.01	0.02	0.00	0.03	0.01
	Whole Glass Beer Bottle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Whole Glass Soda Bottle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Broken Glass	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	Glass Baby Food	0.00	0.00	0.45	0.01	0.00	0.00	0.15	0.00
Metal	Aluminum Cans	0.12	0.00	0.02	0.00	3.70	0.06	1.28	0.02
Total	Total	3.68	0.44	1.80	0.54	4.91	1.34	3.46	0.77

Table 29: Average Weekly Recyclables per Resident

Appendix U – Possible Recyclable Profits

Possible Weekly Recyclable Profit									
Material		Average Per Resident		Total Montes de Oca		Average Price		Weekly Profit	
		Unit	Kg	Unit	Kg	Unit	Kg	Unit	Kg
Plastic	Plastic Bottles	1.12	0.05	60370.15	2946.78	₡30.75	NA	₡1,856,382.10	NA
	Plastic Bags	0.52	0.01	27982.41	393.98	NA	₡98.33	NA	₡38,741.07
	Plastic Gallons	0.10	0.01	5183.65	756.91	NA	₡380.00	NA	₡287,623.93
	Other Plastic	0.01	0.04	404.84	1936.68	NA	₡380.00	NA	₡735,937.95
Paper	Loose Paper	0.00	0.40	0.00	21722.71	NA	₡18.00	NA	₡391,008.82
	Newspaper	0.00	0.09	0.00	5102.54	NA	₡18.00	NA	₡91,845.78
Cardboard	Whole Cardboard Box	0.04	0.01	2275.03	482.01	₡53.33	NA	₡121,334.79	NA
	Broken Cardboard	0.29	0.05	15752.39	2763.33	₡23.33	NA	₡367,555.80	NA
Glass	Whole Wine Bottle	0.19	0.05	10064.93	2847.90	₡17.80	NA	₡179,155.69	NA
	Whole Liquor Bottle	0.03	0.01	1567.26	550.44	₡17.80	NA	₡27,897.27	NA
	Whole Glass Beer Bottle	0.00	0.00	0.00	0.00	NA	NA	NA	NA
	Whole Glass Soda Bottle	0.00	0.00	0.00	0.00	NA	NA	NA	NA
	Broken Glass	0.00	0.01	0.00	366.33	NA	₡14.50	NA	₡5,311.85
	Glass Baby Food	0.15	0.00	8096.89	161.94	₡17.80	NA	₡8,096.89	NA
Metal	Aluminum Cans	1.28	0.02	69213.92	1187.51	NA	₡130.00	NA	₡154,376.61
Total	Total	3.46	0.77	187222.38	41879.30	NA	NA	₡4,265,269	

Table 30: Possible Weekly Recyclable Profit

Appendix V- Possible Daily Recyclable Profit

Possible Daily Recyclable Profit									
Material		Average Per Resident		Total Montes de Oca		Average Price		Daily Profit	
		Unit	Kg	Unit	Kg	Unit	Kg	Unit	Kg
Plastic	Plastic Bottles	0.16	0.01	8624.31	420.97	₡30.75	NA	₡265,197	NA
	Plastic Bags	0.07	0.00	3997.49	56.28	NA	₡98.33	NA	₡5,534
	Plastic Gallons	0.01	0.00	740.52	108.13	NA	₡380.00	NA	₡41,089
	Other Plastic	0.00	0.01	57.83	276.67	NA	₡380.00	NA	₡105,134
Paper	Loose Paper	0.00	0.06	0.00	3103.24	NA	₡18.00	NA	₡55,858
	Newspaper	0.00	0.01	0.00	728.93	NA	₡18.00	NA	₡13,121
Cardboard	Whole Cardboard Box	0.01	0.00	325.00	68.86	₡53.33	NA	₡17,334	NA
	Broken Cardboard	0.04	0.01	2250.34	394.76	₡23.33	NA	₡52,508	NA
Glass	Whole Wine Bottle	0.03	0.01	1437.85	406.84	₡17.80	NA	₡25,594	NA
	Whole Liquor Bottle	0.00	0.00	223.89	78.63	₡17.80	NA	₡3,985	NA
	Whole Glass Beer Bottle	0.00	0.00	0.00	0.00	NA	NA	NA	NA
	Whole Glass Soda Bottle	0.00	0.00	0.00	0.00	NA	NA	NA	NA
	Broken Glass	0.00	0.00	0.00	52.33	NA	₡14.50	NA	₡759
	Glass Baby Food	0.02	0.00	1156.70	23.13	₡17.80	NA	₡1,157	NA
Metal	Aluminum Cans	0.18	0.00	9887.70	169.64	NA	₡130.00	NA	₡22,054
Total	Total	0.49	0.11	26746.05	5982.76	NA	NA	₡609,324	

Table 31: Possible Daily Recyclable Profit

Appendix W – Average Solid Waste Value

Averages

Average Household Size

Neighborhood	Residents
Sinai	4.10
Rodeo	3.71
Granja	2.33
Total	3.38

Daily Average Waste By Neighborhood

Neighborhood	Solid waste Per Resident	Solid Waste Per Household
Sinai	0.09	0.27
Rodeo	0.09	0.35
Granja	0.08	0.24
Total	0.09	0.28

Daily Average Solid Waste By Neighborhood

Neighborhood	Solid waste Per Resident	Solid Waste Per Household
Sinai	0.24	0.98
Rodeo	0.34	1.18
Granja	0.65	2.23
Total	0.41	1.46

Daily Biodegradeable Waste By Neighborhood

Neighborhood	Biodegradeable Waste Per Resident	Biodegradeable Waste Per Household
Sinai	0.09	0.45
Rodeo	0.17	0.55
Granja	0.38	1.55
Total	0.21	0.85

Daily Average Recyclables By Neighborhood

Neighborhood	Recyclables Per Resident	Recyclables Per Household
Sinai	0.06	0.26
Rodeo	0.08	0.29
Granja	0.19	0.45
Total	0.11	0.33

Table 32: Table of Averages

Appendix X – Example Data Collection Table – Recyclables

_____ Week 1 Recyclables

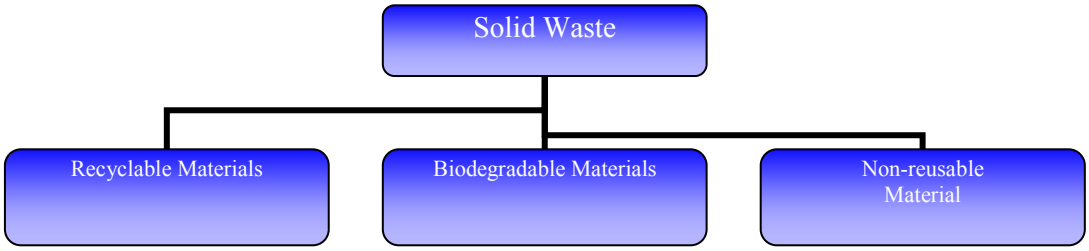
		House Number		1		2		3		4		5		6		7		8		9		10		Total	
		Average House Weight		0		0		0		0		0		0		0		0		0		0		0	
		Weight Per Person		0		0		0		0		0		0		0		0		0		0		0	
			Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.	Units	Kg.
Plastic		Bottles																					0	0
		Bags																					0	0
		Gallons																					0	0
																							0	0
																							0	0
Paper		Loose																					0	0
		Newspaper																					0	0
																							0	0
																							0	0
																							0	0
Cardboard		Whole																					0	0
		Broken																					0	0
																							0	0
																							0	0
																							0	0
Glass		Whole Wine																					0	0
		Whole Liquor																					0	0
		Whole Beer																					0	0
		Whole Soda																					0	0
		Broken																					0	0
Metal		Aluminum																					0	0
																							0	0
																							0	0
																							0	0
																							0	0
Total			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 33: Example of Data Collection Table

Appendix Y - Example of Sample Pamphlet

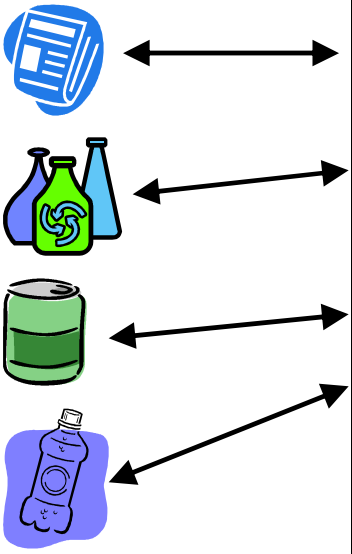
Recycling and Solid Waste Management in Montes de Oca

Municipality of Montes de Oca, University of Costa Rica, COOPEMUJER



Why is recycling important?

- Reduction of environmental contamination.
- Preservation of natural resources.
- Extend the life of existing landfills and prevent the construction of new landfills.
- Creates employment opportunities.



What materials are recyclable?

PAPER: newspaper, magazines, telephone books, computer paper, notebooks, cardboard

GLASS: glass bottles, wine bottles, window glass, beer bottles

METAL: rinsed aluminum cans

PLASTIC: rinsed drink bottles, plastic number one and two, milk gallons

What materials are not recyclable?

PAPER: fax paper, napkins, carbon paper, toilet paper, dirty or wet cardboard or paper, Tetra Brik, Tetra Pak, egg cartons

GLASS: thermometers, mirrors, fluorescent lights, ceramics plates, light bulbs

METAL: unwashed food cans

PLASTIC: plastic envelopes (junk mail), unwashed plastic

What are other non-recyclable materials?

Disposable diapers, feminine products

Dirty or wet materials, ex plastic or paper

What are Biodegradable Materials?

Kitchen refuse, Garden refuse

Examples of biodegradable materials: Fruit peels, vegetable peels, egg shells, soil, yard trimmings, manure from vegetarian animals (cows, horses, goats, etc.)

Why are Biodegradable Materials useful?

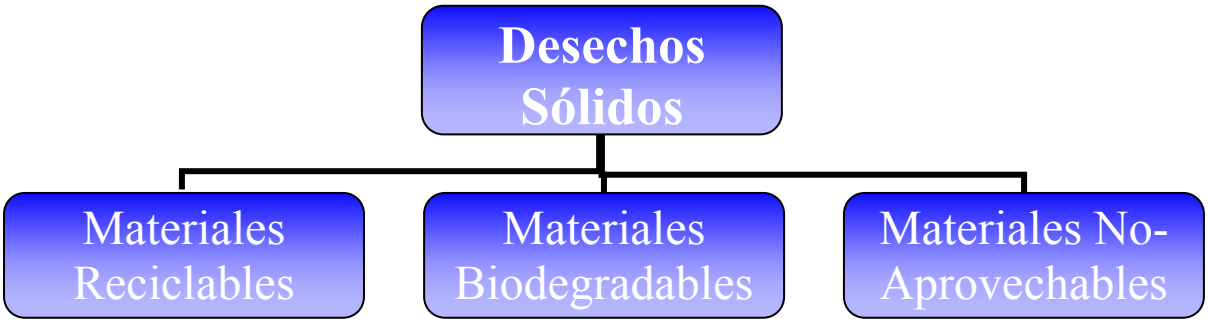
Can be made into compost for use as fertilizer for use in agriculture or for use in prevention for soil erosion.

If you have questions or suggestions, please call:
COOPEMUJER: ####-##-##
Municipality of Montes de Oca: ####-##-##
University of Costa Rica: ####-##-##

Appendix Z - Example Pamphlet in Spanish

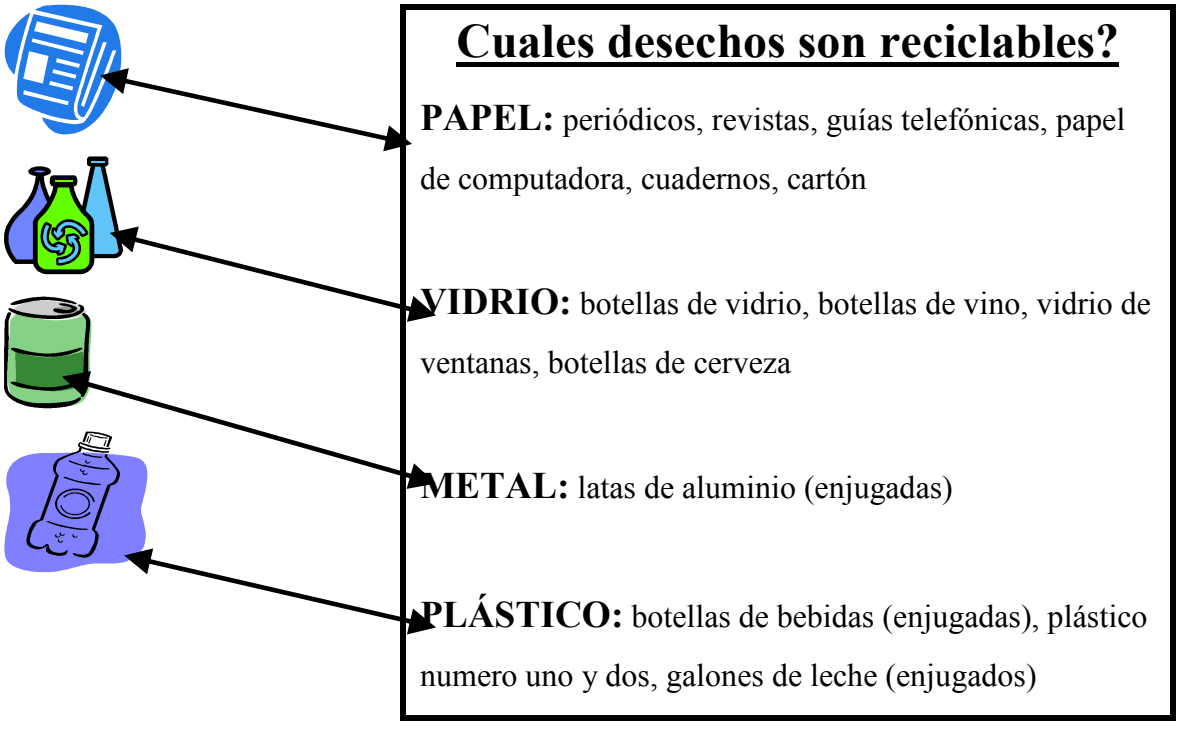
Reciclaje y el Manejo de Desechos Sólidos en Montes De Oca

Municipalidad de Montes de Oca, Universidad de Costa Rica, COOPEMUJER



¿Por qué es reciclaje importante?

- Reducción de la contaminación ambiente.
- Preservación de los recursos naturales.
- Preservar la vida de los rellenos sanitarios y parar la construcción de rellenos sanitarios nuevos.
- Genera oportunidades nuevas de trabajo.



¿Cuales materiales no son reciclables?

PAPEL: papel de fax, servilletas, papel carbón, papel higiénico, cartón o papel sucio o mojado, Tetra Brik, Tetra Pak, cartón de huevos

VIDRIO: termómetros, espejos, bombillos, fluorescentes vajillas cerámicas

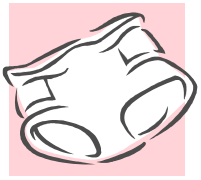
METAL: latas sucias de alimentos

PLÁSTICO: envolturas de plástico, plástico sucio o no enjugado

¿Cuáles mas materiales no son reciclables?

pañales desechables, toallas sanitarias

materiales sucias o mojadas



¿Cuales materiales son biodegradables?

Las cáscaras, materiales del jardín

Ejemplos de materiales biodegradables: cáscaras de frutas, vegetales y huevos, suelo, abono de animales vegetarianos (vacas, caballos, etc.)

¿Cómo se puede usar los materiales biodegradables?

Pueden hacer compost y usar en agricultura para fertilizar las plantas o también usar para prevenir erosión de suelo.

Por favor, sí tiene preguntas o recomendaciones llame:
COOPEMUJER: ####-##-##
La Municipalidad de Montes de Oca: ####-##-##
La Universidad de Costa Rica: ####-##-##

References

"2001 Panels - Costa Rica." EM Research Organization. 17 April 2006, http://www.emro.co.jp/english/library/gallery/2001panels/panelcostarica.html

22 Apr. 2006 from, http://www.paho.org/Spanish/SHA/prflCOR.html.

A Better Earth. 2006. 22 Apr. 2006 from, http://www.abetterearth.org/article.php/871.html

AF&PA Takes Note of Outstanding Paper Recycling Programs." American Recycler. Aug. 2005. 27 June 2006 from, http://www.americanrecycler.com/0805af.shtml

Arnulfo, D. (2005). Garbage Collection and Recycling. 14 May, 2006 from, http://www.nosaranet.com/nosaragarbagecollectionrecycling.html

Anderson, Keith. "Making Compost: Journey to Forever Organic Garden." Handmade Projects. 4 Apr. 2006, from http://journeytoforever.org/compost_make.html

"ATSDR - ToxFAQs: Chromium." ATSDR. Feb. 2005. Agency for Toxic Substances and Disease Registry. 30 Mar. 2006 from, http://www.atsdr.cdc.gov/tfacts7.html#bookmark06

"Bans on Recyclables." The Official Site of the City of Seattle, Washington. 2006. 25 Apr. 2006 from, http://www.seattle.gov/util/About_SPU/Recycling_System/History_&_Overview/Ban_on_Recyclables_in_Garbage/index.asp

"Basic of Landfills." Zero Solid waste. Environmental Research Foundation. 3 Apr. 2006 from, http://www.zerosolid wasteamerica.org/BasicsOfLandfills.htm

Brower, Michael, and Warren Leon. The Consumer's Guide to Effective Environmental Choices. New York: Three Rivers P, 1999. 19-42.

Brown, Sam. "Disease Suppression." Commercial Composting. 20 Feb. 2006. 29 Mar. 2006 from, http://www.compost.me.uk/html/disease_suppression.html

Canterbury, Janice. "HOW TO SUCCEED WITH PAY AS YOU THROW." BioCycle 39 (1998). EBSCOhost. 17 May 2006

Canterbury, Janice. "Pay-as-You-Throw: a Growing MSW Management Success Story." Resource Recycling (October 1997): 16-22. 17 May 2006 from, http://www.epa.gov/epaoswer/non-hw/payt/pdf/rr1097.pdf

"Census Bureau Home Page." U.S Census Bureau. 29 June 2006 from, http://www.census.gov/

"Climate Change and Municipal Solids." Pay as You Throw. 22 Feb. 2006. 17 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/payt/tools/factfin.htm

"Composting." VegWeb. 2005. 29 Mar. 2006 from, http://vegweb.com/composting/

"Compost Use in Agriculture." Commercial Composting. 5 Apr. 2006. 29 Mar. 2006 from, http://www.compost.me.uk/html/compost_use_in_agriculture.html

"Container Options." Pay as You Throw. 22 Feb. 2006. 17 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/payt/top3.htm

"Costa Rica." InfoPlease. 17 Apr. 2006 from, http://www.infoplease.com/ipa/A0107430.html

"Costa Rica." Intel in Your Community. 2006. 17 Apr. 2006 from, http://www.intel.com/community/costarica/environment.htm

Costa Rica (n.d). *Pan American Health Organization.* Retrieved on June 25, 2006, from http://www.paho.org/English/DD/AIS/cp_188.htm

"Costa Rica." The World Fact Book. 29 Mar. 2006. 17 Apr. 2006 from, http://www.cia.gov/cia/publications/factbook/geos/cs.html

"Costa Rica Information." General Information About Costa Rica. Centralamerica.Com, Corp. 1995-2001. 29 Mar. 2006 from, http://centralamerica.com/cr/info/

"Cover Up with Compost." EPA. July 2002. 4 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/muncpl/ghg/f02022.pdf

"Dirección De Protección Al Ambiente Humano." Ministerio De Salud. 2000. 22 Apr. 2006 from, www.netsalud.sa.cr/ms/ministe/memoria/me2000/prote.htm

"EARTH University." EARTH University. 2006. 24 Apr. 2006 from, http://www.earth.ac.cr/ing/index.html

"EHC-Glossary (Q-Z)-NSC." National Safety Council. 27 Sept. 2005. NSC. 29 Mar. 2006 from, http://www.nsc.org/ehc/glossar2.htm

"El Reciclaje." UNIVERSIDAD INTERAMERICANA DE PUERTO RICO, RECINTO DE PONCE. 2006. 19 Apr. 2006 from, http://ponce.inter.edu/whoiswho/organiza/abacus/ismael/recycle.html

Farrelly, Maura J. "Solid waste-to-Energy: Solution to Garbage Control?" World Focus. 18 Apr. 2006 from, http://www.insnews.org/world/focus/1102/solid waste.energy.solution.htm

"FDI Profile of Costa Rica." CINDE.ORG. 2004. 29 Mar. 2006 from, http://www.cinde.org/eng-situacionactual.shtml

Folz, David H. "Municipal Recycling Performance: A Public Sector Environmental Success Story.(Statistical Data Included)." *Public Administration Review* 59.4 (July 1999): 336. *Expanded Academic ASAP*. Thomson Gale. Worcester Polytechnic Institute. 27 June 2006 <http://find.galegroup.com/ips/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=IPS&docId=A55579493&source=gale&srcprod=EAIM&userGroupName=mlin_c_worpoly&version=1.0>.

"FXConverter - 164 Currency Converter." OANDA the Currency Site. OANDA Cooperation. 29 June 2006 from, http://www.oanda.com/converter/classic

"Garbage and Recycling in Nosara Costa Rica." Voice of Nosara. 7 Apr. 2006 from, http://www.voiceofnosara.com/currentissue/page6.html

"Global Warming." U.S. Environmental Protection Agency. 24 Jan. 2004. 17 Apr. 2006 from, http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsSolid waste.html

"Glossary of Marketing Terms." Oxford University Press. 2005. 7 Apr. 2006 from, http://www.oup.com/uk/booksites/content/0199267529/student/glossary.html

"Help with Recycling – Separate Your Garbage." Garbage & Recycling in Nosara Costa Rica. 17 Apr. 2006 from, http://www.voiceofnosara.com/currentissue/page6.html

"How to Succeed with Pay as You Throw." U.S. Environmental Protection Agency. 27 Apr. 2006. 23 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/payt/pdf/bc1298.pdf

"Improve Your Recycling IQ." The Official Site of the City of Seattle, Washington. 01 June 2005. 22 Apr. 2006 from, http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/recyclable_2003120207594812.pdf.

"Incineration." The Environmental Literacy Council. 30 Jan. 2006. 29 Mar. 2006 from, http://www.enviroliteracy.org/article.php/60.html

"Index of Economic Freedom 2006- Costa Rica." 2006 Index of Economic Freedom. 2006. The Heritage Foundation. 29 Mar. 2006 http://www.heritage.org/research/features/index/country.cfm?id=CostaRica

Levesque, A.P., Pelletier, B.W. & Samuels, E.J (2003). *Solid Waste Management in Costa Rica and the United States.* WPI-Interactive Qualifying Project.

Lexico Publishing Group, Llc. "Biodegradable." Dictionary.Com. 2006. 25 Mar. 2006 http://dictionary.reference.com/search?r=2&q=Biodegradable

"Massachusetts State Symbols Capital Constitution Flags Maps Songs." 50 States. 2006. 29 Mar. 2006 from, http://www.50states.com/massachu.htm

Noehammer, H., & Byer, P. (1997). Effect of Design Variables on Participation in Residential Curbside Recycling Programs. Waste Management and Research, 15(4), 407-427.

"Papel-Carton." Escuela De Reciclaje En El Hogar. 2006. 25 Apr. 2006 from, http://escuelas.consumer.es/web/es/reciclaje/online/pag0403.php

"Pay as You Go Continues to Grow." U.S. 27 Apr. 2006. 24 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/payt/pdf/wa5-99.pdf

Pidwirny, Dr. Michael. "The Greenhouse Effect." Physical Geography. 2006. University of British Columbia Okanagan. 23 Apr. 2006 from, http://www.physicalgeography.net/fundamentals/7h.html

"Programs by State." Pay as You Throw. 22 Feb. 2006. 17 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/payt/comm-2.htm

"Recycling in Latin America." Zona Latina. 23 Feb. 2002. 7 Apr. 2006 from, http://www.zonalatina.com/Zldata223.htm

"Recycling Means Business." Sept. 1995. EPA. 18 May 2006 . http://www.epa.gov/epaoswer/non-hw/recycle/business/rmb.pdf>.

"Recycle This." 2005. 7 Apr. 2006 from, www.recyclethis.org/QP_Res_dictionary.html

Rita Mora, Zoyla. "Programa De Reciclage En Alfaro Ruiz Obtiene Buenos Resultados." La Nación 1 July 2006, sec. A: 14.

"Safety and Health Topics: Benzene." U.S. Department of Labor. 3 Apr. 2006 from, http://www.osha.gov/SLTC/benzene/index.html

"Solid waste Combustion and Incineration." U.S. Environmental Protection Agency. 22 Feb. 2006. 3 Apr. 2006 from, http://www.epa.gov/epaoswer/non-hw/muncpl/landfill/sw_combst.htm

"Solid Waste Definition." The Global Research Development Center. 2006. 24 Apr. 2006 from, http://www.gdrc.org/uem/solid waste/swm-glossary.html

"Solid waste Management Glossary." Documents and Info Sheets. 3 Apr. 2006 from, http://www.gdrc.org/uem/solid waste/swm-glossary.html

"Use of Compost in Highway Schemes." Commercial Composting. 5 Apr. 2006. 30 Mar. 2006 from, http://www.compost.me.uk/html/compost_use_in_highway_schemes.html

Solid waste Management. 7 Apr. 2006 from, www.recyclethis.org/QP_Res_dictionary.html

"State of Solid Waste in Costa Rica." 22 Apr. 2006 from, http://www.ifam.go.cr/PaginaIFAM/docs/estadodesituaciondesechossolidos..pdf

Villegas S., Jairo. "Montanas De Basura Están Al Aire Libre En Río Azul." La Nación 30 June 2006, sec. A: 10.

"Washingtonians are Recycling Less." Seattle Daily Journal of Commerce Online Edition (2001). 18 May 2006 .
<http://www.djc.com/news/enviro/11118498.html>.

"Wastem2.Jpeg." 3 July 2006 from,
http://www.city.sault-ste-marie.on.ca/wastemanagement/wastem2.jpg