FEASIBILITY OF TIN CAN RECYCLING FROM THE CITY OF WINNIPEG MUNICIPAL WASTE STREAM

BY

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ABSTRACT

Waste minimization is being encouraged in all areas of our society. One way in which waste can be minimized is by recycling. Recycling of raw materials can save energy, reduce environmental degradation from pollution and extend the lifetime of our non-renewable resources.

In Winnipeg, many private recyclers are recycling goods and materials such as tin cans, aluminum cans, plastics, newspapers and glass. Tin cans are easily recycled by scrap metal companies and a need exists to see how they could be integrated into a city-wide recycling program.

The practicum has attempted to summarize the major types of recycling programs (curbside recycling, drop-off depot recycling and centralised separation). A discussion of the costs of the three types of programs has been done and has been tailored to the City of Winnipeg. A comparison of the revenues from the sale of tin can scrap to the costs of each program has also been done. The costs and revenues associated with the construction and operation of a detinning plant was also examined. A detinning plant would accept the tin can scrap and produce end products of # 1 bundle steel and tin.

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CHAPTER 1

INTRODUCTION

1.1 Background:

Waste minimization is being encouraged in all areas of our society. Landfill sites are approaching maximum capacity and new ones are not being found to replace them. The establishment of new landfill sites is a lengthy process and many complications are involved. This delay in establishing new landfill sites has increased the pressure to minimize waste. Because of this time delay landfill sites are filling up and closing faster than new landfill sites are opening up. In Manitoba, about 1 million tonnes of waste are disposed of every year (Manitoba, 1989). This amounts to about 1 tonne of waste per person per year.

One method of waste minimization is recycling. Recycling of some consumer waste is being done around the world but recycling is much more prevalent in industry. Paper, aluminum cans, glass, polyethylene teraphthalate (PET) soft drink bottles and steel cans, all components of consumer waste, are being recycled in many areas of the world. Communities in the U.S. recycle 11 percent of their waste while some communities in Japan recycle about 50 percent of their waste (Manitoba, 1989). In Canada, we recycle less

than 2% of our household waste (Manitoba, 1989).

Recycling of waste has other secondary benefits besides just extending landfill sites lifetimes. Some of these benefits are:

1) In many cases, recycling saves energy of processing since the recycled products are in a more finished form than the raw ore. (Manitoba, 1989)

2) Recycling extends the lifetimes of our nonrenewable resources. (Ontario, 1979)

3) A new sector of the economy can be created with a potential for many new jobs. (Manitoba, 1989)

4) Environmental degradation will be reduced. (Ontario, 1979)

Although Brady landfill site has about 40 years left (Duguay, 1990), Winnipeg should also begin recycling as much waste as possible. Presently in Winnipeg, programs to recycle paper, aluminum cans, glass, PET containers and tin cans from post-consumer waste have begun.

The collection of tin cans from post consumer waste is a well established process. The collection can be done by either a curbside collection process, neighbourhood drop off

bins or a bulk sorting procedure which may involve shredding, air separation and/or magnetic separation. Curbside collection and neighbourhood drop off bins involve washing and cleaning of the cans by the consumer.

Curbside collection and neighborhood drop-off bins depend on voluntary consumer participation. Without the participation of the consumer, curbside collection and neighbourhood drop off bins would be totally unsuccessful. The third method of collection, magnetic separation, requires no change in present consumer activity. The consumer continues to dispose of everything. Magnetic separation requires a transfer station to which all of the garbage from the municipal waste stream is brought. A magnet at the transfer station separates ferrous scrap including tin cans from the garbage.

After collection, detinning of the tin cans can be done. The tin that is plated over the steel has to be separated from the steel before recycling. The cans are shredded and run through an air separator. The air separator cleans the scrap of any impurities, such as dirt or organic food particles which may be sticking to the metal. The shredded and cleaned can is washed in a solution which separates the tin from the steel (Lilley, 1985). The tin which is dissolved in the washing solution is removed by electrolysis (Rosenberg, 1989). The tin and steel are then sold on the market.

1.2 Issue Statement:

The pressure to find locations for new landfill sites in many cities has led to strategies to reduce the waste dumped in landfills. One way to minimize waste is to recycle. Recycling of waste also has many secondary benefits.

In Winnipeg, newspaper, PET bottles, glass, aluminum cans and tin cans are already being recycled. Decreased environmental degradation, extended landfill lifetimes and economic growth can result if Winnipeg recycles tin cans and other materials. The need exists for a study to see how recycling of tin cans can be expanded to encompass the entire City of Winnipeg.

1.3 Objectives:

The primary purpose of this practicum is to determine whether recycling of tin cans from the City of Winnipeg municipal waste stream is socially and economically feasible.

Specific objectives include:

1/ To assess the economic feasibility of a detinning plant in the City of Winnipeg area.

2/ To collect data on amount of tin cans that could be collected in Winnipeg.

3/ To analyze and compare this data with tin can recycling programs in other cities.

4/ To recommend alternatives to client(s) depending on results from first three objectives.

1.4 Methods:

The following methods have been done in the course of investigation into recycling of specifically tin cans in the City of Winnipeg.

1/ A survey/questionnaire was sent out to a representative sample of Winnipeg households to determine their attitudes and resultant behaviours towards recycling. A sample of 500 randomly selected households in the City of Winnipeg was generated from the City of Winnipeg white pages phone book. This method of sampling and the sample size was determined after meeting with a statistical consultant at the University of Manitoba.

2/ The amount of tin cans which could be collected by a curbside, drop-off or magnetic separation recycling program was estimated using waste composition stream data and possible participation rates.

3/ The costs and revenues for curbside, drop-off or magnetic separation recycling programs were estimated and compared after conferring with the City of Winnipeg, researching the literature and discussing with other sources.

4/ The costs of a detinning plant built in the City of

Winnipeg were compared to the revenues that could be generated by the plant through the volume of tin cans that could be generated and collected by recycling programs in the City.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction:

Tin cans have been used to preserve the freshness of food since 1810 (Apotheker & Marksthaler, 1986). They are convenient, unbreakable and store easily. Tin cans are so named because of the thin layer of tin which is coated over the steel. Tin is coated onto the steel because it is more resistant to corrosion than steel and because of its glossy shiny look. Tin does not have the same strength as steel and, as a result, cannot be used to make the entire can. Tin is also more expensive than steel making steel cans with a thin layer of tin much more economical than a can constructed of only tin. Today's tin cans are coated with a tin coating in the range 0.00038-0.00015 mm (Metals, 1979) with the tin making up about 0.25 percent (Watson, 1989) of the tin can by weight. The tin cans are made out of tin-plate which is a low carbon steel plated on both sides by tin. Tin cans use about 90 percent (Apotheker & Marksthaler, 1986) of the tin-plate produced today.

2.2 Attitudes towards recycling:

Successful recycling of any material from the municipal waste stream in today's society depends on the attitudes of consumers towards the environment, towards the recycling process and towards the method of collection. Recycling of tin cans is no different.

A number of surveys have been done to determine consumer's attitudes towards recycling in an attempt to determine the number of people who would participate in any sort of organized recycling program. These surveys are conducted both, before and after, recycling programs are begun, to determine the percentage of people who actually do participate versus those who say they would. As McGuire et al. have shown in their study in Tucson, Arizona "what people say about recycling and how they dispose of recyclable materials are two different things." (McGuire et al., 1982). Actual participation in a recycling program is generally less than what is indicated by any survey.

A pilot study done by the City of Edmonton of "before" recycling attitudes from a sample of 823 households found that 83 percent of the people surveyed would participate in a recycling program. Of this sample, 83 percent favoured a home curbside collection process (Stokes 1987, 39).

Respondents were also asked if presently they saved tin cans to be recycled. In the pilot study, 16 percent said they always saved tin cans to be recycled while 24 percent said they saved tin cans some of the time (Stokes 1987, 37).

In another similar study by the City of Edmonton of 224 households, it was found that 66 percent of the households would be willing to participate in a recycling program (Stokes 1987, 39). In this questionnaire, households were also asked what type of collection they would be willing to accept and whether they would be willing to separate collectibles from the garbage. Of the households surveyed, 87 percent indicated that they would be willing to accept a home curbside collection process as compared to 48 percent for local drop-off depots. This survey also indicated that 69 percent of the respondents were willing to separate and rinse metal containers and tin cans. Both of these City of Edmonton studies were conducted before a recycling program was initiated. An "after" recycling survey has not yet been done.

A number of other recycling programs have examined participation rates in their communities. A study by Springfield Township in Pennsylvania found an overall participation rate of 85 percent with a weekly participation rate of 65 percent (Fulginiti, 1985). The overall

participation rate is defined as the number of households that participate in the recycling program but may not put out recyclables every week whereas a weekly or monthly participation rate is defined as the percentage of people who put out their recyclables in one week or one month. Another study in Santa Cruz county found a monthly participation rate of 74.2 percent (Smedberg, 1989). In Ontario, recycling studies have indicated 80 percent of the population would recycle. Generally, recycling programs in Ontario achieve a participation rate of 70-90 percent. However, recycling programs do exist that have been poorly run and badly managed that have not done well, achieving participation rates of only 20 percent (Taylor, 1986). In Winnipeg, a preliminary survey by the Resource Recovery Institute of 300 Wolseley area households has indicated a participation rate of 97 percent (Golden, pers.comm.).

2.3 Recycling Programs:

One of the most important components in any recycling program is the number of citizens and residents who participate in that recycling program. High participation rates may lead to large volumes of material collected but large volumes are not necessarily guaranteed by high participation rates. The volume of recyclables collected

then determines the amount of revenues brought in by selling the recyclables. The backbone of many recycling programs is the participation rate of it's participants which determines the quantity of material collected and often the success of the program. Other components of recycling programs which determine its success include the strength of its markets, and whether collection is fully commingled or complete source separation. The following discussion will primarily discuss how participation rates in recycling programs is affected by various factors.

2.3.1 Curbside Recycling:

2.3.1.1 Participation:

A number of studies and papers have reported the results of surveys of recycling collection programs across Canada and North America. One of the most extensive surveys done involved 450 cities in the United States with 264 cities replying corresponding to a return rate of about 60 percent (Folz & Hazlett, 1990). Of the 264 cities which replied, 175 operate voluntary recycling programs and the other 89 are mandatory. The types of recycling programs, the participation rates , the mean diversion rates and the number of each type of program are summarized in Table 1 below.

Table 1
Participation and diversion rates by program type (N=264)

Type	Mean participation rate	Mean diversion rate
Mandatory (n=89)	74.3 %	21.6 %
All voluntary (n=175)	39.7 %	12.2 %
Curbside only (n=109)	48.6 %	12.3 %
Drop-off only (n-66)	24.6 %	10.8 %

Virtually all of the mandatory recycling programs surveyed were curbside programs. As can be seen from Table 1, mandatory recycling programs (74.3%) have a higher participation rate than voluntary recycling programs (39.7%) as well as a higher diversion rate. The mean diversion rate is the percent of total annual waste volume that is diverted from the landfill by that recycling program. When curbside programs are compared directly with drop-off depot programs, curbside programs have a significantly higher participation rate (48.6% to 24.6%).

In another survey of recycling programs across North America conducted by *Biocycle* during March 1988, participation rates for 21 more curbside recycling collection programs were determined. Once again the average participation rate for mandatory programs was 83.3 percent (n=6, standard dev. of 13.28 %) for 6 programs which was

greater than the 54.4 percent participation rate for 13 voluntary programs (n=13, standard dev. of 18.28 %).

Factors which influence participation rates in recycling programs are varied and many. Frequency of collection, amount of resident separation, voluntary or mandatory recycling and provision of containers are some of the characteristics which affect the participation rates in curbside programs. These characteristics and their effect on participation in curbside recycling programs will be discussed.

2.3.1.1.1 Mandatory vs Voluntary Recycling:

Recycling programs can be set up as either mandatory or voluntary. Each type of program has advantages and disadvantages. For a mandatory recycling program, enforcement regulations must be set up either by the province or by local municipalities. A mandatory recycling program can have a participation rate higher than in voluntary participation programs (Fulginiti, 1985) but a mandatory program is not effective without enforcement. Enforcement is required to show the householders that the municipality is serious about instituting a recycling program (Glenn, 1989). In a mandatory recycling program, once the public realizes the seriousness of the municipality's view towards recycling, participation in the

recycling program may well increase to a point that is greater than the participation rate in a voluntary recycling program. In Islip, New York, a mandatory recycling program was started but was not actively enforced. In the early 1980's at the start of their recycling program, participation was around 50 percent. As the program established itself and enforcement remained low profile, participation fell off to about 30 to 35 percent by 1987. After this drop in participation, Islip decided to actively enforce their mandatory recycling bylaw. As a result, participation has risen to an estimated 90 to 95 percent (Glenn, 1989).

Most mandatory recycling programs are started with education of the consumers about recycling. Educational pamphlets and letters are sent out to households and residences explaining recycling, describing the new mandatory program and detailing penalties for not recycling. A period of grace is granted to home-owners before active enforcement is begun. How does the municipality check if people are recycling? The recycling inspectors keep track of those houses who recycle and those houses who do not recycle. The next pick-up day all the houses who did not recycle on the previous pick-up day have their garbage checked. If recyclables are in the garbage, warnings are issued to the householder. If the householder continues to

throw out recyclable material, fines ranging from $25 to $1000 and possibly even more may be levied (Glenn, 1989). These fines generally escalate as the householder continues not to recycle.

Another way some communities check for recyclables is by making random checks for loads at landfills. In Groton, Connecticut, a landfill inspector checks incoming loads for recyclables. If recyclables are not found, the regular tipping fee of $30/ton is charged. Otherwise, if recyclables are found, a tipping fee of $100/ton is charged (Watson 1989, 60). Using this system, private contractors aid in enforcement of mandatory recycling. They will not pick up any garbage that has recyclables in it, forcing the householder to remove the recyclables or take his/her garbage to the dump and pay the appropriate tipping fees. In many cases, educating the consumer about recycling and its benefits for the environment and society is enough to spur the consumer to recycle and obey the bylaw.

Advantages of a mandatory recycling program are:

1/ More publicity for recycling as a result of the public hearing process. (Fulginiti, 1985)

2/ Participation can be higher than in a voluntary

program because fines can be used to spur nonparticipating householders to participate. (Ibid)

3/ Enforcement of a mandatory recycling program assures involvement of government and local municipalities in recycling.(Ibid)

Disadvantages of a mandatory recycling program are:

1/ Assurance of participation requires persistent checks and enforcement of regulations. (Ibid)

2/ Failure to enforce may imply to citizens that local municipality is not serious about recycling leading to a drop in participation. (Ibid)

3/ Spirit of voluntary participation is degraded. (Ibid)

One community which does have a successful mandatory recycling program with active enforcement is Woodbury, New Jersey where participation rates of 85 to 90 percent have been achieved (Watson, 1989).

Another option which other communities have tried is voluntary recycling. Advantages of a voluntary recycling

program are:

1/ Participation is likely to be more consistent. (Fulginiti, 1985)

2/ Recyclables will be better separated, better cleaned and more care will be taken to have them placed at the curb. (Ibid)

3/ Better spirit exists in the recycling program. (Ibid)

The disadvantage of a voluntary recycling program is that people are not required to recycle and voluntary participation may not raise enough recyclables to make a recycling program economically feasible. However, financial incentives can be used to improve participation. St. Louis Park, Minnesota and Seattle, Washington have both used financial incentives to improve their voluntary recycling efforts. In conjunction with education and convenience of participation in a recycling program, financial incentives have boosted participation in St. Louis Park from a rate of about 50 percent in 1986 to more than 80 percent in 1988 (Wysopal, 1989).

St. Louis Park initiated a garbage service charge after a

survey indicated that 94 percent of the citizens surveyed preferred economic incentives to promote recycling. A base rate of $11 ,as of February 1, 1988, was set for garbage collection per household per week. Recycling credits were granted to households who recycled at least 3 times in a 3 month period. Recycling credits were also granted to citizens who used other recycling services such as buy back centres and church or charity organization's recycling services. This incentive system has boosted their weekly participation rate by more than 30 percent (Wysopal, 1989).

The city of Seattle uses a similar financial incentive to encourage recycling. Seattle uses a variable garbage can rate. As consumers reduce the amount of waste thrown away, they pay less for garbage services. As of June 1989, garbage collection costs the citizen $13.75 per month for the first can of garbage while the second and third each cost $9.00 per month. All curbside collection costs are included in the garbage can rates and the customers are not charged for this service. Seattle also has other subsidies and incentives for reducing waste for multi-family buildings, low-income, elderly, and handicapped customers, yard waste and backyard vs curbside garbage pick-up (Parker, 1989).

2.3.1.1.2 Day of Collection:

Folz and Hazlett in their 1990 article in *RESOURCE RECYCLING* have attempted to correlate various characteristics of curbside recycling programs with citizen participation. Their results are shown below.

Table 2

Factor	r	Sig.	N
Program type Voluntary = 0 Mandatory = 1	.56	.000	244
Curbside pickup No = 0 Yes = 1	.38	.000	245
Provision of containers No = 0 Yes = 1	.12	.061	170
Sanction or reminder No = 0 Yes = 1	.49	.000	172
Recyclables collected by a private contractor No = 0 Yes = 1	.22	.000	244
Composting used as a method of solid waste disposal No = 0 Yes = 1	.13	.01	240
Collection the same day as garbage No = 0 Yes = 1	-.015	.422	170
Separation Not required = 0 Required = 1	0.28	.355	172

The "r" in Table 2 indicates the strength and direction of these relationships. An "r" that is close to zero indicates little or no relationship between the variables. An "r" of one either positive or negative indicates a

perfect relationship. Generally, a correlation of "r" of less than .10 is weak, .10 to .20 is modest, .21 to .30 is moderately strong; and correlations larger than .30 indicate stronger relationships.

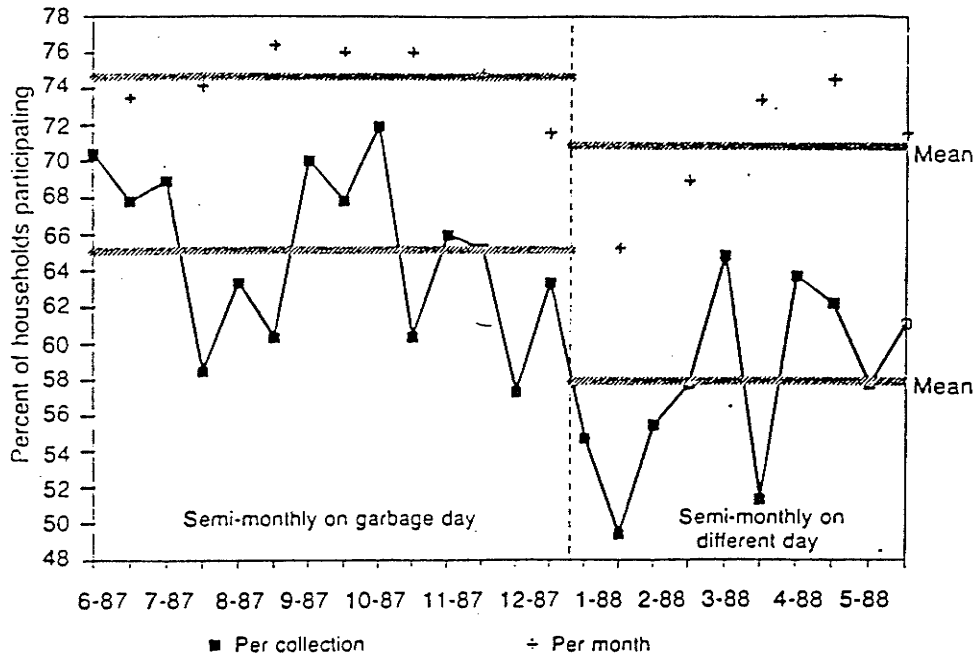
'Sig.' (statistical significance) in Table 2 indicates how likely it is that the association measured between two variables is wrong. The accepted standard in policy research is .05, indicating that there is a 5% probability that the association is incorrect or, in other words, a 95 percent chance that it is correct. (Folz & Hazlett, 1990)

One of the main concepts in recycling is convenience will increase participation (Taylor, 1986). Looking at Table 2, a modest correlation of -0.15 exists between high participation rate and collection of recyclables on the same day as garbage. It is surprising that the recycling participation rate is not more strongly related to collecting recyclables on the same day as garbage. This implies that participation may not decline if recyclables are picked up on different day than the garbage day. However, the statistical significance is .422, which indicates a 42.2 percent probability that the correlation is incorrect or a 57.8 percent probability that the correlation is correct. Clearly this analysis still leaves the question of whether participation rate is maximized if recyclables are collected on the same day as garbage day open to debate.

In another study by the Village of Glen Ellyn,

recycling day was originally on the same day as trash collection but after a seven month data gathering period, it was switched to a different day than trash collection (Foshay & Aitchison, 1991). The effects of a recycling collection day different than the trash collection day and its effect on participation were studied. When recycling day coincided with garbage day, the monthly participation rate in Glen Ellyn was 75 percent, with 65 percent of the households setting out every collection day (with collection being semi-monthly). After seven months, the recycling

Figure 1 Day of Collection - Participation Rate



collection day was switched to a different day than garbage collection. The recycling participation rate, after switching the collection day, decreased to 71 percent and the set-out rate fell to 58 percent. The results of the Glen Ellyn research are shown on the previous page in Figure 1.

In the same article Foshay & Aitchison show the results of two neighbourhoods in Naperville, a suburb of Chicago. One neighbourhood had simultaneous trash and recycling day collection and each household was given a recycling bin. In the other neighbourhood, recyclables and garbage were collected on different days and no recycling bins were provided. Table 3 shows the results.

In this study, participation is higher in the neighbourhood with same day collection and a recycling bin. It is unclear which factor, the same day collection or the recycling bin, has the effect on participation. Foshay &

Table 3 Collection of Recyclables on Same Day and Different Day than Trash Collection

Neighbourhood	Collection day for trash and recycling	Container provided	Monthly participation rate
Cress Creek	Different	No	79 percent
Cedar Glen	Same	Yes	88 percent

Aitchison state that "scheduling recycling collection to coincide with garbage is helpful" to optimize participation but providing a recycling bin and collecting recyclables weekly are more important.

Another article by Dr. Stevens agrees with and reinforces this point by Foshay & Aitchison. Dr. Stevens states that cities which have same day recyclable collection as garbage collection have higher participation rates than if recyclables are collected on different days. (Stevens, 1990).

Comparison of participation rates when collection of recyclables is done on either the same day as trash collection or on a different day than trash collection is difficult. It does appear that the participation rate in a curbside recycling program does not decrease when recyclables are collected on the same day as trash is collected. It is still uncertain, however, whether the participation rate in a curbside recycling program actually increases when the recyclables are collected on the same day as trash is collected.

2.3.1.1.3 Frequency of Collection:

Foshay & Aitchison in their study also examined the relationship between participation rate and frequency of collection of recyclables (Foshay & Aitchison, 1991). In Naperville City, a pilot program serving 1,000 was started

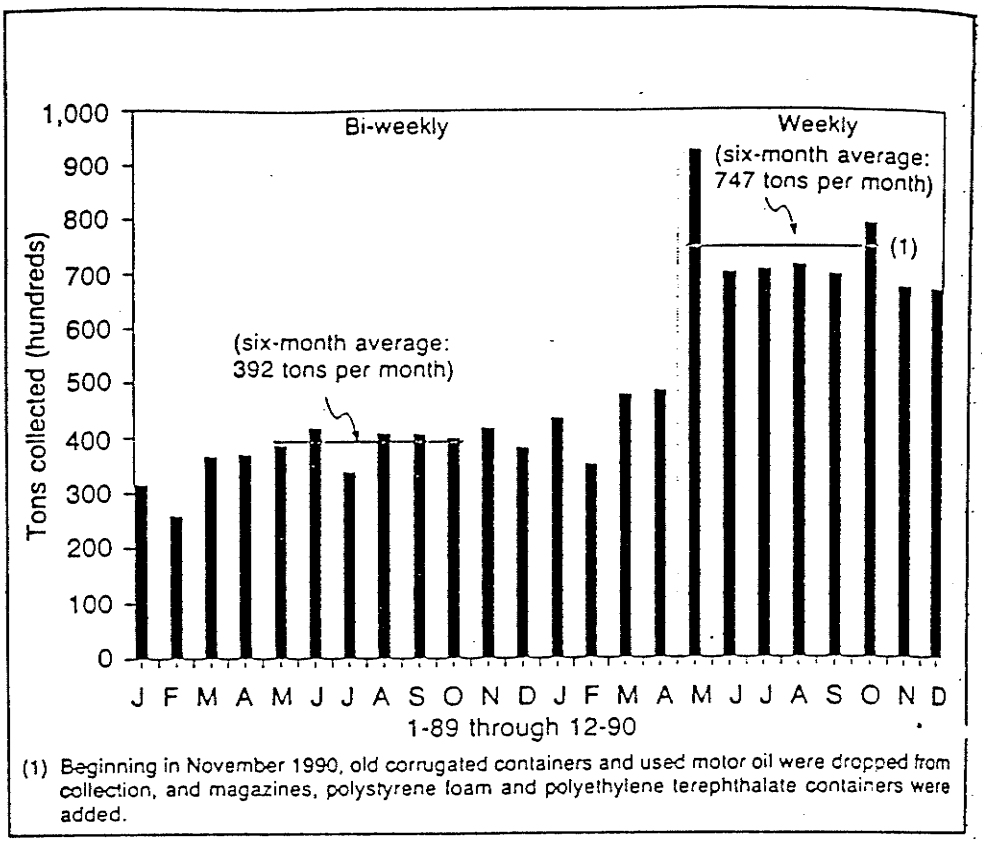
at bi-weekly collection. The collection rate was increased to weekly collection to find out if the participation rate would be affected. The results are shown below.

Parameter	Old service	New service
Increase service from bi-weekly to weekly	54 % monthly participation	79 % monthly participation

The curbside program was expanded city-wide shortly thereafter and an extensive monitoring program of each household's participation was maintained. The participation rate in the city-wide program followed the example set by the pilot study. Initially ,during bi-weekly collection, the monthly participation rate was 54 percent, while it increased to a monthly participation rate of 87 percent when collection occurred every week.

The increase in collection frequency from bi-weekly to weekly had another effect not including the increase in the participation rate. An increase in tonnage collected was the most noticeable change. During the six month period from May-October 1989 when collections were bi-weekly, an average yield of 392 tons per month was collected while during the same period one year later, when collections were weekly, the average monthly yield was 747 tons, an increase in 90 percent. These results are shown on the next page in Figure 2.

Figure 2 Collection Frequency - Participation Rate



(1) Beginning in November 1990, old corrugated containers and used motor oil were dropped from collection, and magazines, polystyrene foam and polyethylene terephthalate containers were added.

While the tonnage increased, it also increased for certain materials unproportionately. Since total tonnage increased by 90 percent, one might expect similar increases for each material (Foshay & Aitchison, 1991). This was, however, not the case. Old corrugated containers, HDPE (high density polyethylene) containers, and steel, which is mostly tin cans all increased by amounts greater than 90 percent. This is of particular interest for my study on tin cans. The increase in tonnage of tin cans amounted to 230 percent of the initial collection amount. While a portion

of this amount can be attributed to the increased introduction of bi-metal cans, the tonnage increase of tin cans is still 180 percent. Foshay & Aitchison attribute this to the fact that tin cans must be cleaned and delabeled before they are set out for collection. Citizens might have been hesitant to prepare them for bi-weekly collection. However, it is likely that the weekly collection served as a reminder that overcame the reluctance. This reluctance to clean and delabel the tin cans may, however, no longer be a problem. AMG Resources Corporation has created an efficient system which can separate all the contaminants such as food, paint, and labels before the tin can scrap is detinned (AMG, 1990). The contaminants and labels can be separated if the tin can scrap is shredded and run through a magnetic separator (Morgan, pers. comm.).

Clearly, when collection is increased from bi-weekly (once every two weeks) to weekly, the total amount of recyclables collected increases, and the monthly participation rates increase. From the discussion above, a recycling collection program should include weekly collection. One option is to start a recycling program at bi-weekly or monthly collection and use the move from bi-weekly or monthly collection to weekly collection as part of an overall educational and promotional tool to promote recycling and possibly increase participation in a recycling program. In this way citizens could be introduced to

recycling slowly and once participation has levelled off, the move to weekly collection could serve as a reminder to recycle and be a promotional and educational tool.

2.3.1.1.4 Recycling Containers:

Several studies have been made on distribution of standardized recycling containers to citizens and their effect on participation. Foshay & Aitchison also explored recycling container use in their study (Foshay & Aitchison, 1991). They state, that after comparing recycling programs with a standardized recycling container to one without a standard container, that "giving residents a container in which to put their recyclables appears to make a significant difference". When collection is weekly, a bin may add 5 to 10 more percentage points to participation (Foshay & Aitchison, 1991). The recycling container gives the residents an obvious place to store their recyclables until they need to be set out on the curb. The recycling bin also serves as a daily reminder and advertising tool of the recycling program (Foshay & Aitchison, 1991).

Folz & Hazlett also explore the issue of participation and providing a recycling container. As can be seen from Table 2, a modest correlation (r=0.12) exists between provision of containers and participation in a recycling program. Folz & Hazlett state that communities that provide

recycling containers to residents also have higher participation rates. Their results do not support such a strong statement. A correlation may exist between higher participation rates and the provision of a recycling container but it is not strongly supported here by an r=.12. A recycling program which provides recycling bins may not have a lower participation rate than one which does not provide recycling bins but the data from Folz & Hazlett does not bear out the statement that a higher participation rate is expected.

However, it is generally accepted in the recycling community that the distribution of free collection bins for recyclables strengthens participation rates (Gitlitz, 1989). The two studies discussed above do not disagree with this point. While the Folz & Hazlett study does not wholeheartedly agree (a Sig.=.06 indicates that there is a 6 percent probability that the association between citizen participation and provision of containers is wrong), it does nonetheless not disagree. Folz & Hazlett cannot make a strong claim either way for provision of containers and enhanced participation rates. Foshay & Aitchison have shown that participation is optimized in a recycling program when recycling bins are given to residents.

2.3.1.2 Commingled or Separation of Recyclables:

An important decision in starting any curbside collection program is going to be whether the citizens separate the recyclables from each other and place them in separate compartments in a recycling container or whether the recyclables will be fully commingled in one container and the separation will be done by the collection company. There are four basic types of source separation programs which can be used in a curbside recycling program.

Complete citizen separation - the resident completely separates all recyclables (Apotheker, 1990).

Truck-side sorting - driver sorts all or part of the recyclables at the curb and places them in separate compartments (ibid).

Fully commingled - material is separated at a processing facility (ibid).

Co-collection - pick-up of separated, bagged recyclables at same time as garbage in a packer truck (ibid).

Each source separation type has advantages and disadvantages. Some of the issues which must be considered include material recovery rates, citizen participation rates, material contamination, amount of residue, collection costs, use of truck space and other processing costs. Table 4 below shows some of the commonly held beliefs regarding the benefits of the fully commingled and complete citizen

separation options.

Table 4 Comparison of recycling options

	Commingled	Complete Separation
Household	Less storage space Less containers to set out	More storage space More containers to set out
At curb	Fewer containers to dump & return to curb	More containers to dump & return to curb
Quantity	More weight / container	Less weight / container
In Transit	Better truck use, can serve longer route before unloading	Poorer truck use,shorter route before needing to unload
Unloading	Less time needed	More time needed
Processing	More costly	Less Costly
Residue	More residue (15-30%)	Less residue (5-10%)

(Powell, 1991)

2.3.1.2.1 Material Recovery:

Much research has been done studying the issue of commingled collection versus complete separation. Conventional wisdom states that commingled programs collect more waste, produce a better quality of material and cost less to operate than citizen separation programs (Apotheker, 1990). This understanding has recently been questioned and doubted. Scott McGrath, an environmental planner with Gannett Fleming, Inc., studied the monthly per capita recovery rates of glass, tin and aluminum in New Jersey in 1988 (Apotheker, 1990). He showed, in the first part of the

study in 1988, that complete separation of the material types into five different categories resulted in a 21 percent higher recovery rate than the fully commingled collection. In 1989, comparing the same five separation options, complete separation still exceeded commingled by 11 percent (Apotheker, 1990). It is unclear if this increase is a pattern and due to increased education or increased participation by people who were not participating in 1988 and as a result are not as enthusiastic about recycling and would not make as much effort recycling. As a result the decreased willingness to make the effort would increase the recovery in the commingled option while the recovery in the complete separation option would not increase as much.

The author also includes several qualifications in his study. First of all, the figures include material generated and collected from the commercial establishment including the residential establishment. In 1988, the commercial program was just starting and a larger effect would be seen from the commercial collection in 1989. Secondly, the residue from the commingled option is not subtracted from the figures used in the study. Residue is usually 10-20 percent of weight of incoming material in a commingled program. Residue in commingled curbside program consists of waste materials included in the recyclables plus any other materials such as broken glass or paper which does not get separated by the processing method. The data and figures

suggest that the complete separation approach has a higher recovery rate than the commingled approach, one that would be even higher if the residues were subtracted from the commingled figures (Apotheker, 1990).

In another study in 1987 of 39 curbside programs in Canada and the U.S. by Robert Sinclair released by the Recycling Council of Ontario used statistical analyses to show that "the larger the number of categories [sorted by the resident]...the greater the diversion [recovery] rate." (Apotheker, 1990). Sinclair also cautioned, however, that other considerations may have affected the result such as frequency of collection, simple preparation requirements, and provision of recycling bins (Apotheker, 1990).

In another study conducted by R. W. Beck and Associates for Sacramento County in 1990, where they compared the commingled approach to the separation option into three bins, Beck's stated that "...commingled collection may in theory encourage greater participation due to the ease to the resident of recycling commingled materials, and might enable a much broader variety and volume of materials to be collected if sorting facilities are available, but evidence to date is not available to support this conclusion." (Apotheker, 1990). Complete separation in a curbside program could lead to greater participation than in a commingled approach because it would "instill a greater recycling ethic and lead to greater participation"

(Apotheker, 1990).

Another study by Richard Bishop Consulting Ltd. ,which surveyed 12 New Jersey recycling programs in communities with populations ranging from 5,000 to 300,000, found that separation programs - not commingled programs - resulted in greater waste diversion. While the main purpose of their study was to examine costs associated with commingled programs in comparison to separation programs, they did find that separation programs resulted in 15 percent greater waste diversion commingled programs (Powell, 1991).

2.3.1.2.2 Material Quality:

Material quality in any recycling program is the quality of the material separated and if it has any contaminant or residues which would affect its market quality. Tin cans, for example, may need to be washed and the labels may need to be taken off. The quality of the tin cans is decreased if food particles and labels are not washed off the can. The tin cans would then be sold for a lower price than if they had been of higher quality. In a commingled recycling approach, much more material is contaminated because it is all mixed together. Glass may be broken, paper may be shredded, cut and/or soiled from run-off from the rest of the recyclables. (Watson, 1990). The only market for broken glass is mixed-color cullet which is a poorer market and

pays less per ton than any single color cullet or re-using the glass bottles (Apotheker, 1990). A major problem in the commingled approach is that glass container shards contaminated the paper that is recycled (Apotheker, 1990). Glass pieces that are imbedded in the paper can damage machinery used to recycle the paper (Watson, 1990). The main difficulty in the commingled approach is that the quality of the materials suffers. Add to that the cost of separation involved in a building and running a processing facility and it can be seen why a citizen separation program with the ability to get top market price for the recyclables is attractive.

2.3.1.2.3 Costs:

Costs for various source separation programs originate in different areas. A complete separation program provides recycling bins and trucks with different compartments to collect the recyclables. These components make up much of the cost of recycling. Commingled recycling programs must do more processing after collection than source separation programs.

While initially the costs associated with purchasing multiple-sort home storage containers (stacking bins, multiple bag systems etc...) exceeds the costs of most single container systems for the collection of commingled

recyclables (Bullock & Burke, 1989), the processing for commingled collection may make commingled more costly than complete separation. As Bullock & Burke state, "Probably the biggest advantage for curbside sorting [citizen source separation] is in not having to develop and pay to operate expensive processing facilities." Costs for labour and fuel in collection are also greater for curbside sorting than commingled sorting. Commingled collection utilizes truck space better than curbside sorting (Bullock & Burke, 1989). When a recycling collection truck is divided into three, four or five compartments, it is much tougher to fill all the compartments to capacity at the same rate. Consequently, curbside separation collection trucks are often not completely full when they must be unloaded. This increases costs of labour and equipment because trucks must dump their recyclables more than in commingled collection.

Another advantage of commingled collection is a larger collection route than source separation (curbside) can be covered in a day. More time is required to unload the recyclables into the truck in a curbside complete separation program than for a commingled program. A commingled program can cover more houses in a day than a complete separation program. Bullock & Burk, 1989 conducted a study examining collection times of 5 separations at the curb with commingled. The commingled collection time was 7 to 10 seconds less per stop than the separation program collection

time which averaged about 30 seconds per stop. This also increases labour costs and equipment costs for complete separation programs and as a result make collection more expensive for separation than commingled programs.

A cost comparison study was done between commingled (one or two separations) and complete separation options by Richard Bishop Consulting Ltd. for the New Jersey Office of Recycling (Powell, 1991). The average cost of recycling collection and processing for complete separation programs was $91 per ton, compared to $129 per ton for commingled programs. A 41 percent savings for complete separation over commingled. Collection costs were cheaper for commingled programs by $10 to $15 per ton but processing costs for commingled were more expensive than for complete separation. The study found that a processing plant for commingled recyclables increases the cost by an average of $63 per ton. The analysis conducted also included the sale of recyclables and included this as revenue. It was found that a complete separation program could sell its recyclables for a higher price per ton than the commingled program (Powell, 1991).

The costs of commingled and separation collection of recyclables originate in different areas. While purchasing recycling bins and providing collection make up the bulk of the cost for separation collection processing, processing and separation of the recyclables make up the bulk of the cost for commingled collection program. Generally the cost

of processing for commingled collection programs is greater than the cost of collection for the separation program. This results in generally greater cost for commingled programs than for separation.

2.3.2 Drop-off Recycling:

Drop-off recycling programs are sites located in highly visible locations where citizens come and drop-off their recyclables into bins or depots or other types of containers. They are usually located in shopping department stores, church parking lots or any other public institution. Drop-off sites usually do not collect as many recyclables as curbside programs.

Participation is as important in drop-off recycling programs as it is in curbside recycling. Drop-off programs must operate at the convenience of the public and should be encouraged to maximize participation (Biocycle, 1990). Convenience in designing a drop-off program means having a significant number of depots throughout the area of recycling. It must be convenient to drop-off the items. A rule of thumb according to "The Biocycle Guide to Collecting, Processing and Marketing Recyclables" recommends having a drop-off site for every 5,000 to 10,000 residents (Biocycle, 1990).

Some drop-off depot programs pay citizens for their

recyclables. The citizens bring their recyclables and are paid the going market price for the material. These drop-off programs which pay for recyclables are known as buy-back centres and tend to require more money to operate than drop-off depots. Buy-back centres also have more administrative work and require constant supervision. Drop-off depots appear to be more popular and preferable with municipalities and governments than buy-back centres because of the reduced administrative work and decreased costs.

2.3.2.1 Participation:

Various studies have been done examining participation rates in drop-off programs. Buy-back centres are not common and participation rates are not available. One survey of curbside and drop-off programs was explained in the curbside section above. In this study it was found that drop-off programs participation rate averaged 24.6 percent for 66 voluntary drop-off programs (Folz & Hazlett). When curbside programs from this survey are directly compared with drop-off depot programs, curbside programs have a significantly higher participation rate (48.6% to 24.6%). In a study by *Biocycle* magazine in 1990, some drop-off recycling programs were surveyed and participation rates were determined. The average drop-off participation rate for 7 programs was found to be 16.8 percent with a standard

deviation of 9.6 percent. Participation rates in drop-off programs are generally less than curbside programs. Drop-off programs do, however, serve an important function as they are less expensive and less time consuming to operate than curbside programs (Apotheker, 1991).

Visibility of the drop-off programs can aid participation and help to educate the public about recycling (Apotheker, 1991). In Champaign and Urbana, Illinois, an effort was made to maximize the public's participation in drop-off programs. The non-profit corporation that provides the collection service in Illinois identified a set of criteria for successful drop-off sites (Apotheker, 1991). These criteria are shown.

Criteria for Drop-off Depots:

*Parking spaces available for containers (about 5 parking spaces). Sites must be large enough to accommodate large weekend participation.
*Space for large collection vehicles to manoeuvre.
*Lighting for security and ease of use by patrons.
*Paved surface for material handling and easy control of litter and spills.
*Twenty-four hour site access by public.
*Lot management services (e.g. security, snow plowing, sweeping).
*Good drainage.
*Visibility of site from well-travelled streets.
*Large population (e.g., 10,000 to 15,000 people per week) visits the site to shop.
*Low impact on traffic flow; good ingress and egress.
*Good geographic distribution.
*Cooperative advertising is possible, especially on shopping bags.
*Store traffic and company image can be enhanced.

Source: (Apotheker, 1991)

The effectiveness of advertising in various media were explored in a study by the University of Illinois (Apotheker, 1991). It was found that in Champaign-Urbana, more people learned from seeing information at the drop-off sites than from other sources of information. The responses from the 1986 survey were:

* Drop-off sites - 88 percent
* Newspapers - 70 percent
* Radio - 52 percent
* Friends - 51 percent

Drop-off sites are good vehicles to advertise the recycling program and increase and encourage participation because of the highly visible location which is usually adjacent to a busy road.

2.3.3 Drop-off and curbside programs:

Drop-off recycling program can also be used as a supplement to a curbside recycling program. The advantage of the drop-off site is that it is usually open 24 hours a day and it serves as a backup for people who miss a curbside pick-up. Drop-off programs also allow residents and some businesses the opportunity to get involved in recycling (Apotheker, 1991). People who are not serviced by a curbside program may use the drop-off program to deposit their recyclables. Drop-off programs also allow other materials to be collected which are not collected by the curbside program such as corrugated containers and used

motor oil (Apotheker, 1991).

2.3.4 Centralised Separation:

Centralised separation is accomplished through a variety of mechanized and labour intensive processes and methods. They can be done either at a transfer station where the waste is switched from small size trucks to bigger size trucks or at the landfill or at a MSW processing plant. Equipment which would be required would include shredders, air classifiers, and conveyor belts. For tin cans, a magnetic separator conveyor is required. The magnetic separator conveyor would be able to separate about 95 percent of the tin cans included in the residential waste stream.

2.4 Conclusions:

Two main types of recycling programs are used in cities across North America, curbside pickup and drop-off programs. One of the most important aspects of any recycling program, whether it is curbside or drop-off, is the participation rate of the people serviced by the recycling programs. Curbside programs generally have a higher participation rate than drop-off depots but on the other hand they are also more expensive to run. Many factors can affect the participation in a curbside program. The day of collection,

the frequency of collection, providing recycling containers and whether the recyclables will be commingled or separated by the resident. Each of these option also affects the costs of running the program, the amount of recyclables. Each option also has individual benefits and costs. For example commingled collection affects the quality of the recyclables collected but the cost of collection is much less than the cost of collection for a citizen separation program. Centralised separation of recyclables from the waste stream is another option to collect recyclables. Centralised separation does not require any change in behaviour of the resident who continues to throw his/her trash in the garbage.

Not nearly as much information is available referring to drop-off programs as exists for curbside programs. Drop-off programs generally cost less and do not collect as many recyclables as curbside programs but drop-off programs can be used as an effective advertising tool if they are located in highly visible sites.

CHAPTER 3

METHODS

3.1 Introduction:

In this chapter, the methodology which was used in my practicum will be discussed. The methods have already been presented briefly in chapter 1 but they will be more fully discussed and expanded in this discussion. My methods briefly from chapter 1 are the following:

1) Survey/questionnaire.

2) Estimate of the amount of tin cans that could be collected in the city of Winnipeg.

3) Costs and revenues for curbside, drop-off and magnetic separation programs.

4) Economic assessment to determine if volume of tin cans can support a detinning plant.

3.2 Survey/questionnaire

Although this feasibility study could have been conducted without primary data from the City of Winnipeg, I believe that valuable information for use in my study and possible future studies has been obtained from this survey. The

survey has helped in determining possible participation rates in any recycling program which may be set up in the City of Winnipeg.

When developing any sort of survey, the type of data and information and the population group to be targeted must be clearly defined. In this survey, I attempted to determine the attitudes and resultant behaviours or actions of Winnipeggers towards recycling. This involved not only their attitudes towards recycling in general, but specifically in reference to tin can recycling. The survey was also conducted to determine the importance of recycling to Winnipeggers and to determine their views on recycling and the various approaches that can be used. It was also done to determine some sort of participation rate for a city-wide recycling program.

3.2.1 Sample Generation:

The sample of 500 names was generated from the 1991 City of Winnipeg telephone directory white pages. While another method of determining the sample may have been better, more representative and not have built-in biases such as unlisted phone numbers, many other options were explored and the best possibility of determining the sample was found to be the phone book. Two random numbers from 1 to 100 were generated using the random (RND) number button on a Sharp EL-545

calculator. The first number represented the page number of the phone book. The second number represented the nth name in the first column of that page number. The phone book was then flipped through in blocks of 100 to get a page number 100 greater than the first random number generated and the nth name was chosen from the first column. The next two random numbers generated work in exactly the same manner except the nth name is chosen from the second column all the way through the phone book and so on for the third and forth columns in the phone book. Care was taken that all the addresses and names generated were not businesses or apartments but were households or residents. If the nth name was a business or an apartment block, the closest name in one direction that was a residence would be chosen and the next time a name in the opposite direction that was a residence would be chosen.

3.2.2 Sample Size:

The sample size generated was 500 names and addresses which were cross referenced to find their postal codes. A cover letter with a copy of the survey was sent out to the addresses on June 26, 1991. The cover letter which was included with the first mail-out explained the purpose of the survey and the importance of responding to it. The survey was stamped so that in the second mail-out the people who had already responded would not receive another survey.

The survey also included a brief overview and background to the study. The overview explained what the Natural Resources Institute is, what the survey would be used for, how each persons name was selected and a brief paragraph about confidentiality. This overview is included with the survey in Appendix A.

After about 10 days, on July 8, 1991, another letter was sent to all the households. This letter was sent to the entire sample generated and served to remind them of the importance of them filling it out and returning it. It also served as a check to see whether all the households had received the initial letter and survey. Another cover letter with a copy of the survey was sent out 5 weeks after the reminder letter, on August 12, 1991. Five weeks after the first reminder letter, another letter was sent out with another copy of the survey to all the members of the sample who had not sent in their questionnaire. The cover letter included in this mail-out was a little more insistent and less diplomatic than the initial letters sent. All of these methods followed in my survey research were described in a book by Don Dillman entitled "Mail and Telephone Surveys: The Total Design Method". Copies of the survey and all the cover letters are included in Appendix A.

Bias in any survey must be carefully watched and avoided. Bias has been defined by Leedy in Practical Research as "any influence, condition or set of conditions

that singly or together distort the data from what may have been obtained under conditions of pure chance". One example of bias is shown below. For example, if I generate a random sample of people to be surveyed by flipping through the phone book and taking the top person on each page, bias is present in this procedure. Low income persons who may not have a phone and high income persons who have unlisted numbers are not represented. Consequently, the sample will be biased towards middle-income households.

Bias can also exist in a much less obvious manner. If only 75 percent of the respondents reply to a questionnaire, it must be asked why the other 25 percent did not reply? The results may be biased if the 25 percent who did not reply had some particular motivation for doing so. Bias is almost impossible to avoid and must be recognized as such. Bias must be watched for with the realization that it has probably already affected the data somehow.

3.3 Amount of Tin Cans Recovered:

The amount of tin cans that potentially could be recovered from the City of Winnipeg waste stream was determined. The municipal waste composition stream for the City of Winnipeg was determined from previous studies done nationwide, a couple of studies done in the City of Winnipeg

in the last few years and from the amount of waste landfilled in the City of Winnipeg in 1990. The amount of the waste stream which is composed of tin cans was determined. Using this data and possible participation rates from different types of recycling programs (drop-off, curbside and magnetic separation), a figure was arrived at for the amount of tin cans which could be recovered in the City of Winnipeg dependent on the type of recycling program.

3.4 Costs and Revenues for Recycling Programs:

The costs and revenues for the three types of recycling programs curbside, drop-off and magnetic separation were determined from the literature, discussion with people from the City of Winnipeg and discussion with members of the Recycling Council of Manitoba. The Recycling Council of Manitoba also provided copies of their 1st and 2nd quarter reports for their drop-off depot recycling program. The City of Winnipeg's Recycling Coordinator provided me with cost figures for various recycling programs run in other cities as well as possible figures for the City of Winnipeg. Landfill tipping fees were also provided to me by the City of Winnipeg.

Revenues were determined by surveying the scrap metal companies and steel companies in Winnipeg, Hamilton and

Minneapolis during the research of the practicum to determine a possible price which could be expected for tin can scrap, and detinned steel. These prices were used as the basis for the price that could be received for the materials that would result from recycling of tin cans and possible processing of the tin cans.

3.5 Economic Assessment of a Detinning Plant:

Using a ballpark figure from a detinning plant in Canada, the revenue made from the sale of tin cans collected in the City of Winnipeg was compared to the cost of a detinning plant. The revenue generated from additional sale of the tin and detinned steel were compared to the 'ballpark' figures of capital costs for construction of a detinning plant and operating costs. These figures were received from detinning plants in Canada and extrapolated to Winnipeg.

The critical elements in the success financially of a detinning plant in Winnipeg are the price of the steel and tin on the world market and the amount of tin cans that can be collected in Winnipeg.

3.6 Conclusions:

In this study, my data is primarily secondary in terms

of costs, revenues and recovery rates from literature. The primary data, that was used and generated, is the survey of Winnipeggers to determine their recycling attitudes. This data was used in determining participation rates for determining the amount of tin cans and other recyclable goods which may be able to be collected.

Chapter 4

COSTS AND REVENUES OF RECYCLING

4.1 Introduction:

This discussion will take into account three factors of recycling; costs, avoided costs and revenues. Revenues will be the price received for recyclables. Avoided costs will include the avoided landfill disposal costs and avoided collection costs in refuse collection that come from the decrease in refuse to collect and transport to the disposal site (Stevens, 1989). The costs will be the capital and operating costs to run recycling programs, curbside, drop-off and centralised separation.

4.2 Costs:

4.2.1 Curbside Recycling:

Curbside recycling costs involve capital and operating and maintenance costs (Biocycle, 1990). Capital costs include land, buildings, processing equipment, vehicles and recycling home storage containers. Another capital cost is the necessary financing required to make purchases (Biocycle, 1990). Financial costs such as transaction costs, paying financial advisors and other financial charges are capital costs.

Operating and maintenance costs include labour, fuel, vehicle maintenance, utilities, insurance and licenses. Labour costs usually comprise the largest single expenditure in operating and maintenance costs (Biocycle, 1990). Expenses involved with administration and running of the recycling program are also operating costs (Stevens, 1989). Three potential and possible work sheets, formulas and/or guidelines to determine the cost of curbside recycling are shown below.

1) COST CALCULATIONS

ESTIMATED CAPITAL COSTS	
Design and Start-up	_____
Collection Trucks	_____
Home Storage Containers	_____
TOTAL	_____

ESTIMATED OPERATING & MAINTENANCE COSTS	
Labour - coordinators	
drivers	
others	_____
Fringe benefits @ 30% of labour costs	_____
Public education @ $1/household/yr	_____
Insurance	_____
Fuel	_____
Maintenance - 5% of Equipment Capital Cost/yr	_____
Equipment Replacement Fund	_____
Administrative Expenses	_____
TOTAL	_____

According to 'The Biocycle Guide to Collection, Processing and Marketing Recyclables' a one person crew can pass 1000 homes/day (5000 homes/week) with one vehicle (Biocycle, 1990). The article goes on to explain how the

present net value (PNV) for cost and benefits of the recycling program are calculated.

2) In another article in the same Guide by Biocycle magazine, Dr. Stevens discusses another way to determine costs of a curbside recycling program in relation to the costs of the municipalities refuse collection service (Stevens, 1990). The author's discussion of costs assumes the integration and overlaying of the recycling program with the refuse collection program. An integrated recycling collection program would involve the collection of refuse and recyclables by the same company or same department in the government or municipality. By integration of the recycling and refuse collection programs, savings in refuse collection can be used to help finance the recyclables collection program. These savings in refuse collection originate from the decrease in refuse to collect and transport to the disposal site. Dr. Stevens goes on to present data , the costs for recyclable and refuse collection, for a hypothetical community. The data is based on typical expenses and work rates of collection crews in actual communities (Stevens, 1990).

Essentially, adding a weekly recycling collection program to the weekly refuse collection program is equivalent to adding another weekly pickup of refuse. The cost of adding a weekly recycling program is essentially the same as adding an extra weekly pickup to the regular refuse

collection service (Stevens, 1990). Research done by Dr. Stevens has shown that increasing collection frequency from once a week to twice a week increases collection costs by about 26 percent. Determining the cost of a recycling program is fairly simple. Determine first the cost of the weekly refuse collection service minus the disposal cost and use the .26 as a multiplier to determine the cost of a weekly curbside pickup program (Stevens, 1990). This system allows a municipality to start off with its own costs as a basis for estimating the cost of curbside collection, and allows for local factors such as wages and fringe benefits which are different from neighbourhood to neighbourhood and can be included in the costs. Dr. Stevens sums up the article by stating that; " Curbside recycling can be a profitable or break-even program. This is most likely to occur when recyclables collection costs are kept as low as possible by integrating the collection of recyclables and refuse, when markets for recyclables are good or excellent, and when high avoided disposal costs can be credited to the program.". (Stevens, 1989)

Three more cost work sheets from Middlesex county are included in Appendix B to calculate costs for a curbside recycling program.

4.2.2 Drop-off Programs:

Drop-off recycling programs costs arise from labour if the depots are supervised, purchasing of the depots, transportation of the depots to either a storage location or the recycling facility for emptying, advertising, education and other administrative costs.

One rule of thumb for drop-off recycling programs is to have a drop-off site for every 5,000 to 10,000 residents (Biocycle, 1990). Containers can be various sizes and shapes. Containers can be specialized and require special trucks to load and unload. They can be roll-offs which roll off trucks and are transported to a storage site where they are emptied. The last type of container would be a container that is emptied into the truck at the drop-off site. The containers can either be compartmentalized so they can collect multiple types of material or they can be geared to collect only one type of material (Biocycle, 119).

Any complete assessment of the costs of a City of Winnipeg recycling program will include all of the above costs mentioned and possibly more.

4.2.3 Centralised Separation:

The costs for separation of recyclables via centralised separation come from capital costs, and operating and

maintenance costs of the facility. Capital costs include construction of the building, purchase of the land and purchasing the mechanized equipment which will do the sorting and any other machinery which may be required such as forklifts and trucks. Operating costs would involve labour costs, fuel and any maintenance costs of the equipment, machinery and building and other miscellaneous costs.

4.3 Revenues:

Marketing the recyclables can finally return some money back to the recycler. Two possible markets exist for recycled tin cans: the steel industry and the detinning industry.

4.3.1 Steel Industry:

In the steel industry, the tin cans can be mixed with other steel scrap and used to produce steel. If the tin is in sufficiently large quantities (greater than 0.1 percent), there are few uses for the steel except as low grade castings or wrought iron (Apotheker & Marksthaler, 1986). If the tin in the tin cans can be diluted enough, then technically the steel industry could accept all the recycled tin cans. It is generally estimated that quantities of tin

on the order of 0.02 percent to 0.04 percent are the maximum allowable specification levels of tin in most steel products (Apotheker, 1990). Once large quantities of tin cans are being collected, it is likely that the steel industry would not be able to absorb all of them. In the long term, the tin can recycling industry and the steel industry needs detinning plants to remove some of the tin from the steel scrap (Apotheker, 1890)

In Manitoba, the steel industry is represented by the scrap metal companies and the rolling mills. The markets for tin cans in Winnipeg within the steel industry would be either of the two above mentioned industries or shipment of the scrap tin cans to another city.

4.3.2 Detinning:

The detinning industry is another area where the recycled tin cans could be sold. Various methods of detinning exist with the two main methods in use today being described below.

1. "Batch" Process:

The "batch" process involves placing the tin scrap in mesh baskets and lowering the basket into an iron tank, which acts as the cathode, containing an electrolyte of sodium or potassium hydroxide. An electric potential is

applied between the plate cathodes which are suspended in the solution and the anode which are the mesh baskets and tin cans (Apotheker & Marksthaler, 1986). The tin is separated from the steel partly in the form of liquid sodium stannate but mostly in the form of tin at the cathode. The cathodes are stripped in a furnace and the tin melts and is poured into ingots and marketed to chemical and pharmaceutical companies (Chevalier & Orendorff, 1990). The high quality, low residual detinned steel scrap is baled and shipped to foundries and mini-mills. This detinning process is used by AMG Resources Corporation (Chevalier & Orendorff, 1990)

2. "Continuous" Process

The second approach used in detinning plants called the "continuous process" was pioneered by Proler International Corp. in 1974 (Proler, 1990). The scrap is fed into a reactor tube where chemicals to detin the scrap are also released. The tube tumbles and rotates and this movement allows continuous changing of the liquid films on the scrap which brings abundant quantities of fresh reactant and oxygen to the scrap surfaces for rapid and efficient tin removal (Proler, 1990). When the scrap reaches the end of the reactor tube, the chemicals are separated from the detinned scrap. The scrap then enters a rinse system where the sodium stannate and the reaction solution are washed

off. The final results are No. 1 low residual steel and tin stannate which can be sold to various tin smelters for refining (Proler, 1990). This detinning process is used by Proler International Corp. at all of their detinning plants (Proler, 1990).

The city of Seattle has a detinning plant run by MRI Corp., a subsidiary of Proler, which accepts the tin cans from Seattle's recycling programs. Although it is one of the smallest plants in the United States, it processes more post-consumer cans than any other U.S. facility (Watson, 1989). The Seattle plant guarantees a tin content of less than 0.06 percent on the steel after detinning. Often the steel has a tin content of less than 0.035 percent (Watson, 1989).

The Seattle plant uses a "batch" method of detinning. The cans are dipped into a tank of chemicals for detinning and then dipped into another tank for rinsing. In Seattle, the melted tin forms ingots that are 99.98 percent tin (Watson, 1989). After detinning, the steel scrap should contain no more than 0.03 to 0.05 percent tin. From the detinning process the tin and steel are sold to prospective buyers. In Seattle, their tin was sold for about $4/lb and the steel for $100/ton as of the fall of 1988 (Watson, 1989). The New York composite metals market price of tin as of January 4, 1992 was $3.72/lb (The Globe & Mail) in US funds. Based on a Canadian dollar of 87 cents US, the tin

is worth about $4.27/lb in Canadian funds.

4.3.3 Sale of Recyclables:

The tin cans which are collected can be sold to scrap metal companies in the City of Winnipeg area or they could be shipped to Minneapolis or to Hamilton. In Minneapolis and Hamilton, the tin cans could be sold to detinning plants and detinned and/or they could be sold as tin can scrap to the steel industry. Another possibility with the tin can scrap is to detin the tin cans in Winnipeg at a detinning plant and sell the detinned steel and the pure tin to markets in Manitoba, Ontario or the United States.

MINNEAPOLIS:

An investigation of the options of transportation of tin can scrap and detinned steel down to Minneapolis of tin cans was done in early 1991. The results are shown below.

After talking with Jane Robertson of Manitoba Soft Drink Recyclers (MSDR), she indicated to me that MSDR ships to Minneapolis by truck-trailer for about $22/tonne (C) based on assured shipping and the ability of the trailer company to back haul. If we receive $38/tonne ($34.50/ton) (US) in Minneapolis for tin can scrap, this leaves a net revenue of about $18.80/tonne (US) or about $21.60/tonne (C) (based on a Canadian dollar of 87 cents US).

Table 5 Transportation to Minneapolis - Options

Price received (US$)	Transportation (US$)	Net cost (US$)
US $34.50/ton at door of detinning plant	1) CP Express $625 US/truck-trailer. 40,000 lb load. 20 tons. $31.25/ton	+3.25 /ton
	2) CP Intermodal Sunak International. $900-1000/trailer 22-24 tons. $40.91-45.46/ton.	-$6.41 to -$10.96/ton
	3) CN 100,000 lbs/car. US $2,160/car. $43.20/ton.	-$6.70/ton
	4) Hyman Freightways $650 US/trailer 44,000 lbs/trailer $29.55/ton	+4.95/ton

Another option in Minneapolis is to sell the detinned steel to the steel industry. The detinning plant currently in operating in Minneapolis sells its detinned steel for $100/tonne (US) or $114/tonne (C). Subtracting the freight costs from above of about $22/tonne (C), net revenues from sale of the detinned steel at the same market price would be $92/tonne (C) not including operating costs of the detinning plant.

HAMILTON:

The cost of transportation to Hamilton is shown below.

Transportation to Hamilton - Options

1) CN Rail
   $2.50/100 lbs
   min 50 tons
   $50/ton

2) Atomic Transportation Systems
   $1500 + GST/trailer (cap 25 tons)
   $64/ton

3) Motorways
   $1650 + GST/trailer (cap 22.5 tons)
   $78.50/ton

4) Reimer
   50 tons - $3500
   $70/ton

The least expensive mode of transportation is with CN rail for about $50/ton if shipping a minimum of 50 tons. Other costs to transport are between $60/ton and $73/ton. Tin can scrap from the recycling program along with tin and detinned steel from the detinning plant could be sold to Hamilton. The tin can scrap could be sold in Hamilton for $60-$70/ton ($67.20-$78.40/tonne) and the detinned steel could be sold for $100/ton ($112/tonne) (Morgan, pers. comm.). According to the least expensive transportation cost of $50/ton, net revenues from the sale of tin can scrap in Hamilton would be $10-$20/ton ($11.20-$22.40/tonne) and net revenues from the sale of detinned steel would be $50/ton ($56/tonne) not including operating costs of the detinning plant.

WINNIPEG:

Another option is to sell the tin can scrap collected in the recycling program to the steel scrap industry in Winnipeg. A market survey of the prices for tin can scrap has been conducted.

COMPANY	PRICE	QUALITY
Western Scrap Metal Inc.	$22.4/tonne	-
Logan Iron & Metal Co. Ltd.	$39.2/tonne	-
Chisick Metal Ltd.	$33.6/tonne	-

Above survey was done in early February 1991. Prices are prices that the consumer would receive bringing tin cans to the scrap metal company. If a constant large supply of tin can scrap could be assured, it is possible that a higher price could be received from the scrap metal company. In two instances, Western Scrap offered $39.20/tonne for tonnages of about 100 tons per month and Logan Iron & Metal Co. offered between $44.80-$56.00/tonne for about 100 tons per month. These prices are not quotations but can be interpreted as 'ballpark' figures. Another market survey was done between May 13, 1991 and May 23, 1991 with the results shown on the next page. Again the price is the price the consumer would receive if they brought tin cans to the door of the scrap metal company.

The required quality of the tin cans turned in was also

asked at each establishment and for the majority, it was preferable if not demanded that the labels be taken off and the tin cans rinsed out. Some of the companies were not asked this question and in these locations a '-' is shown. Most likely, in a tin can recycling program collection large amounts of tin cans, the cans would be required to be delabeled and rinsed out. While a small amount of contaminant would be allowed, allowing all the tin cans that were collected to have paper and food particles would probable add too many contaminants to the scrap company's operation. A simple way to separate the tin cans from the food particles and labels is to run everything through a shredder and then magnetically separate the tin can scrap from the food particles and the rest of the residue.

COMPANY	PRICE	QUALITY
Orloff Scrap Metals	$44.8/tonne	-
Den-Ches Enterprises Ltd.	$39.2/tonne	does not matter
Industrial Metals Processing	$44.8/tonne	-
General Scrap & Car Shredder	$39.2/tonne	no food, label
Mandak Metal Processors	$44.8/tonne	-

Another market survey was also conducted September 24, 1991 and the results are displayed below. The steel industry was feeling the effects of the recession in the May

and September market surveys. Many of the scrap companies that were talked to mentioned the recession and the steel surplus as reasons for low prices for tin can scrap. It was also mentioned that the steel industry is the first industry to feel the recession and the last to usually get out of a recession.

COMPANY	PRICE	QUALITY
Orloff Scrap Metals	$33.6/tonne	rinse tin cans
Den-Ches Enterprises Ltd.	$33.6/tonne	-
Industr. Metals Processing	$33.6/tonne	no paper on them
Gen. Scrap & Car Shredder	$22.4/tonne	rinse, labels OK
Chisick Metal Ltd.	$22.4/tonne	rinsed & labels off
Mandak Metal Processors	$39.2/tonne	washed out
Western Scrap Metals Inc.	$22.4/tonne	washed & labels off
Logan Iron & Metal Co.	$33.6/tonne	rinsed & labels OK

Prices for tin can scrap range from $22/tonne to $45/tonne dependent on the market and the steel scrap company. The tin can scrap that is collected from a recycling program can be sold for a price in the above range.

The detinned steel from the detinning plant could also be sold in Winnipeg at about $55/tonne to Mandak Metal Processors. According to Mr. Hart Chisick at Mandak Metal Processors, this price is relatively low because of the

state of the economy and the low demand for steel. He expects the price to rise in the coming year.

The option of shipping the tin can scrap and/or detinned steel to Regina was also explored. However, the price that Ipsco would be willing to pay was not deemed to be enough to cover further exploration. Wheat City Metals, the broker for Ipsco would be willing to pay $30-$35/tonne for tin can scrap (about the same as the Winnipeg market) and $45/tonne for detinned steel (December 1991).

4.4 Avoided Cost Savings:

Avoided costs in any recycling programs come from when costs in other parts of the garbage disposal program run by the municipality such as transportation costs, fuel costs, landfill costs, collection costs, facility operation costs are reduced and as a result saved (Biocycle, 1990).

For example, if a municipality has a fleet of ten or more trucks and the amount of waste collected by the garbage disposal crews is 10% less (10% is recycled), the municipality can increase its collection efficiency. The municipality could reorganize its route and eliminate a truck and crew (or switch the crew to collecting recyclables). This could result in crew costs savings, maintenance costs savings and other operating costs savings (Middlesex, 1984).

Avoided landfill costs arise from the refuse which is recycled and not disposed at the landfill (Stevens, 1989). If the landfill tipping fee is $20/ton and 40 tons per week of tin cans are collected and recycled, an avoided cost of $800/week results. This can sometimes push a recycling program from losing money to breaking even or making a profit.

However, if a municipality that is doing the recycling owns the landfill, the avoided cost of landfilling will be minimal but would be evident in the prolonged life of the landfill. Less waste will be landfilled because recyclables are being collected. Most of the costs of operating a landfill are fixed rather than being related to the amount of waste handled. However, the municipality could have avoided costs equivalent to the tonnage recycled times the operating cost of the landfill. However, if the waste that is being recycled is not of a significant amount then the worker's productivity may decrease, increasing the operating cost per ton of running the landfill. Once less workers are required and less equipment is used, then avoided costs will result in a landfill owned by the municipality. Consequently, avoided cost savings are lower for publicly owned landfills than for privately owned landfills (Deyle & Schade, 1991).

If the landfill is privately owned and the municipality paid for its garbage to be dumped there, then full avoided

disposal costs would be included in the cost savings of recycling. This figure can be very important in possibly striking a balance between costs incurred and revenues in a recycling program.

4.5 Conclusions:

Selling the tin can scrap in Winnipeg for between $22.4/tonne and $44.8/tonne yields a potential net revenue which would be greater than shipping the tin can scrap to either Hamilton or Minneapolis. Shipping the tin can scrap to Hamilton and selling it there would yield net revenues of $11.2-$22.4/tonne. The tin can scrap could generate net revenues of about $21.6/tonne if it was shipped to Minneapolis. Clearly, selling the tin can scrap to Winnipeg scrap metal companies could generate the most revenue and would avoid dealing with shipping costs to Hamilton and Minneapolis.

Detinned steel from the detinning plant could generate net revenues of $56/tonne if shipped to Hamilton, $55/tonne if sold to Mandak Metal Processors and about $92/tonne (Can) if shipped to Minneapolis. The best location to sell the detinned steel is Minneapolis where the detinning plant could sell the detinned steel for $114/tonne (Can). These revenue figures do not include any operating costs of the detinning plant which will be discussed in chapter 6.

CHAPTER 5

SURVEY RESULTS

5.1 Introduction:

A survey of Winnipeg householders was conducted. It was conducted to determine the importance of recycling to Winnipeggers and to determine their views on recycling and the various approaches that can be used. It was also done to determine some sort of a participation rate for a city-wide recycling program.

5.2 Results:

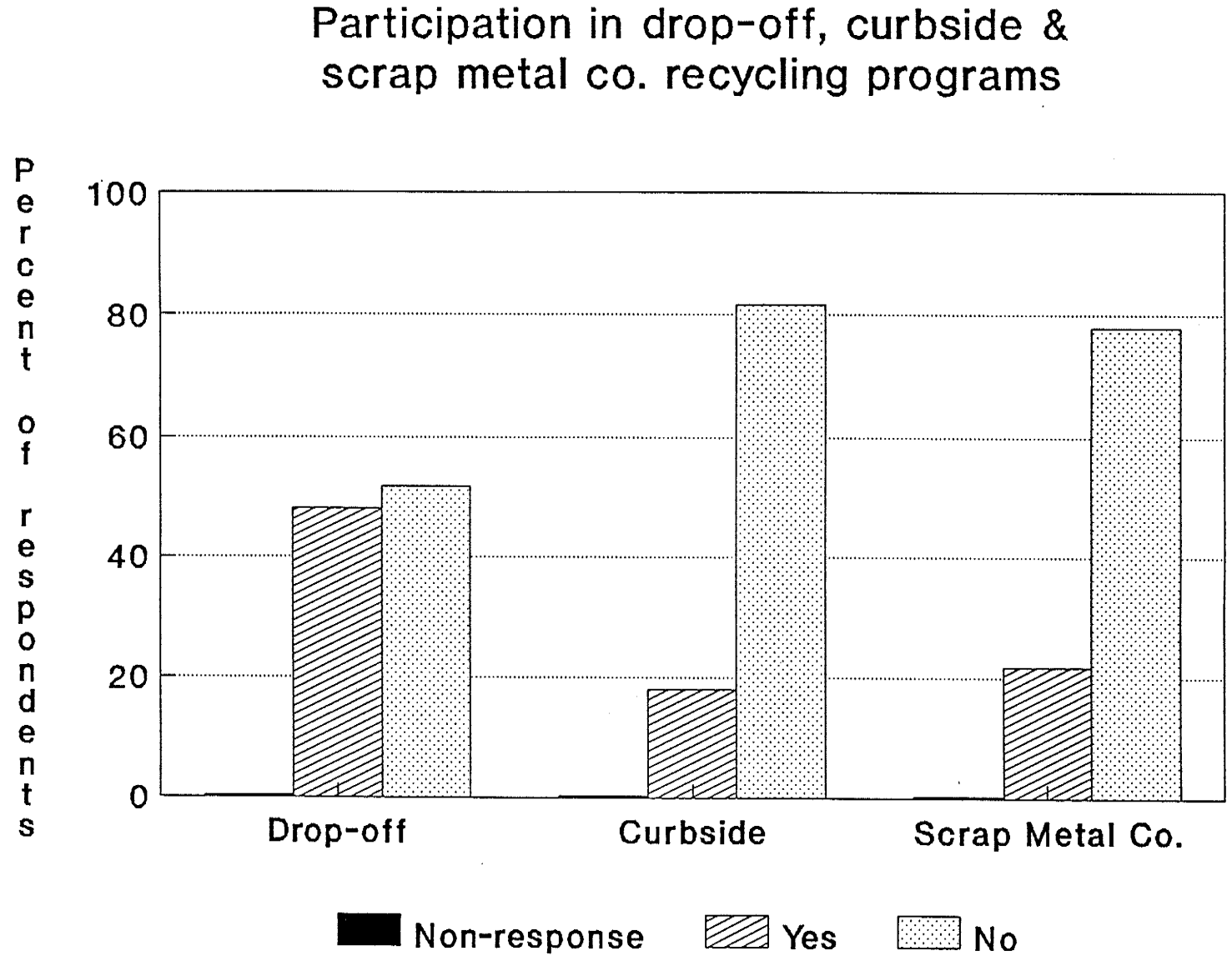
Of the 500 surveys sent-out in the first mail out, 252 were answered and returned. 240 additional surveys were mailed out and 71 were answered and returned for a total return of 323 surveys. This results in a total response rate of 64.6 percent for the mail-out survey. These results were coded and typed into the University of Manitoba mainframe computer and analyzed using SAS, a language for statistical analysis. The questionnaire consisted of 13 questions on recycling and some demographic questions. Additional space was left for any comments that the respondent may have wanted to make. For the purpose of this practicum, we are primarily interested in results pertaining to tin can recycling. The following discussion may reflect this bias but all of the results are presented in Appendix A.

5.2.1 Participation in Recycling:

Various questions in the survey targeted the amount of participation in recycling by the respondents in the past, the present and the future. In question #1, the residents were asked if they had participated in drop-off or curbside recycling programs sometime in the last 5 years. The results are shown in figure 3. 48.0 percent of the respondents replied that they had used a drop-off depot and 18.0 percent answered that they had used a curbside recycling program in the last 5 years. 51.7 percent of the respondents replied negatively to participating in a drop-off depot in the past 5 years while 81.7 percent of the respondents had not participated in a curbside recycling program. Clearly, more people have participated in a drop-off program than in a curbside program. This is probably just the case because curbside programs have not been extensively utilized throughout the entire city whereas drop-off depots are spread out over the city (St. James, St. Vital, Kildonan). The curbside programs which the sample participated in would have been either Plan-it Recycling, the blue bag program run by Resource Recovery Institute, the Red Box Recycling program and/or any other small curbside collection programs.

Another part of question #1 asked the respondents if they had ever taken items to a scrap metal company to be

Figure 3



(In the last 5 years)

recycled. Scrap metal companies accept most items for recycling and can be used for a measure of people going to these places and using them as drop-off depots. Only 21.7 percent of the people who answered the questionnaire replied that they had brought items to a scrap metal company in the last 5 years. 78.0 percent had not brought any items to a scrap metal company in the last 5 years. Clearly some people have been bringing recyclable goods including tin cans to scrap metal companies and bypassing the drop-off depot programs and the curbside programs.

Another question (question #4) was asked to determine if the surveyed population would be willing to save and separate newspaper, glass, aluminum cans, plastic pop bottles and tin cans to be recycled in a curbside and drop-off recycling program (see figures 4 and 5). For curbside collection programs, an over whelming majority of the respondents were willing to save and separate all materials from their garbage to be recycled. With a high of 86.1 percent for newspaper and a low of 77.7 percent for aluminum cans, participation in a curbside collection program would be high according to these results. Negative responses varied from 5.0 percent for tin cans to 2.8 percent for newspaper. However, missing responses or no answers ranged from 11.1 percent for newspaper to 19.2 percent for aluminum.

Unfortunately, many of the respondents misinterpreted

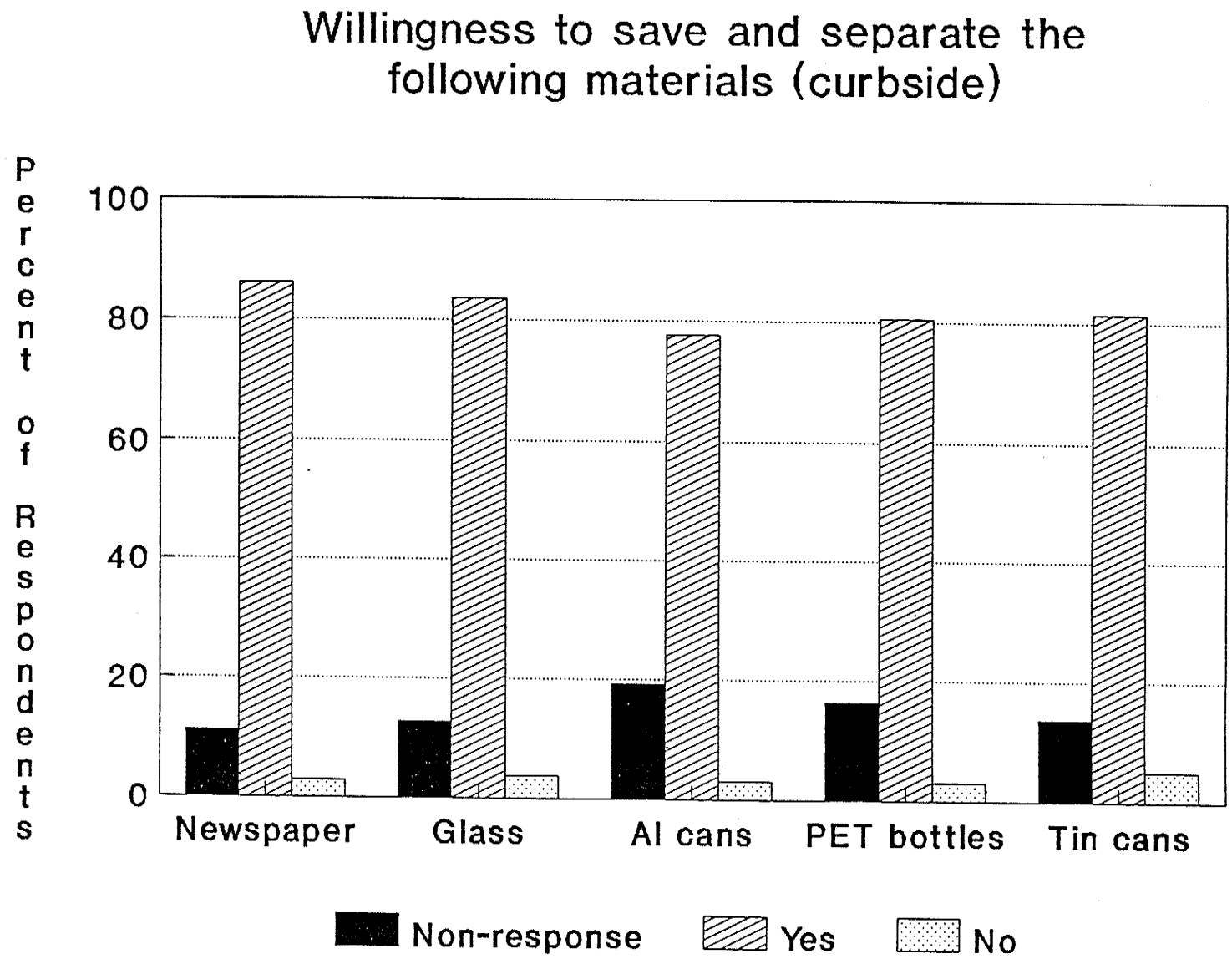

Willingness to save and separate the following materials (curbside)
Percent of Respondents
100
80
60
40
20
0
Newspaper
Glass
Al cans
PET bottles
Tin cans
Non-response
Yes
No

Figure 4

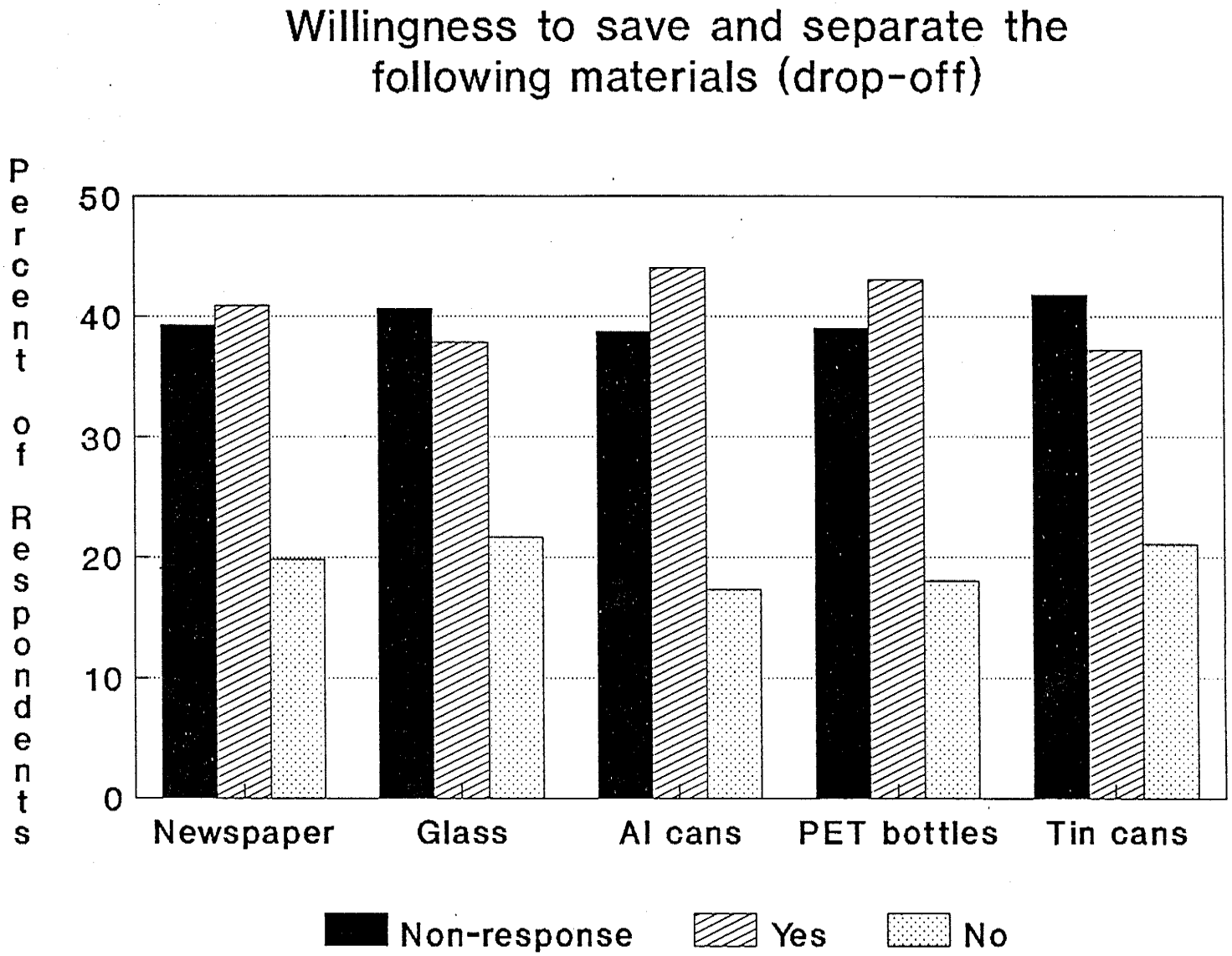

Willingness to save and separate the following materials (drop-off)
Percent of Respondents
50
40
30
20
10
0
Newspaper
Glass
Al cans
PET bottles
Tin cans
Non-response
Yes
No

Figure 5

this question. Many of them answered the curbside part of the question and would not answer or left the drop-off part blank. I get the impression that many of these people thought that the question wanted them to make a preference choice between curbside and drop-off rather than simply making a choice between being willing to save and separate the various materials to be recycle in a curbside program and a drop-off program and not being willing to save and separate for the two programs. For drop-off programs, about 40.0 percent of the respondents indicated that they were willing to save and separate the 5 materials. The positive responses for saving and separating the 5 materials varied from a high of 44.0 percent for aluminum cans to a low of 37.2 percent for tin cans. The negative responses varied from 21.7 percent for glass to 17.3 for aluminum cans. The percentage of respondents who did not answer this question averaged about 40 percent. This high non-response rate tends to confuse the data in this question. It is not certain if these people understood the question correctly or if they seemed to think that their non-response would be interpreted as not being willing to save and separate the items for drop-off depot recycling.

5.2.2 Problems:

One entire question (question #3) was set up to attempt to determine the main problems facing people in recycling.

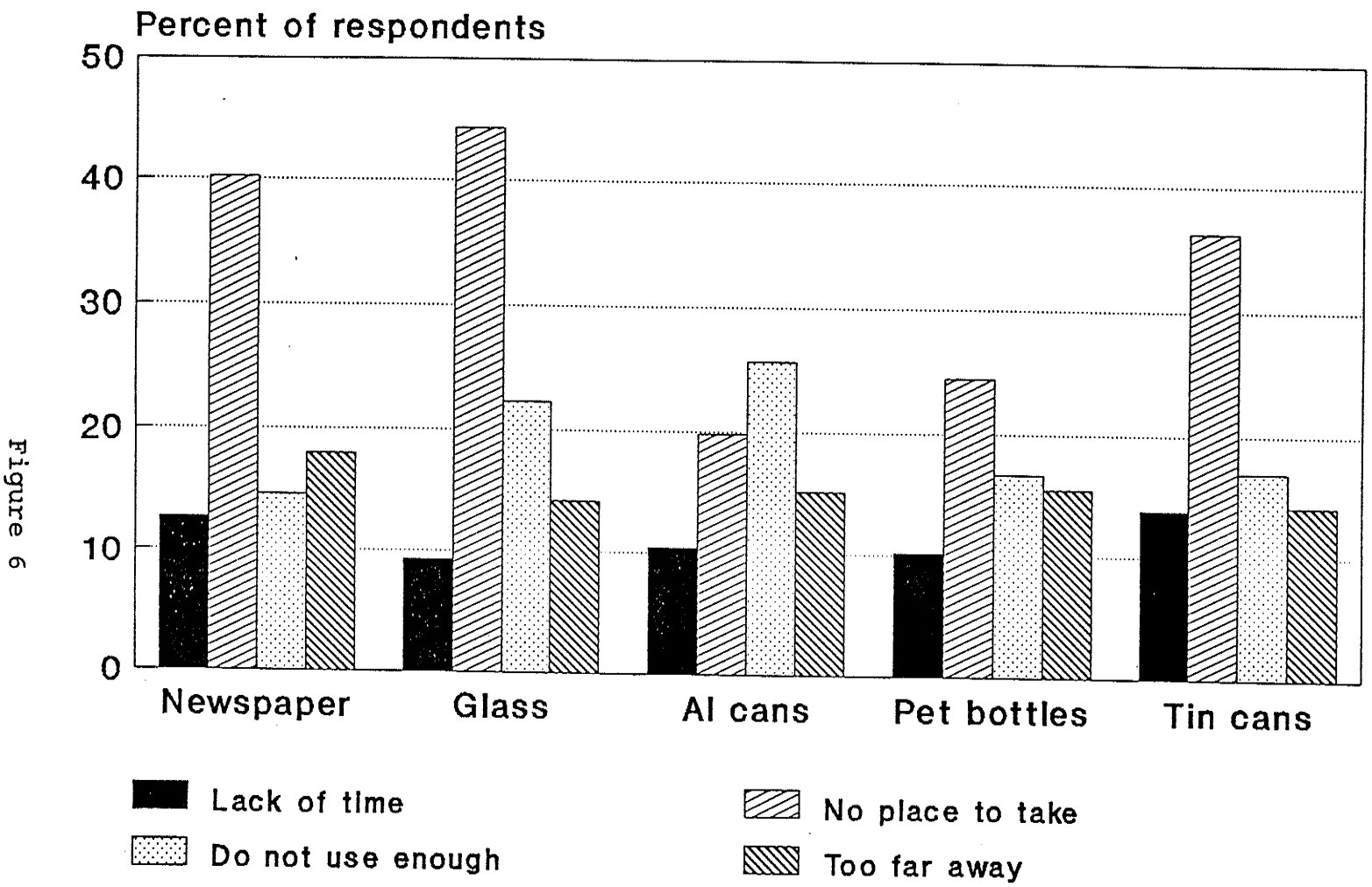

Problems in Recycling by Material
Percent of respondents
50
40
30
20
10
0
Newspaper
Glass
Al cans
Pet bottles
Tin cans
Lack of time
Do not use enough
No place to take
Too far away

Figure 6

Another problem which was attempted to be addressed by the survey was the prime location for a drop-off depot. This question (question #8) addresses two of the potential problem categories that were listed in the survey, no place to take it and recycling centres being too far away. The location ranked as the best location (# 1) by the most respondents (41.5 %, 134 out of 323) was a depot at the local shopping centre. The second most preferred location (35.9%, 116 out of 323, by the percent of people who ranked it number 1) was a depot within 6 city blocks. Well back was a depot at school (only 7.7% of the respondents ranked this as their number 1 choice) and a depot at work (6.8%).

It is, however, unclear if people chose a depot at the local shopping centre as their most preferred location because of the fact that is where most of the depots presently are and they have been conditioned to think that it is a good place or they actually have made an informed decision. (Their choice may have been biased by the fact that the RCM presently operates three large drop-off depots at shopping malls).

Question 8 was also misinterpreted at times. Some of the surveys came back with not a ranking of choices but rather just one choice ticked off or selected. The choice that was ticked off was interpreted as the respondents 1st choice and the rest of the choices were coded in as missing values. This is why the missing values are so large among

the 4 choices - 29.1 percent, within 6 city blocks - 47.1 percent, work - 23.8 percent, shopping center - 45.5 percent, school.

5.2.3 Separation & Preparation Willingness:

Two questions were asked to determine the degree of willingness to separate and prepare materials for recycling. This is a major difficulty in recycling. Many of the problems above such as lack of time could be interpreted as it takes too much time to prepare the materials for recycling. Most materials do have certain quality requirements and this section will attempt to determine if these requirements pose a serious barrier to recycling.

Participants in the survey were asked if they presently separate certain materials (newspaper, glass, aluminum cans, plastic pop bottles, tin cans, garden refuse, vegetable scrap) from their garbage (question #2, see figure 7). For newspaper, aluminum cans and plastic pop bottles, about 55 percent of the respondents indicated that they do presently separate and remove these materials from their garbage. Conversely, only 28.2 percent for tin cans and 34.1 percent of the respondents for glass presently separate and remove these materials from their garbage. These reduced numbers for tin and glass probably reflect the preparation time needed to clean and remove the labels from these containers. Clearly, the preparation time is a major factor in

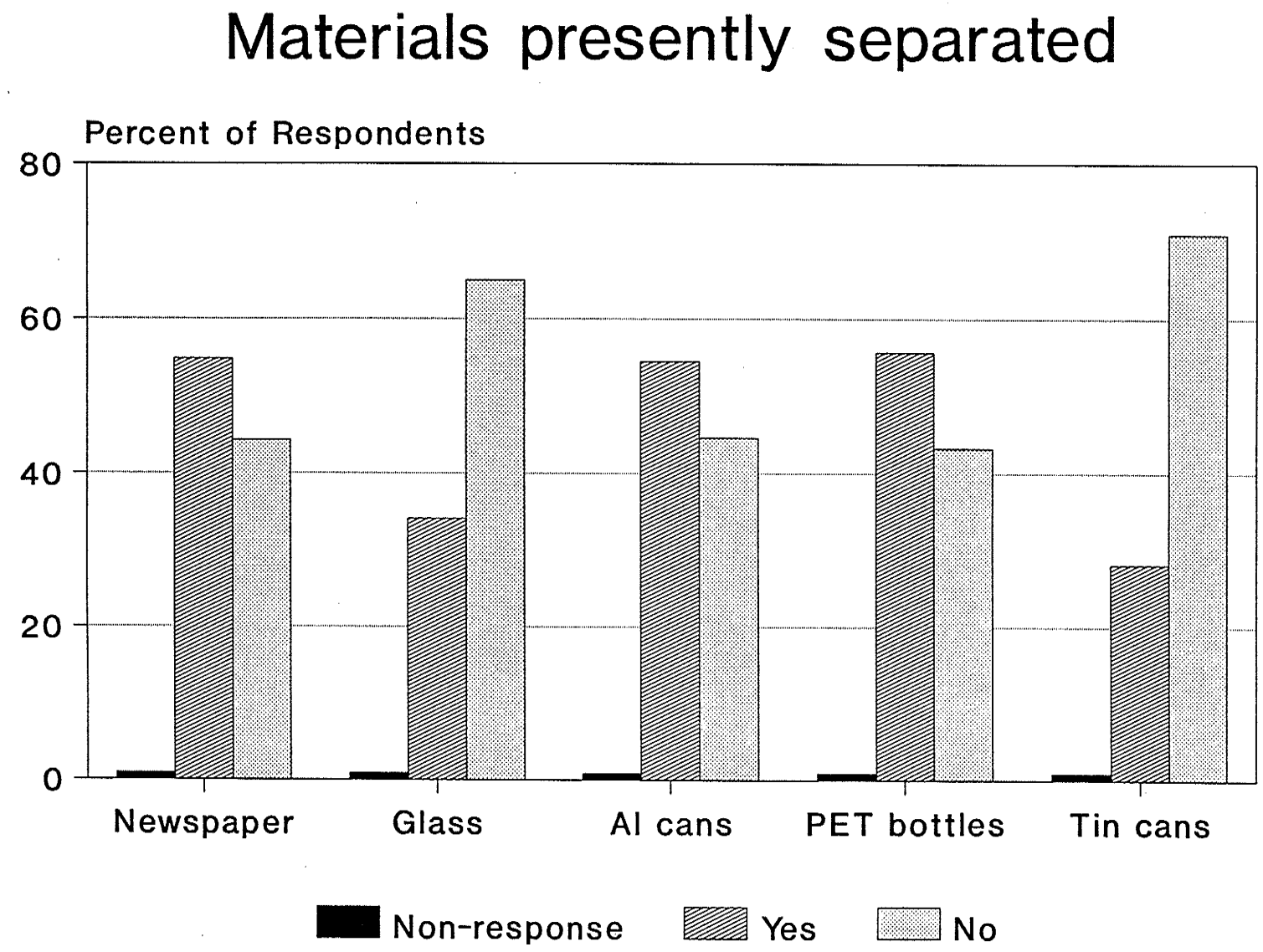

Materials presently separated
Percent of Respondents
80
60
40
20
0
Newspaper
Glass
Al cans
PET bottles
Tin cans
Non-response
Yes
No

Figure 7

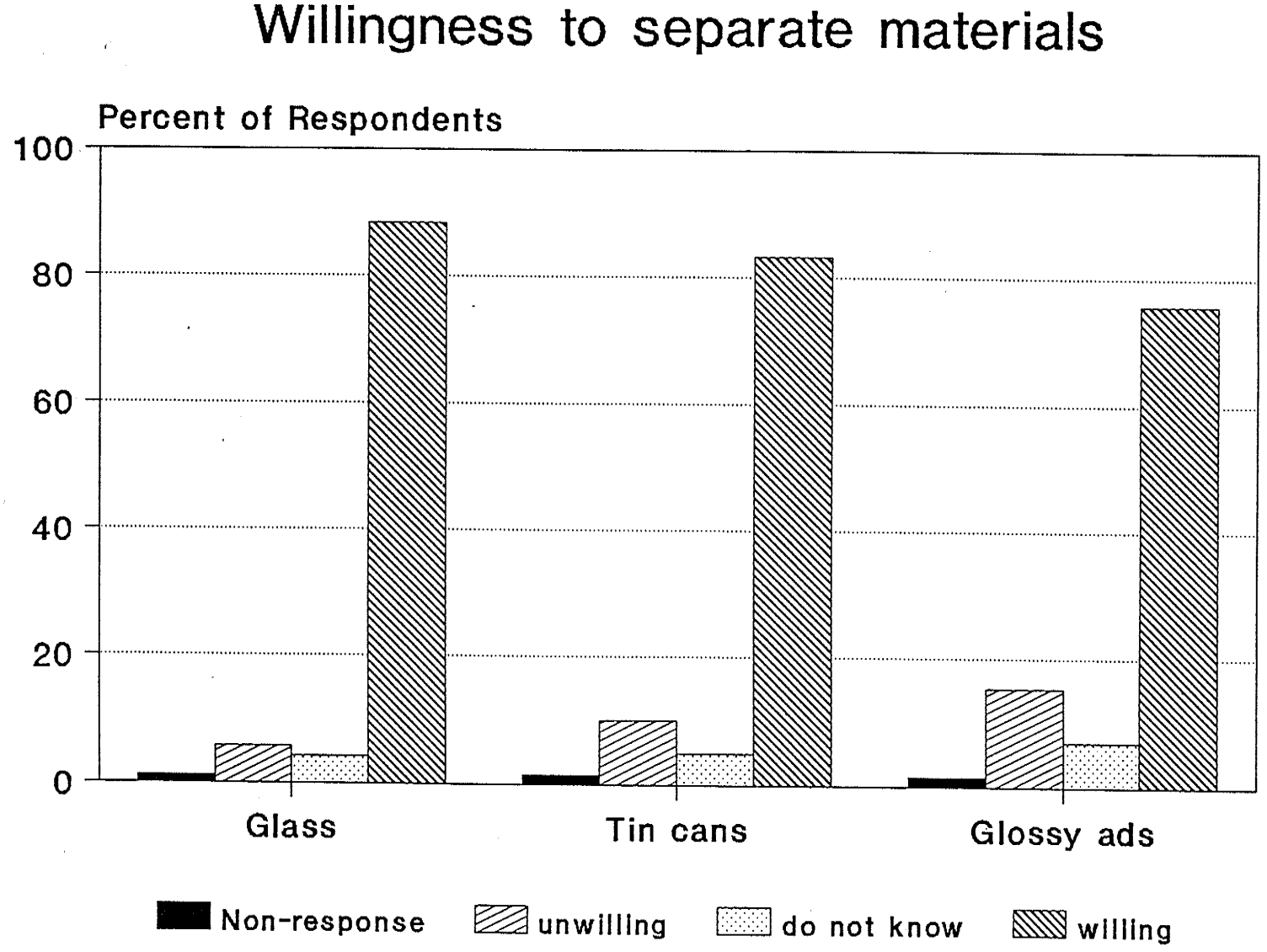

Willingness to separate materials
Percent of Respondents
100
80
60
40
20
0
Glass
Tin cans
Glossy ads
Non-response
unwilling
do not know
willing

Figure 8

separating these items from one's garbage to be recycled.

Another question (question #7) was asked to determine participants willingness to prepare tin cans, glass and plastic bottles and newspaper for recycling. The scale of willingness went from not willing through I don't know to very willing. The results are shown on the second following page in figure 8 with the two positive (somewhat willing and very willing) and two negative values (not willing and not very willing) collapsed and added together.

Clearly from figure 8, people are overwhelmingly willing to prepare tin cans, glass bottles and newspaper for recycling. One thing must, however, be kept in mind when looking at these results. People tend to say they will do things especially when it is perceived as a good thing to do, but when it comes down to doing less people will actually do the task. It is highly likely that if a city wide recycling program were started tomorrow, that not all of the people who say they would prepare tin cans would actually prepare them. Another possibility is that some people will prepare the materials early in any recycling program but once the enthusiasm has abated will no longer prepare the materials as often if not at all.

5.2.4 Monetary Issues:

Three questions were also asked concerning monetary issues with respect to funding recycling programs and a

reward or penalty method of encouraging recycling. The first question (question #10) asked was to determine if the respondents felt that encouragement of recycling should be done through monetary rewards or penalties. 43.3 percent of the respondents felt that there should be neither monetary rewards or monetary penalties to encourage or discourage recycling. 32.8 percent of the respondents on the other hand felt that there should be monetary rewards for people who recycle. Only 11.1 percent of the respondents were in favour of monetary penalties to encourage recycling. The data from this question indicates that no consensus exists for or against monetary rewards except that monetary penalties are not acceptable to the respondents to encourage recycling.

In the comments section of this question some of the people suggested both monetary rewards and monetary penalties. A classification category including this choice should have probably been included in this question.

Another question (question #12) asked was if a recycling program should be run with or without government support. Generally, the consensus was for a recycling program requiring no government support. 66.3 percent favoured a recycling program with no government support. 28.5 percent of the respondents did, however, approve of a recycling program run with government money.

Question #11 asked the residents to determine if they

would be willing to pay a 5 cent tax on certain goods to support a recycling program. The tax or deposit would then be returned when the items were brought to a recycling depot or centre. In looking at the entire sample who returned their surveys, most people (53.3%) who returned their survey were unwilling to pay a 5 cent tax. However, the response to not pay was not overwhelming. 43.7 percent were willing to pay a 5 cent recycling tax.

5.2.5 Other Recycling Issues:

Three other questions were also asked in the survey which address other general recycling issues. The respondents were asked which method of collecting their recyclables they preferred (question #9). The preference among the respondents was for a home collection service of recyclables. 63.2 percent of the respondents preferred this method. 26.6 percent preferred drop-off depots while only 3.7 percent preferred separation at a transfer point. One difficulty which may have been encountered with this question is that the respondents may not have understood exactly what a transfer point is. The fact that some individuals may not have understood completely is ,however, not expected to alter the results significantly. While the preference for home collection was slightly higher (64.8 percent) in the second mail-out of the survey than the initial mail-out (62.7 percent), this is not, however, a

significant difference.

Another question (question #6) was asked of the respondents to answer how valuable to them personally a recycling program was. A total of 66.0 percent of the respondents replied that a recycling program was either somewhat valuable or very valuable with 21.7 percent answering "I don't know" and 9.3 percent replying negatively. A positive answer was received from two-thirds of the respondents.

The final question (question #13) on the survey asked respondents to say how quickly they feel a recycling program should be started. The overwhelming response (77.4%) for this question is that a recycling program should be started immediately. 18.9 percent of the respondents felt that it should be started some time in the future. Some of these people who felt that a recycling program should be started some time in the future added comments emphasizing that planning must be done before a recycling program is started. Only 1.2 percent of the respondents felt that a recycling program should never be started or started a long time in the future. Clearly Winnipeggers think that a city-wide recycling program should be started.

5.2.6 Investigations into non-response:

The second set of surveys which was mailed out included a more insistent cover letter to attempt to get the initial

non-respondents to respond. Chances are the people who responded to the first mail-out right away are enthusiastic about recycling and do a lot of it already. Similarly, those people who do not respond right away but respond after the second mail-out are probably not as enthusiastic about recycling. Comparing the results of the first mail-out with the results of the second mail-out may give us possible clues to how the people who did not reply to the survey may have answered. One must not forget that my response rate was 64.6% which means that a full one-third of my sample did not respond. How the one-third of my sample who did not respond to my survey would have answered or felt about recycling would have a definite effect on the success of any recycling program in the city.

Most of the results for each question from both the first mail-out of 500 (252 were returned) and the second mail-out of 240 (71 returned) are similar. However, some of the results for particular questions are dissimilar and may show possible trends of the non-respondents. These trends will be discussed below.

5.2.6.1 Participation in Recycling:

In comparing the results of the number of people who have participated in a curbside or drop-off recycling program in the past 5 years, a slight drop is seen in the number of people who brought some goods to a drop-off depot

in the second set of (second mail-out of 71 surveys returned). Only 38.0 percent (27 of 71) of the people dropped their items off at a drop-off depot compared to 50.8 percent (128 of 252) in the initial mail-out. Similarly, a drop in the number of people who took their recyclables to a scrap metal company was seen. The percentages dropped from 23.4 percent (59 of 252) in the first mail-out to 15.5 percent (11 of 71) in the second mail-out. These slight drop-offs may indicate the decrease in enthusiasm towards recycling by the people who responded to the second mail-out. The people who replied to the surveys right away would be more interested in the topic of recycling and those who would have waited would have had other things to do and would not be as excited or interested in filling out a survey. This lack of excitement in the topic is reflected in their percentage decrease in going out of their way and dropping items off at a drop-off depot or a scrap metal company.

5.2.6.2 Problems:

In comparing the preferred depot location of the two mail-outs, the second mail-out respondents have a much a higher preference for a depot at the shopping center than the respondents from the first mail-out (shopping center was ranked first by 53.5% from second mail-out to 38.0% from first mail-out). The respondents from the first mail-out

also seem to equally prefer a depot within 6 city blocks to one at the shopping centre. An almost equal number of people ranked a depot within 6 city blocks (39.7%) as their number one choice as the number of people who chose a depot at the shopping center (38.0%) as a number one choice. No obvious trend is seen here except that if the non-respondents feel similarly to the way the second mail-out feels, then a depot at the local shopping centre would be the first choice of the sample as a whole.

5.2.6.3 Separation & Preparation Willingness:

There is an increased unwillingness to prepare glass, tin cans and newspaper for collection and recycling. A definite increase in unwillingness to prepare occurs when comparing the first mail-out to the second mail-out . Unwillingness to prepare the items increases from 13.9 percent to 21.1 percent for newspaper, from 9.2 percent to 14.0 percent for tin and metal containers and from 4.8 percent to 9.8 percent for glass. Along with this, there is a decreased willingness to prepare the materials for recyclables. From 77.8 percent to 69.1 percent for newspaper, from 84.2 percent to 80.3 percent for tin cans and form 89.7 percent to 84.5 percent for glass were the decreases in willingness to prepare the goods for recycling (from the first mail-out to the second mail-out). Clearly, the shift is towards less willingness (or more

unwillingness) to prepare the items. If the people who did not respond to the survey at all continue this trend then it may be that only about 65 - 75 percent of the 500 people may be willing to prepare the items for recycling.

5.2.6.4 Monetary Issues:

The difference between those respondents supporting the 5 cent tax and those not supporting it is somewhat greater in the surveys returned after the second mail-out. Of the 71 returned, 60.6 percent were against a 5 cent tax while 36.6 percent were in support of it. The results from the first mail-out were as follows; 51.2 percent were against and 45.6 percent were in support. Clearly the trend from the first mail-out to the second mail-out is one of increasing pessimism regarding the 5 cent tax. This could possibly illustrate how the non-respondents may feel regarding the 5 cent tax. If the increasing pessimism continues or the non-respondents at least have the same views as the second mail-out, then the overall trend is probably about a 60 against - 40 for re the 5 cent recycling tax.

5.2.6.5 Other Recycling Issues:

Very little difference is seen in the answers between the two mail-outs in the preferred method of collection. Curbside is preferred in both sets by about 60 percent of

the respondents to about 27 percent who prefer drop-off depots. The valuableness of a recycling program to each person decreased from the first mail-out to the second mail-out (68.7% to 56.3% considered a recycling program valuable). However, most of the shift went from considering a recycling program valuable to not knowing and being unsure how valuable they considered a recycling program to be (19.4% to 29.6% did not know).

5.2.7 Demographics:

A group of demographic questions were also asked. The questions included year of birth, amount of education, rental or ownership of present home, number of people including children living in the house, occupation and income level. The age of the respondents of the survey were analyzed and compared to Winnipeg demographics according to the 1986 Census of Canada (Statistics Canada, 1990). The comparison is made to simply determine the composition of the respondents by age and to determine if it is a representative sample.

Age group	1986		survey	
	freq.	%	freq.	%
20 - 24	60,280	13.3	4	1.2
25 - 34	114,105	25.2	66	20.4
35 - 44	86,240	19.0	82	25.4
45 - 54	59,015	13.0	61	18.9
55 - 64	58,285	12.9	48	14.9
65 - 74	45,000	9.9	35	10.8
75 +	30,530	6.7	27	8.4

The comparison of ages between the 1986 Census and the survey indicate that the survey has a larger representation of people aged between 35 and 54 than is present in the general population. The difference in age profiles is possibly evident because the 1986 Census data is the age groups of the general population while the survey just includes households. The belief may exist that a certain amount of money must be earned before a house can be lived in by the survey respondents. Therefore, the people in the younger age categories would be under-represented and the people in the older age categories would be over-represented. The education and income demographics data is also shown below with comparison to the 1986 census data. The second percent column below is simply the percentage of respondents in each category not including the missing values category.

Amount of Education	survey		
	freq.	%	%
missing values	8	2.5	-
Elementary	15	4.0	4.8
Junior High	13	4.0	4.1
Some High School	35	10.8	11.1
High School Graduation	58	18.0	18.4
Some Technical/Community College	63	19.5	20.0
Some University	43	13.3	13.7
University Graduation	88	27.2	27.9

Amount of Education	1986 census	
	freq.	%
Less than Grade 9	65,775	13.4
Grades 9-13		
-without graduation	154,650	31.4
-with graduation	49,315	10.0
Trade certificate or diploma	10,885	2.2
other non-university education		
-without certificate	30,275	6.1
-with certificate	67,335	13.7
University (without degree)	58,650	11.9
(with degree)	55,450	11.3

Comparing the education demographic data between the survey and the 1986 Census is difficult to do because the education types are grouped differently. In the 1986 Census data, the education profile is for all people over 15 years of age while my survey only surveyed people over 18 years. It is difficult to compare the data because of these differences. However, it is evident by looking at the education profile that the survey was filled out by a higher number of people who had a University education. This is probably a result of the sample which I chose to survey. Since most people who would be earning a significant amount of money would live in a house, and of these people probably a good portion have a university education.

Total Family income	1986		survey		
	freq.	%	freq.	%	%
missing values	-	-	44	13.6	-
Less than $10,000	11,870	7.7	9	2.8	3.2
$10,000 - $20,000	25,165	16.3	31	9.6	11.1
$20,001 - $35,000	46,035	29.7	56	17.3	20.0
$35,001 - $50,000	41,845	27.0	72	22.3	25.8
Over $50,000	39,905	25.8	111	34.4	39.8

In comparing the total annual family incomes of the survey respondents to the 1986 Census data, the survey has a higher proportion of families earning over $50,000 per year than the general population according to the 1986 Census. At the same time the percentage of respondents whose family income is less than $50,000 is less than the demographic data from the 1986 census. Unfortunately, 44 of the survey respondents chose to not answer this question and we do not know the true profile of our respondents. However, people may not have responded to this question for a variety of reasons; 1) Fear of the information being used incorrectly and non-confidentially. 2) None of my business how much they make, whether it is a lot a little bit 3) They simply feel it is not required for my survey. Other reasons for not filling out this question on the survey also undoubtedly exist. My survey does have some built-in bias because it was sent only to households and the households were selected from the phone book. Families who could not afford a phone would have been excluded from the study, biasing it towards

higher income families. Unlisted numbers were also not included in the survey. It is ,however, not possible to say which type of family according to income, have unlisted numbers. Another bias which may increase the number of higher income respondents is that only households were selected. The perception may exist with families that to rent or own a house requires a certain amount of money. As a result lower income families may wait until they reach a certain income bracket before they rent or buy a house. This perception would increase the number of higher income families in my survey. However, the target population for my survey was households.

5.2.8 Misinterpretation of Questions:

Taking high non-response rates as indicators of misinterpretation, three of the questions in the survey may have been misinterpreted. Question #4 ii), question #8 and question #9 may all have been misinterpreted. In Question 4 ii), respondents may have thought that they were supposed to make a choice between curbside and drop-off rather than simply a choice between willing to do the action or not willing to do the action. Question 8 had a high non-response rate because instead of ranking their choice for a drop-off depot from 1 to 4, they would check off 1 choice or just rank their two choices as 1 and 2. In Question 9, what was meant by a transfer point may have been unclear to some

of the respondents.

Originally, a pilot study was to be held but because of time constraints and the need to get the survey out as quickly as possible, only a very small number of people were asked to look at the survey. Clearly, a pilot study should have been done and it may have picked up the misunderstandings in the survey.

5.2.9 Summary of Results:

1. 48.0 percent of the respondents had used a drop-off depot in the past 5 years.

2. 18.0 percent of the respondents had participated in a curbside recycling program in the past 5 years.

3. About 80.0 percent of the respondents were willing to save and separate newspaper, glass, aluminum cans, plastic pop bottles and tin cans to be collected in a curbside recycling program.

4. About 40.0 percent of the respondents were willing to save and separate newspaper, glass, aluminum cans, plastic pop bottles and tin cans to be collected in a drop-off depot program.

5. About 35 percent of the respondents indicated that the most common complaint was that there was no place to take the recyclables. The second most common complaint as indicated by 19.3 percent of the respondents was that they do not use enough of the goods to make it worthwhile for

them to recycle.

6. A depot at the local shopping center was ranked as the number 1 choice location for a drop-off depot by 41.5 percent of the respondents.

7. 82.6 percent of the respondent indicated positively that they would be willing to prepare newspaper, glass, and tin cans for recycling.

8. 66.3 percent of the respondents favoured a recycling program run without any government support.

9. 63.2 percent of the respondent preferred home collection or curbside collection service while 26.6 percent of the respondents preferred drop-off depot collection program for recyclables.

5.3 Conclusions:

The most preferred method of collection was home curbside collection favoured by 63.2 percent of the respondents. 26.6 percent favoured drop-off depot collection and the site ranked the most preferable most often for a drop-off depot was a shopping centre. The survey results will now be integrated with discussion from the two previous chapters and used to discuss relevant participation rates for curbside and drop-off depots for the City of Winnipeg.

CHAPTER 6

RECYCLING IN WINNIPEG

6.1 Introduction:

In this chapter, the amount tin cans generated in the City of Winnipeg will be tied together with possible participation rates and costs of operation of recycling programs to attempt to generate a City of Winnipeg scenario. This scenario will attempt to depict the costs and revenues that might be expected in a tin can recycling program in the City of Winnipeg. The analysis will look at both drop-off and curbside recycling programs. However, the composition of tin cans in the waste stream is also a crucial piece of information to determine. This is what will be done first.

6.2 Tin Cans Generated and Collected:

In determining the number of cans generated in the City of Winnipeg, one of the most important numbers to have is the percentage of the waste stream which consists of tin cans.

6.2.1 Waste Composition:

The composition of the residential and/or municipal waste stream is one of the most important figures to have in determining the amount of recyclables that can potentially be collected. However, there is much confusion respecting the various terms of general municipal refuse, municipal

solid waste, domestic solid waste and others. Many of the terms are very rarely defined to illustrate the context in which they are discussed. Many types of waste categories exist - residential, commercial, industrial, medical, sludge, construction and demolition debris. These terms should be defined in the context of their use. For example, municipal solid waste can mean residential waste (waste generated by residences) in some cities while it can mean the entire town's or city's waste generated by the residential, commercial and industrial sectors in these towns or cities. In researching some of the data for the City of Winnipeg, some terms were not defined but I have attempted to determine what the waste type is.

Various studies have been done of the composition of waste in the waste streams of Canada's cities. The landmark study in Canada was done in 1978 by Bird & Hale. Two recent reports , one by Speers & Associates and another by M.M. Dillon, had waste composition stream figures for the City of Winnipeg based on the Bird & Hale results. Unfortunately, many of the waste composition studies that have been done are old and possibly out of date or, of the ones done recently, lack information. Another difficulty with many of the waste composition studies is that the wastes are broken down into components such as metal but are not then further broken down. For these studies to be of much use to recycling, the waste composition studies must be broken down

into further categories - for example not just metals but ferrous metals and non-ferrous metals and not just ferrous metals but tin and steel cans and other ferrous scrap. To determine the composition of the waste stream for tin cans is extremely difficult to do. Most of the waste composition studies include categories for ferrous and nonferrous scrap but have no information detailing the composition of tin and steel beverage cans within the ferrous scrap category.

One of the studies done in the City of Edmonton in 1976 found a municipal waste stream (predominantly inorganic and combustible residential waste collected from the residences) composed of the following: 44.5% paper, 2.6% wood, 9.8% cardboard, 17.1% grass, 5.9% plastic, 2.5%cloth, 1.4% foodstuff, 11.6% miscellaneous or inert material and 5.6% metal (Edmonton, May 1978). The metal constituent consists of both ferrous and nonferrous waste. The City of Edmonton study also states that about 88% of the metal constituent of the waste stream or 4.9% of the total municipal (residential) waste stream is ferrous metal. The ferrous scrap portion consists mainly of steel, bimetal and/or "tin" cans (Edmonton, 1978). The ferrous scrap waste stream consists primarily of two types of containers, food tin cans and bi-metal beverage cans. However, the individual proportions of these cans are not known in the waste stream. Clearly the ratio of food containers (tin cans) to beverage containers is an important figure to have to determine the

composition of tin cans in the waste stream.

A study conducted in 1989 by Edward A. Speers & Associates for the Recycling Council of Manitoba also explored the issue of the composition of the municipal (residential) waste stream. Their waste composition stream, which includes the total amount of waste landfilled in Winnipeg in 1988, is shown below. Their waste composition is adapted from a Bird & Hale report in 1978.

Table 6

ESTIMATED AMOUNT AND COMPOSITION OF WASTE LANDFILLED IN WINNIPEG (1988)

Material	Average Composition (%)	Total Amount Generated (tonnes)
Total	99.99	566,337
Paper	41.13	232,934
Glass	5.63	31,885
Metal	5.93	33,584
Plastic	5.24	29,676
Textiles, Leather, Rubber	4.30	24,352
Wood	4.33	24,522
Putrescible	21.97	124,424
Yard Waste	7.70	43,608
Other	3.70	21,351

Source: Speers and Associates, Waste Product Recycling in Manitoba, 1989.

The most recent waste composition breakdown of the City of Winnipeg was in a Winnipeg Waste Minimization Study completed in June 1990 for the City of Winnipeg Waterworks, Waste and Disposal Department by M. M. Dillon Limited. Once again, they adapt the Bird & Hale study of 1978 to the City

Table 7

COMPOSITION OF GENERAL MUNICIPAL REFUSE IN MANITOBA

	% WEIGHT	ESTIMATED WINNIPEG RESIDENTIAL/COMMERCIAL IN TONNES/1989*
PAPER	38.76	98 400
Kraft Paper and Corrugated Cardboard	9.23	23 400
Newsprint	9.69	24 600
Fine Paper	7.13	18 100
Other Paper	12.71	32 300
GLASS	5.19	13 200
Beer Containers	0.05	100
Reusable Soft Drink	0.08	200
Non-reusable Soft Drink	0.33	800
Liquor and Wine	1.59	4 100
Containers - Food	1.74	4 400
Containers - Other	0.40	1 000
Flat and Cullet	1.00	2 600
FERROUS METALS	4.37	11 100
Food Cans	1.97	5 000
Other	2.40	6 100
NONFERROUS METALS	1.28	3 300
Aluminum Beverage Cans	1.21	3 100
Other Aluminum	0.04	100
Other	0.03	100
PLASTICS	4.03	10 200
Containers	1.03	2 600
Sheet Film/Other	3.00	7 600
OTHERS		
Ceramics Rubble	0.97	2 500
Lumber	3.92	10 000
Putrescible	23.92	60 700
Textiles/Leather/Rubber	5.16	13 100
Yard Wastes, Brush	10.89	27 700
Other Fines	1.08	2 700
Petroleum/Chemical Mix	0.43	1 100
TOTAL	100%	254 000**

* Modified from:
Bird and Hale Ltd., 1978, "Municipal Refuse Statistics for Canadian Communities over 100,000 (1976-1977)," Environment Protection Service, Environment Canada.

** This figure is 40 percent of the total 1989 waste generation amount (634 000).

of Winnipeg in 1990. The waste generated in the city is split 40 percent Residential and 60 percent Industrial based on the City records (Dillon, 1990). Their results for the composition of general municipal (residential) refuse and the projected annual quantities of the residential waste stream for Winnipeg in 1989 are shown in Table 7. Dillon states that the wastes studied under the Bird & Hale report falls under the classification of wastes in Winnipeg that is collected from residences by the city and by contract workers.

As can be seen in comparing this table to the table from Speers & Associates, there is a significant difference between the two estimates of the composition of Winnipeg's waste stream. In Bird & Hale, 1978, a waste composition study for Canada and various regions was done. The breakdown of the national waste composition stream is shown.

Table 8

NATIONAL WASTE COMPOSITION STREAM

Material	Average Composition (%)
Total	100.00
Paper	36.45
Glass	6.61
Metal	6.63
Plastic	4.65
Textiles, Leather, Rubber	4.26
Wood	4.18
Putrescible	27.59
Yard Waste	6.09
Other	3.54

Source: Bird & Hale Ltd. 1978.

In 1990, 624,728 tonnes of refuse were landfilled in the City of Winnipeg landfills. This was composed of 196,017 tonnes of residential refuse collected and hauled by the city and contractors, 372,882 tonnes of commercial/industrial refuse and 55,829 tonnes of residential disposals (individuals bringing in and dropping off their own garbage). Bird & Hale in 1978 state that "general municipal refuse is defined as residential, commercial and housekeeping wastes from industries. Wastes excluded from the survey because they tend to be much more site specific and thus not amenable to random sampling are industrial processing wastes, construction and demolition wastes, street sweepings and park landscaping wastes, scrap automobiles and sewage sludge.". This definition of general municipal refuse includes the 251,846 tonnes of residential refuse, drop-off and hauled, (55,829 tonnes of residential disposals and 196,017 tonnes of residential refuse collected and hauled by the city and contractors) that was landfilled in 1990.

The estimated composition of the 1990 City of Winnipeg municipal (residential) waste stream according to Dillon is shown in Table 9. Table 9 differs from Table 7 in that Table 9 is for the year 1990 and Table 7 is for the year 1989.

Table 9: COMPOSITION OF GENERAL MUNICIPAL REFUSE IN WINNIPEG (1990)

Material	Average Composition (%)	Total Amount Generated (tonnes)
Total	100.00	251,846
Paper	38.76	97,616
Glass	5.19	13,070
Ferrous Metals	4.37	11,006
Nonferrous Metals	1.28	3,224
Plastics	4.03	10,149
Textiles/Rubber	5.16	12,995
Lumber	3.92	9,872
Putrescible	23.92	60,242
Yard Wastes, Brush	10.89	27,426
Other	2.48	6,246

Source: Adapted from M. M. Dillon

In both the Speers and Dillon reports, the authors adapted the Bird & Hale report. In comparing the composition of ferrous scrap in all three waste composition studies, it varies from 4.37 percent (Dillon), 6.06 percent (Bird & Hale) to 5.93 (Speers). In the Dillon report, food cans form about 45 percent of the ferrous scrap waste stream or 1.97 percent of the total residential waste stream. Other studies have placed the composition of tin cans in the waste stream from 2 to 4 percent (municipal waste stream by weight) (Crawford, 1991) to 2 to 3 percent by weight of municipal waste stream (entire communities waste) (5 to 6 percent of residential waste stream) (Apotheker & Marksthaler, 1986). In the analysis of costs and revenues in this chapter, tin cans will be assumed to be 1.97 percent of the residential waste stream as Dillon has shown.

Another waste composition study was completed in 1991 for the Waste Management Branch of the Ontario Ministry of the Environment by Gore & Storie Ltd. This was an investigation into the composition of the waste streams of three municipalities, the Town of Fergus (population 6,757); The Borough of East York (population 101,085); and The City of North Bay (population 51,313). The results of this study are shown in Table 10 on the next page. As can be seen from Table 10, food containers make up anywhere from 1.91% (Fergus) to 2.37% (East York) to 3.62% (North Bay) of the total waste stream. Tin cans (i.e. ferrous soft drink containers and food containers) make up 2.95% (Fergus), 2.00% (East York) and 4.39% (North Bay) of the waste streams in their respective communities. Tin cans in this practicum, as defined by their categories would either be food containers or both the food containers and the ferrous soft drink containers. One of the many difficulties in comparing waste composition studies and adapting waste composition studies for use in other documents and reports is that the categories being used are usually not defined or grouped in the same manner. For example, are tin cans as used in this practicum identical to food containers as used in the Ontario Ministry of the Environment study or should ferrous soft drink containers be included. The results of Ontario study are included here simply for comparison and will not be used in the analysis

TABLE 10: ESTIMATED AVERAGE WASTE COMPOSITION FOR THE TOWN OF FERGUS, BOROUGH OF EAST YORK, AND THE CITY OF NORTH BAY

	Fergus			East York			North Bay	
	Percent Composition: Regular Waste and Blue Box	Percent Composition: Combined Waste Streams	Per Capita Generation (kg/cap/day) Combined Waste Streams	Percent Composition: Regular Waste and Blue Box	Percent Composition: Combined Waste Streams	Per Capita Generation (kg/cap/day) Combined Waste Streams	Percent Composition: Total Waste Stream	Per Capita Generation (kg/cap/day) Total Waste Stream
(1) Paper (a) Newsprint	5.21%	10.26%	0.083	13.11%	18.99%	0.166	10.53%	0.096
(b) Fine Paper / CPO / Ledger	1.87%	1.87%	0.015	1.65%	1.65%	0.016	1.76%	0.016
(c) Magazines / Flyers	4.22%	4.22%	0.034	4.71%	4.71%	0.046	3.14%	0.029
(d) Waxed / Plastic / Mixed	2.08%	2.08%	0.017	2.37%	2.37%	0.023	2.11%	0.020
(e) Boxboard	5.00%	5.00%	0.040	4.03%	4.03%	0.040	4.24%	0.040
(17) BLUE BOX ITEMS (a) Newsprint	5.08%	- N/A -	- N/A -	5.87%	- N/A -	- N/A -	- N/A -	- N/A -
(b) Liquor / Wine Bottles	1.00%	- N/A -	- N/A -	0.59%	- N/A -	- N/A -	- N/A -	- N/A -
(c) Food Jars / Other Bottles	1.30%	- N/A -	- N/A -	0.58%	- N/A -	- N/A -	- N/A -	- N/A -
(d) Food Cans (i) ferrous	0.55%	- N/A -	- N/A -	0.37%	- N/A -	- N/A -	- N/A -	- N/A -
(ii) non-ferrous	0.11%	- N/A -	- N/A -	0.00%	- N/A -	- N/A -	- N/A -	- N/A -
(e) Beer Cans (i) ferrous	0.02%	- N/A -	- N/A -	0.00%	- N/A -	- N/A -	- N/A -	- N/A -
(ii) non-ferrous	0.04%	- N/A -	- N/A -	0.01%	- N/A -	- N/A -	- N/A -	- N/A -
(iii) American	0.01%	- N/A -	- N/A -	0.00%	- N/A -	- N/A -	- N/A -	- N/A -
(f) Pop Cans (i) ferrous	0.16%	- N/A -	- N/A -	0.04%	- N/A -	- N/A -	- N/A -	- N/A -
(ii) non-ferrous	0.23%	- N/A -	- N/A -	0.11%	- N/A -	- N/A -	- N/A -	- N/A -
(g) PET Bottles	0.09%	- N/A -	- N/A -	0.01%	- N/A -	- N/A -	- N/A -	- N/A -
(h) Plastic Jugs	- N/A -	- N/A -	- N/A -	0.09%	- N/A -	- N/A -	- N/A -	- N/A -
(i) OCC	- N/A -	- N/A -	- N/A -	0.07%	- N/A -	- N/A -	- N/A -	- N/A -
SUBTOTAL (for Category)	8.59%	- N/A -	- N/A -	7.74%	- N/A -	- N/A -	- N/A -	- N/A -

* Percent composition of each component is calculated using a "weighted average" of all EAs sampled in the respective municipality. Therefore the percent composition for a municipality may not sum to 100%

** Percent composition of Blue Box materials are calculated using the bi-weekly put-out rate as described in Section 2.2.4.2

of the waste stream of the City of Winnipeg. Other waste composition studies which have recently been done in Ontario include Perks (1988), Recycling Advisory Committee (1989), Green Cone Inc. (1989), OMMRI - II (1990), City of Guelph (1990) and SWEAP (1990). These studies are fully referenced in the bibliography. All of the waste composition information from the above studies can be seen and compared to each other in the Ontario Waste Composition Study mentioned above (Gore & Storie, 1991).

6.2.2 Technology Changes and the Tin Can:

The use of the tin can in society will undergo trends and increase and/or decrease in use. Recently in Ontario, Coca-Cola has recently switched from aluminum cans to tin cans for its beverage drinks. Tin cans are easier to separate for recycling programs than aluminum cans because a magnet can simply pull them out. Aluminum ,on the other hand, must be hand picked (Morgan, pers. comm.). Tin cans are also cheaper than aluminum cans and represent a savings in production of the container to hold the drink. This trend of switching from aluminum to tin cans may or may not be continuing in the future. The ease of recyclability of the tin can is one reason why tin cans may be chosen over aluminum cans.

However, the future of the tin can may be in doubt. Dofasco is in the midst of attempting to promote a new type

of steel can. Dofasco has the North American rights to a 2 piece steel can which instead of using a tin and lacquer coating for corrosion resistance uses chrome and plastic layers to provide corrosion protection. Dofasco says that the plastic layer that would be used would likely consist of some sort of polypropylene or polyethylene material. They also believe that this coating is environmentally friendlier than the lacquered coating of polyvinylchloride (PVC). They also claim that the new plastic coating would protect the steel can and the contents from corrosion better because there are virtually no failures in the plastic coating. Dofasco also states that the operating costs of producing this steel can would decrease compared to present operating costs of tin cans because a cheaper steel can be used in the process and the plastic is cheaper than the tin. While the capital costs would increase initially because of having to switch over and buy new equipment, the operating costs would decrease (Greenfield, pers. comm.). Presently, however the new type of steel can is just being promoted and is not currently in production. However, increasingly the trend in tin cans has been to reduce the amount of tin being used. This trend will likely continue with the possible substitution of other materials to replace tin.

6.3 Curbside Programs:

According to the literature search and surveys done in

chapter 2, the average participation rate in voluntary curbside programs was 48.6% (for 109 programs) (Folz & Hazlett, 1990). In another study of 13 voluntary curbside programs, the average participation rate was 54.5 percent (Biocycle, 1990a). In a study of mandatory curbside programs, the average participation rate was 74.3 percent (Folz & Hazlett, 1990). One of the participation rates which we will use will be the average voluntary and mandatory participation rates as shown above.

Another participation rate can be pulled from the survey of Winnipeg residents that was done. A participation rate for curbside recycling program of about 75 percent can be assumed from question 4, the willingness to separate and save the materials to be recycled in curbside recycling program.

The 1990 landfilled figures of residential waste of 251,846 tonnes includes waste collected from residential waste both dropped off by residential citizens and hauled by the city and contractors. In any curbside program, only the waste that is hauled and collected by the city would be accessible to curbside collection. The residential waste that is dropped off at the landfill would still be taken there. Clearly, the residences that drop-off their refuse will continue to do so. If they are not serviced by garbage collection, then they will not, in this study, be serviced by curbside collection. The amount of waste that the

curbside collection program has access to is 196,017 tonnes. With tin cans composing 1.97 percent of the residential waste stream, the amount of tin cans that can be collected in the city can be calculated. However, any curbside collection program would collect only from households and not from apartment buildings. Households comprise 141,355/236,325 = 59.8 percent (Statistics Canada, 1988) of the supply of tin cans in the city. Of the 3,862 tonnes of tin cans in the residential waste stream, 2,309 tonnes of tin cans would be in the waste stream of the households.

# of tin cans that could be collected

Voluntary avg participation	48.6%	1,122 tonnes
Mandatory avg participation	74.3%	1,716 tonnes
avg participation from survey	75.0%	1,732 tonnes

An upper and lower bound for the number of tin cans which can be collected in a curbside recycling program per year will be taken from this table. By taking two numbers, an upper and a lower bound, the analysis will be able to determine if recycling is feasible given the best and worst possible participation rate. The upper bound is 1,732 tonnes. The lower bound is 1,122 tonnes.

The best market for the tin can scrap from investigations done in Chapter 4 is scrap metal companies in the City of Winnipeg. The tin cans collected could be sold for a market price in Winnipeg anywhere between about $22.40-$39.20/tonne depending on market demand for steel and

the state of the economy. The figure of $22.40/tonne is the lowest price that could have been received at the time of the last market survey, September 24, 1991. The figure of $39.20/tonne is the highest that could have been received. The revenue received from selling the quantity of tin cans calculated above is shown.

Price received for tin cans	$22.4/tonne	$39.20/tonne
Lower bound - 1,122 tonnes	$25,133	$43,982
Upper bound - 1,732 tonnes	$38,797	$67,894

Avoided costs may also play a part in this analysis. However, since the City of Winnipeg landfills are publicly owned, the avoided costs are not simply equal to the tipping fees. If the amount of waste landfilled each year by the city decreases then the cost of operating the landfill will also decrease. The City of Winnipeg will save money if waste is recycled and diverted from the landfill. The amount of money it saves is equal to the operating cost of the landfill times the tonnage of waste diverted. However, if the productivity of the workers goes down, then the operating cost per tonne of waste landfilled would go up. This would occur when the waste being diverted form the landfill is not of a large enough amount to merit reducing labour or equipment costs. While some savings such as fuel costs may result, they would probably not be significant. As long as the waste diverted does not make up a significant portion of the waste landfilled, then avoided costs savings

will probably not result, the workers productivity will decrease and the operating cost per tonne of the landfill will increase.

At the upper bound of 1,732 tonnes, this constitutes less than 1 percent of the total waste going into the landfill. Clearly this is not a significant amount and would not result in any avoided costs in operation of the landfill.

6.3.1 Costs:

The City of Edmonton has a city-wide curbside recycling program. About half the city is serviced by the Edmonton Recycling Society (ERS) and the other half is serviced by Browning Ferris Industries (BFI). As of January 1991, the recycling program served 134,470 households. Their recycling program collects all types of glass, metals, plastic soft drink containers, newsprint, cardboard, all plastic, magazines and cardboard milk containers in 5 compartments. Aluminum cans and tin cans are collected commingly and then separated using magnetic separation (Fiegel, per. comm.). Their total cost of recycling ranges from $2.87 for BFI to $3.34 per household per month for ERS in 1990. ($34.44 to $40.08 per household per year) (Fiegel, pers. comm.). The cost of collection of recyclables in the City of Edmonton in 1989 ranged from $1.64 to $2.20 per household per month (Dillon, 1990). The total costs of the

Edmonton program run roughly around 5.5 million dollars (Fiegel, pers. comm.).

The comparative costs of refuse collection in the cities of Winnipeg and Edmonton can yield some interesting information regarding comparative costs of recycling in the two cities. In the City of Edmonton, refuse collection averages $39.57 per household per year (not including disposal costs) or $45.37 per tonne for 1990 (50% of the waste is contracted and 50% is collected by the city). In the City of Winnipeg, the costs of garbage collection averaged $50.83 per household (not including disposal costs) per year ($58.14 per household for the city and $39.87 per household for contractors) or $55.84 per tonne ($65.82 per tonne for the city and $40.86 per tonne for the contractors) where 60 percent of the waste is collected by City of Winnipeg and 40 percent by contractors. The average cost of collection of residential waste in the City of Winnipeg is 28 percent more expensive than the costs of collecting residential refuse in City of Edmonton. Since the collection of garbage in the City of Winnipeg costs more than it costs Edmonton to collect its garbage, it follows that it would cost the City of Winnipeg more to collect its recyclables than it costs the City of Edmonton. The cost of collecting recyclables in the City of Winnipeg would range from $2.10 to $2.82 per household per month ($25.20 to

$33.84 per household per year). According to 1986 household figures of 141,355, the collection cost of a curbside recycling program in Winnipeg would range between $3,562,146 and $4,783,453. If processing and separation costs of recyclables is about the same in the two cities then the total cost of curbside recycling in the City of Winnipeg would be between $5,648,546 and $6,717,190 per year ($39.96 to $47.52 per household per year).

The processing equipment required specifically to separate the commingled tin cans and aluminum cans would be a magnetic separator conveyor. The commingled aluminum and tin cans would go on a conveyor belt and the magnet would pull the tin cans out either from above or from below. Tim-Tech industries of Trenton Ontario manufactures a magnetic separator conveyor that costs $13,500 + taxes = $15,390 (Can). With an expected lifetime of 10 years (Albert, per. comm.) an amortization replacement fund of $1,539 per year would be set up. If we assume utility and maintenance costs of $1,500 per year, magnetic separators are fairly inexpensive. Capital costs of $15,390 (including a hopper to load and unload the tin cans) and operating costs of about $3,000 per year are the net processing costs of tin can recycling.

The revenues calculated above range from $25,133 to $67,894. These revenues are all below the estimated collection and total costs for recycling calculated above.

The revenues can account for between less than 1 percent and 2 percent of the total cost of curbside recycling. However, the tin can revenues could cover the specific costs associated with processing of the tin cans. The operating costs are easily covered by the revenues brought in and the capital costs of the magnetic separator are also easily covered in one year of tin can collection and recycling. While the tin cans revenues do not come close to covering the total costs of recycling, other materials collected simultaneously would account for some of the rest of the total cost of recycling. The revenue figures calculated in this example do not include any other products which would be collected alongside tin cans if a city-wide curbside recycling program were begun. Aluminum cans, glass and plastic PET bottles, newspaper are possible other materials which could be collected and also generate revenue to support the recycling program. The total tonnage that would be diverted from the waste stream in recycling these items may also be of a significant quantity that avoided cost savings from decreased labour requirements at the landfill, decreased fleet size to collect general municipal refuse and other cost savings may also be reaped to improve the economics of the recycling situation. It is, however, also unrealistic to assume that the revenues from the sale of other recyclables will significantly cover the costs of recycling as most curbside programs costs are greater than

$200/tonne and the revenues are often in the neighborhood of $50/tonne (Dillon, 1990)

6.4 Drop-off Depots:

The average participation rate in drop-off depot recycling programs according to the literature search done in chapter 2 is 24.6 percent in a survey of 66 voluntary drop-off depot recycling programs (Folz & Hazlett, 1990). It is unclear if the participation rate mentioned here is a yearly, monthly or a weekly participation rate. We will ,however, assume that 24.6 percent of the households bring their recyclables semi-regularly (1/month to 4 times/year) to the depot to be recycled.

The Recycling Council of Manitoba has been operating three drop-off depots in three City of Winnipeg shopping malls for a year. Their calculated participation rate is approximately 9 percent for their first 6 months of operation (Recycling Council of Man., 1991).

If we have participation rates of 9 percent and 24.6 percent in a drop-off depot program the following amounts of tin cans can be collected. In the drop-off depot recycling program, the entire residential waste stream of 251,846 tonnes is available to be recycled as people who live in apartments can participate as well as people who live in households.

AMOUNT OF TIN CANS IN THE WASTE STREAM

1.97 %
4,961 tonnes

Participation Rates		
Average drop-off program	24.6 %	1,220 tonnes
Average RCM drop-off rate	9.0%	446 tonnes

If tin cans are 1.97 percent (4,961 tonnes) of the waste stream, then the participation possibilities of 9 percent and 24.6 percent yield tin can tonnages of 446 tonnes and 1220 tonnes respectively. Similarly to the curbside recycling analysis the table below shows the revenue received from selling the tin can scrap at $22.40/tonne and $39.20/tonne.

	lower bound 446 tonnes		upper bound 1220 tonnes	
Price per tonne	$22.40	$39.20	$22.40	$39.20
REVENUES	$9,990	$17,483	$27,328	$47,824

The drop-off depot program is assumed to be a set of 3-4 igloo or domelike containers which may or may not collect some materials commingled (tin cans and aluminum cans). The containers will be located throughout the city accessible 24 hours per day, 7 days a week. The materials from the drop-off depots will be collected by a collection truck and transported to a separation facility or shipped directly to the end market.

6.4.1 Costs:

Costs for a drop-off recycling program could potentially be the follows for the City of Winnipeg. Let us assume that 30 sites are located for drop-off depot use. This way a drop-off depot would exist for about every 20,000 residents.

i) Equipment & Transportation	
120 Depot containers: @ $1,000	$120,000
Amortization period (10 years)	$12,000
32 hrs per week @ $60/hr.	$99,840
SUBTOTAL 1 :	$231,840
ii) Advertising & Education	
$1,500 per month -pamphlets, advertising and other educational material	$18,000
iii) Labour	
Drop-off program coordinator @	$35,000
iv) Administration Costs	
Facility supplies	$10,000
Insurance	$ 5,000
Miscellaneous	$20,000
SUBTOTAL 2	$35,000
TOTAL	$319,840

Capital Costs - $120,000
Operating & Maintenance Costs - $199,840

The depot containers would be of an igloo-type design and would have a capacity of about 4 cubic yards. (About 7 m^3). Each depot site would have 4 igloos. One igloo would collect tin cans. one igloo would collect aluminum cans, one igloo would collect newspaper, one igloo would collect plastic pet bottles on one side compartmentalized from the

other side which would collect glass. The materials would be picked up by either a flatbed truck with crane or a truck and trailer, which would empty one igloo from a site before moving on to the next site where it would empty another igloo with the same materials. The truck once it is full of a particular material would take the material directly to the market. The cost of $60/hr covers the salary, depreciation costs, maintenance costs and other operating costs of the truck (Coley, pers. comm.). The trucks would be used by the drivers on a spare shift when they are not being used by the city. The possibility also exists that the drop-off depots could be emptied during the night-shift when more spare trucks are available and less traffic would be on the roads. It is estimated that each depot would collect about 285 kg of tin cans per week which would occupy a volume of about 3.25 m^3 (tin can density being 11.37 m^3 /tonne (Proctor, 1990) if the lower bound of tin can amounts (446 tonnes) were collected. If the upper bound of 1220 tonnes were collected each year, each depot site would collect about 782 kg of tin cans/week occupying a volume of about 8.9 m^3. It is estimated that the truck with a capacity of around 205 m^3 (120 cubic yards) could go to all of the depots in one trip before it would be full of tin cans. It will be assumed that visiting 30 depots in the city and emptying one container at each depot site will take about 8 hours per trip. The exact same assumption has been

made for the other materials collected at the depot sites as well.

From the above discussion of costs and revenues, the revenues from the tin cans could cover anywhere from about 5 to 24 percent of the operating costs of a drop-off depot program. The remainder of the costs may be covered by the other materials collected at the depots.

The Recycling Council of Manitoba ran a recycling drop-off depot program for a year at three shopping malls. They ran the program at a loss and in their mid-term report they suggest that to maintain a break-even operation going would require a subsidy of about $10 per year ($5 per household for 6 months) per household. This is also a possibility for a drop-off depot run city wide with estimated costs as estimated above. Any subsidy would improve the economics of this situation significantly.

However, a recycling depot would not collect only tin cans but would also collect aluminum cans, plastic PET bottles, glass, newspaper and possibly other materials. One difficulty with the type of drop-off depot program which has been discussed here is that since the depots will be unattended and unsupervised, a large amount of residue may end up contaminating the recyclables. People may either start throwing garbage in the bins or they may commingle recyclables when they should not be. This could become a serious quality control problem. The difficulty is not that

great with tin cans because the end market in Winnipeg, the scrap metal companies would probably shred the tin cans and run them through a magnetic separator to separate the residue from the tin cans. However, with other materials which are not as easily separated, large amounts of residues and garbage could seriously affect the quality of recyclables collected. These other materials could, however, contribute revenue and also improve the economics of the situation.

6.5 Centralised Separation:

A municipal solid waste processing plant using magnetic separation could potentially capture up to 95% of the tin cans in the municipal waste stream (Morgan, 1987). The municipal waste stream is the waste created by residences and apartments in a municipality. Assuming that tin cans compose 1.97% of the residential waste stream, the magnetic separation could capture 4,713 tonnes of tin cans. At prices of $22.40/tonne and $39.20/tonne, the highest and lowest prices from the last market survey, the tin cans if sold in Winnipeg to the local scrap companies could generated revenues of:

$22.40/tonne x 4,713 = $105,578
$39.20/tonne x 4,713 = $184,750

6.5.1 Costs:

The costs for centralised separation would include the building, land and equipment for separation. For the purposes of separating the ferrous scrap from the municipal waste stream, the required piece of equipment would be an overhead transverse magnetic separator conveyor which would be about one foot above a main conveyor belt upon which all the waste is put. The main conveyor belt after running the municipal waste through a variety of shredders and air classifiers would take the waste that was not separated at the magnetic separator and run it through other processes and methods to separate the other recyclables.

A pilot wet-dry recycling project, the wet refuse and dry commingled recyclables are collected curbside in separate containers, is being operated in Guelph, Ontario. After collection of the wet-dry refuse, the wet-dry materials are taken to two separate processing plants. The dry materials are taken to a materials recovery facility (MRF). An engineering and design study has been done for a wet-dry facility in Guelph to handle 120,000 tonnes annually. The wet-dry facility is set to go ahead in the spring pending Ontario Ministry of Environment approval. Cost estimates and a study on the operating costs and capital costs of the facility, both wet and dry, have been done for the project. The cost estimates for a MSW processing facility which will handle municipal solid waste

in Winnipeg will be based on the figures for the MRF or dry facility in Guelph. It will be assumed that the City of Winnipeg MSW processing plant will be located at either a transfer station where all of the residential refuse goes through or at Brady landfill. The MRF in Guelph is designed for a capacity of 80,000 tonnes. Any processing plant for Winnipeg designed to handle the residential waste stream of 251,846 tonnes would have to be about three to four times as big as the Guelph facility to accommodate growth in the population of households and possible growth in the rate of garbage generation. Let us assume a capacity of 300,000 tonnes for a facility which will process the City of Winnipeg residential waste stream. The costs for the MRF to be built in Guelph breakdown as follows.

Capital Costs: (dry MRF facility only)	
Building	$3,640,000
Equipment	$6,182,000
TOTAL1:	$9,822,000
Operating costs: (wet and dry MRF facility)	
Labour	$2,840,000
Equipment & Maintenance	$797,000
Utilities	$346,000
Transportation costs	$1,383,000
TOTAL2:	$5,366,000

In the figures above, the capital costs were available broken down separately for the wet and dry facility, but the operating costs for the facilities were not broken down. As a result the operating costs are the operating costs for

both the MRF and the wet facility. The operating costs for the MRF in Guelph must be estimated from the figures above. The residual transportation costs, in Guelph, are required to ship the leftover garbage and residual to a landfill (Gibson, pers. comm.). This would not be required in the City of Winnipeg processing plant because it would be located either at the transfer station where the refuse would be delivered anyway or at Brady landfill. This reduces the total operating costs to $3,983,000.

The total operation, wet and dry facility, in Guelph is going to employ 71 people. However, the MRF (dry facility) in Guelph will employ about 60 of the 71 staff. The proportional labour costs according to this ratio would be $2,400,000.

The total capital costs of both facilities is $16,000,000. The equipment and maintenance operating costs and the utilities costs will be assumed to be proportional to the capital costs. For the MRF, the equipment and maintenance costs total $489,258 and the utilities total $212,401. The total operating cost for the MRF is $3,101,659.

The total operating cost per tonne is $38.77/tonne. For the City of Winnipeg MSW processing plant, it will be assumed that the operating costs per tonne remain about the same as you increase the tonnages to 251,846 tonnes. The operating costs would total $9,764,069 for a MSW processing

plant in Winnipeg. While this assumption may be unrealistic because economies of scale which would theoretically decrease the costs per tonnage, the Winnipeg operation would involve separating residential waste from the recyclables at the MSW processing plant which would involve more processes than the MRF at Guelph which separates commingled recyclables.

Capital costs will be more difficult to determine. However, land costs may be much less in Winnipeg than in Guelph. The land in Guelph, 10 hectares or 26 acres will cost an estimated $877,000 (Gibson, pers. comm.). After calling the City of Winnipeg Land and Real Estate Branch, a similiar amount of land near the Brady landfill site would cost about $1500/acre or a total of $39,000 (Souza, pers. comm.). Since the City of Winnipeg facility would have a higher throughput, more land will be needed than the Guelph facility. It will be assumed that a total of $70,000 will cover the required amount of land (equivalent to about 46 acres). This reduces the capital costs in comparison to the Guelph facility by $807,000 to $9,015,000. If the Winnipeg facility is to be able to handle 300,000 tonnes per year, the throughput would be potentially 4 times as much as Guelph. Capital costs will, however, probably not be 4 times as much as the Guelph facility. It will be assumed that the capital costs for a facility in the City of Winnipeg would range somewhere between $20,000,000 and

$30,000,000. Large amounts of capital investment from government or business will be required to build a facility with the capacity to process all of the City of Winnipeg's residential waste.

Once again to separate the tin cans from the rest of the waste and the recyclables, a magnetic separator conveyor would be used. Since the MSW processing plant would be handling such a large amount of tonnage, a magnetic separator conveyor would have to pull out the ferrous scrap with much higher efficiency and better results than in a MRF facility separating commingled recyclables. The revenue from the sale of the tin can scrap does not even make a dent in the 9 million dollars operating cost of any MSW processing plant in Winnipeg. The revenues could cover about 2 percent of the operating costs of the plant. Again, while other recyclables would contribute some revenue, it would not be even near enough to offset the operating costs.

6.6 Detinning Plant:

Another option with the tin cans is to send them to a detinning plant or explore the option of building one in the City of Winnipeg. Minneapolis and Hamilton both have detinning plants. The detinning plant could sell the tin and steel separately and bring in greater revenues than just selling the tin can scrap to a scrap metal company.

A detinning plant would be further processing of the tin cans collected in the curbside and drop-off recycling programs. Generally, any further processing of any product is worthwhile only if the cost of processing is less than the increase in revenue due to the additional processing (Stevens, 1990). Each ton of tin can scrap contains about 5 lbs of tin (Apotheker, 1990) and the rest is steel. If a detinning plant were established, the value of the scrap would increase by the value that 5 lbs of tin is worth plus whatever extra could be received for the detinned steel which is No.1 low residual steel (Proler, 1990) or No.1 bundle steel (Paulowich, pers. comm.). Presently the market price for tin is $3.72 Metals Week composite price per lb (Globe & Mail, January 4, 1992) in US funds or $4.27/lb on Canadian funds. For every ton of steel cans recycled, the tin is worth about $4.27 X 5 lbs = $21.35. This does not, however, include shipping costs to the market for tin.

For any recycling program the detinned steel can be shipped to Hamilton for $56/tonne and sold to Dofasco for $112/tonne for a net return of $56/tonne or the detinned steel could be shipped to Minneapolis for $22/tonne and sold to steel companies in Minneapolis for $114/tonne for a net return of $92/tonne (Canadian dollars). None of the figures above include the operating costs of the detinning plant. In the discussion below, it will be assumed that the detinned steel will be shipped to Minneapolis.

Operating costs of a small detinning plant of throughput capacity between 10,000 and 20,000 tonnes according to Nigel Morgan at MRI in Hamilton would be between $33.60/tonne to $56/tonne depending on throughput, price of caustic soda, price of power, labour costs and other costs. He also stated that capital costs would be minimum $500,000 not including costs of the land or the buildings (Morgan, pers. comm.) Operating costs of $56/tonne will be assumed for tonnages less than 10,000 tonnes because the throughput would not be close to the maximum capacity of the plant. Each tonne of input of steel (1 tonne = 2240 lbs) into the detinning plant is composed of 2234 pounds of steel and 5.6 pounds of tin. One tonne of tin can scrap is worth ,according to the value of steel at $92/tonne and the value of tin at $4.27/lb, $113.35 (C). With detinning plant operating costs of $56/tonne, each tonne of tin can scrap has a net worth as end products of detinned steel and tin of $57.35/tonne. Operating costs may actually be much greater then the $56/tonne because the amount of tin can tonnages does not approach the capacity of the plant.

Curbside:

In a curbside recycling program, the detinned steel and tin could bring in net revenues of:

Lower bound - 1,122 tonnes Net revenues	$64,347
Upper bound - 1,732 tonnes Net revenues	$99,330

Drop-off Depot:

In a drop-off depot recycling program the tin and detinned steel could bring in net revenues of:

Lower bound - 446 tonnes Net revenues	$25,578
Upper bound - 1,220 tonnes Net revenues	$69,967

Centralised Separation:

4,713 tonnes Net revenues	$247,291

All of the above revenue figures are the net revenues after operating costs of the detinning plant have been subtracted. As mentioned above capital costs of a detinning plant, of capacity between 10,000 and 20,000 tonnes, not including the land and building is about $500,000 (Morgan, pers. comm.). Jack Lazarek of General Scrap & Car Shredder also mentioned a 'ballpark' figure of capital costs of about 2 million dollars for a detinning plant. Rick Gaby, Vice

President of Operations of AMG Corp, which owns a number of detinning plants in the United States, estimated that capital costs of a detinning plant would run in the neighborhood of 2-2.5 million dollars. Clearly, capital expenditures on the order of 1 to 2 million dollars will be required for a detinning plant.

The net revenues which could be generated from the detinning plant range from $25,537 from drop-off depot to $247,291 from the MSW processing plant. Some of these revenues could go towards carrying the collecting and processing costs of the recycling program or they could go towards debt servicing of the capital investment of the detinning plant. A capital cost of between 1 and 2 million dollars would require debt servicing at 10% of between $100,000 and $200,000 yearly. Of the revenues brought in from the various collection programs, only the revenues of $247,291 from the MSW processing plant could come close to covering the debt servicing charges. The revenues from detinning of the tin cans from the curbside and drop-off depot programs could carry some but not all of the debt servicing. When equipment would have to be replaced, a further capital expenditure would be required because there is simply not enough revenue coming in to place money in a replacement fund. Clearly, with not enough revenue to establish a replacement fund, a detinning plant is not able to support itself. Capital investment will be continually

required to replace equipment.

While it appears that a detinning plant may come close to breaking even in the centralised separation case in this analysis, a couple of things must be taken into account. First of all, our tin can tonnages are well below the maximum capacity of the detinning plant of 20,000 tonnes. The tonnages that we are dealing with in this case of around 1500 to 4000 tonnes per year could push operating costs per tonne up substantially. If that were the case, the economics would not look nearly as favourable. Secondly, tin is being used less and less in tin cans. The tin layer is getting thinner and thinner and other technology may be replacing the tin in food cans. Dofasco is very positive and enthusiastic about their plastic lining with chrome to replace the tin can in the future. A number of detinning plants have also closed recently in the United States. Whether these closings were symptoms of the recession or some other trend in the detinning industry is not known. Any foray into the detinning industry requires a serious assessment of the economics and of the future use of tin in steel cans.

6.7 Conclusions:

Tin cans compose about 1.97 percent of the residential waste stream by weight. All of the discussion in this document has been done in relation to the weight of refuse

and tin cans. An important consideration in looking at the costs of recycling and collection is to also look at the costs in relation to the volumes of materials. Research should be done on the volumes of tin cans and other materials which could be collected and recycled.

In each of the 3 recycling programs examined the revenues from the sale of specifically tin cans could cover about 2 percent of the operating cost of curbside recycling, about 5 to 24 percent of the operating costs of a drop-off depot program and less than 1 percent of the operating costs of a MSW processing plant. However, a MSW processing plant could divert the most waste from the waste stream with the curbside program and the drop-off program diverting lesser amounts. In this discussion, only tin cans have been looked at to contribute revenue to the program. Any recycling program would not pick up just one item. Other items including aluminum cans, glass, newspaper, and PET bottles would also be collected simultaneously with tin cans. These materials would contribute revenue and divert much more waste from the waste stream than tin cans would. For the other materials which could be collected, more research must be done integrating these materials and tin cans in a recycling program.

CHAPTER 7

CONCLUSIONS & RECOMMENDATIONS

7.1 Discussion:

Recycling can be done in a number of ways in the City of Winnipeg. Curbside and drop-off depot programs are options to collect recyclables such as aluminum cans, glass, newspaper, plastics and tin cans. One of the backbones in any recycling program is the participation rate of the program. A literature search established average participation rates for recycling programs. Voluntary curbside programs averaged 48.6 percent, mandatory curbside programs averaged 74.6 percent and voluntary drop-off programs averaged 24.6%. Curbside programs would collect more tin cans but it would also operate at a greater cost than a drop-off recycling program. A participation rate from a survey which was sent to 500 Winnipeg households was also deduced. According to one of the questions, a participation rate of about 75 percent would result if a curbside recycling program were started. Due to problems with one of the questions, a participation rate for a drop-off depot recycling program was not available.

Another option for recycling is a MSW processing plant. This plant does not require any change in present consumer activity. The households simply continue to put their

garbage out. The garbage is then brought to the MSW processing plant and the recyclables are separated from the other refuse.

The waste stream in the city is composed of many materials. Tin cans compose about 1.97 percent of the residential waste stream (the waste that is collected from private households and apartments as well as residential drop-offs) . According to the City of Winnipeg 1990 landfill refuse statistics, this means that about 4,961 tonnes of tin cans are available to be recycled. The participation rate of the recycling program would then tell us the total amount of tin cans that could be collected. The tin cans would then be sold to the scrap metal companies in the City of Winnipeg. The price for tin can scrap can vary from $22.40/tonne to $44.80/tonne. In the present economic climate, however, the most that could be expected is about $33.60/tonne. Avoided disposal costs may also improve the economics of recycling but since the City of Winnipeg owns and runs all the landfills, no avoided costs result from avoided tipping fees. Avoided cost savings could, however, result in savings in fuel, and labour in operation of the landfill. However, the amount of waste examined which could be recycled according to this document and diverted from the landfill constitutes less than 1 percent of the total waste entering the landfills in the City of Winnipeg. This amount of waste diversion is not of

a large or significant enough quantity to have any avoided cost savings. However, if the analysis of the amount of waste that could be diverted through recycling were extended to include all the materials that could be collected in a recycling program then an avoided cost saving may result. In all cases examined ,in the curbside and drop-off depot recycling programs and in the MSW processing plants, the revenues are not greater than the costs of collection and separation. Similarly, the construction of a detinning plant would not be feasible at our present generation rate of tin cans. Any detinning facility that would operate in the City of Winnipeg would be operating far below capacity unless tin can scrap could be imported from other local regions. Any further processing of the tin cans is only worthwhile and economically beneficial if the added processing costs is less than the increased value of the processed product.

7.2 Conclusions:

1/ The feasibility of a recycling program, either curb-side, drop-off or centralised separation is unknown at this point. More research must be done to determine the revenues that can be brought in by the other materials, such as aluminum cans, glass, newspaper and plastics that would be collected along side tin cans.

2/ The processing cost associated with purchasing and operation of a magnetic separator to recycle tin cans is easily covered by the revenues brought in by the tin cans in a curbside recycling program. The revenue generated by sale of the tin can scrap could cover about 1 to 2 percent of the total costs of curbside recycling.

3/ The revenue generated by collection of tin cans at a drop-off depot recycling program can cover about 5 to 24 percent of the operating costs of a drop-off depot recycling program collecting aluminum, glass, newspaper, tin cans and plastics.

4/ A municipal solid waste processing facility while able to capture the largest percentage of tin cans will require large amounts of capital investment to start and to operate continuously. The revenues brought in from the tin cans which are sold from a MSW processing plant could cover about 2 percent of the operating costs of a MSW processing plant. More research must be done to determine if the revenues brought in from other recyclables could cover a significant portion of the operating costs of the plant. The economics of a MSW processing plant will improve when landfill tipping fees are significantly increased.

5/ A detinning plant is also not economically feasible

at this time. Winnipeg does not generate enough tin cans to make a detinning plant a break even operation. Continued capital expenditures would be required to keep the detinning plant in operation. The future use of tin in the food and steel can is also uncertain.

6/ Winnipeggers are generally positive about recycling with about a 70 percent to 90 percent positive response from the respondents to the survey.

7/ The major problems stopping people from recycling are no place to take the recyclables and lack of time to prepare the recyclables for recycling and pick-up.

8/ From purely a financial perspective, a drop-off recycling program is by far the most economically viable of the three options of recycling goods. A drop-off programs costs are much more covered by the sale of tin cans than any other option. The other materials that would also be collected may be able to make the drop-off depot economically viable.

9/ From purely a waste diversion perspective, a MSW processing plant would be able to divert the most waste from the landfill. However, it requires by far the largest capital investment and would require strong financial

support from business and/or government. It is also doubtful if the revenues generated from the sale of recyclables would come close to covering the costs of the plant.

10/ While a curbside collection program could divert more waste from the landfill than a drop-off depot program, it would also cost more than a drop-off depot. A curbside recycling program would cost less than a MSW processing plant, but would not divert as much waste from the landfill. The revenues generated from sale of the recyclables could probably not cover all of the costs of a curbside program. The revenues from the sale of tin cans covered about 1 percent of the costs of the curbside recycling program. The curbside program would, however, generate a greater recycling and environmental ethic among the participants than a MSW processing plant possibly leading to adoption by some citizens of two other 'R's of reduction and re-use.

7.3 Recommendations:

1/ More advertising and education of Winnipeggers with respect to location for recycling depots and about recycling in general. A common complaint in the surveys was that they did not where to take it or they did not know the item was recyclable. Only about 15 percent of the respondents felt that there was enough advertising of recycling in the city.

2/ A recycling program not be started unless government or business is willing to support and fund a program but that more research should be done into possible recycling programs in the City of Winnipeg incorporating collection and sale of tin cans, aluminum cans, plastic pop (PET) bottles, glass and newspaper. Any recycling program should decide which type of program to pursue, one of financial accountability or one of waste diversion.

3/ A detinning plant not be established until more research is done to determine its feasibility. Key factors to include in such an analysis include the price of raw tin and the number of tin cans which can be collected from Winnipeg and the surrounding region. Winnipeg does not generate enough tin cans presently to support a detinning plant. More research must also be done when discussing a detinning plant on the future use of tin in the steel food can.

4/ More research into the first 2 R's of minimizing waste, reduction and re-use, be investigated as methods of waste minimization. Reduction and re-use initiatives could be developed as a complement or as an alternative to a recycling program.

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Appendix A

SURVEY, COVER LETTERS AND SURVEY RESULTS

A CITY-WIDE SURVEY OF WINNIPEG CITIZEN'S ABOUT WASTE DISPOSAL AND RECYCLING ISSUES.

THIS SURVEY TAKES A FEW MOMENTS TO COMPLETE. PLEASE TAKE THE TIME TO FILL IT OUT AS SOON AS POSSIBLE AND RETURN IT IN THE POSTAGE PAID ENVELOPE.

WHO ARE WE?

The Natural Resources Institute is a research and graduate institute devoted to researching topics and training graduate students in natural resource management. The Natural Resources Institute is in the Faculty of Graduate Studies at the University of Manitoba. If you have any questions regarding this survey, you can call the Natural Resources Institute at 474-8373 between 9 A.M. and 4 P.M.

WHAT IS THIS STUDY FOR?

This study will be used to determine recycling attitudes and behaviours in the City of Winnipeg. The survey will canvas a number of people in the City.

HOW WAS YOUR NAME SELECTED?

Your name was randomly selected from the MTS white pages. No one except myself and my university advisor know you have been contacted.

WHAT ABOUT CONFIDENTIALITY?

We know you are concerned about confidentiality. Your completed questionnaire is directed to the Natural Resources Institute at the University of Manitoba and will be destroyed immediately after the information has been analyzed. Under no circumstances will anyone except me and my advisor have access to your survey.
ALL INFORMATION YOU PROVIDE IS CONFIDENTIAL AND ANONYMOUS.

THIS SURVEY IS YOUR OPPORTUNITY TO EXPRESS YOUR VIEWS ON RECYCLING AND WHAT YOU THINK COULD BE DONE IN WINNIPEG. PLEASE COMPLETE IT AS SOON AS POSSIBLE.

Natural Resources Institute
177 Dysart Rd.
Winnipeg, Manitoba, R3T-2N2

First we would like to ask you about what types of recycling you do and what problems you encounter in recycling.

1) Please indicate what kinds of recycling you have done in the last 5 years? (Circle all appropriate numbers)

01 DONATED CLOTHING TO A CHARITY

02 RETURNED BEER BOTTLES

03 RETURNED SOFT DRINK OR POP BOTTLES

04 GAVE BOTTLES TO A BOTTLE DRIVE

05 DONATED PAPER TO A COMMUNITY CLUB

06 RETURNED POP OR BEER CANS

07 DROPPED ITEMS OFF AT A DEPOT

08 PUT GARDEN REFUSE INTO A COMPOST

09 PARTICIPATED IN A CURBSIDE PICKUP PROGRAM

10 BROUGHT ITEMS TO A SCRAP METAL COMPANY

11 OTHER (please specify) _____

_____

2) What materials, of the ones listed, are presently separated and removed from the garbage in your household? (Circle all appropriate numbers)

1 NEWSPAPER

2 GLASS

3 ALUMINUM BEVERAGE CANS

4 PLASTIC POP BOTTLES

5 TIN CANS

6 GARDEN REFUSE

7 VEGETABLE SCRAPS

8 OTHER (please specify)_____

_____

3) What problems do you face in recycling the following items? (Please check off all that are appropriate to your situation)

	LACK OF TIME	NO PLACE TO TAKE IT	DO NOT USE ENOUGH OF IT	TOO FAR AWAY
1 NEWSPAPER	____	____	____	____

OTHER PROBLEMS TO RECYCLING _____

_____

2 GLASS	____	____	____	____

OTHER PROBLEMS TO RECYCLING _____

_____

3 ALUMINUM CANS	____	____	____	____

OTHER PROBLEMS TO RECYCLING _____

_____

4 PLASTIC POP BOTTLES	____	____	____	____

OTHER PROBLEMS TO RECYCLING _____

_____

5 TIN CANS	____	____	____	____

OTHER PROBLEMS TO RECYCLING _____

_____

Recycling programs can be based on citizen separation with either curbside (back-lane) pickup or drop-off depots. Each recycling program operates differently for different reasons. We would now like to ask you some questions regarding these recycling systems.

4) Would you be willing to save and separate the following materials from your garbage to be recycled in a curbside (back-lane) pickup or drop-off depot program? (Please circle number for each part)

a) Newspaper

i) Curbside	ii) Drop-off Depot
1 YES	1 YES
2 NO	2 NO

b) Glass

i) Curbside	ii) Drop-off Depot
1 YES	1 YES
2 NO	2 NO

c) Aluminum beverage cans

i) Curbside	ii) Drop-off Depot
1 YES	1 YES
2 NO	2 NO

d) Plastic pop bottles

i) Curbside	ii) Drop-off Depot
1 YES	1 YES
2 NO	2 NO

e) Tin cans

i) Curbside	ii) Drop-off Depot
1 YES	1 YES
2 NO	2 NO

5) Do you feel recycling programs in Winnipeg are adequately advertised? (Circle number)

1 YES

2 NO

IF YES, OF WHICH RECYCLING PROGRAMS ARE YOU AWARE?

_____

_____

6) How valuable to you personally is a recycling program run in your neighborhood? (Check off one only please)

( )	( )	( )	( )	( )
NOT VERY VALUABLE	NOT VALUABLE	DO NOT KNOW	SOMEWHAT VALUABLE	VERY VALUABLE

7) If a recycling program was established in your neighborhood, how willing would you be to;

a) rinse glass bottles, glass jars and plastic bottles and to remove their lids? (Check off one only please)

( )	( )	( )	( )	( )
NOT VERY WILLING	NOT WILLING	DO NOT KNOW	SOMEWHAT WILLING	VERY WILLING

b) rinse metal containers and tin cans? (Check off one only please)

( )	( )	( )	( )	( )
NOT VERY WILLING	NOT WILLING	DO NOT KNOW	SOMEWHAT WILLING	VERY WILLING

c) separate glossy paper advertisements from newspaper? (Check off one only please)

( )	( )	( )	( )	( )
NOT VERY WILLING	NOT WILLING	DO NOT KNOW	SOMEWHAT WILLING	VERY WILLING

8) Rank the following choices for your preferred locations for drop-off depots. (from 1-4)

( ) DEPOT WITHIN 6 CITY BLOCKS OF YOUR HOME

( ) DEPOT AT YOUR PLACE OF EMPLOYMENT

( ) DEPOT AT YOUR LOCAL SHOPPING CENTRE

( ) DEPOT AT YOURS OR YOUR CHILDREN'S SCHOOL

9) Which type of recycling program would you prefer? (Circle number)

1 HOME COLLECTION OF RECYCLABLES

2 NEIGHBORHOOD DROP-OFF DEPOTS

3 SEPARATION AT A TRANSFER POINT

Our next concern is how recycling programs should be run.

10) Should participation in a recycling program be encouraged through monetary rewards or penalties? (Circle number)

1 MONETARY REWARDS FOR PEOPLE WHO RECYCLE

2 MONETARY PENALTIES FOR PEOPLE WHO DO NOT RECYCLE

3 NO MONETARY REWARDS OR MONETARY PENALTIES

4 OTHER (please specify) _____

_____

11) Would you be willing to pay a 5 cent tax on tin cans, aluminum cans and glass bottles which you would get back by returning the items to a recycling depot? (Circle number)

1 YES

2 NO

12) Should a recycling program be designed to be able to pay for itself without any government support? (Circle number)

1 YES

2 NO

13) How quickly do you think a city wide recycling program should be started? (Circle number)

1 STARTED IMMEDIATELY

2 SOME TIME IN THE FUTURE

3 LONG TIME IN THE FUTURE

4 NEVER

--------PLEASE GO ON TO THE NEXT PAGE--------

BACKGROUND INFORMATION

This last section asks some questions of a statistical nature. We use this information to ensure that our random sample represents all types of residences and householders in the City of Winnipeg.

14) In what year were you born?

19____

15) How far have you gone in school?

1 ELEMENTARY

2 JUNIOR HIGH

3 SOME HIGH SCHOOL

4 HIGH SCHOOL GRADUATION

5 SOME TECHNICAL/COMMUNITY COLLEGE

6 SOME UNIVERSITY

7 UNIVERSITY GRADUATION

16) Do you rent or own your present home?

1 RENT

2 OWN

17) How many people live in your house? (including yourself)

_____ ADULTS (18 years and older)

_____ CHILDREN (under 18 years of age)

18) What is your occupation? (Please indicate the work done, NOT the place of employment)

_____

_____

19) Please indicate your approximate total annual family income from all sources.

1 LESS THAN $10,000

2 $10,000 - $20,000

3 $20,001 - $35,000

4 $35,001 - $50,000

5 $50,001 - $70,000

6 OVER $70,000

Please feel free to add any additional comments below and on the next page.

Additional Comments:

Any additional comments regarding any topics raised by this questionnaire may also be addressed here. Feel free to add anything more that you wish below.

Thank-you for your cooperation in filling out this survey. Your help in determining how Winnipegger's feel about recycling is greatly appreciated. If you have any further questions or comments, feel free to contact me at:

Attention: Christian Weber
Natural Resources Institute
177 Dysart Rd.
Winnipeg, Manitoba
R3T-2N2.

THE UNIVERSITY OF MANITOBA
NATURAL RESOURCES INSTITUTE
Winnipeg, Manitoba
Canada R3T 2N2
(204) 474-8373

June 28, 1991

Name
Address
City,Prov.
Postal Code

Dear Name

Landfills across North America are filling up. In many areas in Canada and the United States new landfills are taking a long time to site and start. Sites for new landfills are also difficult to find as the best sites were used for previous landfills. This landfill problem has led to an interest in waste minimization and recycling. Recycling is being examined as a potential option in the City of Winnipeg. However, it is not known what people in the City of Winnipeg think about recycling.

Your household is one of a small number in which people are being asked to give their opinion on these matters. It was drawn in a random sample of the entire city. In order that the results will truly represent the thinking of the people of Winnipeg, it is important that each questionnaire be completed and returned. It is also important that the right person fill out this questionnaire. We would like the questionnaire to be filled out by one of the adult heads of the household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so we can check your name off the mailing list when your questionnaire is returned and so we will not contact you in the follow-up reminder. Your name will never be placed on the questionnaire.

The results of the research will be made available to the Government of Manitoba and the City of Winnipeg. If you have any questions please do not hesitate to write or call me at 474-8152. If I am unavailable, you may contact Christina McDonald at the Natural Resources Institute.

Thank-you for your assistance.

Sincerely,

Christian Weber
Principal Investigator

THE UNIVERSITY OF MANITOBA

NATURAL RESOURCES INSTITUTE

Winnipeg, Manitoba
Canada R3T 2N2

(204) 474-8373

July 8 , 1991

Name
Address
City,Prov.
Postal Code

Dear Name

Last week a questionnaire seeking your opinion about recycling in the City of Winnipeg was mailed to you. Your name was drawn from a random sample of households in the City of Winnipeg.

If you have already completed and returned it to us please accept our sincere thanks. If not, please complete and return the questionnaire today. Your household is one of a small number in which people are being asked to give their opinion on these matters. In order that the results will truly represent the thinking of the people of Winnipeg, it is important that each questionnaire be completed and returned.

The results of the research will be made available to the Government of Manitoba and the City of Winnipeg. If you have any questions please do not hesitate to write or call me at 474-8152. If I am unavailable, you may contact Christina McDonald at the Natural Resources Institute.

Thank-you for your assistance.

Sincerely,

Christian Weber
Principal Investigator

THE UNIVERSITY OF MANITOBA

NATURAL RESOURCES INSTITUTE

Winnipeg, Manitoba
Canada R3T 2N2

(204) 474-8373

August 12, 1991

Name
Address
City,Prov.
Postal Code

About four weeks ago I wrote to you seeking your opinion about the state of recycling in Winnipeg and the future of recycling in the City of Winnipeg. As of today we have not yet received your completed questionnaire.

We have undertaken this study because of the belief that citizen opinions should be taken into account in deciding what the future of recycling should be in Winnipeg. After all any recycling program is entirely dependent upon the cooperation of the city's residents.

I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was drawn through a scientific sampling process in which every household in Winnipeg had an equal chance of being selected. This means that only about one out of every 300 households in Winnipeg will be asked to complete this questionnaire. In order for the results of this questionnaire to be truly representative of the opinions of all Winnipeg residents it is essential that each person in the sample return their questionnaire. As mentioned in our last letter the questionnaire should be completed by any adult head of the household.

In the event that your questionnaire has been misplaced, a replacement is enclosed.

Your cooperation is greatly appreciated.

Cordially,

Christian Weber
Principal Investigator

RECYCLING SURVEY RESULTS

Q1-01 DONATED CLOTHING TO CHARITY

A1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	283	87.6	284	87.9
NO	39	12.1	323	100.0

Q1-02 RETURNED BEER BOTTLES

A2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	287	88.9	288	89.2
NO	35	10.8	323	100.0

Q1-03 RETURNED POP BOTTLES

A3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	233	72.1	234	72.4
NO	89	27.6	323	100.0

Q1-04 GAVE TO BOTTLE DRIVE

A4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	170	52.6	171	52.9
NO	152	47.1	323	100.0

RECYCLING SURVEY RESULTS

Q1-05 GAVE PAPER TO COMMUNITY CLUB

A5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	67	20.7	68	21.1
NO	255	78.9	323	100.0

Q1-06 RETURNED POP CANS

A6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	212	65.6	213	65.9
NO	110	34.1	323	100.0

Q1-07 DROPPED ITEMS OFF AT DEPOT

A7	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	155	48.0	156	48.3
NO	167	51.7	323	100.0

Q1-08 PUT GARDEN REFUSE IN COMPOST

A8	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	100	31.0	101	31.3
NO	222	68.7	323	100.0

RECYCLING SURVEY RESULTS

Q1-08 PARTICIPATED IN CURBSIDE PROGRAM

A9	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	58	18.0	59	18.3
NO	264	81.7	323	100.0

Q1-10 BROUGHT ITEMS TO SCRAP METAL CO.

A10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	1	0.3	1	0.3
YES	70	21.7	71	22.0
NO	252	78.0	323	100.0

Q2-1 SEPARATED NEWSPAPER

B1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	177	54.8	180	55.7
NO	143	44.3	323	100.0

Q2-2 SEPARATED GLASS

B2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	110	34.1	113	35.0
NO	210	65.0	323	100.0

RECYCLING SURVEY RESULTS

Q2-3 SEPARATED ALUMINUM CANS

B3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	176	54.5	179	55.4
NO	144	44.6	323	100.0

Q2-4 SEPARATED PLASTIC POP BOTTLES

B4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	180	55.7	183	56.7
NO	140	43.3	323	100.0

Q2-5 SEPARATED TIN CANS

B5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	91	28.2	94	29.1
NO	229	70.9	323	100.0

Q2-6 SEPARATED GARDEN REFUSE

B6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	87	26.9	90	27.9
NO	233	72.1	323	100.0

RECYCLING SURVEY RESULTS

Q2-7 SEPARATED VEGETABLE SCRAPS

B7	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	3	0.9	3	0.9
YES	90	27.9	93	28.8
NO	230	71.2	323	100.0

Q3-1 NEWSPAPER-LACK OF TIME

C1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	41	12.7	45	13.9
NO	278	86.1	323	100.0

Q3-1 NEWSPAPER-NO PLACE TO TAKE IT

C2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	130	40.2	134	41.5
NO	189	58.5	323	100.0

Q3-1 NEWSPAPER-DO NOT USE ENOUGH OF IT

C3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	47	14.6	51	15.8
NO	272	84.2	323	100.0

RECYCLING SURVEY RESULTS

Q3-1 NEWSPAPER-TOO FAR AWAY

C4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	58	18.0	62	19.2
NO	261	80.8	323	100.0

Q3-1 NEWSPAPER-OTHER PROBLEMS

C5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	62	19.2	66	20.4
NO	257	79.6	323	100.0

Q3-2 GLASS-LACK OF TIME

D1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	30	9.3	34	10.5
NO	289	89.5	323	100.0

Q3-2 GLASS-NO PLACE TO TAKE IT

D2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	143	44.3	147	45.5
NO	176	54.5	323	100.0

RECYCLING SURVEY RESULTS

Q3-2 GLASS-DO NOT USE ENOUGH OF IT

D3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	72	22.3	76	23.5
NO	247	76.5	323	100.0

Q3-2 GLASS-TOO FAR AWAY

D4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	46	14.2	50	15.5
NO	273	84.5	323	100.0

Q3-2 GLASS-OTHER PROBLEMS

D5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	39	12.1	43	13.3
NO	280	86.7	323	100.0

Q3-3 ALUMINUM-LACK OF TIME

E1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	34	10.5	38	11.8
NO	285	88.2	323	100.0

RECYCLING SURVEY RESULTS

Q3-3 ALUMINUM-NO PLACE TO TAKE IT

E2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	64	19.8	68	21.1
NO	255	78.9	323	100.0

Q3-3 ALUMINUM-DO NOT USE ENOUGH OF IT

E3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	83	25.7	87	26.9
NO	236	73.1	323	100.0

Q3-3 ALUMINUM-TOO FAR AWAY

E4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	49	15.2	53	16.4
NO	270	83.6	323	100.0

Q3-3 ALUMINUM-OTHER PROBLEMS

E5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	31	9.6	35	10.8
NO	288	89.2	323	100.0

RECYCLING SURVEY RESULTS

Q3-4 PLASTIC POP-LACK OF TIME

F1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	33	10.2	37	11.5
NO	286	88.5	323	100.0

Q3-4 PLASTIC POP-NO PLACE TO TAKE IT

F2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	79	24.5	83	25.7
NO	240	74.3	323	100.0

Q3-4 PLASTIC POP-DO NOT USE ENOUGH OF IT

F3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	54	16.7	58	18.0
NO	265	82.0	323	100.0

Q3-4 PLASTIC POP-TOO FAR AWAY

F4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	50	15.5	54	16.7
NO	269	83.3	323	100.0

RECYCLING SURVEY RESULTS

Q3-4 PLASTIC POP-OTHER PROBLEMS

F5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	34	10.5	38	11.8
NO	285	88.2	323	100.0

Q3-5 TIN CANS-LACK OF TIME

G1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	45	13.9	49	15.2
NO	274	84.8	323	100.0

Q3-5 TIN CANS-NO PLACE TO TAKE IT

G2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	117	36.2	121	37.5
NO	202	62.5	323	100.0

Q3-5 TIN CANS-DO NOT USE ENOUGH OF IT

G3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	55	17.0	59	18.3
NO	264	81.7	323	100.0

RECYCLING SURVEY RESULTS

Q3-5 TIN CANS-TOO FAR AWAY

G4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	46	14.2	50	15.5
NO	273	84.5	323	100.0

Q3-5 TIN CANS-OTHER PROBLEMS

G5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
YES	34	10.5	38	11.8
NO	285	88.2	323	100.0

RECYCLING SURVEY RESULTS

Q4a-i CURBSIDE - NEWSPAPER

H1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	36	11.1	36	11.1
YES	278	86.1	314	97.2
NO	9	2.8	323	100.0

Q4b-i CURBSIDE - GLASS

H3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	41	12.7	41	12.7
YES	270	83.6	311	96.3
NO	12	3.7	323	100.0

Q4c-i CURBSIDE - ALUMINUM

H5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	62	19.2	62	19.2
YES	251	77.7	313	96.9
NO	10	3.1	323	100.0

Q4d-i CURBSIDE - PET BOTTLES

H7	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	53	16.4	53	16.4
YES	260	80.5	313	96.9
NO	10	3.1	323	100.0

RECYCLING SURVEY RESULTS

Q4e-i CURBSIDE - TIN CANS

H9	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	44	13.6	44	13.6
YES	263	81.4	307	95.0
NO	16	5.0	323	100.0

Q4a-ii DROP-OFF - NEWSPAPER

H2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	127	39.3	127	39.3
YES	132	40.9	259	80.2
NO	64	19.8	323	100.0

Q4b-ii DROP-OFF - GLASS

H4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	131	40.6	131	40.6
YES	122	37.8	253	78.3
NO	70	21.7	323	100.0

Q4c-ii DROP-OFF - ALUMINUM

H6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	125	38.7	125	38.7
YES	142	44.0	267	82.7
NO	56	17.3	323	100.0

RECYCLING SURVEY RESULTS

Q4d-ii DROP-OFF - PET BOTTLES

H8	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	126	39.0	126	39.0
YES	139	43.0	265	82.0
NO	58	18.0	323	100.0

Q4e-ii DROP-OFF - TIN CANS

H10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	135	41.8	135	41.8
YES	120	37.2	255	78.9
NO	68	21.1	323	100.0

Q5 ADEQUATELY ADVERTISED

I1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	16	5.0	16	5.0
YES	46	14.2	62	19.2
NO	261	80.8	323	100.0

Q6 VALUABLENESS OF RECYCLING

J1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	10	3.1	10	3.1
NOT VERY VALUABL	20	6.2	30	9.3
NOT VALUABLE	10	3.1	40	12.4
DO NOT KNOW	70	21.7	110	34.1
VALUABLE	89	27.6	199	61.6
VERY VALUABLE	124	38.4	323	100.0

RECYCLING SURVEY RESULTS

Q7a WILLINGNESS TO RINSE GLASS

K1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	4	1.2	4	1.2
NOT VERY WILLING	10	3.1	14	4.3
NOT WILLING	9	2.8	23	7.1
DO NOT KNOW	14	4.3	37	11.5
WILLING	87	26.9	124	38.4
VERY WILLING	199	61.6	323	100.0

Q7b WILLINGNESS TO RINSE TIN CANS

K2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	5	1.5	5	1.5
NOT VERY WILLING	14	4.3	19	5.9
NOT WILLING	19	5.9	38	11.8
DO NOT KNOW	16	5.0	54	16.7
WILLING	93	28.8	147	45.5
VERY WILLING	176	54.5	323	100.0

Q7c WILLINGNESS TO SEPARATE GLOSSY ADS

K3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	5	1.5	5	1.5
NOT VERY WILLING	25	7.7	30	9.3
NOT WILLING	25	7.7	55	17.0
DO NOT KNOW	23	7.1	78	24.1
WILLING	86	26.6	164	50.8
VERY WILLING	159	49.2	323	100.0

RECYCLING SURVEY RESULTS

Q8a PREFER DEPOT WITHIN 5 BLOCKS

L1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	94	29.1	94	29.1
FIRST CHOICE	116	35.9	210	65.0
SECOND CHOICE	59	18.3	269	83.3
THIRD CHOICE	40	12.4	309	95.7
FOURTH CHOICE	14	4.3	323	100.0

Q8b PREFER DEPOT AT WORK

L2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	152	47.1	152	47.1
FIRST CHOICE	22	6.8	174	53.9
SECOND CHOICE	26	8.0	200	61.9
THIRD CHOICE	44	13.6	244	75.5
FOURTH CHOICE	79	24.5	323	100.0

Q8c PREFER DEPOT AT SHOPPING CENTRE

L3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	77	23.8	77	23.8
FIRST CHOICE	134	41.5	211	65.3
SECOND CHOICE	61	18.9	272	84.2
THIRD CHOICE	39	12.1	311	96.3
FOURTH CHOICE	12	3.7	323	100.0

Q8d PREFER DEPOT AT SCHOOL

L4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	147	45.5	147	45.5
FIRST CHOICE	25	7.7	172	53.3
SECOND CHOICE	37	11.5	209	64.7
THIRD CHOICE	52	16.1	261	80.8
FOURTH CHOICE	62	19.2	323	100.0

RECYCLING SURVEY RESULTS

Q9 RECYCLING PROGRAM PREFERENCE

M1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	21	6.5	21	6.5
CURBSIDE COLLECT	204	63.2	225	69.7
DROP-OFF PROGRAM	86	26.6	311	96.3
TRANSFER STATION	12	3.7	323	100.0

Q10 ENCOURAGEMENT OF RECYCLING

N1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	16	5.0	16	5.0
MONETARY REWARDS	106	32.8	122	37.8
MONETARY PENALTI	36	11.1	158	48.9
NO MONETARY REWA	140	43.3	298	92.3
OTHER	25	7.7	323	100.0

Q11 WILLING TO PAY 5 CENT RECYCLING TAX

D1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	10	3.1	10	3.1
YES	141	43.7	151	46.7
NO	172	53.3	323	100.0

Q12 GOVERNMENT SUPPORT FOR RECYCLING

P1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	17	5.3	17	5.3
YES	214	66.3	231	71.5
NO	92	28.5	323	100.0

RECYCLING SURVEY RESULTS

Q13 SPEED OF STARTING RECYCLING PGM.

Q1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NON-RESPONSE	8	2.5	8	2.5
START IMMEDIATEL	250	77.4	258	79.9
SOME TIME	61	18.9	319	98.8
LONG TIME	2	0.6	321	99.4
NEVER	2	0.6	323	100.0

Appendix B

CURBSIDE COSTS WORKSHEETS FROM MIDDLESEX COUNTY

LOCAL WORKSHEET NUMBER ONE

WORKSHEET FOR CALCULATING DAILY COSTS FOR MUNICIPAL CURBSIDE RECYCLING PROGRAM

Program Administrative Costs:

Approximate Administrative Costs: _____per year
Estimate hours spent on program by anyone (mayor, administrator, DPW director, clerical) who is normally employed in non-recycling activity, multiply by salary plus benefits rate on an hourly basis for the hours spent on the program and add the salary and benefits of recycling coordinator or any others working exclusively on recycling)

Promotional Costs: _____per year
Estimate Costs of advertising, bumper stickers, handouts, etc.

Total Administrative Costs _____per year

Divide Total Administrative Costs by the number of materials which will be collected. Use the result of this division in the material cost worksheets which follow.

ADMINISTRATIVE COSTS PER MATERIAL _____per year

Office of Recycling Grants

Program Planning Grant _____per year
Education Grant _____per year
Recycling Grant _____per year

Total Grant Funds _____per year

Divide Total Grant Funds by the number of materials collected. Use the result of this division in the material cost worksheets which follow.

GRANT FUNDS PER MATERIAL _____per year

MATERIAL COST WORKSHEET

_____
(Material)

ADMINISTRATIVE COSTS PER MATERIAL _____per year

Use the result of the division from the first page of the worksheet to allocate share of Administrative costs to material collection.

Labor Costs

Collection and Delivery

Driver _____per year
(Wage per hour X hours per year)

Helpers _____per year
(Wage per hour X hours per year X number of helpers)

Benefits _____per year
(Yearly wage of driver and helpers X appropriate percent)

Intermediate Processing

Laborer _____per year
(Wage per hour X hours per year X number of laborers)

Benefits _____per year
(Yearly wage X appropriate percent)

TOTAL LABOR COST _____per year

Equipment Capital Cost:

(If not used exclusively for recycling activities, estimate the percent of the time used for recycling. Multiply cost by this percent to obtain the portion of the cost assigned to the recycling program)

Vehicle Purchase Price (if new) _____

Capital Cost spread over 5 years _____per year
(Finance Charges) _____per year
Additional Vehicle(s) _____per year

Cost of Additional Equipment _____per year
(Processing equipment, storage bins, etc.)

TOTAL EQUIPMENT CAPITAL COST _____per year

Equipment Operating Cost:

Fuel (Collection) _____per year
(Recycling collection days per year X miles per day X price per gallon divided by miles per gallon)

Fuel (Delivery to Market) _____per year
(Miles roundtrip to market X number of trips to market per collection day X number of collection days per year X price per gallon divided by miles per gallon)

Maintenance, Tires, Repairs _____per year
(Include percent of mechanic's wages and benefits for work on vehicle)

Insurance, Licenses, etc. _____per year

TOTAL EQUIPMENT OPERATING COST _____per year

Program Cost Summary:

ADMINISTRATIVE COST PER MATERIAL _____per year
TOTAL LABOR COST _____per year
TOTAL EQUIPMENT CAPITAL COST _____per year
TOTAL EQUIPMENT OPERATING COST _____per year

Sub-Total _____per year

SUBTRACT SHARE OF RECYCLING GRANTS _____per year

Use result of division from first page of worksheet to allocate share of Grants to material collection

Total Program Cost _____per year
(Sub-Total minus Share of Grants)

DAILY PROGRAM COST

Total Program Cost per year divided by the number of recycling collection days per year = Daily Program Cost _____per day