A FEASIBILITY STUDY OF INTEGRATING A SOLID WASTE RECYCLING SYSTEM FOR WINNIPEG'S AUTOMATED SOLID WASTE COLLECTION PHASE I AREA

BY

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ABSTRACT

In recent decades conserving the environment has been a top priority for many North American metropolitan areas. Municipal waste generation has increased considerably and has led to overburdened local landfill capacity. In addition, there has been public opposition to siting of new landfill sites owing to the Not-In-My-Back-Yard (NIMBY) syndrome. Local government officials have reacted to this issue by drafting stringent waste minimization strategies. Many officials have found the recycling option attractive owing to its potential to reduce disposal costs and extend landfill life.

At present Winnipeg is one of the few North American metropolitan areas lacking a comprehensive recycling program. Recently, Winnipeg implemented phase I of automated solid waste collection in the north-end of the city. The purpose of this study is to determine the feasibility of integrating a prototype recycling system within the above mentioned area.

A methodology for evaluating criterion of municipal programs was developed for the prototype program which has applications as a general model for other North American metropolitan programs. The evaluation criterion included, material recovery estimates, a technical reliability analysis, a public opinion survey and a benefit-cost analysis.

Results indicated that although the recommended program appeared to be efficient and cost effective, and public response was generally favourable, it was not an economically viable option (costs exceeded benefits). In order to make the program economically viable, a "full cost accounting" approach, which would include benefits such as, an extension of local landfill life, the preservation of natural resources, the reduction of energy and pollution, the savings from worker's compensation payments and opportunities for employment would have

to be taken into account. In implementing the program, it is recommended that a "full cost accounting" approach be employed to determine the true benefits of the program.

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Dedicated to the memory of my late father, Mr. Shamshudin Dharsi.

CHAPTER 1

INTRODUCTION

1.1 Background:

In the past decade, solid waste management has been given priority by politicians, the public and all levels of government. As a nation, we generate approximately sixteen million tonnes of municipal solid waste each year, and over time this amount is expected to increase (Environment Canada, 1991, 66). In 1989, we generated 1.7 kg of municipal waste per capita daily, compared with 1.6 kg in the United States, 1.3 kg in Switzerland, 0.9 kg in the United Kingdom, and 0.8 kg in Sweden (Environment Ontario, 1990, 7).

Figure 1 illustrates the breakdown of Canada's residential solid waste stream into 8 major components. According to Olijnyk (1992), paper accounts for 35% of the residential waste stream and constitutes the largest single component. Food waste represents the second largest component (22%). The remaining significant components are: yard waste (15%), metals (6.4%), glass (5%), cloth (4%), wood (3%) and miscellaneous (9.6%), which includes plastics, rubber and leather.

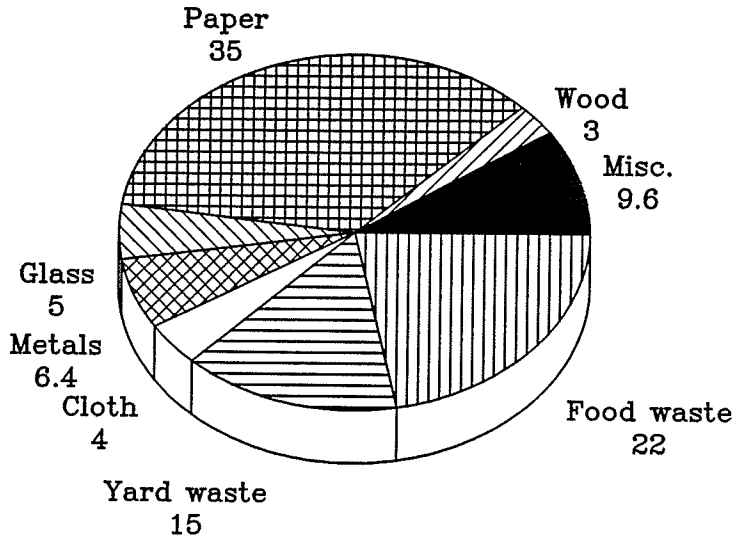


Figure 1: Canada's residential solid waste composition (by percentage).

Modified from: Olijnyk, Zena. "Old trash habits in the garbage heap. City takes action to teach Winnipeg residents about the four Rs." Winnipeg Free Press. May 24, 1992, B13.

Historically, Canadians have been careless about waste generation and disposal. The present lifestyle in Canada, with its high level of consumption and waste production has left local governments with few management options. Diminishing landfill capacity, public health and safety concerns, such as contamination of land, and the emission of dangerous gases, make it increasingly difficult for municipalities to find new disposal sites. The rising costs of waste collection and disposal, coupled with the concerns raised by an environmentally conscious public, have placed considerable pressure on traditional waste disposal practices (National Round Table on the Environment and the Economy, 1991, 1).

During the last decade, the ability of landfill sites to properly handle the disposal of

municipal solid waste has reached crises levels in many major North American metropolitan centres (City of Winnipeg, Waterworks, Waste & Disposal Department, 1992, 2). Some have either run out or are running out of landfill space, while others have raised concerns about the environmental impact of inefficient waste disposal practices. Furthermore, current waste management practices cost Canadians in excess of $1.5 billion per year (Government of Canada, 1991, 2).

Pressure from the public and environmental interest groups regarding improper and costly waste disposal practices has led the provincial government to adopt a four-tiered hierarchy of waste management, namely, the "4 Rs": reduce, reuse, recycle and recover (Manitoba Environment, 1991, 155). In the context of this hierarchy "reduce" and "reuse" are emphasized as priorities, followed by the "recycle" and "recover" components (Manitoba Environment, 1991, 155).

According to the State of Environment Report (1991), the term "reduce" means to cut down the consumption of products by controlling waste production; "Reuse" means to utilize products as many ways as possible before disposal; "Recycle" means to separate or extract useful materials from waste and then use them to produce new materials; and "Recover" means to reclaim energy or resources from the waste stream, by such means as composting.

According to Carless (1992), there are five major benefits to minimize municipal solid waste:

1. It conserves valuable natural resources and energy
2. It reduces the cost and volume of municipal solid waste disposed at landfill sites
3. It reduces reliance on landfills and extends their capacity
4. In some cases it produces a positive monetary return

5. It is a morally tenable solution.

In order to successfully manage and control increasing municipal waste disposal problems, we need to adopt an integrated waste management approach. This will likely involve the "reduce-reuse-recycle-recover" approaches combined with either landfill or incineration methods as final disposal techniques (Carless, 1992, 4). Waste minimization strategies that are comprehensive, and place a greater emphasis on a holistic approach to waste reduction, (that is, a program that equally emphasizes all the strategies of reduce, reuse, recycle and recover) should be implemented.

Recycling is one part of an overall solution to the problem. However, by itself, it cannot solve all municipal solid waste management problems. Many municipalities have preferred the recycling option over other alternatives, because approximately 75% of the municipal waste stream has recycling potential (O'Leary et al. 1988, 36). Yet, in 1991, Canadians only recycled 10% of their municipal waste stream; the rest was disposed of in rapidly filling landfill sites or it was incinerated. This does not compare favourably with recycling rates of 30% in Europe and 50% in Japan (Environment Canada, 1991, 1).

In 1990, Manitoba Environment drew up an action plan for waste minimization strategies in the form of the Waste Reduction Action Prevention Act (WRAP Act). This Act stated that the provincial goal was to achieve a 50% per capita landfill waste reduction by the year 2000, compared with 1988 figures (Manitoba Environment, 1991, 156). The WRAP Act is legislated as a "waste minimization" rather than a "recycling plan", due to the Province's stated preference for "reduce" and "reuse" approaches over a recycling approach (Manitoba Recycling Action Committee, 1990, 2). The WRAP Act recommends that whenever pragmatic, the "4 Rs" should be the preferred (Recycling Action Committee, 1990, 13).

One proposed approach to achieve the province's 50% solid waste diversion target was to hold producers and distributors who market their products in Manitoba accountable for drafting waste minimization plans for the waste produced by their products. The WRAP Act used the term "distribution chain" to describe those involved with and responsible for products because of their link to it.

Since enacting the WRAP Act, the province has delayed drafting regulations designed to hold producers and distributors responsible for the waste they generate. However, on July 14, 1993, a province-wide $8 million environmental stewardship plan, also called the Canadian Industry Packaging Stewardship Initiative (CIPSI) model was unveiled by the Environment Minister, Glen Cummings (Campbell, July 15, 1993, A1).

This stewardship plan holds the CIPSI, industry association of manufacturers and marketers of food, beverage and consumer products, as well as the publishers of Manitoba newspapers, responsible for creating an Industry Funding Organization (IFO) (Manitoba Government, July 14, 1993, 2). The IFO would provide a minimum three year commitment of capital and operating funds to municipalities for collecting and processing recyclable materials (Manitoba Government, July 14, 1993, 2). Furthermore, the plan proposes to implement a multi-material curbside recycling service for recyclable materials in Winnipeg, largest city in the province (Manitoba Government, July 14, 1993, 3). At present, it is one of the few North American metropolitan areas lacking a comprehensive recycling program.

1.2 Statement of Purpose:

This study was prepared for the city of Winnipeg, North West Works and Operations District. The purpose was to conduct a feasibility study that would integrate a recycling

system for the city's automated solid waste collection Phase I area.

1.3 The Importance of the Study:

Winnipeg lacks a comprehensive and efficient recycling program, thus there is a need for an efficient program. Recently, the city of Winnipeg implemented phase 1 of automated solid waste collection system in the north-end part of the city, namely, part of the Lord Selkirk-West Kildonan community, also known as the North West Works and Operations District. At the present, the system lacks a recycling component. This study addresses the issue of integrating a recycling system with the city's automated solid waste collection phase I area.

To implement such a program, there is a need for a feasibility study to determine if it is viable to integrate a recycling component to the above noted area.

1.4 Objectives of the Study:

The following comprise the overall objectives of the study:

1. To identify from pertinent literature the efficiency variables and conditions that affect municipal recycling programs.
2. To design a prototype recycling program for the city's Phase I automated solid waste collection based on a review of the literature and case study findings.
3. To evaluate the prototype program based on evaluation criterion identified in the literature review.
4. To recommend a recycling program based on results of the evaluation of the prototype program.
5. To submit conclusions, recommendations and further research to the client based on

study results.

1.5 Methodology:

The study uses the following four research methods:

1. Predicting the potential amount of targeted materials by estimating the study area's material recovery amount and whether collection schedule and number of trucks can handle the volumes generated (see prototype evaluation, 84-88).
2. Through calculations, determining the technical reliability of the collection equipment and if it is suitable to handle the volume of targeted materials and durability of the equipment (see prototype evaluation, 88-91).
3. Conducting a public opinion survey to determine the respondents' long term commitment to recycling and their acceptability of the prototype program (see program evaluation, 91-120).
4. Conducting a detailed benefit-cost analysis to determine economic viability of the program (see prototype evaluation, 120-140 and recommended program, 148-156).

1.6 Practicum Constraints:

There are five limitations, within which this study worked:

1. The automated solid waste collection system has only been in operation for one year. With such a short operational history there are limited generalizable financial data. It is, therefore, difficult to accurately project the technical and financial feasibility of the proposed program that allow assumptions to be made.

2. Waste composition information, that is, a waste audit breakdown of the quantity and quality of solid waste is not available for Winnipeg. The study will, therefore, make assumptions about waste components based on Metropolitan Toronto's (1991) waste composition study.

3. The study assumes the use of identical collection equipment to that currently used in the solid waste collection system.

4. It is beyond the scope of the study to conduct an intensive market analysis. Therefore, only local markets will be assessed for the materials collected by the program.

5. It is beyond the scope of the study to determine the effects of the prototype program on existing collection programs operating in Winnipeg.

1.7 Organization:

The study is divided into seven chapters (see Figure 2). Chapter 2 reviews the literature on recycling behaviour and recycling programs. The recycling behaviour section includes factors that encourage or discourage recycling. The recycling programs section reviews distinct curbside, and drop-off/buy back program features. Based on the literature review findings, evaluation criterion would be developed and were used to evaluate the prototype and recommended programs.

Chapter 3 reviews and identifies existing local conditions in the city's automated Phase I collection area. An overview of physical features, demographics, and economic characteristics is presented. Furthermore, a waste composition estimate projecting the potential type and amount of material to be recovered from the study area is reviewed. This chapter also reviews and discusses the current automated solid waste collection system and

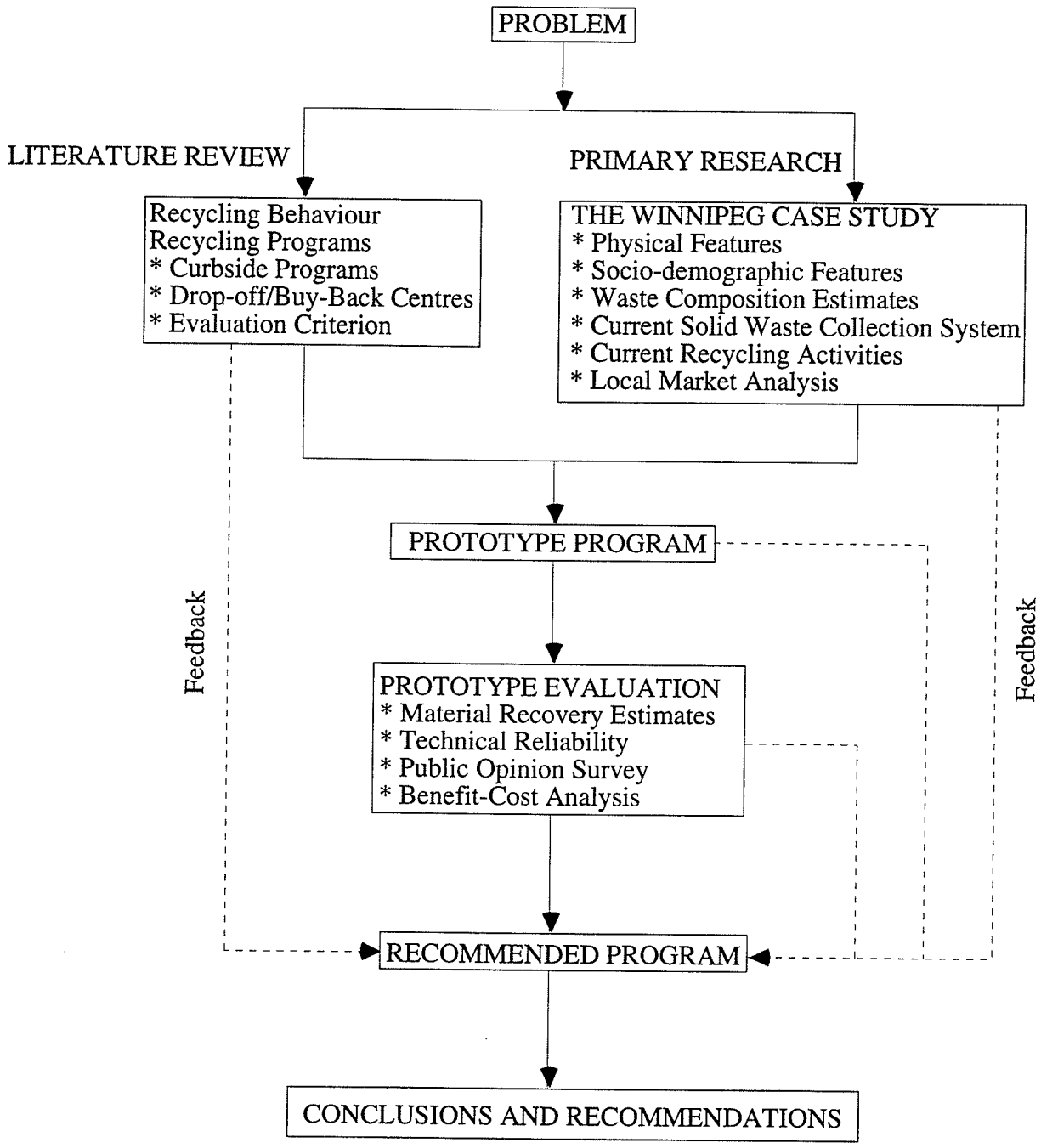


Figure 2: Research Framework

current recycling opportunities available to the people residing in the study area. Finally, local markets for potential materials to be collected, by the program, are analyzed.

Based on the literature review and Chapter 3 research results, Chapter 4 presents a prototype program which includes such features as: collection equipment and truck requirements; home storage container provisions; types and numbers of materials to be collected; material preparation requirements; collection frequency and schedule; and initial promotional and educational campaigns.

Chapter 5 evaluates the prototype program, using efficiency criterion identified in the literature review. Material recovery estimates are used to determine the potential types of materials that could be recovered. The technical reliability section analyzes and evaluates the equipment to be used for material storage and collection. The public opinion section reviews and analyzes a survey on participants' attitudes, behaviours and opinions towards the proposed program. The survey results are presented and significant variables and their relationship to the research literature are also discussed.

The final section consists of a benefit-cost analysis. This section discusses the capital, operating, initial promotional and educational campaign costs, their potential revenues from the types and volumes of materials collected, and the dollar value for waste recovered per category. This analysis also includes both costs and savings generated from implementation of the prototype program.

Chapter 6 describes recommended program based on the outcome of the prototype evaluation, the literature review, and the local condition assessment results chapters.

The final chapter presents conclusions, recommendations, and the need for further

research.

1.8 Glossary of Terms:

The following glossary of terms will be used throughout the study.

Aluminum containers:
Aluminum beverage and beer cans.

Avoided collection costs:
Solid waste management savings resulting from recycling, such as, extending solid waste equipment life, and extending collection routes.

Avoided disposal costs:
Savings through recycling as a result of reduced waste hauling requirements such as, avoided tipping fees, (a charge assessed for unloading solid waste at a landfill or transfer site) and other operational costs.

Capture rate:
The percent of available recyclable material actually recovered divided by the total targeted materials available.

Commingling:
The combining of two or more recyclable materials into one category.

Diversion rate:
The percentage of waste recovered and effectively diverted from disposal through recycling.

Household storage container:
Buckets, bins, or bags supplied by a recycling program for use by residents for interim storage materials prior to collection day.

MRF:
An acronym for Materials Recovery Facility. A facility for the processing and marketing of source-separated recyclables for end users.

MSW:
An acronym for municipal solid waste. Includes residential, commercial, and institutional solid waste.

ONP:
An acronym for old newspapers.

Participation rate:

The percentage of households that actually participate in a recycling program.

Processing:

The sorting, cleaning and packaging of recyclables so that they are ready to ship to end markets.

Recovery rate:

The percentage of a given material that is recovered by a recycling program.

Set out rate:

An empirical measure by counting number of individual households that set-outs materials on collection day over the total number of households served.

Stewardship:

Taking responsibility; caring for and protecting an entity such as resources and the planet.

Source separation:

The separation of recyclables from the solid waste stream at the point of generation (typically in the home), to keep them clean and improve their marketability.

Tin containers:

Refers to tin food cans.

Waste audit:

A statistical analysis of the waste flow composition in the disposal system.

CHAPTER 2

LITERATURE REVIEW

The literature review is divided into four sections. The first section reviews recycling behaviour, including factors which influence recycling. The second section reviews collection programs, such as curbside, and drop-off/buy-back centres. The third section discusses the evaluation criterion based on the literature review findings. The final section summarizes the program features. In each section, Canadian program examples, where they exist, or American examples will be used to illustrate particular program features.

2.1 Recycling Behaviour:

Percy (1984), and Folz (1991) found that public involvement in the decision making process, such as program design and planning led to corresponding feelings of duty, obligation, or responsibility. These research suggests that to achieve high participation rates and corresponding waste stream diversion in any solid waste recycling program, it is essential to involve the public in such elements as strategic planning, policy inception, action plan development and decision implementation.

Allan, Platt, and Morris (1989), Platt, Doherty, Broughton and Morris, (1991) and Folz and Hazlett (1991) found policies mandating participation or policies that set specific recycling or waste diversion goals, promoted higher recycling rates. For example, in the early 1980's, Islip, New York implemented a voluntary recycling program. Over time, participation rates dropped significantly from 50% to 30-35%. When the city passed a by-law

making program participation mandatory, within a few months, participation rates rose to 90% (Glenn, 1989a, 31).

Vining; Linn and Burdge (1992) and McCornack (1993) found that psychological research has focused on two basic motivational approaches to recycling behaviour. The first approach concentrates on processes designed to influence participants' behaviour. Offering monetary rewards or enforcing penalties for not recycling are two examples of this approach. The second approach centres on the values, beliefs, intentions and attitudes that might influence participants' behaviour. Dunlap and Van Liere (1984), De Young (1986) and Vining and Ebreo (1990a) suggest that participants are encouraged or discouraged by factors, such as concern for the environment, or waste reduction. Furthermore, De Young (1986), De Young and Kaplan (1985-86) and Diamond and Loewy (1991) suggest that authentic motivations, such as feeling good about the community or the environment or personal satisfaction, were significant inducements for individuals to recycle. However, these same studies indicate that when rewards or penalties were removed, participants' behaviour returned to that of a non-recycler.

Vining and Ebreo (1989) found that factors such as social influence from family members, peers, friends, neighbours and the community influenced recycling behaviour, but not to same extent as convenience. The same study found that a lack of support or pressure from members of the household led to non-conservation behaviour. In addition, Vining and Ebreo (1990a) found that individuals living in communities offering few recycling opportunities were unlikely to have negative attitudes towards recycling. On other hand, Luyben and Bailey (1979) and Vining and Ebreo (1990b) found that the people who felt that sorting, storing and transporting materials to be personally inconvenient and those who

believed that recycling was not a worthwhile activity, were unlikely to recycle.

Folz (1991), Folz and Hazlett (1991) and Platt et al. (1991) agree that accessibility to recycling information creates awareness and may influence behaviour. Bennett (1990) suggests that long term program success depends on the quality of the service offered. The same study stresses that programs providing educational and promotional information were successful in positively influencing recycling behaviour.

Mass media campaigns have proven to be a positive means of promoting recycling (McCornack, 1993, 10:10 and Wolfe, 1993, 30:3). A survey conducted by Byrd et al. (1989) showed that more than one-fifth of the respondents indicated they did not recycle because there was a lack of information on how or where to participate. Burn and Oskamp (1986) investigated the effects of information and public commitment on recycling behaviour. The study found that using individual or a combination of variables was an effective means of increasing recycling behaviour. For example, Luyben and Bailey (1979) found that using the combination of flyers, as an information tool, and container location as an convenience tool, increased participation rates by nearly 50%.

Charging a mandatory user fee for volume-based garbage collection service encourages recycling behaviour. Parker (1989), for example, reviewed Seattle, Washington user fee approach. A flat fee of US $13.75 per month was charged for the first can of garbage and US $9 for each addition can of garbage; however, this program was coupled with a free of charge recycling option. Over time, local administrators found a reduction in waste generation and an increase in recycled materials. Therefore, a mandatory user fee for solid waste collection influenced behaviour with respect to recycling and waste generation.

Vining et al. (1992) studied local solid waste management planning to determine whether socio-demographic characteristics affect a community's recycling behaviour. The study results indicate that local solid waste management planning can be influenced by public perception of local governmental preferences or by the allocation of funds for community recycling. However, many researchers, have found that the relationship between socio-demographic variables and concern for the environment have been unclear. While, the Van Liere and Dunlap (1980) study suggests that socio-demographic variables such as age, income, educational level, home ownership, occupation and gender correlate positively to environmental awareness, they cite the Sandahl and Robertson (1989) study which detects a negative relationship between environmental concern and socio-demographic variables.

The Van Liere and Dunlap (1980) and De Young (1986) studies suggest that young, well-educated individuals with high incomes tend to express more concern for the environment. Vining and Ebreo (1990a), however, found that recyclers were older and belonged to a high income group. In contrast, Sandahl and Robertson (1989) found a negative relationship among education, age and environmental concern. The Neuman (1986), Oskamp, Harrington, Edwards, Sherwood, Okuda and Swanson (1991) and Vining and Ebreo (1990b) studies found that socio-demographic variables do not discriminate recyclers from non-recyclers. Both De Young (1984) and Vining and Ebreo (1990a) agreed that females were more environmentally conscious than males. The Vining et al. (1992) study results indicated that all races were equally concerned about the environment, but black populations had lower rates of environmental participation. Folz and Hazlett's (1991) study of programs using the neighbourhood or meeting approach to create awareness and to educate found that over time they experienced higher levels of participation and waste diversion.

In summary, a number of studies have found that passing or setting specific recycling goals can lead to high participation and waste diversion rates. On the other hand, providing benefits and penalties can also influence overall behaviour. A number of studies have found no significant correlation between demographic variables and recycling behaviour. Some studies suggests that effective promotion and education campaigns can influence overall recycling behaviour. On the other hand, in communities with no accessibility to any type of recycling programs, residents tend to have non-recycling attitudes and behaviours.

2.2 Municipal Recycling Programs:

In 1991, 73 of 83 Canadian municipalities with a population over 50,000 had some type of recycling program (Canadian Press, March 26, 1993, A3). There are generally 2 types of programs accessible to residents: curbside pick-up, and drop-off centres.

2.2.1 Curbside Programs:

In the past decade, curbside programs have become a popular form of recycling, since they produce relatively high participation rates given their relative convenience. By the end of 1992, the United States had nearly 5,400 curbside programs in operation (Steuteville and Goldstein, 1993, 42). However, numbers are unavailable for Canadian programs in operation. Curbside programs are considered the most convenient and effective form of recycling for single-family, and low-rise multi-family units. In a typical curbside program, participants separate certain types of materials at source and place them at the curbside (or in an alley) for pick-up by a collection vehicle.

Glass Packaging Institute (1988), Platt et al. (1991), Carless (1992), Reinfeld (1992)

and Friedman (1992) have found that there is a direct relationship between convenience and the effectiveness in typical curbside programs. The key convenience factors include source separation of materials by participants, weekly scheduled garbage-day curbside collection, and the use of either containers, buckets or bags to store materials. The program is capable of diverting between 10-15% of residential waste, (between 4-5% of the total waste stream) from landfill sites and is capable of achieving participation rates in excess of 75% (Dillon, 1990, 13).

Factors such as mandatory versus voluntary participation, types of materials collected, collection frequency, provision of home storage containers, day of collection, collection crew, and collection equipment all affect participation levels and waste diversion rates and the cost of operating the program. These are discussed separately in the following sections.

2.2.1.1 Mandatory versus Voluntary Participation:

In curbside programs, participation can be either mandatory or voluntary. In a mandatory program, enacted legislation requires householders to separate specified recyclable items from their household waste. In a voluntary program, households participate in the program by choice.

Platt et al. (1991) and McMillen (1993) suggests that mandatory curbside programs can achieve high participation rates which result in higher volumes of materials being diverted from landfill sites. Furthermore, the programs can be made cost efficient and legislation helps to demonstrate the importance of the program to participants. Participation enforcement should assure that both the public and the local municipality have input into the design and implementation of the program.

Allan et al. (1989) and McMillen (1993) suggest that mandatory curbside programs also have several disadvantages. They require frequent monitoring and enforcement which can be difficult in certain circumstances such as high-rise apartment buildings. In Tacoma Park, Maryland, the recycling coordinator periodically travels on collection routes to monitor household garbage for recyclables. If recyclables are found in regular garbage, the household is issued a warning notice. If households fails to comply again, the resident is charged a fine of US$20 for noncompliance (Roy and Tyrone, 1991, 71). If households fail to participate in the recycling program, their garbage is not collected.

Platt et al. (1991) suggest that voluntary curbside programs, if promoted with extensive public education, are capable of achieving substantial levels of participation and waste diversion. However, in voluntary programs, participation and recovery of the materials can be minimal and make the program economically and politically unacceptable. Platt et al. (1991) found that mandatory curbside programs were more successful than voluntary programs. In his sample, participation rates for 17 mandatory programs average 90%, while participation in 7 voluntary programs average only 54%. According to Folz and Hazlett (1991), mandatory programs average a 74.3% participation rate and divert an average of 21.6% of waste. On other hand, voluntary programs averaged a participation rate of only 39.7% and divert an average of 12.2% of waste.

In the Platt et al. study, 9 of the 13 mandatory curbside programs used an enforcement system, such as refusal to pick-up garbage, and fines for non-compliance. However, mandatory programs with no enforcement system had the lowest participation rates. On the other hand, voluntary participation programs had high participation rates owing to various types of incentives. Seattle, Washington, for example, used mandatory volume-based

garbage collection rates for residential solid waste collection service while providing recycling service at no cost. Some of the program examples using a mandatory participation approach are: Islip, New York; Hamburg, New Jersey; and Wellesley, Massachusetts. No Canadian programs were identified in the literature as having employed this approach. Examples using a voluntary participation approach include: Brampton, Ontario; the Borough of East York, Ontario; and District of Surrey, British Columbia.

2.2.1.2 Source Separation versus Commingled Collection:

In curbside programs, an important decision is whether to source separate, partial commingle or fully commingle materials. In source separation, participants are responsible for the separation of each kind of recyclable material from all other recyclables. In this approach, the materials collected require only a minimal level of processing before being marketed. From the program operator's point of view, complete separation is the preferable approach, because it saves sorting and processing costs. However, it may discourage participation owing to the extra effort required for sorting and the space needed for storing recyclables by type in the home. Some of programs using full separation collection approach are: Austin, Texas; San Jose, California; and the State of Rhode Island.

In partial commingling, materials such as metal cans, plastic and glass containers are stored in one household container, while materials such as newspapers and old corrugated cardboard are kept separate, usually bundled or bagged. Commingled materials are sorted at a processing facility, and then shipped to the market.

This approach is more convenient for participants and increases overall collection efficiency. It can also accommodate changes to the mix of collected materials. Finally, this

approach requires fewer household containers to store materials, which reduces container costs. The disadvantage is that it may require a Material Recovery Facility (MRF), the cost of which depends on the degree of commingling and the number of materials collected.

Resource Integration Systems Limited/Resource Conservation Consultants, Pacific/West Communications Group Incorporation, DPRA Incorporation, Recovery Sciences Incorporation, Irvin Hampton and Company, Joanne Kumamoto and Associates, CM2M HILL, TreePeople, Maurice Sampson and Associates, Uyeda and Associates, Leslie Song Winner and Associates and Moya, Villanueva and Durazo (1989), Bullock and Burk (1989) and McMillen (1993) agree that if a program collects fewer than four types of materials, the instating of MRF can be avoided, by authorizing private companies to sort or ship materials. Since, participants are required to do minimal sorting, the approach can result in higher levels of unrecyclable materials at the processing facility. The partial commingling collection approach is used in: Edmonton, Alberta; Toronto, Ontario; and Vancouver, British Columbia.

In the commingling approach, participants only separate recyclables from waste, sorting takes places at a processing facility. This approach simplifies recycling for participants, because it requires less storage space, and few containers to store materials. For participants, commingling is more convenient and, therefore, preferable to source separation and partial commingling. But for operators, a processing plant is labour intensive and instating a MRF requires a substantial capital. Furthermore, in this approach, materials have a greater chance of being contaminated which may affect quality, and market value. Program examples using commingling collection approach are: Mississauga, Ontario; Niagara Falls, Ontario; and Regional District of Nanaimo, British Columbia.

2.2.1.3 Numbers and Types of Materials:

The number and type of material to be collected depends on: a) the quantity of material in the waste stream; b) the existence of a market for the collected materials; and c) collection and processing requirements. Research suggests that materials such as old newspapers (ONP), plastic, metal cans, and beverage containers, generally need well developed markets to justify collection.

The Staff of Biocycle (1990) and Friedman (1992) suggest that if a program's principal goal is to divert materials from landfill or incineration facilities, then the number and type of materials collected and community participation are crucial for achieving any waste diversion goal. National Round Table of Environment and the Economy (1991) found that during the initial implementation stage, not all materials in the waste stream could be targeted for collection; some materials may be of poor quantity, or unmarketable. The study recommends that when feasible conditions exist, new materials can be added to the collection.

Glenn's (1992) findings confirm that it is advantageous to maximize the number and types of materials collected, but that such endeavours need caution. Local waste composition studies are necessary to examine whether significant quantities of material and suitable markets exist. In certain cases, industry commits itself to collect specific materials from programs. For example, in Peterborough, Ontario, plastic PVC (polyvinyl chloride) is collected in the local curbside program. Du Pont Canada along with the Plastic Film Manufacturers Association of Canada guarantees to buy all the plastic film material (Meade, 1992, 62).

2.2.1.4 Home Storage Containers:

The Glass Packaging Institute (1988), Resource Integration Systems Limited et al. (1989), Allan et al. (1989), The Staff of BioCycle (1990), Platt et al. (1991), Carless (1992), Reinfeld (1992), Friedman (1992) and McMillen (1993) have indicated that providing standardized home storage containers has positive effects on: a) participation levels; b) collection efficiency; c) program visibility; d) material recovery levels. Providing home storage containers add to the convenience of sorting and storing materials and encourages individuals to source separate. Table 1 illustrates participation rates before and after providing home storage containers, with Champaign, Illinois showing the greatest increase. Kitchener, Ontario experienced the smallest increase after providing home storage containers. However, between 5 cities, the participation rates averaged 40.2%, before providing home storage containers. On the other hand, after providing home storage containers, rates increased to 73.8%. In conclusion, home storage containers have positive effect on participation and waste diversion levels.

Table 1: Participation rates before and after providing home storage containers.

City	Before	After
Champaign, Illinois	11%	83%*
Kitchener, Ontario	65%	75%
San Jose, California	48%	75%
Santa Rosa, California	35%	70%
Toronto, Ontario	42%	66%

* Rate for one of five collection zones in the City. Average participation rate for all zones is 65%.

Source: Glass Packaging Institute. Comprehensive Curbside Recycling: Collection Costs and How to Control Them. Washington, D.C.: Glass Packaging Institute, 1988. 18.

Traditionally, curbside programs have used 3 basic types of home storage containers: single containers, stacking bins, and wheeled rolling carts. Containers are either round or rectangular shaped and range in size from 12 to 22 gallons depending on the number and type of materials collected. The cost of these containers range between US $4-$9.75 each depending on the size and number ordered (Glenn, 1989b, 49). A single container is suitable for commingled collection. Some program examples using a single containers: Edmonton, Alberta; Toronto, Ontario; and Vancouver, British Columbia.

Stacking bins usually consist of three rectangular containers, similar to milk crates, ranging from 12 to 14 gallons each. Multiple stacking containers are used for the collection of separated materials. The cost of three stackable containers range from US $14-$20 (Glenn, 1989b, 49). Although expensive, stacking containers have been very successful in Jacksonville, Florida, San Jose, California and Seattle South, Washington. According to Schmerling (1990), they have generated the highest set-out rates, with the lowest collection

time.

Wheeled rolling carts range in size from 32 to 105 gallons and cost between US$18-75 each (Glenn, 1989b, 49). They are appropriate for collecting large amounts of material, on a monthly basis. Some programs using this type of container are: Guelph, Ontario; Phoenix, Arizona; and Seattle North, Washington.

Some programs include lids to protect materials from contamination and wind, while others, provide dividers to separate materials. Schmerling (1990) recommends that containers have holes in the bottom, to ensure water drainage and to discourage other uses. The study also recommends that containers are imprinted with a program logo. Meade (1992) found that using attractive container colours, especially blue, enhanced participation. All of the above studies suggested that containers be made of durable plastic. Other container options are: woven bags, plastic bags, and round buckets. According to Platt at al. (1991), program decision makers must consider whether containers can accommodate future program growth, in terms of additional materials included in the collection program.

Home storage containers significantly increase the convenience factor and participation rates. Most Curbside programs in North America provide home storage containers. Some of program examples providing home storage containers are: Burnaby, British Columbia; North York, Ontario; and Vancouver, British Columbia.

2.2.1.5 Collection Frequency:

Weekly, bi-weekly, and monthly collection options can be employed to collect materials. Grove (1989), Platt et al. (1991), Glenn (1991), Moore (1992) and McCornack

(1993) agree that frequent collection increases participation and set-out rates. The same studies concluded that the most convenient option was weekly collection, which appeared to encourage participation. Bi-weekly and monthly collection are inconvenient for participants, because it is difficult to remember collection day, and it creates storage problems, owing to the accumulation of materials over a longer period of time. All these factors, taken together, may discourage program participation.

Platt et al. (1991) found that programs with weekly pick-up had higher participation rates, compared with bi-weekly and monthly pick-up programs. Further, the study's survey determined that the average participation rate of the 8 curbside programs with weekly pick-up was 91%, compared with 81% in the 7 programs with bi-weekly pick-up. In Haddonfield, New Jersey, when the program switched from bi-weekly to weekly collection, a 150% increases in the collection of certain materials was experienced (Platt et al. 1991, 40). Some of programs which have adopted weekly collection service are: Edmonton, Alberta; Toronto, Ontario; and Vancouver, British Columbia. Some of programs with bi-weekly collection service are: Newcastle, Ontario; Niagara-on-the-Lake, Ontario; and Regional District of Nanaimo, British Columbia. Some of programs using a monthly collection service are: Berkeley, California; Seattle South, Washington; and West Linn, Oregon.

2.2.1.6 Day of Collection:

The National Association of Towns and Townships (1989), Grove (1990), Resource Integration Systems Limited and Waste Matters Consulting (1990), Moore (1992), Resource Integration Systems Limited (1993) and McMillen (1993) indicate that there is a relationship between participation rate and day of collection. These studies found that simplicity

encouraged participation. If the service was provided on regularly scheduled days, preferably on the same day as garbage collection service, participation rates were higher than if collection days varied.

Waste Age magazine's (1988) survey findings indicate that participation rates averaged 76% when recyclables were scheduled to be collected on the same day as garbage pick-up. On the other hand, participation rates averaged 41% for separate day pick-up. Some of programs examples which have adopted same day recycling and solid waste collection service are: Etobicoke, Ontario; Guelph, Ontario; and Richmond, British Columbia. Some of programs examples that use different collection days to collect recyclables and solid wastes are: Edmonton, Alberta; St. Cloud, Minnesota; and Toronto, Ontario.

2.2.1.7 Collection Crew Size:

Garbage and recycling collection services differ in a number of aspects. Generally in recycling pick-up service, fewer stops are made, even in the programs with the highest participation. According to the Glass Packaging Institute (1988) study, recycling collection vehicles stop at 30-50% of homes, while on the same route, garbage collection vehicles stop at every home. The same study also found that one-man crews are the more efficient than either two or three person crews. On average, daily stops by a one person crew were 275, compared with 138 for two-person crew (Glass Packaging Institute, 1988, 20). Some of programs using one-person collection crew are: Davis, California; East Greenwich, Rhode Island; and Seattle, Washington. Some of programs using two or more person crews are: Edmonton, Alberta; Toronto, Ontario; and Vancouver, British Columbia.

2.2.1.8 Collection Vehicle:

Recycling vehicle design can have a significant impact on collection efficiency and, therefore, vehicle selection is important. According to the Editor of BioCycle (1989), generally three types of vehicle design are used to collect recyclables: open top trucks, closed body hydraulic trucks, and trailers. The open top trucks have the flexibility of dividing into three separate bins that can be loaded and unloaded either at the side or rear. In this truck, loading is done manually. These vehicles' capacities range from 11 to 28 yd^3, depending on whether it is a single or multiple-type design. The estimated price of these trucks range between US $35,000 to $60,000 (Graham, 1993, 27.10). The disadvantages of these trucks are the high loading height and the inflexible bin sizes.

Closed body hydraulic trucks have a compartmentalized enclosed body and can be loaded from the side and unloaded from the rear. The truck's compartments can be adjusted to allow for different volumes of material. This truck has a constant low loading height, which is advantageous for the collection crew. The truck's capacity is usually over 30 yd^3. which enables it to serve longer collection routes. The closed trucks typically range in price from US $60,000 to $85,000 (Graham, 1993, 27.10).

Traditionally, North American programs have used trailers as collection vehicles, owing to their relatively low cost compared with trucks. However, in the past few decades, trailers have lost a considerable market share to trucks, primarily owing to their lack of manoeuvrability and capacity (The Staff of Biocycle, 1990, 118). The estimated price of these trailers range from US $11,000 to $20,000 (Graham, 1993, 27.9).

2.2.1.9 Program Costs:

Typical curbside programs have high implementing and operating costs, extensive and complex program management, material processing expenses and education and promotion costs. Capital costs may include the purchasing or leasing of household containers, collection vehicles, storage sites, and processing equipment. Operating costs may include labour, education and promotion costs, transportation and maintenance costs, and the amortization of debt, if money is borrowed to finance the program. Grants from various governmental agencies and organizations and revenues from the sale of processed recyclables are some of the sources of income. In addition, avoiding disposal costs and extending the life of landfill sites are other major economic benefits.

Glass Packaging Institute (1988), Resource Integration Systems Limited at al. (1989), The Staff of BioCycle (1990), Platt et al. (1991), Carless (1992), Reinfeld (1992), Moore (1992) and McMillen (1993) have found curbside programs to be the most expensive method of collecting recyclables. A survey conducted by Glenn (1990) indicated that in 1990 program costs ranged from approximately US $1-$2.80 per household per month. According to Rick Findlay of the First Consulting Group, it costs Ontario's Blue Box program between CDN $200-$300 per tonne to collect recyclables, when all hidden costs are included (Cummings, 1992, 16), while, operating costs of Edmonton's curbside program have exceeded CDN $200 per tonne (McKeen, April 5, 1992, E1). A survey by Recycling Council of British Columbia (1991) and Miller (1993) confirms the findings. British Columbia's Blue Box curbside program operating costs range from a high of CDN $300 per tonne in the outer areas of the Capital Regional District on Vancouver Island to a low of CDN $77 per tonne in Penticton (Recycling Council of British Columbia, May 1992, 6).

Miller (1993) agrees that curbside collection costs are high and often range between US $115-$120 per ton. However, these costs do not take into consideration processing cost, revenue from sale of recyclables and external savings, such as, extending the usable life of landfills and solid waste disposal savings.

The program's high costs can be attributed to the enormous expenses incurred to provide: home storage containers, collection vehicles, public promotion and education outreach program and a MRF. Many programs have found that revenues from the sale of processed recyclables only marginally offset operating costs. They have therefore, relied heavily on government grants and other subsidies for operation. Brown, Vence and Associates (1992) findings suggest that typical overall curbside program costs for home storage containers, collection vehicles, and processing capabilities range between US $10,000-$100,000+. These capital costs varied depending on the size of the service area and the number of households served.

2.2.2 Drop-off Programs:

Drop-off programs represent the most common form of community recycling. In this paradigm, participants source separate recyclables and transport them to designated drop-off collection sites. These programs can range from simple un-staffed material collection containers to staffed multi-material collection depots. Un-staffed facilities are typically situated in prominent and visible locations, such as shopping mall parking lots, schools or other public buildings, and are accessible at any time of the day. On site, large clearly marked containers, are set out to collect specified materials. Owing to their economic value and the availability of markets, the most commonly collected materials are newspapers, metal

cans, and beverage containers. From various program experiences, have found that longer hours of operation increase convenience and participation and waste recovery.

Another notable factor boosting participation is education. Basic information, such as, why, and how to participate, the location of drop-off sites, hours of operation, and materials accepted by the program could have a significant effect on overall participation levels. Distance to drop-off centres is another influential factor. Watson (1990), Reinfeld (1992), Levetan (1993) and McMillen (1993) have found that the further the distance the public has to travel to participate in these programs, the less likely they are to recycle.

Schlauder (1991), and the National Round Table on the Environment and the Economy (1991) and Levetan (1993) described the importance of highly visible locations and public accessibility to drop-off sites for both the public and the service provider. Furthermore, these studies stressed that the sites should have all weather paved surface accessibility. Watson (1991) and Reinfeld (1992) have shown that the public patronize a centre only if it is within a few kilometres from their home. Larger programs tend to operate several drop-off centres in the community.

Another important factor is the program's expansion flexibility. Not only can they collect the traditionally recycled materials, such as newspapers, plastic, glass beverage bottles and metal cans, but as they grow they can also achieve significant recovery rates by including non-traditional materials such as batteries, scrap metal and used motor oil. The National Round Table on the Environment and the Economy (1991) recognized that involving community non-profit groups can boost participation. Successful drop-off programs include: Maple Ridge, British Columbia; Kelowna, British Columbia; and Windsor Lake, Nova Scotia.

Watson (1990 and 1991) and McMillen (1993) reported that mobile drop-off sites can be used in urban, suburban or rural areas, where curbside and stationary drop-off sites do not exist. These mobile centres use enclosed tractor trailers, panel trucks, or compartmentalized trailers. This approach can generate awareness and recycling interest in a neighbourhood. Centres usually operate on previously announced locations and collection generally takes place on weekends.

A buy-back or redemption centre is similar to a drop-off program; except that it offers financial incentives for recyclables to encourage participation. But, the system only accepts marketable recyclables with restricted levels of contamination.

The location of the buy-back centres is usually not as convenient as drop-off centres. Since, buy-back centres operate for a profit, their collection and processing take place on a strategically located site. The public, therefore, must transport their recyclables to either designated centres or at the redemption centres. Since buy-back centres are staffed, their hours of operation are limited compared with drop-off centres. Successful buy-back programs include: the province's Manitoba Soft Drink Recycling Incorporation (MSDR) mobile depots, Alberta's beverage container depots and the State of California's redemption depots.

Although curbside programs have been more popular and more thoroughly researched, drop-off programs have the potential to be effective in diverting recyclables from the waste stream. The Staff of BioCycle (1990) and Carless (1992) agree that in many municipalities, these programs have been effective, when curbside program were less feasible. Drop-off programs can also be used as pilot projects, for communities not previously engaged in recycling activities. The National Round Table on the Environment and the Economy

(1991) described these programs is suitable for municipalities with lower population densities, or for those generating smaller volumes of recyclables.

2.2.2.1 Participation and Recovery Rates:

A 1988 BioCycle (1990) study of 10 drop-off programs, found that participation rates ranged between 4-30%, while waste recovery rates ranged between 5-13%. The Mielke and Walters (1988) study found that these systems achieved participation rates between 10-20%, but only diverted between 1-7% of the total waste stream. Therefore, in both cases participation and waste stream diversion was low compared with curbside programs. Unlike, curbside programs, which provide participants with the convenience of curbside collection, and home storage containers, drop-off programs do not provide these conveniences.

A number of studies have examined participation rates in curbside and drop-off programs, but less importance have been given to participation rates in buy-back centres, and therefore, results are unavailable. Brown, Vence and Associates (1992) findings suggest that provision of monetary rewards, however, are a strong incentive to recycle, therefore, it is assumed that participation rates in buy-back programs are slightly better than those of drop-off centres.

Brown, Vence and Associates (1992) found that waste diversion from buy-back centres were higher than for drop-off programs, but they still only diverted less than 5% of the residential waste stream. Furthermore, the same study found that these program achieved higher waste diversion rates when strong market prices for recyclables exist.

2.2.2.2 Program Costs:

Drop-off systems have fewer operating costs, because participants bring their recyclables directly to the designated sites and only a minimal staff is required to manage sites. The major costs in drop-off systems are the installation of containers and the transportation of recyclables to processing facilities. In addition, other costs may include processing, equipment and facility requirements. Some drop-off programs are capable of avoiding these costs by appointing brokers to process and market materials. According to Brown, Vence and Associates (1992), operating costs are relatively minimal compared with other recycling options. Operating costs range between US $15-$75 per ton and the approximate cost of the waste diverted ranges between US $10-$50 per ton. Buy-back centre operating and waste diverted costs are slightly higher than those for drop-off programs. Depending on drop-off program design, capital costs range from US $10,000-$50,000 per site, while, buy-back centre capital costs are greater than US $100,000. In most programs, recyclables recovered from the system can cover operating costs.

The National Association of Towns and Townships (1989), Brown, Vence and Associates (1992), and Carless (1992) acknowledge that buy-back programs are more expensive than drop-off centre. Buy-back programs require more administration, skilled labour, storage space, equipment, and machinery to process and transport recyclables. Furthermore, market conditions determine the type of materials collected by the program. Buy-back programs collect only highly valuable recyclable materials, such as aluminum, and ignore recyclables with unstable markets.

Brown, Vence and Associates (1992) estimate that capital costs for multi-material

facilities with processing capabilities are roughly US $100,000. Equipment requirements depend on the number and types of materials targeted and market specifications. The cost of the waste diverted from a buy-back program ranges between US $30-$60 per ton. As in drop-off centres, the revenues have the potential to cover operating costs.

2.3 Program Evaluation Criterion:

Based on the literature review findings, the following evaluation criterion were formulated to evaluate the prototype and recommended programs: material recovery estimates, technical reliability, a public opinion survey and benefit-cost analysis.

The purpose of the material recovery estimates is to estimate the potential amount of targeted materials and whether the proposed collection schedule and number of trucks can handle the volumes generated. Technical reliability is meant to determine if the collection equipment is suitable to handle the volume of targeted materials and durability of the equipment. The public opinion survey would determine long term commitment to recycling and public acceptability of the program. Finally, the purpose of benefit-cost analysis is to determine the dollar value for waste recovered per category and determine overall economic viability of the program.

2.4 Summary:

It appears from the literature review that two of the most important elements in any recycling program are participation and waste diversion rates. Recycling behaviour findings reveal the importance taking into consideration participants' attitudes, behaviour and perception of convenience during the designing and planning stages of a recycling program.

Many studies have attempted to discover a relationship between participants' behaviours and attitudes with respect to recycling. However, only few have found positive relationship among behaviour, attitudes and recycling. Motivational factors such as altruism, convenience, financial incentives, penalties, home storage containers, education and program promotion positively influence recycling behaviour. Studies agree that enacting a mandatory participation by-law leads to significantly increased participation and waste diversion rates.

Studies have also found that there is no positive correlation between socio-demographic variables and recycling behaviour. However, researchers did find a relationship exists between socio-demographics variables and environmental concerns.

Curbside collection is both a convenient and effective means of recycling for single family dwellings. It is capable of achieving in excess of 75% participation rates and between 10-15% waste diversion levels. Factors, such as, mandatory participation, collection frequency, collection day, home storage containers, and material preparation requirements significantly affect participation and waste diversion levels. However, these factors also affect overall program implementation and operating costs. In general, researchers found that curbside programs are very expensive to implement and operate, compared with other recycling options.

Drop-off programs are voluntary and generally capable of achieving between 5-25% participation rate and between 5-10% waste diversion from residential waste stream. Another typical perception about these programs is that they are inconvenient because the public must transport their recyclables to designated centres. Education and convenience are factors that can generally increase participation and waste diversion levels in these programs.

On the other hand, drop-off program are cost effective compared with other recycling options, owing to low operating and processing costs. Buy-back centres tend to attract higher participation rates compared with drop-off centre, owing to monetary incentive offered for recyclables. But, buy-back centres are more expensive compared with drop-off centres, owing to higher administrative, labour and equipment costs. Furthermore, they incur higher implementation and operation costs. Table 2 provides a summary analyses of the two most popular recycling options, curbside and drop-off/buy-back centres.

Table 2: Recycling Program Analyses.

Criteria	Curbside program	Drop-off/Buy-back program
Participation rate	The program is capable of achieving participation rates in excess of 75%.	Drop-off programs are capable of achieving participation rates between 5-25% Buy back centres can attain slightly higher participation rates.
Waste diversion potential	The curbside pick-up program is capable of diverting between 10-15% of the residential waste or between 4-5% of the total waste stream.	The programs are capable of diverting between 5-10% of the residential waste or less than 2% of the total waste stream. Buy back centres can attain greater waste diversion than drop-off programs, but data are unavailable.

Table 2: Recycling Program Analyses. (Cont.)

Criteria	Curbside program	Drop-off/Buy-back program
Capital costs	Capital costs depend on the size of the area and the number of households served. Capital costs for home storage containers, collection vehicles, and processing capabilities range from US $10,000-$100,000+.	Depending on the program design, capital costs range from less than US $10,000 to $50,000 per site. Minimal processing equipment and facility requirements. Buy back centre's capital costs with processing capability are greater than US $100,000. Equipment and processing requirements depends on the number and type of materials targeted and market specifications.
Cost effectiveness	In most cases, material revenues are often insufficient to cover operating costs. Cost per diverted tonne range between CDN $77-$300.	In most cases, materials recovered from both drop-off and buy-back centres are sufficient to cover operating costs. In drop-off programs, cost per diverted ton range between US $10-$50. While, in buy back centres, cost per diverted ton range between US $30-$60. Buy-back programs' administrative, labour and facility requirements are substantial compared with drop-off programs.

Table 2: Recycling Program Analyses. (Cont.)

Criteria	Curbside program	Drop-off/Buy-back program
Operating experience	5,400+ programs in North America. Appropriate for single family dwellings only. Suitable for urban areas. Program design varies from one municipality to another. In recent years, it has become standardized.	2,000+ programs in North America. Appropriate for all types of dwellings. Suitable for both urban and rural areas. Several thousand buy-back operations exist in North America. Wherever material markets exist, buy back centres have been established. Both drop-off and buy-back centres are technically and operationally reliable options.
Operating costs	Operating costs range between CDN $75-$300+ per tonne.	Operating costs range between US $15-$75 per ton. Buy-back centres operating costs are higher than those of drop-off programs.

* 1 tonne = 2,204.62 lbs.
1 ton = 2,000 lbs.

CHAPTER 3

THE WINNIPEG CASE STUDY

The purpose of this chapter is to identify and analyze distinct Winnipeg area conditions that might affect the overall design of the prototype recycling program. This chapter is divided into 6 sections: the first deals with general background information; the second examines existing physical and demographic conditions; the third analyses waste composition estimates; the fourth reviews current automated solid waste collection practices in the Winnipeg's Phase I automated solid waste collection area; the fifth examines current recycling opportunities available to the residents of the study area, and; the final section examines local recyclable materials market.

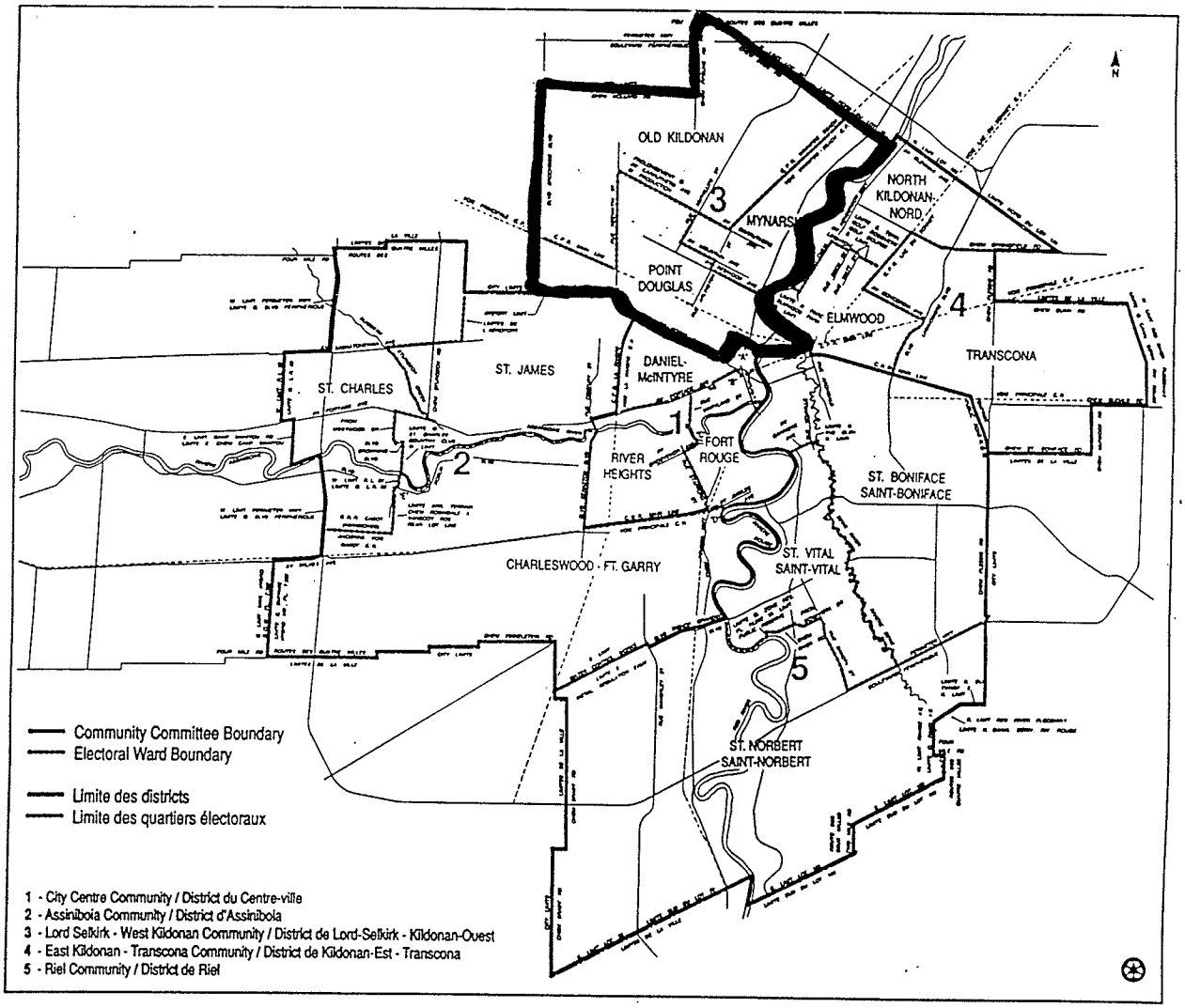
3.1 Background Information:

Winnipeg, the capital and largest city in Manitoba is located at the junction of the Assiniboine and Red Rivers. The city is situated midway between the Atlantic and Pacific Oceans. Owing to its strategic geographical location, it has become a major transportation, industrial, warehousing, financial, distribution, retail and cultural centre of Western Canada (Winnipeg's Henderson Directory, 1993, 7). Furthermore, the extension of the transcontinental railway line, created enormous urban growth and prosperity (The Canadian Encyclopedia, 1988, 2316). The city is 571.60 km^2 in area and has a population of approximately 652,354 (1991 Census Data).

Over the decades, Winnipeg has witnessed numerous physical changes, such as, the creation of Unicity (1972), and the separation of Headingley from Winnipeg (1992). The

high costs of providing basic public services, such as street repairs and cleaning, garbage collection and snow removal, along with recent funding cuts, has lead to a reorganization and creating new community ward boundaries (see map 1). The automated solid waste collection Phase I area is located in the Lord Selkirk-West Kildonan community (highlighted area) consisting of Old Kildonan, Mynarski and Point Douglas wards.

Map 1: Location of the automated solid waste collection Phase 1 area in the context of Winnipeg.



Source: Winnipeg's Planning Department, Winnipeg, MB. 1993.

3.2 Physical and Socio-Demographics Analysis:

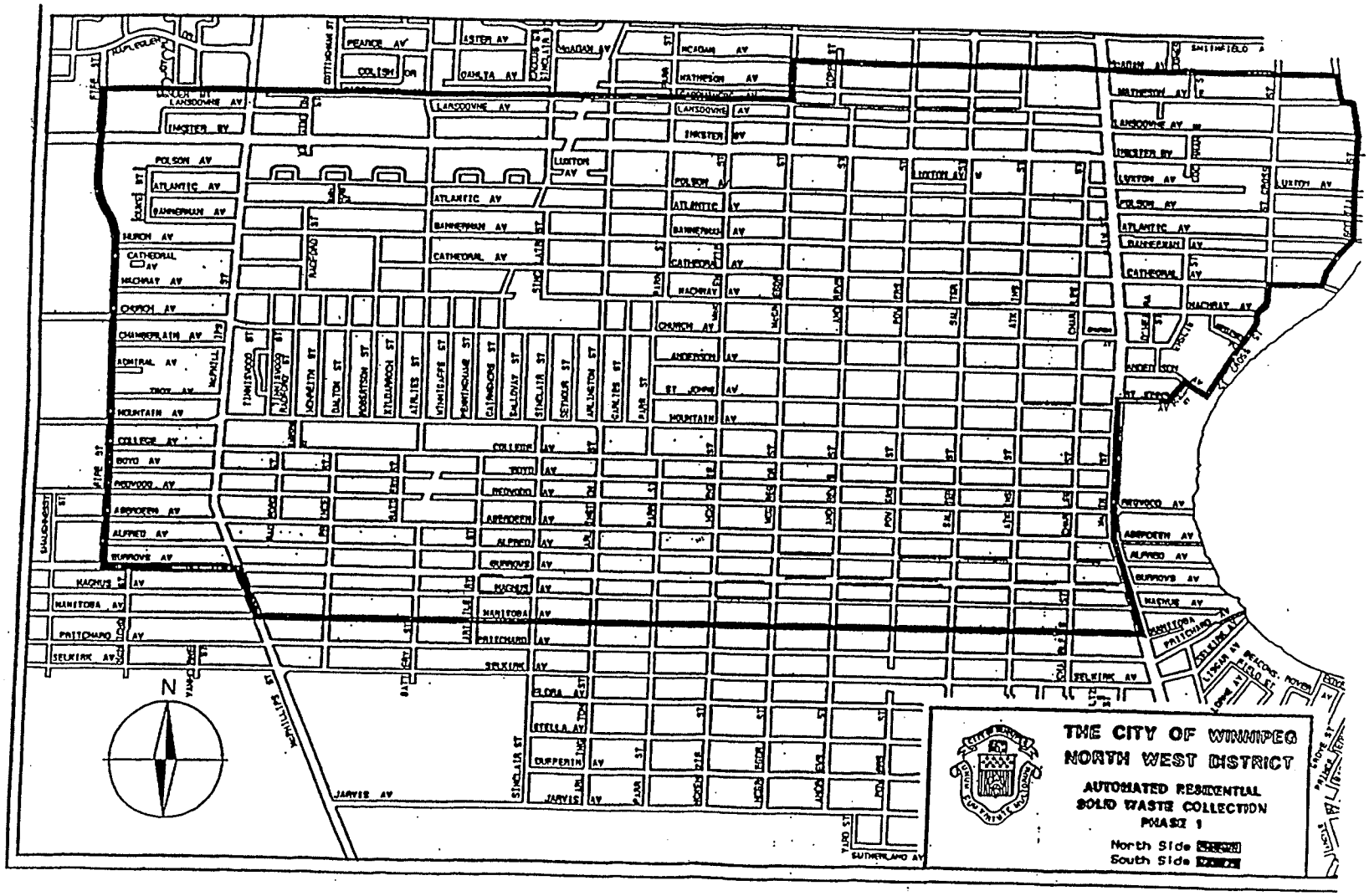
The following overview of the study area describes current physical and socio-demographic conditions that may affect the planning and designing of the proposed recycling program. This study assumes that the physical features of the study area are representative of the city in general.

3.2.1 Physical Features:

Winnipeg lies on the prairie plains and is relatively flat. The average topographic elevation of the area being 239 metres above sea level (The Canadian Encyclopedia, 1988, 2317). The climate is the continental; dry and vigorous with four distinct seasons, distinguished by well defined seasonal temperature variations. For eight months of the year (September to April), the weather is unpredictable. During September to April, Winnipeg annually receives 114.8 cm of snowfall. From May to August, the weather is typically hot and humid. During this period, the city receives 40.4 mm of rainfall (Winnipeg's Henderson directory, 1993, 7). The average annual precipitation is 525.5 mm and the prevailing winds blows from the south, generally under 19 kilometres per hour (Winnipeg's Henderson directory, 1993, 7).

In the Lord Selkirk-West Kildonan Community, the automated garbage solid waste collection Phase 1 area is bordered by the Red River on the east, by Point Douglas neighbourhood on the south, and by the Old Kildonan neighbourhood on the west and north (see Map 2). McPhillips and Main Street are the main thoroughfares linking the study area with downtown and other parts of the city. The area generally consists of well laid out neighbourhood streets, with accessibility to wide back lanes and side walks. However, it also

consists of a few narrower neighbourhood streets that have either no back lanes or no side walk accessibility.



Map 2: Winnipeg's Phase I of automated Solid Waste Collection area.

Source: City of Winnipeg, North West Works and Operations District, 1993.

3.2.2 Socio-Demographic Features:

This section discusses housing, population, and socio-economic conditions of the study area. Since 1991 Census Data were unavailable, Winnipeg's Neighbourhood Area Characterization Profiles, based on 1986 Census Data was used. Furthermore, this section analyses the study area in relation to the Lord Selkirk-West Kildonan community and the city as a whole.

The Phase 1 area consists of 9 neighbourhoods, namely: Burrows Central, Inkster-Faraday, Luxton, Mynarski, Robertson, Shaughnessy Park, St. John's, St. John's Park, and William Whyte. All profile boundaries match the Phase 1 area boundaries, except for the Shaughnessy Park neighbourhood. This neighbourhood exceeds the automated solid waste collection Phase I area significantly. Inspection of this neighbourhood determined that it includes Northwood Park, and a significant number of industrial, commercial and manufacturing buildings, and, therefore, would not bias the area's socio-demographic features. Therefore, the neighbourhood profile was included in the analyses.

3.2.2.1 Housing Inventory:

According to 1986 Census Data, the automated solid waste collection Phase I area has 10,020 single dwelling units, representing 71.3% of the total dwelling units in the area (see Table 3). This figure is higher than both the Lord Selkirk-West Kildonan community (66%) and the city (53.7%). Another notable fact is that 65% of the households in the study area and community were owner occupied, while, 35% were rented. These figures were also higher compared with the city at 60% owner occupied and 40% rented. The significant number of single dwellings units and the low turn over rate could result in higher rates of

participation and diversion, and lower promotional and container replacement costs.

Table 3: Housing Inventory (1986).

Dwelling Type	The Study Area	Lord Selkirk-West Kildonan	Winnipeg
Single Family	71.3%	66%	53.7%
Multiple Family	2.5%	5.5%	12.1%
Others	26.2%	28.5%	34.2%

Modified from: City of Winnipeg Planning Department. Winnipeg Area Characterization Profiles. Winnipeg, MB. 1991.

3.2.2.2 Population Characteristics:

The 1986 Census reported that the population of the area was 36,175, or only 35.1% of the Lord Selkirk-West Kildonan community. This figure represents a population of 51.7% female and 48.3% male. The average 1986 single dwelling household size was 2.7 persons. This figure was lower than both the Lord Selkirk-West Kildonan community (2.9 persons) and the city (3.0 persons).

The 1986 age composition of the study area, the community and the city is illustrated in Figure 3. In the study area, roughly, 27% of the total population are represented by the 20-34 year age group. The structure of the remaining population reflects that very high proportion of people over 35. Roughly, 25% of the total population were in the 35-59 age group and 23% were over 60 years of age. The figure shows that the study area, the community and the city have similar population structures. Generally, the figure show that all three area's population is aging.

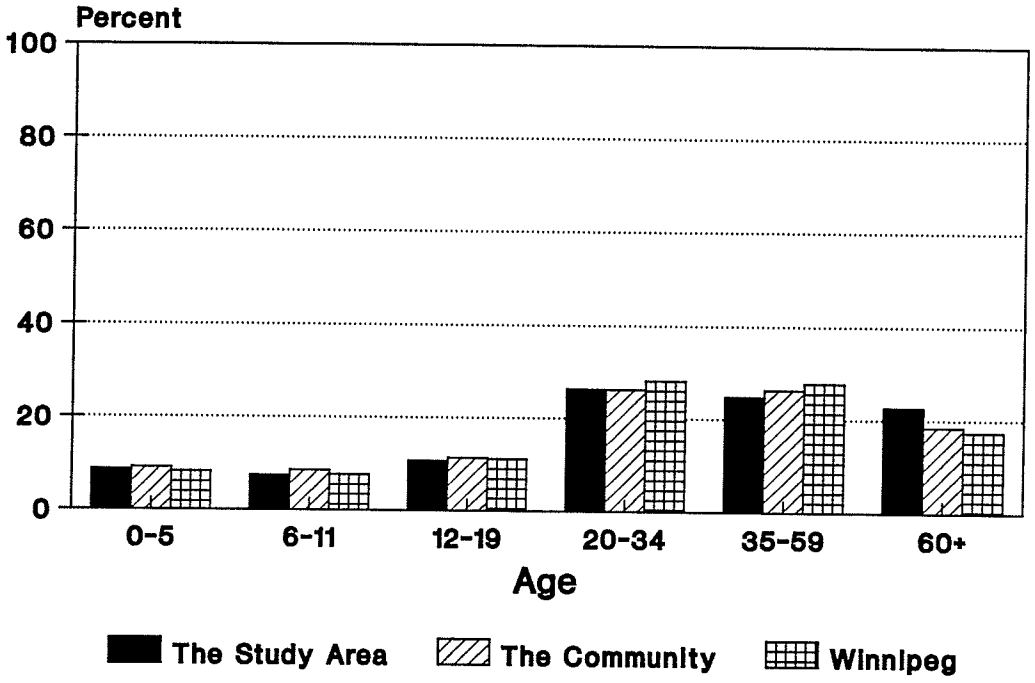


Figure 3: Population Composition by Age (1986).

Modified from: City of Winnipeg Planning Department. Winnipeg Area Characterization Profiles. Winnipeg, MB. 1991.

3.2.2.3 Average Household Income:

In the study area, the average 1986 household income was $26,835, which is well below the levels of Lord Selkirk-West Kildonan at $29,449 and the city at $33,294. Generally, the figure show that the study area has lower household income than the community and the city as a whole, which may impact the overall participation and diversion levels.

3.2.2.4 Education:

Figure 4 illustrates the education levels attained by the population of the study area.

The most striking statistic is that 61% of the study area's population (15+ population) have no high school certificate. Comparatively, this percentage is higher than both the community (54.9%) and the city (44.5%). Other notable educational statistics were: 9.4% of the population have a high school certificate, 16.9% have a Trade/Diploma type of the education and 12% have some university education. The graph clearly show that the study area has lower education levels than the community and the city as a whole. This feature may also impact overall participation and diversion levels.

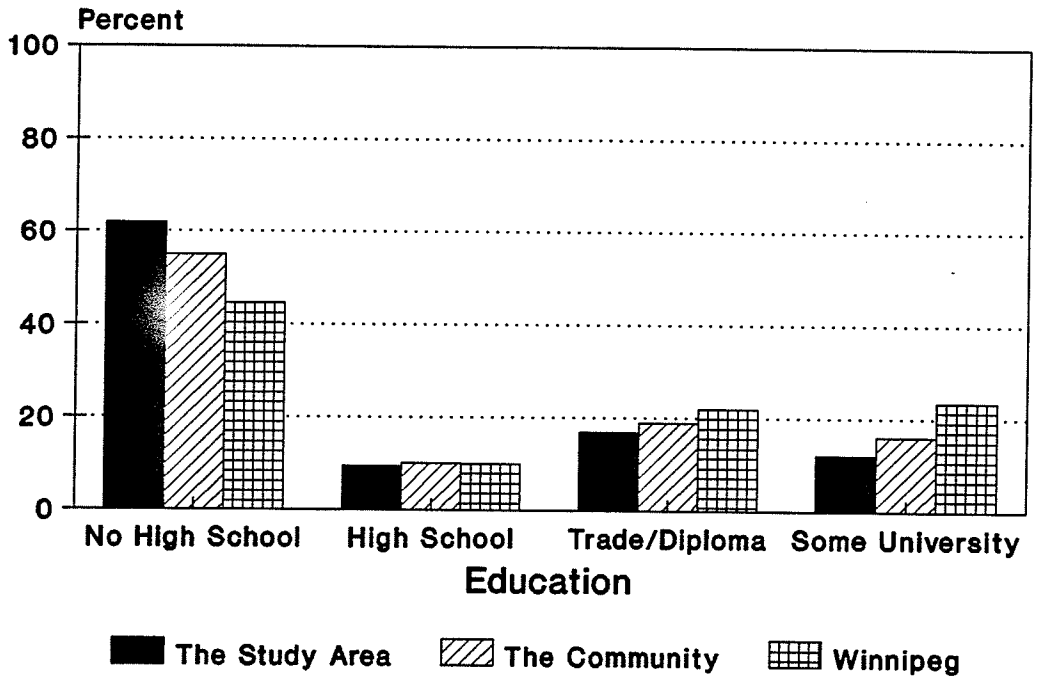


Figure 4: Education (15+ population).

Modified from: City of Winnipeg Planning Department. Winnipeg Area Characterization Profiles. Winnipeg, MB. 1991.

3.2.2.5 Ethnic Distribution:

Table 4 shows a population breakdown for the study area, the community and the

city on the basis of ethnic origin. All three regions include a relatively high number of residents of British origin. In the study area, people of British origin represent 40.9% of the total population. Other predominant ethnic groups include: French (17.5%), Ukrainian (14.3%), and German (11.2%). Similar ethnic trends were evident in both the community and the city. The only significant difference in the study area was the relatively small proportion of Aboriginal and Jewish populations when comparing with the community. Generally, the community figures indicate that it is ethnically diverse compared to the study area and the city.

Table 4: Ethnic Distribution (1986).

Ethnic Group	The Study Area	Lord Selkirk-West Kildonan	Winnipeg
British	40.9%	31.9%	48.7%
Ukrainian	14.3%	19.6%	11.3%
German	11.2%	7.3%	10.6%
French	17.5%	3.1%	13.3%
Other Eastern European	5.5%	9.3%	5.2%
Pacific Island Origins	4.2%	8.6%	3.9%
Native and Aboriginal People	3.3%	12.3%	3.6%
Jewish	3.1%	7.9%	3.4%

Modified from: The City of Winnipeg Planning Department. Winnipeg Area Characterization Profiles. Winnipeg, MB. 1991.

From Table 4, it is evident that in 1986, the British were the largest ethnic group in the all three regions. However, other ethnic groups, such as, Ukrainian, German and French also represented a significant parts of the population. Generally, the table shows that the study area has few language barriers and generally, the promotional and educational materials

can be delivered in English.

Another notable factor is the unemployment rate (1986) of the study area; at 15.8%, it was higher than both the community (9.2%) and the city (7.9%). This feature may have major impact on overall participation and diversion levels.

In summary, physical and socio-demographic characteristics are important to the program's design, implementation and success. Factors such as number of people per household, household income, and language barriers may affect planning, and program success. The 1986 Census Data indicate that the study area characteristics have a potential for high participation and waste diversion levels, owing to a high number of single dwelling units, an English speaking population and wider lanes. Generally, the study area consists of smaller than average households with lower than average total household incomes, an aging population, with lower education levels and higher unemployment rates than the Lord Selkirk-West Kildonan community and the as a whole. However, these barriers can be addressed by promoting the program through a well defined promotional and educational campaign.

3.3 Waste Composition Estimates:

The purpose of this section is to identify the types and amounts of waste available for recycling. Knowledge of municipal waste composition enables local decision makers to develop new management strategies to reduce, reuse, recycle and recover waste. This estimate is critical to the overall design and implementation of any recycling program and is essential for the design (including size and scope) of the proposed recycling program. Furthermore, this estimate would predict the savings gained through the extension of local landfills. Potential material recovered from the municipal waste stream will be discussed

further in Chapter 5.

Numerous studies have been conducted in North American on the municipal solid waste (MSW) composition, but little is known about waste composition in Winnipeg. Furthermore, many studies have either outdated or inconsistent data and therefore caution must be exercised when estimating municipal waste composition. Numerous Canadian municipalities and private consultants, such as, A. Edward and Associates and M. M. Dillon Limited have relied on the Bird and Hale report, a waste stream study of Canadian communities of over 100,000, conducted between 1976 and 1977. Owing to changes in attitude, lifestyle, packaging, and technology since 1977, this report is also considered obsolete.

This section relies on the 1991 waste composition study conducted by Proctor and Redfern Limited and SENES Consultants Limited on behalf of Metropolitan Toronto Works Department on the City of East York's low income/single detached dwellings. This sample was selected owing to the similarities in demographic structure between the study area and the sample group. The sample group's estimates were calculated with reference to the amount of waste collected by automated trucks in the course of one year (bi-weekly data were obtained from Ray Kolody, Refuse Supervisor and Assistant District Engineer, John Friesen, City of Winnipeg, North West Works and Operations District). The data includes solid waste collected by automated trucks between December 26, 1992 - December 24, 1993. These data were then used to estimate the study area's waste composition. This study has statistical limitations, since it does not take into account seasonal variations in solid waste generation. Bird and Hale's (1979) report has indicated that this task requires a large number of samples for reliable analysis, which is both costly and time consuming.

Table 5 presents 1993 solid waste estimates for the study area (in tonnes), based on sample findings. The total solid waste collected in 1993 was 12,786 tonnes. These numbers seem significantly higher than the Winnipeg's per capita residential waste generation. These numbers were generally qualified during public opinion survey, when the author found non-residential waste, such construction debris, appliances, furniture and hazardous materials in the Autobins. However, it is beyond the scope of this study to undertake a waste composition analysis.

Approximately 4,741 tonnes or 37% of the MSW consists of: old newspapers (ONP), fine paper, magazines, waxed/plastic (fliers), boxboard, kraft, old corrugated cardboard (OCC), and other paper material, with ONP constituting the largest share (16.1% or 2,055.99 tonnes). Organic materials makes up 34.4% or 4,403.50 tonnes of the MSW consists of organic materials including: food, yard refuse, landclearing/landscaping materials, and other miscellaneous organic wastes. Approximately 6.1% of MSW consists of glass materials, with liquor and wine bottles constituting 2.4% or 308.14 tonnes and soft drink containers representing 0.6% or 78 tonnes of MSW.

Plastics form 6.3% or 813.19 tonnes of the MSW. In this category, Polyethylene Telephthalate (PET) beverage containers represent 0.7% or 77.99 tonnes, while High Density Polyethylene (HPDE) containers comprise 1.1% or 140.65 tonnes. Metals represent 4.5% or 568.98 tonnes of MSW. In this last component, tinplate steel containers represent 3.2% or 402.76 tonnes, while aluminum containers only represent 0.5% or 67.77 tonnes. Other types of materials, such as, household hazardous wastes, textiles, leather, rubber and other miscellaneous waste made up approximately 11.6% or 1,478.06 tonnes of the MSW. These estimates indicate that there is the potential to divert significant volume of materials from the

waste stream to recycling. However, the waste recovered by the program depends on factors, such as the number and type of materials collected and favourable and stable long term market conditions. Chapter 5 further discusses the potential material recovery estimates from the proposed recycling program in greater detail.

Table 5: 1993 Waste Composition estimates for the study area based on the city of East York's low Income/Single Detached Estimates (in tonnes).

Type	Weight estimates (%)[1]	Study area estimates
Paper		
Old Newspapers (ONP)	16.08	2,055.99
Fine Paper	1.38	176.45
Magazine	4.43	566.42
Waxed/plastic	2.82	360.57
Boxboard	3.91	499.93
Kraft	1.09	139.37
Old Corrugated Cardboard (OCC)	2.51	320.93
Other	4.86	621.40
Glass		
Soft drink containers	0.61	77.99
Liquor and wine	2.41	308.14
Other	3.09	395.09
Plastics		
PET soft drink containers	0.76	97.17
HPDE containers	1.10	140.65
Other	4.50	575.37
Metals		
Aluminum containers	0.53	67.77
Tinplate steel containers	3.15	402.76
Other	0.77	98.45
Organic (Food and Yard waste)	34.44	4,403.50
Household Hazardous Waste	0.41	52.42
Textiles, Leather and Rubber	2.83	361.84
Other	8.32	1,063.80
Total	**100.00**	**12,786.00**

[1]Source: Adapted from: Proctor & Redfern Limited and SENES Consultants Limited. Metropolitan Toronto Solid Waste Composition Study: Discussion Paper. (Toronto, ON: Metropolitan Toronto Works Department). 1991.

3.4 Current Solid Waste Collection System:

This section describes the current waste management system operating in the area. This understanding is not only important for initial designing and planning, but also for identify the potential impacts of the recycling component.

In June 1992, Winnipeg implemented Phase I of automated solid waste collection in the Lord Selkirk-West Kildonan Community (see map 2). In total 10,237 single family dwellings (9,500 with back lanes and 737 with front street access) were included (Committee on Works and Operations report, June 10, 1993, 135).

In this collection program, collection trucks are operated by a single crew member. Special mechanical arms lift and empty the Autobins contents into the vehicle's packing unit and then return the container to it's original position.

Autobin containers are neutral earthtone in colour, and made of durable steel, with lightweight hinged polyurethane lids to protect their contents waste from weather. They are provided free of charge by the city.

For participants with back lane accessibility there are two sizes of Autobin: larger (600 gal.) and smaller (300 gal.) containers (see Figure 5). The smaller 300 gal. container is used in narrow lanes and one container is provided for every three households (Autobin information leaflet, 1992, 2). Each container can hold as much as fifteen normal garbage cans. At present, 607 containers are in place and serve up to 1,818 single family dwellings (Committee on Works and Operations report, June 10, 1993, 135). Each container costs roughly CDN $475 (Committee on Works and Operations report, November 6, 1990, 79).

Neighbourhoods with wider lanes are served by the larger 600 gal. container, which is shared among four to six households (see Figure 5). These larger containers can hold as much as thirty normal garbage cans. At present, 1,535 large containers service 7,682 households (Committee on Works and Operations report, June 10, 1993, 135). These containers cost roughly CDN $600 (Committee on Works and Operations report, November 6, 1990, 79). Both types containers are conveniently located along one side of the lane and are easily accessible to both collection trucks and participating households.

The study area also consists of 737 single family dwellings without back lane accessibility. Each of these households is supplied with a 120 gal. wheeled polyurethane plastic bin with a hinged lid (Autobin information leaflet, 1992, 2). These wheeled bins can hold as much as six regular garbage cans (see Figure 5). On collection day, each household is responsible for rolling the bin to the front curb and later retrieving it when emptied by the collection vehicle. These containers cost roughly CDN $175 each (Committee on Works and Operations report, November 6, 1990, 79).

Other implementation costs include the assembly and placement of the containers at CDN $25 each and annual maintenance cost of CDN $15 each (Committee on Works and Operations report, November 6, 1990, 77). Owing to the high cost of containers, the city opted for a seven year lease/purchase option.

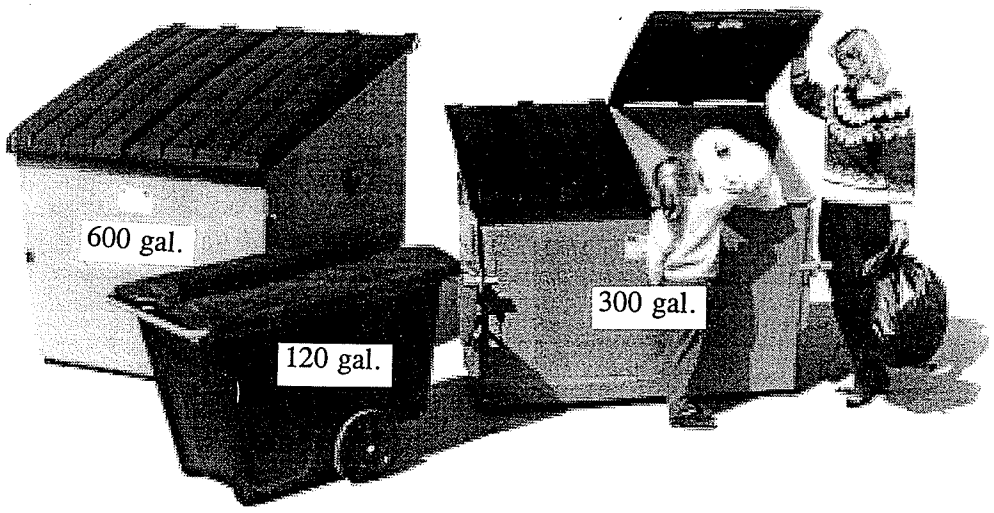


Figure 5: Autobins used for Solid Waste Collection.

Source: City of Winnipeg. Autobin Information Leaflet, Winnipeg, MB: North West District. 1992, 2.

At present, the collection fleet consists of three specially-designed Pak-Mor system trucks with capacities ranging from 29 yd^3 to 33 yd^3 (see Figure 6). Each truck costs between CDN $140,000-165,000 and is funded by the city's Equipment Replacement Reserve (Pers. Comm. Ray Kolody, May 28, 1993). Containers and trucks are supplied by General Body & Equipment Limited, Edmonton, Alberta.

North West Works and Operations District operates a five day solid waste collection cycle. However, on civic and statutory holidays, solid waste collection is "bumped" by a day. Automated collection routes start at the point farthest from the Summit landfill site and move toward the smaller serviced areas nearer to the disposal site and the centralized depot.

Generally, trucks collect full loads during morning shifts and only minimal amounts during afternoon shifts. This difference can be attributed to the time spent travelling back and forth between the collection route and the landfill site.

Figure 6: An Automated Solid Waste Collection Truck.

Source: Winnipeg Free Press, May 19, 1992, 1.

Owing to the wide, flat terrain of the area, automated collection trucks are able to easily traverse back and forth on neighbourhood streets and alleys and are more productive than traditional collection trucks. The initial 9 months of the program results indicated that the average container pick-up cycle time was 20 seconds and the travel time between Autobins was 30 seconds (Pers. Comm. John Friesen, May 13, 1993). Furthermore, present eight hour collection shifts indicate that these vehicles serve roughly 600 households daily during winter months and up to 720 households in the summer months (Pers. Comm. John Friesen,

May 13, 1993).

Various automated solid waste collection programs have found that this system has positive benefits. From the public's point of view, the inconvenience of purchasing garbage cans and missing collection day are avoided. Furthermore, there is an improvement in street aesthetics (see Appendix V). A post program implementation survey conducted by Prairie Research Associates Inc. on behalf of North West Works and Operations District indicated that 81% of back lane users and 71% of front lane users were satisfied with the system (Committee on Works and Operations report, June 10, 1993, 139).

The operator benefits include: increased in crew safety, increased truck collection efficiency, lower manpower costs, fewer job-related injuries and fewer workmen's compensation payments. The North West District estimates that the program will save the city in excess of $3.6 million over twenty years compared with the cost of manual collection (Lett, June 5, 1993, A10).

A number of different programs have found automated trucks to be more efficient than manual collection trucks. For example, in Norfolk, Vermont, automated collection trucks increased efficiency by 65%. Earl Smith, superintendent of Norfolk's Bureau of Solid Waste explained that crew sizes were reduced by 40-60% for a given area. Three rear loader trucks with three crew members could be replaced by a single crew member with an automated truck (Buchholz, 1987, 42). By integrating a recycling component into automated solid waste collection, the city of Los Angeles could save $100 million in avoided equipment and labour costs compared with using a manual system (Joy, 1991, LAS 12). All these factors lead to savings for the city. The disadvantages of this system are the higher equipment costs and potentially increased waste generation. However, the impact of the

initial costs could be alleviated by a lease/purchase option. The easy accessibility of large solid waste Autobin containers might actually discourage residents from reducing waste and may encourage the disposal of items, such as, appliances, equipment, furniture and hazardous material. These materials may in turn negatively affect overall collection equipment's efficiency. This issue can addressed by a well-defined educational campaign.

The implications for a recycling component are many. For example, collection trucks must collect all recyclable items at the same time. To create more space, recyclables would have to be compacted, which in turn, could lead to contamination and unmarketable materials. Generally, the automated solid waste collection system has been efficient, cost effective, technically reliable and well-received by participants. Therefore, there is the potential to successfully integrate a recycling component into the automated solid waste collection system.

3.5 Current Recycling Activities:

At the present, the study area lacks a formal recycling program. However, the residents have access to a number of recycling programs. The City of Winnipeg and Manitoba Soft Drink Recycling Incorporation (MSDR) operate drop-off and buy-back mobile depots, while private companies such as Red Box Recycling Company and Plan-it operate user pay curbside pick-up collection systems.

MSDR, established by the Manitoba Soft Drink Association (makers of Coke and Pepsi products) and suppliers of aluminium and plastic beverage containers operate a redemption centre and mobile buy back centres, in shopping malls parking lots. The organization offers financial incentives for certain types of recyclables. At present, two

mobile centres, (located at the Jefferson and McPhillips Street Safeway, and the Jefferson and Main Street IGA) and redemption centre (located at Paramount Road) are accessible to residents of the study area. However, access is restricted to specifically scheduled times.

In the spring of 1993, the city of Winnipeg opened a recycling drop-off depot at the Garden City Mall to collect recyclables such as, old newspapers, aluminum cans, and PET plastic beverage containers. This depot is accessible 24 hours a day and is also in close proximity to residents of the study area. However, it has achieved little success in its attempt to implement more depots, as a result of opposition from a number of shopping centre owners (Redekop, March 19, 1993, A1). In addition, a number of participants have complained about the depot's inefficient design, which has contributed to generally low participation and waste diversion rates (Sytnick, May 5, 1993, 3)

Red Box Recycling and Plan-It Recycling are two main private recycling companies offering, pay-for-service curbside pick-up. Plan-It Recycling offers curbside commingled pick-up service, on same day as garbage collection for subscribers, and Red Box Recycling offers a fixed collection day pick-up service. Both program operators provide participants with rectangular shaped plastic home storage containers for interim storage. Participants are charged between $70-$80 per annum for subscribing to the program and a further $10 deposit for home storage containers (Pers. Comm. Jeff Golfman, July 28, 1993 and James Zonneveld, August 6, 1993). As of September 1992, just over 10% of the city's households have subscribed to the service (Manitoba Environment, 1993, 149). The figures for the study area are unavailable.

Chapter 2 discussed in detail the minimal participation and waste diversion rates of drop-off programs owing to participants' perceived inconveniences such as cleaning, storing

and transporting materials to collection centres. Although the user-pay curbside programs offer curbside and home storage container conveniences, they may discourage from recycling those who cannot afford to pay for the service. Therefore, these existing programs would have an insignificant impact on the prototype program.

3.6 Local Market Analysis:

Recyclable materials are not actually recycled until they have been converted into other usable products. Collecting a material does not necessarily means it gets recycled. In order to have a successful recycling program, long term stable markets for recyclables must be clearly identified to justify their collection. The main purpose of this section is to identify local markets for traditional recyclable materials.

The information gathered in this section is the result of personal interviews and phone conversations with primary market brokers and processors of old newspapers (ONP), metal, glass and plastics. In next few paragraphs, a general overview of each of the materials is presented, including: local supply and demand descriptions, wherever appropriate; an outline of specification factors applicable to material targeted for recovery; and price information relative to specifications. However, it should be noted that price trends for recyclable materials are cyclical. Supply, demand and price relationships make recyclable material markets difficult to predict. Recently, the price per tonne has fluctuated significantly, owing to the current abundant supply of recyclables in the market. However, it is beyond the scope of the study to project long-term pricing scenarios for the program.

3.6.1 Paper:

Paper makes up 37% or 4,741 tonnes of the study area's solid waste stream. Old newspapers (ONP) comprises 16.49% or 2,056 tonnes of the study area's waste stream. This material is commonly collected by recycling programs. The National Association of Towns and Townships (1989) determined that ONP is used primarily by paper mills and processing facilities to produce newsprint, stationery, towels, tissue, napkins, egg cartoons, livestock bedding, insulation, roofing paper, packaging and paper board. Market specifications determine category, grade and allowable contamination for premium priced materials. The existing domestic market for ONP is dominated by a non-profit organization, Versatech Industries Incorporation and local processor, Gateway Industries. Versatech Industries processes the material at its processing facility at 436 William Avenue in Winnipeg. It grades and prepares ONP according to market specifications before it bales and ships it to either the pulp and paper mills located in Pine Falls and Kenora (Pers. Comm. Jim Moore, August 9, 1993). Gateway Industries recycles ONP into packaging and roofing products. Currently, Versatech do not pay for the ONP, but accepts contributions on a donation basis. Gateway Industries pays $4.50/ton for processed ONP (Pers. Comm. Jim Moore, August 9, 1993).

Abitibi-Price in Pine Falls accepts up to 4,000 tons of clean uncontaminated ONP per year, but it has the capacity to absorb up to 8,000 tons per year (Swanson, Eshetu and Holstun, 1993, 48). The company pays $20 per ton for high grade baled ONP prepared according to its rigid specifications (Pers. Comm. Al Duff, July 28, 1993). However, the company would pay between $40-$45 per ton for large volumes of uncontaminated ONP.

Old corrugated cardboard (OCC) makes up 2.51% or 225.20 tonnes of the study area's solid waste stream. OCC is used by paper mills and processing facilities to produce

the same products as ONP. Currently, there are two private dealers accepting OCC materials, they are: Browning-Ferris Industries Limited (BFI) and Gateway Industries Limited. BFI does not pay for the OCC materials, while Gateway Industries pay $4.50/ton. Local markets indicate that Gateway Industries accept high grade fine paper and boxboard. There are currently no local markets for magazines, waxed/plastic and kraft materials.

3.6.2 Metal:

Both aluminium and tin soft drink cans comprise less than two percent of the municipal solid waste stream. National Association of Towns and Townships (1989) and National Round Table on the Environment and the Economy (1991) acknowledge that half of the aluminum and tin discards are cans, and the remaining half includes major appliances, metal castings and hardware. According to Letcher and Sheil (1986) and Chertow (1989), aluminium recycled cans are used to produce new cans and they are in high demand since it takes 95% less energy to produce aluminum from used materials than from raw materials. However, tin cans have limited demand, owing to oversupplied and distant markets (Pers. Comm. Jody Andrews, March 18, 1993, David Smith, September 14, 1993 and Leroy Williams, January 5, 1994). In contrast to aluminium cans, only 25% of recycled steel is used in manufacture of new products. All metal cans can be marketed directly through local steel scrap brokers and processors.

A local market survey conducted in July 1993 indicated that there were thirteen local steel scrap brokers and two non-profit organizations, (MSDR and Versatech Industries Incorporation), who purchase metal cans from local recycling programs. Table 6 presents local price quotation and material preparation specifications, (that is, cleaning and removing contaminants).

Most local dealers require a certain degree of material preparation before the materials are delivered to their yards. Prices for aluminum containers range from $0.15/lb to $0.30/lb, while, prices for tin containers range from $0.01/lb to $0.03/lb. Most brokers indicated that in the past few years the price has dropped for the following reasons: the state of the economy; oversupply in the scrap steel market; and the low demand for scrap steel. However, overall prices can be negotiated on the basis of the quality, quantity and timing of the product delivered to their yards.

Table 6: Local Scrap Metal Dealers, July 1993.

Local Scrap Dealers/ Non-Profit Organizations	Scrap Aluminum ($/lb)	Scrap Tin ($/lb)	Material Preparation
Ace Industries	0.23	-	Yes
Canadian Scrap Metal Recyclers Incorporation	0.15	0.03	Yes
Chisick Metal Limited	0.30	0.02	Yes
Den-Ches Enterprises	0.15	0.03	Yes
General Scrap & Car Shredder Limited	0.30	0.02	Yes
Industrial Metal Processing Limited	0.25	0.01	Yes
Logan Iron & Metal Company Limited	0.25	0.03	Yes
Manitoba Soft Drink Recycling Incorporation	0.23	-	Minimal
Mendak Metal Processors	-	0.03	Yes
Monarch Metal Company	0.25	0.02	Yes
Orloff Scrap Metals	0.28	0.02	Yes
Tessler's Iron & Steel Limited	0.25	0.02	Yes
Versatech Industries Incorporation	-	-	Minimal
Western Recycling Services Limited	0.25	0.01	Yes
Western Scrap Metal Incorporation	0.25	0.01	Yes

Source: The Author (July 1993).

3.6.3 Glass:

Glass comprises approximately 6% or 780 tonnes of the study area's waste stream. According to Glass Packaging Institute (1988) and National Round Table on the Environment and the Economy (1991), recycled glass materials are used to manufacture products such as: asphalt, brick outdoor surfacing products, reflective paint for highway signs, signs, and drainage material. As with aluminum and tin cans, glass soft drink containers represent less than one percent of the study area's waste stream. On the other hand, liquor and wine bottles represent approximately three per cent of the waste stream. According to the Glass Packaging Institute (1988) and National Round Table on the Environment and the Economy (1991), approximately two thirds of the containers are clear glass and one third are coloured glass.

In the past year, glass recycling and recovery efforts in Winnipeg have intensified. However, MSDR is only organization accepting certain types of glass materials, such as, liquor, juice, water and soft drink deposit bottles (Pers. Comm. Jim Fogg, July 28, 1993). MSDR has minimal material specifications, owing to its manual sorting and processing facility. This processing facility sorts materials into three categories, clear (or flint), green and amber. The materials are then crushed, baled and shipped to glass recycling processing plants. As per July 28, 1993 market rates, were as follows: MSDR paid $0.05/lb for glass liquor bottles, $0.01/lb for certain brands of juice and water bottles, $0.35 each for refillable Coca-Cola soft drink bottles, and $0.20 each for 300 ml. bottles (Pers. Comm. Jim Fogg, July 28, 1993). While, for 750 ml. refillable Pepsi brand soft drink bottles, the organization paid $0.35 for each bottle, and $0.01/lb for 300 ml bottles (Pers. Comm. Jim Fogg, July 28, 1993).

3.6.4 Plastics:

Plastics comprise approximately seven percent of the study area's solid waste stream. Very little information is available about plastic recycling, because recovery and markets for plastics are less developed compared with other materials. However, the focus of most recycling efforts has been on Polyethylene Telephthalate (PET) grade 1 type of plastic rasin used for beverage containers. However, some programs also collect High-Density Polyethylene (HDPE) type 2 plastics used for beverage containers and plastic bags. According to the Staff of BioCycle (1990) and Resource Integration Systems Limited and Waste Matters Consulting (1991) reports, recovered plastic beverage containers are shredded and reprocessed into materials such as: carpets, fibre-fill for pillows, ski jackets, sleeping bags, polyester garments, automobile accessories, floor tiles, audio cassette cases, and bath tubs. However, both PET and HDPE soft drink containers combined, comprise less than two percent of the study area's waste stream.

In Winnipeg, there are few companies buying plastics beverage containers. Ace Industries, Western Recycling Services, Western Scrap Metal Incorporation, MSDR, and Versatech Industries Incorporation accept PET soft drink bottles from the public. MSDR has minimal material specifications, owing to its processing capability. However, the scrap dealers have rigid material specifications, that is, the soft drink bottles must be cleaned, and caps and labels must be removed. Local scrap dealers pay between $0.05/lb to $0.12/lb, while, MSDR pays a scrap price of $0.15/lb for materials brought to its redemption or mobile buy-back centres (Pers. Comm. Jim Fogg, July 28, 1993). Versatech Industries Incorporation does not pay for the PET soft drink containers, but accepts contributions on a donation basis. Local market analysis indicated that PET beverage containers rank second to aluminum cans

in revenue generation.

Winnipeg has a very limited market for HDPE plastics. There are two local processing facilities accepting HDPE plastic materials from the public. These companies pay between $0.03/lb to $0.04/lb for plastic materials brought to their plants. These processing companies are, Polytech Industries and NEMCO Resources Limited. In conclusion, local recyclable material market justify the collection of ONP, aluminum and tin containers, while other materials such as, old corrugated cardboard (OCC), plastic containers and glass containers have limited markets. These materials may be added to the collection in the future when strong stable markets exist.

3.7 Summary:

The study area consists of flat and well-laid out street patterns. Climatically, the area is prone to long winters, high precipitation and windy conditions, which should be taken consideration in the designing and planning of the recycling component.

Physical and socio-demographic characteristics have a major impact on the program's overall design, implementation and success. For the proposed recycling service, an area with a high percentage of single family dwellings is important for high participation and waste diversion rates. The study area consists of significant numbers of single dwelling units with low turn over rates and streets with wider lanes. Although the 1986 census indicates that the area has a high population of British residents, there are also significant Ukrainian, French and German populations.

Many studies have found a correlation between low income levels and low participation rates. According to the 1986 Census Data, the target area has lower than

average household incomes and persons per household, as well as a significant number of residents without high school education and a higher unemployment rates than either the Lord Selkirk-West Kildonan or the city. These factors indicate that the need for well-defined educational and promotional campaigns.

A waste composition estimate is not only important for the design and implementation of the recycling program, but also necessary to project potential amounts and types of materials recovered from MSW. To estimate waste composition, Proctor & Redfern Limited and SENES Consultants Limited (1991) MSW estimates for the city of East York's low income/single detached sample were used. It was found that approximately 72% or 9,206 tonnes of the study area's waste stream would be composed of paper and organic materials. Glass, metals, plastics materials also contributed to a significant amount of MSW. Given these estimates, the study area indicate a significant volumes of materials from the MSW can be divert to recycling.

The current automated solid waste collection practice has provided residents with various kinds of collection containers. On collection day, automated trucks collect the waste from containers. A recent survey conducted by Prairie Research Institute indicates that the current system has been well received by residents. Furthermore, the city has found the program highly efficient since it is able to serve more households more effectively than the traditional system.

Secondly, it has found that the automated system to be more cost and labour effective than traditional manual collection systems. In the automated system, labour costs are lower, since the truck can be operated by a single crew member. The new system is less labour intensive, and there are fewer workmen's compensation claims owing to fewer injuries. The

only major drawback of the system is the intensive initial capital investment. During public opinion survey, the author found evidence that Autobins contained wastes such as, construction debris, appliances, furniture and hazardous waste. However, it is beyond the scope of the study to investigate this issue. Therefore, there is the potential to integrate a recycling component into the current automated solid waste collection system.

Presently, the study area lacks a formal recycling program. However, a number of recycling programs are accessible to study area residents. The mobile buy back and drop off centres operated by MSDR, drop off centres operated by the city of Winnipeg and private companies such as, Red Box Recycling and Plan-It Recycling offer user pay curbside service. These program were found to have achieved insignificant participation and waste diversion rates, owing to inconvenience of transporting materials, general program design and user pay features. Therefore, these programs would have minimal impact on the prototype program.

The success of any recycling effort depends on long-term stable markets for the recovered materials. Local markets for recyclable materials indicate that there are a number of dealers who buy ONP, aluminum and tin containers at competitive prices. Currently, markets for plastic and glass materials have limited market development. Local market analysis justifies the collection of ONP, aluminum and tin containers, owing to the existence of well established domestic markets. On the other hand, materials such as OCC, PET beverage containers, HDPE containers, glass beverage containers and liquor and wine bottles justify the existence of a limited local market, and may potentially be collected in the future.

The next chapter discusses the proposed prototype recycling program features in detail.

CHAPTER 4

PROTOTYPE PROGRAM

This chapter reviews the overall framework of the prototype multi-material prototype recycling program.

4.1 Program Description:

The recycling literature suggests that both curbside and drop-off/buy back centre programs have a number of advantages and disadvantages. The proposed prototype program attempts to incorporate the advantages from both collection systems into a totally unique and efficient system. In the proposed prototype program, each household would separate, prepare and store recyclables in three 12 gal. stacking containers provided free of charge by the city to each participating household. Weekly, each household would place appropriate materials in specially marked communal (300 gal.) Autobins, conveniently located to serve, on average, 15 surrounding households. The recyclables from these bins would be collected by an 29 yd. automated truck, identical to one used for solid waste collection, and transported to a local contracted private material processing facility (MRF). At the MRF, materials would processed and then transported to local markets.

Initially, the program would collect ONP, aluminum and tin containers. The collection schedule would operate on a four week alternative schedule coinciding with collection on the same day as garbage pick-up, that is: ONP in the first week of the month, aluminum containers in the second week, ONP in the third week and tin containers in the fourth week. The initial promotional and educational campaign would include outdoor

advertisements, grassroots word of mouth campaigns and local media coverage.

4.1.1 Home Storage Containers and Autobins Requirements:

Three rectangular shaped, plastic, colour coded, 12 gal. stacking home storage containers (blue for ONP, green for aluminum containers and red for tin containers) would be distributed to residents of the study area for interim storage (see Figure 7). An estimated 683 communal 300 gal. Autobins would be required to serve the 10,237 single family dwellings in the study area.

Designated recycling bins would be placed near, but across the lane from solid waste bins in areas with back lane accessibility. For areas without back lanes, the bins would be placed at convenient curbside locations. Each bin would serve on approximately fifteen households. The bins would be identical in size to those currently used for solid waste collection, but painted a distinct colour to distinguish them from regular solid waste bins.

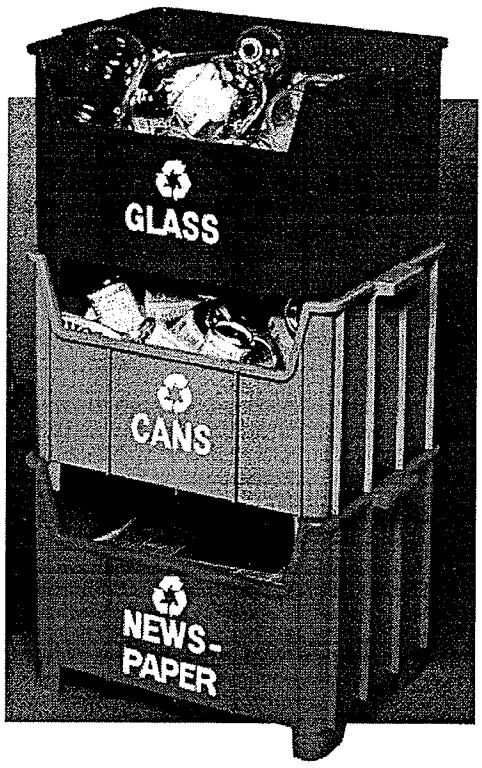


Figure 7: Three 12 gal. Stacking home storage containers.

Source: Shamrock Industries, Inc. Recycling containers - Information Pamphlet, 1993.

4.1.2 Labour and Truck Requirements:

The number of Autobins emptied in a single day has a major effect on both capital and operating costs. Truck requirements and collection productivity, (the number of stops per truck per day) for the study area is primarily a function of: the number of Autobins, the design and capacity of collection trucks, the amount of productive lane collection time and non-productive lane collection time (for example, travel time from the garage, unloading time and crew breaks).

Table 7 illustrates collection truck requirements and specific productivity configurations. In a regular eight hour shift, there are five productive lane collection hours

Table 7: Collection requirements and productivity for the study area.

Automated collection truck requirements and productivity
* 683 Autobin 300 gal. recycling bins, each serving 15 households * Hours worked per day: 8 hours * Productive lane collection hours per truck/day: 5 hours * Non-productive lane collection hours per truck/day: 3 hours Truck productivity calculations: * Travel time per between two Autobins (pass-by) is 90 seconds. * Pick-up time per Autobin (stop) is 20 seconds. Therefore, on average an automated truck is capable of servicing the study area in: (683 x 20) + (683 x 90) = 75,130 seconds or 20 hours 52 minutes

per truck per day, leaving approximately three non-productive collection hours (Pers. Comm. John Friesen, May 13, 1993).

Travel time between Autobins was estimated to be approximately 90 seconds. This included time lost owing to crossing streets, dead ends, traffic lights and other physical obstacles. Furthermore, according to John Friesen, Assistant District Engineer of the Winnipeg's North West Works and Operations District, the time required to pick-up and unload an Autobin is approximately 20 seconds. Therefore, one automated 29 yd. packer truck, with a payload capacity of 14,500 lb. operated by a single crew member, would be able to service all Autobins in the study area in approximately 21 hours of productive lane time.

Therefore, it can be concluded that one collection truck operating on a regular five hour collection shift, will require approximately four days to service all recycling bins in the study area. However, factors such as the truck's payload capacity, traffic, and weather may affect overall efficiency. Taking these factors into consideration, all bins in the study area

will be serviced in five collection days.

4.1.3 Household Separation Requirements:

The prototype program would rely on voluntary household efforts to source separate, prepare, interim store and appropriately place materials in the Autobins prior to collection day. The first step is the source separation of all targeted materials from regular household refuse. The second step requires preparation of recyclable materials by removing glossy materials from newspapers and cleaning aluminum and tin containers. This step would minimize sorting, processing costs and contaminants. While this may be inconvenient for participants, a number of programs have found that it does not affect overall participation owing to the limited volume of material collected.

The third step is the interim storage of the targeted materials. The city would provide each participating household, free of charge, three colour distinct 12 gal. stacking containers. The final step would involve placing appropriate recyclable materials in communal recycling Autobins prior to collection day.

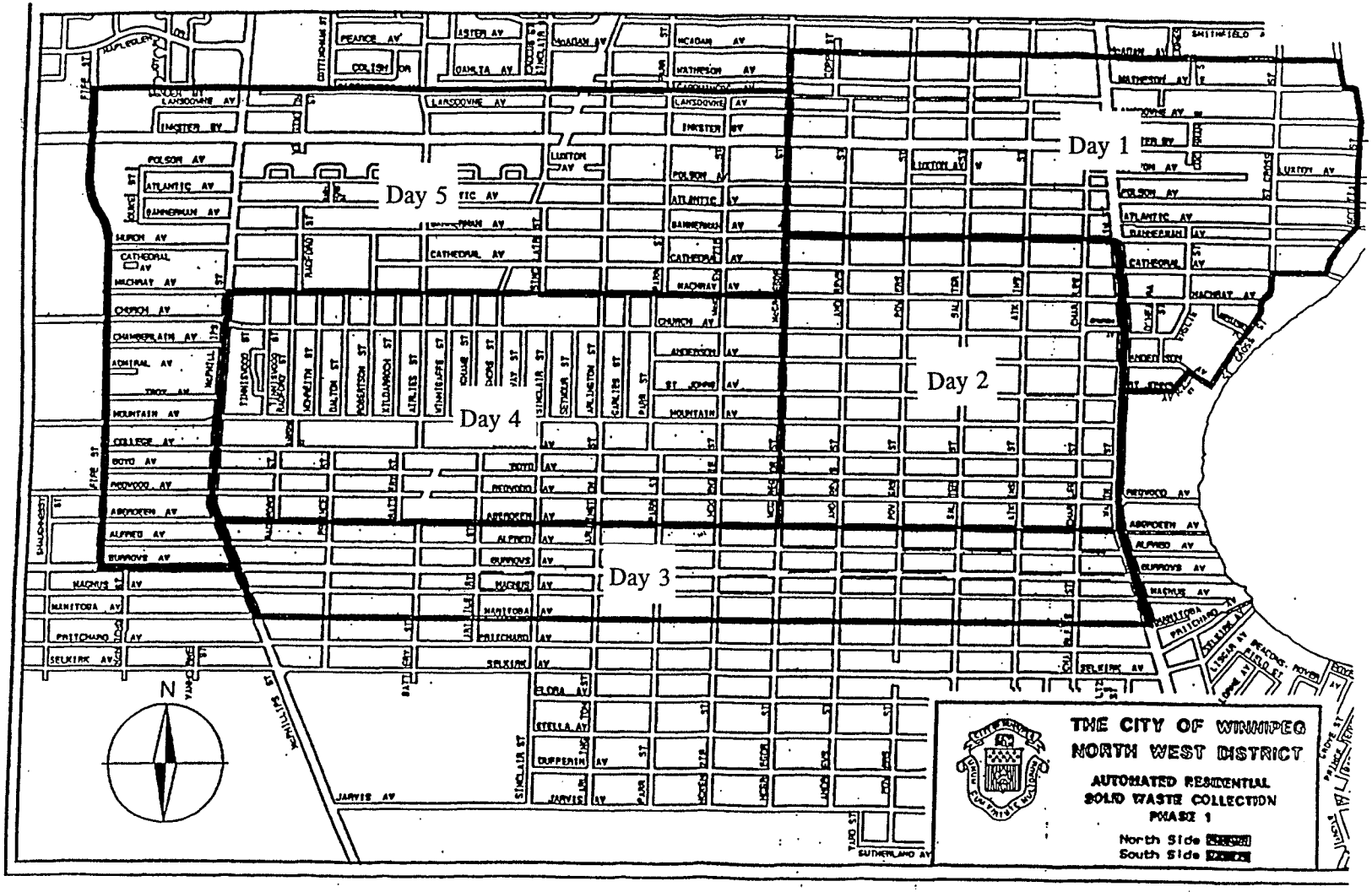
4.1.4 Number and Type of Materials:

Initially, the program would target ONP, aluminum and tin containers for collection. However, the program has the capability of collecting other materials depending on future requirements. The targeted materials would be transported by the automated trucks directly to a local private processing facility, before being shipped to local markets. This approach is consistent with the literature which suggests that recycling programs initially tend to collect only materials which have well established local markets.

4.1.5 Collection Frequency:

The targeted materials would be collected on a schedule coinciding with the 5 day solid waste pick-up cycle (see Map 3). On holidays, the collection day would be shifted to the next working day. The interim collection schedule would operate on a rotating basis, whereby the collection of targeted materials would alternate. For example, ONP would be collected on the first week of the month, aluminum containers on the second week, ONP on the third week and tin containers on the final week. ONP would be collected fortnightly owing to it's high volume in the waste stream.

The literature review suggests that weekly collection leads to higher participation than bi-weekly and monthly collection, because participants' find the storing recyclables inconvenient. On the other hand, the literature also suggests that participants are more likely to remember a single collection day, than alternate days. Certain programs, however, such as Hibbing, Minnesota, have found alternate collection days acceptable to both program operators and participants (Pers. Comm. Paul Sleeman, March 22, 1993).



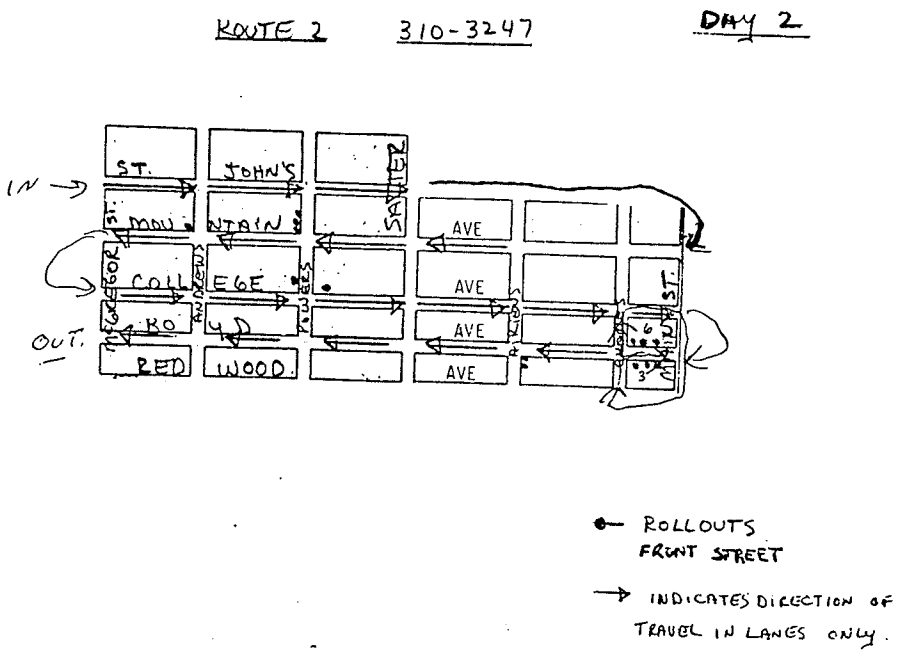
Map 3: Five day solid waste collection cycle.

Source: City of Winnipeg, North West Works and Operations District, 1993.

4.1.6 Truck Collection Routes:

The generally wide street patterns and flat terrain of the study area would allow automated recycling trucks to traverse back and forth on neighbourhood streets and alleys. Theoretically, recycling routes would be identical to solid waste collection routes. Using this approach, the collection truck would traverse all streets in the area at least once per week. However, the routes would start at the point furtherest from the local contracted processing facility and move toward the facility to reduce travelling distance to the final destination. Map 4 illustrates one example of a automated solid waste truck route, however, it is beyond, the scope of this study to design the truck collection route.

Map 4: Example of automated solid waste vehicular route.



Source: City of Winnipeg, North West Operations Department, 1993.

4.1.7 Support Staff Requirements:

It is assumed that administrative, technical and clerical support staff from other departments would be allocated as needed to assist with administration and operation of the program.

4.1.8 Initial Promotional and Educational Campaigns:

Analysing study area's demographic features indicated that the need for well-defined educational and promotional campaigns. The study suggests the pre implementation campaign, however, campaign strategy may vary within the city and furthermore, it is beyond the scope of the study to plan such a intensive campaign. Prior to implementation, there is a need to devise an effective community-based public relations and educational campaign to promote the recycling program. Many programs have found that carefully timed promotional and educational campaigns, delivered in a professional and informative manner, have laid strong foundations not only for the programs but also for future expansion (Zarillo and Long, 1993, 9.2 and Wofle, 1993, 30.3). Appropriate consideration of the demographic characteristics of the study area must be a key strategy of the campaign.

Presented below are some publicity techniques that could be considered for the initial promotional and educational campaign: outdoor advertisements; public workshops; door to door campaigns; the distribution of informational kits containing pamphlets, brochures, fridge magnets, posters, and buttons; newsletters; media relations programs including newspaper articles, radio and TV spots; block leader programs; school presentations; and shopping mall displays (see Appendix III).

The prototype program must have central themes, and slogans. These themes and

slogans would be reproduced on the home storage containers, the Autobins, the automated collection truck, the printed materials, and in the public service announcements. The program theme and slogan should be creative, yet simple, and appealing to study area residents in promoting environmental and recycling awareness (Zarillo and Long, 1993, 9.3 and Wofle, 1993, 30.4).

4.1.8.1 Advertisement Campaigns:

Three months prior to program implementation, a series of outdoor billboards, transit shelter advertisements, community newspaper inserts and formally announced community presentations would be used to promote the program.

4.1.8.2 Grassroots Word-of-Mouth Campaigns:

Four to six weeks prior to the implementation of the proposed program, a grassroots word-of-mouth campaign would be used to publicize the program. It is assumed that local community organizations would assist during this campaign. Each household would be communicate with directly and would receive a promotional kit containing information on how to recycle, placement and location of Autobins, collection schedules, delivery schedules of home storage containers, and information about a telephone hot-line printed on pamphlets and brochures. Ridge Meadows Recycling Society, Maple Ridge, British Columbia, Regional District of Nanaimo, British Columbia, and the Niagara-on-the-Lake, Ontario have used this approach in collaboration with local community organizations, such as the Boy Scouts or home owners' associations.

4.1.8.3 Local Media Relations:

The local media can be used to generate public awareness, interest and program participation. During the promotional and educational campaign period, reporters from newspapers, radio and TV stations would be informed about proposed events. Furthermore, the media should be encouraged to publish a weekly column on waste minimization issues, participants' concerns and program progress.

4.2 Summary:

The prototype program would require participants to source separate, prepare and interim store targeted materials in three rectangular shaped 12 gal. colour distinct, stacking home storage containers provided free of charge by the city. Stacking home storage containers would make the interim storage of recyclable materials more convenient. Prior to collection day, each household would be required to place their recyclable materials in one of the 683 communal 300 gal. Autobins.

Initially, the program would collect only those types of materials which have stable local markets, such as ONP, aluminum and tin containers. However, it has the capability to include other types of materials. The program would adopt a regular weekly collection schedule, identical to the solid waste schedule: however, the type of material collected would alternate. Materials would be transported to a private contracted processing facility to process and ship to local markets.

The program would require one automated 29 yd. truck with a 14,500 lb. payload, operated by a single crew member to service 683 Autobins. The truck size and initial truck productivity calculations indicate that the truck should be capable of servicing all recycling

bins in approximately 21 hours of productive time. Consequently, it will take one collection truck, roughly five days, to service the recycling bins in the study area.

Theoretically, routes would be designed similar to the solid waste collection routes. They would be designed such that each street would be traversed at least once. Furthermore, routes would be designed to begin at the point furtherest and end at the point closest to the contracted processing facility.

It is assumed that resources from other departments would assist to administer and operate the program. Initial promotional strategies would involve effective promotional and educational campaigns such as: advertisements, public workshops, grass root word-of-mouth campaigns, and distribution of promotional materials.

In order to test the efficiency of the prototype program, the next chapter evaluates it against material recovery estimates, technical reliability, a public opinion survey, and benefit-cost analysis.

CHAPTER 5

PROTOTYPE EVALUATION

The purpose of this chapter is to evaluate the proposed prototype program's effectiveness using the evaluation criterion identified in the literature review. The chapter is divided into four sections: the first section discusses material recovery estimates; the second section reviews the technical reliability of home storage containers and collection equipment; the third reviews and analyzes the public opinion survey, and; the final section discusses the benefit-cost analysis of the prototype program.

5.1 Material Recovery Estimates:

The amount of material recovered by a program is essential data for several reasons. Firstly, it measures program success in terms of material diverted from the waste stream. Secondly, it assists in predicting program revenues, and finally, it determines the capacity and number of collection vehicles necessary to handle targeted material volumes. Total amounts of the targeted materials in the study area's waste stream were determined in Chapter 3. These estimates will be used to determine the recovery rates for each type of targeted recyclable material, (the volume of targeted materials was converted from tonnes to pounds).

There are three primary methods used to estimate the volume of materials recovered. The first method to weigh, at either the redemption or processing centre, the collection vehicles before and after unloading. This method provides a weight measure of the quantities collected (Ontario Environment, 1987, 2). The second method is a set-out rate, which is an empirical measure obtained by adding the number of households that set out specific materials

on their assigned collection day, and the number of households in the service area (Resource Integration Systems Limited et al., 1989, 10-7). This measurement method is appropriate for curbside collection programs, where a field service personnel checks and notes the contents of containers before they are emptied by the collection crew. The final method is the capture rate, which refers to estimating the actual amount of material recovered as a percentage of the material available (Resource Integration Systems Limited et al., 1989, 10-7).

The first method is applicable only when the program is fully operational. The set-out rate is only suitable for curbside programs, where individual participant's set-out material can be measured. The last method is the best option to realistically estimate the amount of material to be recovered from the program.

Table 8 illustrates projected material capture rates, for the targeted recyclable materials, from the study area. ONP, the largest single component in the waste stream is estimated to be recovered at rates of 1,133,168.51 - 4,532,674.03 lbs/annually, while aluminum containers can be recovered at rates of 37,349.46 - 149,397.84 lbs/annually. Finally, tin containers have the potential to be recovered at 221,982.64 - 887,930.55 lbs/annually.

Table 8: Projected Recovery Rates for Targeted Recyclable materials for the study area, 1993.

Material Type	Amounts Available (lbs/annually)	Realistic Capture Rates (lbs/annually) 25%	50%	90%
ONP:	4,532,674.03	1,133,168.51	2,266,337.01	4,079,406.63
Aluminum Containers:	149,397.84	37,349.46	74,698.92	-
Tin Containers:	887,930.55	221,982.64	443,965.27	-

It is important to note that without physically implementing the program, it is impossible to project accurately the quantities likely to be recovered. Typically, from private programs operating in the city, such as, Plant-it and Red Box Recycling Company, participating households recycle higher percentages of ONP, compared with either aluminum or tin containers. The program operators' experiences (that is, Los Angeles, California, Orange County, Florida, Richmond, British Columbia, North York, Ontario, Regional Municipality of Peel, Ontario, Toronto, Ontario, and Vancouver, British Columbia) were used to develop two material recovery scenarios for the study's purposes: the worst and the best case scenario recovery rates. In the worst case scenario (low participation and recovery rates), it is assumed that the following amounts of materials will be recovered: 50% ONP; 25% aluminum and tin containers. This scenario was established on the basis of minimum average participation and diversion rates achieved in the above programs. While, in the best case scenario (high participation and recovery rates), it is assumed that the following amounts of materials will be recovered: 90% ONP; 50% aluminum and tin containers. This scenario projects the maximum number of targeted materials potentially recovered from the study area's waste stream.

In the worst case scenario, the following quantities of materials will be recovered in the prototype's proposed alternating collection schedule: ONP 17,433.36 lbs/bi-weekly collection; aluminum containers 574.61 lbs/monthly collection; and tin containers 3,415.12 lbs/monthly. In the best case scenario, the following quantities of materials will be recovered: ONP 31,380.05 lbs/bi-weekly collection; aluminum cans 1,149.21 lbs/monthly collection; and tin containers 6,830.23 lbs/monthly collection.

These calculations indicate that, in the both case scenarios, there are insufficient

volumes of aluminum and tin containers to justify collection, while, ONP volumes would exceed truck handling capacity. As a result, additional trucks would be required to handle the volume of ONP. Even in the best case scenario, however, there are not enough aluminum and tin containers to justify collection. Both scenarios suggest, therefore, that an alternating collection schedule is not a viable option for the prototype program.

Alternatively, using an identical capture rate estimate, the program could adopt either commingling collection approach, where all targeted materials are collected in a single collection day. In the worst case scenario, the following material recovery rates are estimated daily: ONP 8,716.68 lbs/day; aluminum containers, 143.65 lbs/day; and tin containers, 853.78 lbs/day for a total of 9,714.11 lbs/day. While in the best case scenario, the following material recovery rates are estimated daily: ONP 15,690 lbs/day; aluminum containers, 287.30 lbs/day; and tin containers, 1,707.56 lbs/day, for a total of 17,684.89 lbs/day. In the worst case scenario, calculations indicate that the materials recovered would be well within proposed one truck's handling capacity; and consequently, the truck would even be able to add additional materials to its collection, in the future. However, in the best case scenario materials recovered would exceed proposed one truck's handling capacity. However, the difference between the truck's handling capacity and the proposed material recovery volumes are minimal. In Chapter 4 it was established that one collection truck would be able to service the proposed Autobins in less than 21 hours. It is anticipated that the excess truck productive time could be utilized to collect additional materials. Therefore, the truck should theoretically be able to handle the materials recovered given the parameters of the best case scenario.

However, if the program adopts either commingling collection approach, it must make

provisions for a Materials Recovery Facility (MRF) either in house, or by contracting private companies to sort and market the materials. Resource Integration Systems Limited et al. (1989) and Bullock and Burk (1989), report that if a program collects fewer than four types of materials, the instating of MRF can be avoided, by contracting private companies to sort and ship materials to local markets.

Based on the material recovery estimates, it can be concluded that the alternating collection schedule is not suitable for the program, owing to wide range of volumes in the targeted materials. However, in commingling collection, the targeted materials would be within the limits of the truck capacity and furthermore, the program would have the potential to accommodate additional materials in the future. Material recovery estimates are further discussed in the benefit-cost analysis section.

5.2 Technical Reliability:

This section evaluates the convenience, collection efficiency and cost effectiveness of the stacking home storage containers and Autobins.

5.2.1 Convenience:

The 12 gal. stacking home storage containers and the 300 gal. Autobin are convenient for participant for the following reasons:

1. Stacking home storage containers require as much storage space as a single rectangular-shaped box. Furthermore, they require less household storage space than roll-out carts, bags or buckets.
2. Stacking containers which are usually made of durable high-density polyethylene

plastic, are suitable for extreme temperatures, and less susceptible to winds. Stacking containers, when full with materials, are still easy and light to carry (Pers. Comm. Michelle Turner, August 5, 1993).

3. The 300 gal. Autobin steel containers, for collecting recyclable materials are identical to the ones currently used for solid waste collection. They are aesthetically acceptable and 30% to 50% more durable than plastic containers. They also have a minimum 10 year warranty (Pers. Comm. Kel Stewart, May 31, 1993). Furthermore, their design is convenient; they are easy to handle by collection trucks, owing to their height and general upright stability (Committee on Works and Operations report, June 10, 1993, 137). In addition, these containers have durable light weight plastic lids to protect their contents from weather and other problem sources, such as, scavenging animals (Committee on Works and Operations report, June 10, 1993, 137).

4. Based on recovery rate estimates, targeted materials represent only 19.76% or 10.46 lbs/household/week of the waste stream, in which ONP represent 8.51 lbs/household/week. If, theoretically, 100% of the targeted materials are recovered, Autobins would have adequate capacity for interim storage.

5. If, in the future, additional materials are added to the collection, it would be necessary to increase the number of home storage bins for additional materials or need to be combined in the alternating collection schedule. The provision of adding bins could create personal storage problems for participants, and would increase capital costs for the program operator.

5.2.2 Collection Efficiency:

From the city's solid waste collection experience, the automated truck has the flexibility to manoeuvre the 300 gal. Autobins efficiently. Furthermore, truck lifting attachments are flexible enough to retrieve out-of-aligned containers with ease (Committee on Works and Operations report, June 10, 1993, 138). Operationally, the automated trucks have experienced only minor problems, which have been addressed by the supplier (Pers. Comm. John Friesen, August 26, 1993). Last winter, the city experienced heavy snowfall resulting in a significant accumulation of snow, and on several occasions, lane plowing operations were necessary (Committee on Works and Operations report, June 10, 1993, 136). However, these adverse winter conditions have had only a minor impact on overall annual operational costs and service (Pers. Comm. Ray Kolody, May 28, 1993).

Front street Autobins would require coordination with other departments, such as the Streets and Transportation Department, to restrict parking in front of bins for collection truck accessibility.

5.2.3 Collection Equipment Cost:

Stacking bins are less expensive than roll-out carts, bags, or buckets. Each set of three stacking bins would cost around CDN $15.50 (Pers. Comm. Michelle Turner, August 5, 1993). The 300 gal. Autobins would cost approximately CDN $475 (Committee on Works and Operations report, November 6, 1990, 79). An automated 29 yd. packer truck with a 14,500 lb payload would cost around CDN $140,000 (Committee on Works and Operations report, November 6, 1990, 79). Based on estimates from the material recovery section, it was found that an alternating collection schedule was not suitable for the program. If a

commingling collection schedule is adopted, a single home storage container would be sufficient for the interim storage of the targeted materials. However, they are more expansive than a single rectangular plastic box, which costs roughly CDN $5.

The size of the stacking home storage containers was also found to be sufficient to hold targeted materials until collection day. Overall, it has been found that both automated trucks and Autobins are technical reliable pieces of equipment.

5.3 Public Opinion Survey:

The purpose of the public opinion survey was: to determine general perceptions towards recycling; to determine respondents' views toward integrating a prototype program into the present solid waste collection system; and to evaluate the socio-demographic features of the study area. The questionnaire consisted of a three point category scale, with 20 closed-end and 2 open-ended questions (see Appendix I).

The target population for the survey was the heads of the households or their representative equivalent aged 18 and up. The responses serve as a representative sample for the study area. Winnipeg's Henderson Directory was used to determine the addresses of the participants.

Before conducting the main study, three basic survey methods were evaluated, including: the self-administered, face-to-face survey, (where questionnaires are completed by the respondents); the self-administered mail survey (where questionnaires are completed at respondents' own convenience and then returned by mail in a self-addressed enclosed envelope); and the telephone interview. During the pre-testing period, it was found that respondents were less likely to turn down an interviewer standing on their doorstep than

throw away a mailed questionnaire. Furthermore, it was found that there was a tendency of refusal or a high risk of terminating a telephone interview prior to the completion of the questionnaire. Furthermore, the presence of an interviewer created awareness regarding issues, and clarifies closed-answer or ambiguous questions. This, in turn, minimized "blank" responses.

According to Rubin and Babbie (1989), self-administered surveys are more effective in dealing with sensitive issues if the surveys offer complete anonymity. Both Rubin and Babbie (1989) and Dillman (1978) agree this method of collecting survey data is generally cheaper, minimizes bias and achieves high completion rates compared with other methods.

A face-to-face self-administered questionnaire technique was chosen, therefore, owing to: economics; high completion rates; and the truthful responses gained through respondent anonymity. However, it was found that in this method, respondents tended to skip sensitive questions, (such as age, education and household income). Furthermore, the method is very time consuming especially, if respondents were not home, (which led to subsequent visits) or if respondents were unwilling to participate.

Sample size was determined by using the formula obtained from Llwellyn Armstrong, University of Manitoba, Statistical Advisory Service Committee (see Figure 8). The calculations assume a confidence level of 95% (accurate 19 times out of 20), and true proportion of 50% (assuming 50% of the respondents would give positive responses). A number for the sample size was generated with the margin of error ranging from 5-10% to determine the most feasible number of questionnaires. In order that the study would not exceed the bounds of monetary, and time limitations, a target was set for 197 self-administered face-to-face interviews. This would attain a 95% confidence interval with a 7%

margin of error.

$$Z_{.025}\sqrt{\frac{\hat{Var}(\hat{p})}{n}} \equiv .05$$

$$n=\{[\frac{e}{(Z_{.025})\,(p)}]^2+\frac{1}{N}\}^{-1}$$

$$n=\{[\frac{.05}{(1.96)\,(.5)}]^2+\frac{1}{10237}\}^{-1}$$

where: n = sample size for confidence interval
(n = 97 for 10% margin of error)
(n = 120 for 9% margin of error)
(n = 151 for 8% margin of error)
(n = 197 for 7% margin of error)
(n = 266 for 6% margin of error)
(n = 378 for 5% margin of error)
$Z_{.025}$ = the critical value of the standard normal distribution
e = is the margin of error
p = an estimate of the proportion
Var (p) = an estimate of the variance of the proportion.
N = number of total population (10,237 households)

Figure 8: Formula to determine sample size.

A proportional, stratified probability random sample technique was used to select, as close as possible a true representative population of the study area's nine neighbourhoods and then, subjects' addresses within each neighbourhood were similarly selected. This method was used since information such as age, gender, income, and population for each

neighbourhood was available. Table 9 illustrates the stratified random sample proportions for each neighbourhood population. In neighbourhoods with significant populations, the following numbers of questionnaires were distributed: St. John's (37); Burrows Central (33); Robertson (33); William Whyte (28); Inkster-Faraday (26); Luxton (16); and Shaughnessy Park (16). In neighbourhoods with lower population densities, the following number of interviews were attempted: Mynarski (6); and St. John's Park (2).

Table 9: Stratified random probability sample of Self-Administered Face-to-Face Interviews attempted in the study area's nine neighbourhoods.

Neighbourhood	1986 Population	n=197 (7% margin of error)
Burrows Central	1,695	33
Inkster-Faraday	1,335	26
Luxton	785	16
Mynarski	310	6
Robertson	1,680	33
St. John's	1,875	37
St. John's Park	130	2
Shaughnessy Park	760	16
William Whyte	1,450	28
Total	10,020	197

Addresses, for single-dwellings, from Winnipeg's Henderson Directory, were numerically coded, and then entered in an IBM, Excel 3.0 spreadsheet computer program. Addresses were then randomly generated, depending on the representative sample size of the neighbourhood. Care was taken so that the generated addresses were not commercial, institutional or residential blocks.

The survey was constructed according to the principles of Dillman's (1978) Total

Design Method and Rubin and Babbie's (1989) Research Methods for Social Work. MacIntosh's Page Maker version 4.2 was used to design and lay-out the questionnaire. Originally, the questionnaire consisted of 28 structured questions using a five point scale, containing 26 closed-end and 2 open-ended questions.

The survey went through pre-testing periods before the main study was conducted. A pilot test of the questionnaire was conducted on several university colleagues, neighbours and friends. Overall, the pilot study performed well and no significant changes were made. However, after analysing local demographic conditions, it was found that the study area consisted of significant numbers of people with limited education, a considerable number of senior citizens and had an above average unemployment rate. These findings were verified in the field testing period. During this phase, respondents' experienced difficulty in either understanding the wording of the questions, or in the five point scale. Their criticisms were noted and questions were dropped or rewritten for clarity before the final questionnaire survey was printed.

The final questionnaire consisted of a simplified three point category scale, with the number of items reduced to 20 closed-end and 2 open-ended questions (see Appendix I). This final version of the questionnaire was distributed to participants in the study area.

The questionnaire was divided into three sections. The first section included questions on: recycling attitudes, recyclable materials, recycling participation, and attitudes towards mandatory recycling legislation. The second section dealt specifically with participation in the preliminary recycling program. The main objective was to obtain responses to items such as: respondents willingness to participate in the program, respondents' willingness to prepare materials, the ranking of encouraging factors, the ranking

of preferred Autobins locations, the ranking of informational modes, respondents' views on modes of financing the program and respondents' willingness to pay for the service. The final section gathered demographic information including: age, sex, education, occupation, dwelling ownership, total household income, and household size.

Three volunteer interviewers assisted in conducting the survey. Each was carefully selected, well trained, and had a strong commitment to assisting in the study. Interviewers participated in an orientation session designed to acquaint them with the study goals, where they discussed particular information, perceptions and approaches necessary for conducting successful interviews. Generally, the volunteers assisted with the interviews on weekends, while, the principal investigator conducted both weekend and weekday interviews. The principal investigator also regularly conducted random checks by re-interviewing participants to ensure volunteer interview accuracy.

Interviewers used a standard script for consistently relaying the introductory message. They then gave participants a questionnaire package to complete, which included a covering letter, an illustrated example of stacking home storage containers, the question and answer sequence, and a closing message. Use of the script format ensured consistent survey administration and management. Most questionnaires were completed immediately, but in some cases, participants requested that the questionnaire be collected at a later time. In latter case, respondents were asked to leave the completed questionnaires in their mail-box for collection on a pre-given date. In a few instances, occupants were either unavailable or unwilling to participate in the study. In cases were occupants were unavailable at the initial contact stage, subsequent visits were made. No substitution was conducted and in instances where subjects were unwilling to participate or where contact was not possible. According to

Dillman (1978) and Rubin and Babbie (1989), respondents substitution may lead to a build up of the initial sample size, or leave a bias by omitting non-responses.

5.3.1 Results and Discussion:

5.3.1.1 Results:

The survey was conducted between July 29 - September 5, 1993, from 5-9 PM on weekdays and between 11 AM - 5 PM on weekends, (during prime mosquito season in an unusually wet summer). A total of 197 questionnaires or approximately 74% of the 266 questionnaires were valid and completed. Fifty-six or approximately 21% of the subjects were unwilling to participate. Nine or approximately 4% were not available during the interview periods. Three or approximately 1% requested that the interviewer call back, but could not be reached on subsequent visits.

Interviews were generally completed in five minutes; however, in some cases, it took longer because respondents had concerns or questions about the study. During the study, a number of difficulties were encountered. Subsequent visits were time consuming, especially since respondents were either unavailable or sometimes, unwilling to participate. Unfavourable weather conditions posed difficulties, and in total, eleven days were lost to poor conditions, causing delays. Questions pertaining to socio-demographic characteristics were problematic and some respondents were unwilling to respond to this type of query. Fortunately, a significant number of respondents did reply.

The MacIntosh statistical package Statsview version 4.0, was used to compile the survey results and to provide a hard copy of summary results. This was important for data entry verification and data preparation. IBM Excel version 3.0 was used for tabulating

frequency distributions, percentages and cross tabulations. The graphs were produced using IBM Harvard Graphics version 2.3.

The survey results are presented in two forms. First, percentages illustrate response rates for particular categories. Secondly, cross tabulations are used to examine relationships between variables. The study results are reviewed in three main sections: general environment and recycling perceptions; prototype program participation; and socio-demographic characteristics of respondents. It should be noted that percentages in the following discussions have been rounded to the nearest whole number. The two open-ended questions on program effectiveness and lack of community recycling comments are illustrated in Appendix II.

5.3.1.1.1 General Recycling Perceptions:

General questions relating to attitudes and reasons for recycling were asked in this section. Figure 9 illustrates that 90% of the subjects considered recycling a worthwhile practice. Clearly, this response indicates that individuals in the sample group believe that recycling is worthwhile.

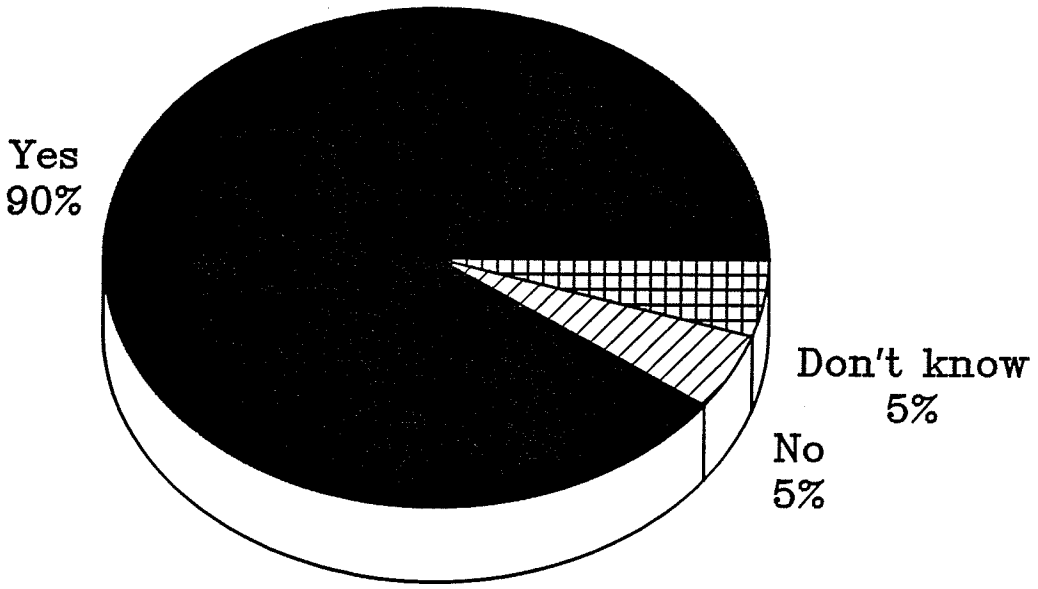


Figure 9: Responses to the question: Is Recycling a worthwhile Practice?

The next question asked respondents if they currently recycled. Eighty-two percent reported that they did; correspondingly, 18% reported that they did not. Since, there is no formalized recycling program in the area, perhaps some respondents may have misinterpreted the question and reported that they recycle at either work or reuse certain materials etc..

Next, respondents who recycled were asked to indicate from a list of eight items, what types of materials they recycle (see Figure 10). Seventy percent reported that their household recycles newspapers, and 79% reported that they recycle metal cans, 78% reported that they recycle plastic and glass beverage containers. In contrast, 46% reported that they recycle other type of containers, 20% reported that they recycle food and yard waste, and 39% indicated that they recycle hazardous wastes, such as, used oil, paint and car batteries.

Twenty-two percent reported that they recycle furniture and home appliances and 30% reported recycling other materials such as, clothing and scrap metal.

Respondents' results to this question suggest that they recycle traditional materials such as, newspapers, metal cans, and beverage containers rather than non-conventional materials. A significant number did indicate that they took hazardous waste to a local centralized drop-off depot. These responses indicate that other materials have recycling potential providing participant convenience is a factor.

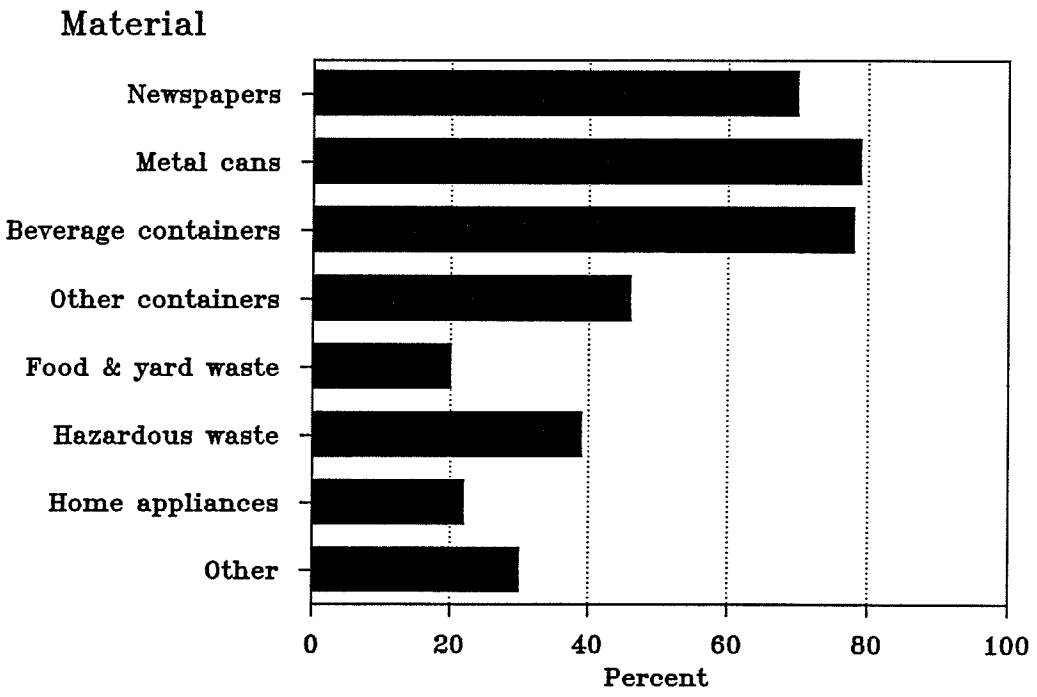


Figure 10: Household Materials currently recycled by the sample group.

Figure 11 illustrates respondents' reasons for recycling. Ninety-six percent reported that it was important to recycle because of environmental concerns. Eighty percent reported that recycling conserved energy. Thirty-two percent believed that recycling was not financially rewarding and 37% were unsure if the activity was financially rewarding. Eighty-

four percent were of the opinion that the activity reduced waste and 79% reported that recycling was an important reason to save resources for future generations. Figure 11 indicates that respondents are motivated to recycle for a number of different reasons, but they generally agree that it does not have any monetary benefit.

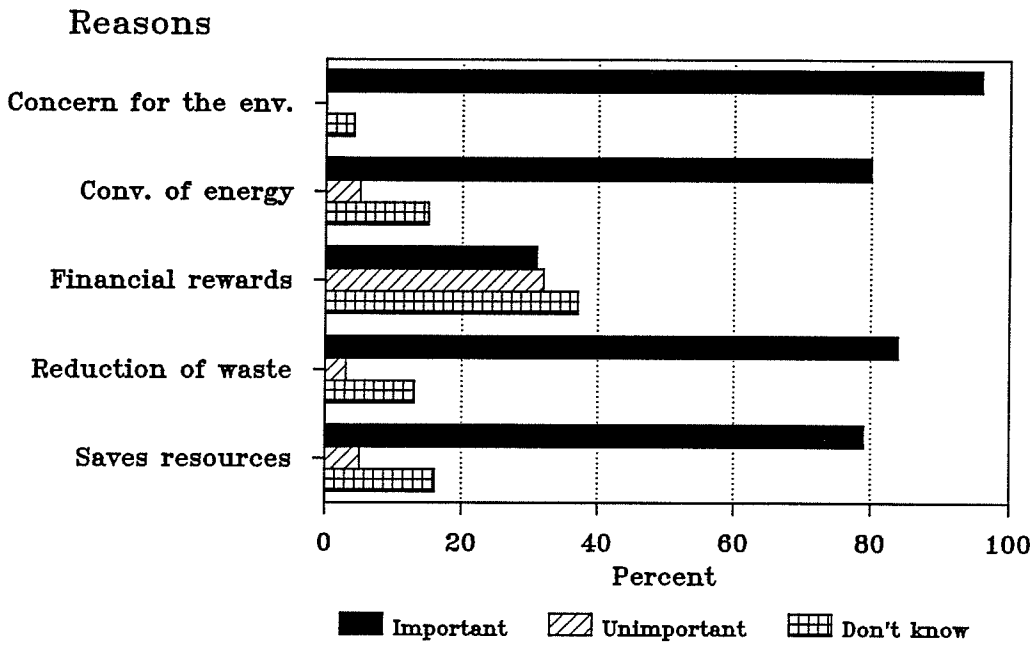


Figure 11: Reported reasons for recycling.

The respondents who recycled were asked if they participated in any type of city recycling programs (see Figure 12). Figure 12 shows that a significant number indicated that they generally do not participate in any of the existing city recycling programs. Only 21% participate in the privately run weekly curbside program. Twenty-two percent of respondents indicated that they participate occasionally in buy-back depots, and 31% reported that they participate occasionally in drop-off programs. Figure 12 indicates that respondents participate more often in drop-off depots than in any other type of program; however, a significant

number do not participate, perhaps owing to: the lack of a convenient accessible recycling program in their neighbourhood, a reluctance to take materials to drop-off and buy-back centres, an unwillingness to prepare materials or to pay for the privately run curbside service. Although respondents have indicated that recycling is important and worthwhile in previous questions, it appears that a contradiction exists between what people report is important and worthwhile and what they actually do.

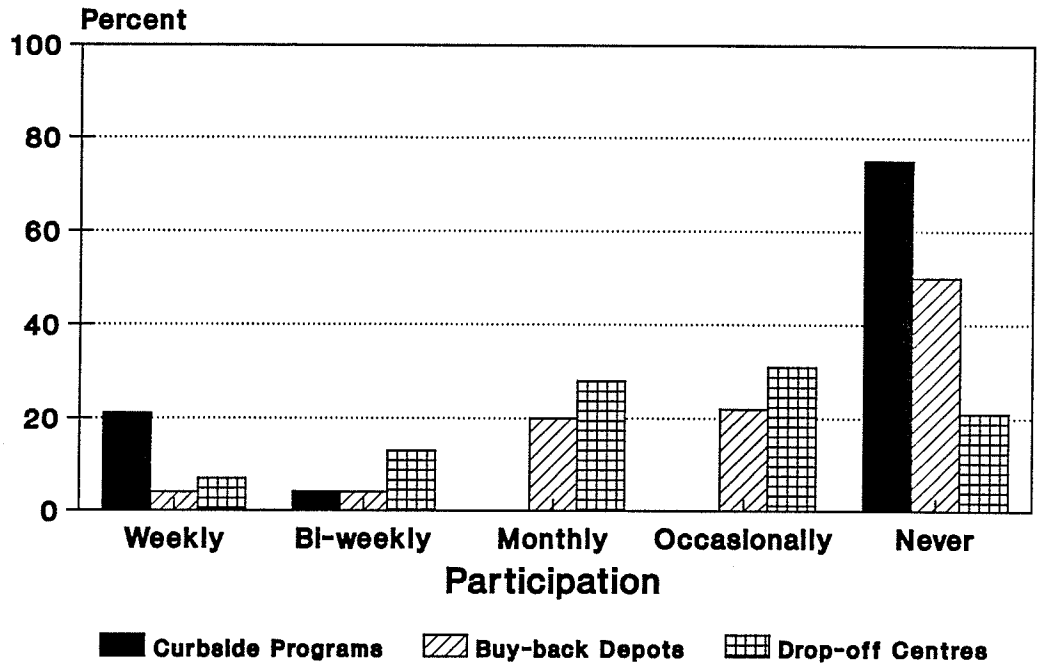


Figure 12: Respondents' reported Participation in existing Recycling Programs.

When respondents were asked about passing mandatory recycling bylaw, (see Figure 13), about half of them agreed that the city should pass a bylaw enforcing participation; 30% were against passing a bylaw and 22% were unsure. Overall, respondents agreed with the concept of mandatory participation and felt it would not only encourage, but enforce non-recyclers' participation. On the other hand, about 1 out of 3 respondents were against passing

by-law and about 1 out of 4 were unsure. On the other hand, perhaps respondents misinterpreted the implications of passing a by-law or believed that it would be too complex to implement enforcement measures necessary for the by-law. In general, respondents who were either non-recyclers or who were not satisfied with current solid waste collection system, did not see a need for mandatory enforcement. Furthermore, they did not see recycling as necessary and were against or unsure about passing a mandatory participation by-law.

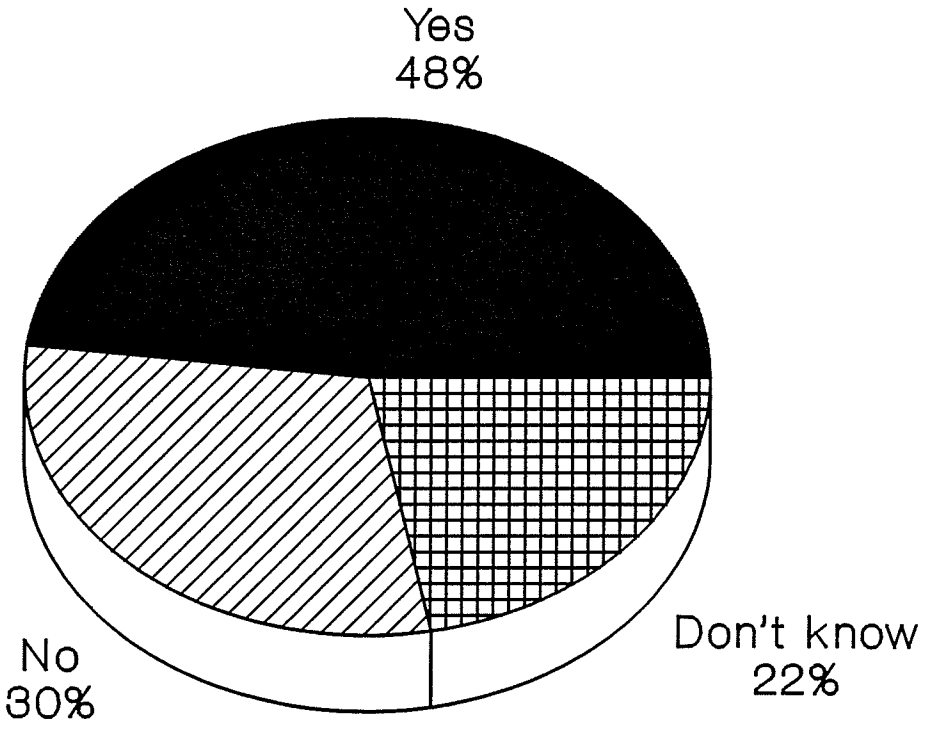


Figure 13: Respondents' attitude towards passing a Mandatory Program Participation Bylaw.

5.3.1.1.2 Program Participation:

The second section of the survey probed respondents' willingness to participate in the proposed recycling program. Other information examined included: willingness to sort materials, encouraging and discouraging factors, preferred bin locations, preferred informational sources, funding schemes and user-pay strategies.

While 77% agreed that they were willing to participate in the automated recycling program (see Figure 14), 13% indicated that they might participate and 10% indicated that they would not participate.

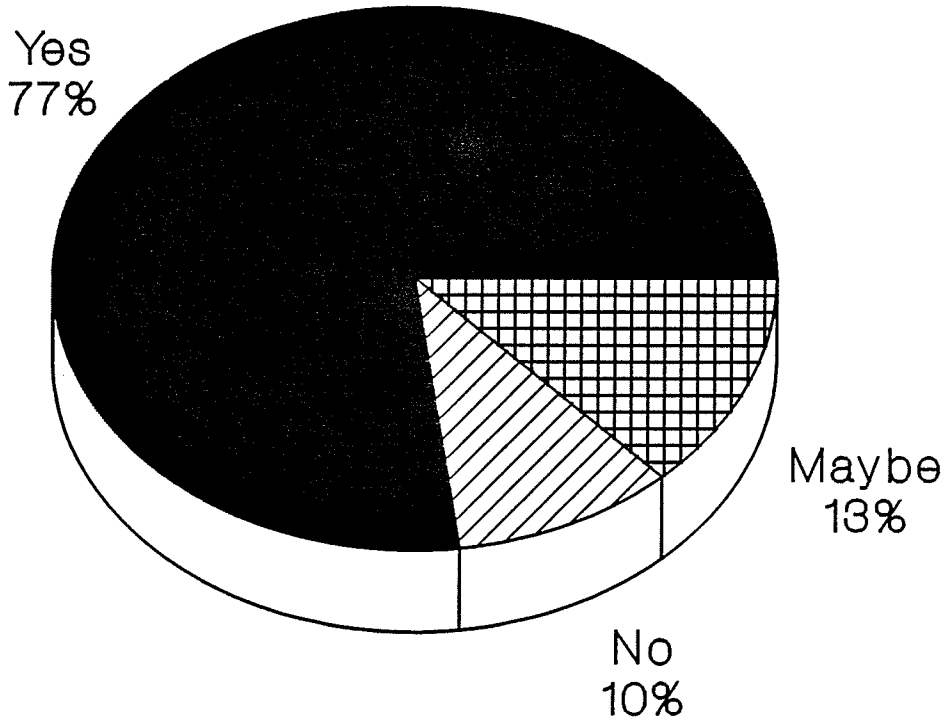


Figure 14: Respondents' willingness to Participate in the Prototype Program.

Regarding preparing materials for recycling, Figure 15 illustrates that a significant number of respondents reported that they would be willing to rinse, flatten and sort materials. Seventy-seven percent were willing to rinse glass, and metal cans, 71% were willing to flatten cans and 74% were willing to separate glossy materials from newspapers. However, the general pattern in previous question appeared in the willingness to participate question. Those respondents who were willing to participate in the program reported a willingness to prepare materials, while, those who had previously responded "no" and "maybe" to program participation were also against the preparation of materials.

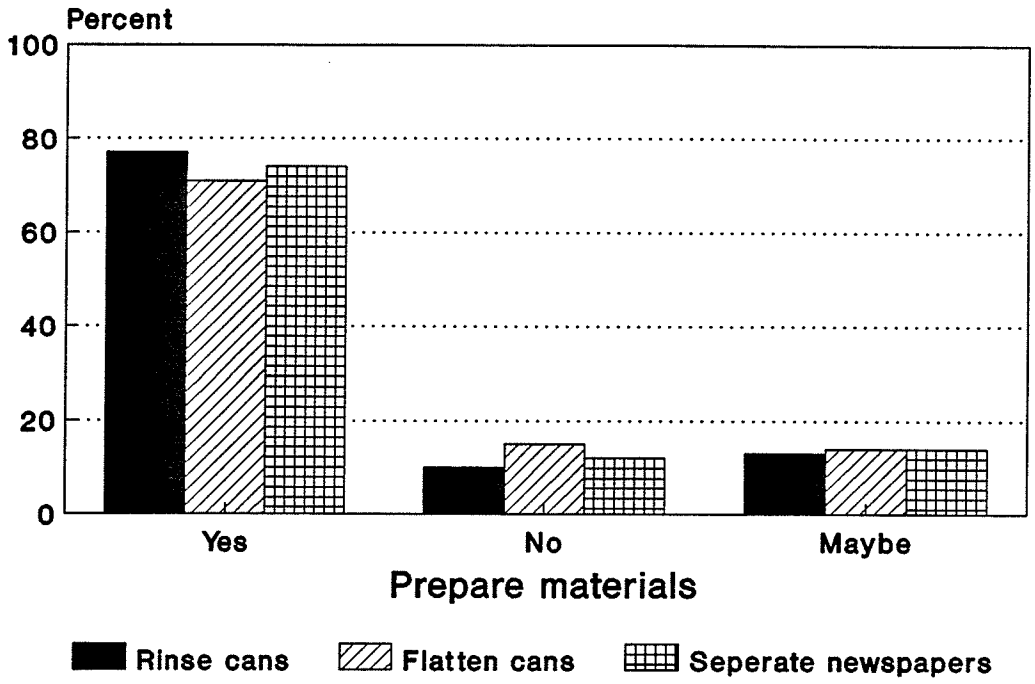


Figure 15: Respondents' willingness to prepare materials for recycling.

Regarding factors which encourage or discourage recycling (see Figure 16). Respondents were asked to rank three out of four possible factors, on a three point scale, one being most encouraging factor and three being the least encouraging factor. Seventy-nine percent ranked free home storage containers as the most encouraging factor and 56% reported distance to Autobins as the least encouraging factor. In contrast, 72% cited remembering the collection day/schedule and 50% cited material preparation as the least encouraging factors. In general, the response to providing free home storage containers corresponds with the literature review findings that home storage containers create awareness and encourage participation. The study findings also indicate that the collection day schedule and the material preparation components may require specific promotion attention to create awareness and encourage target group participation.

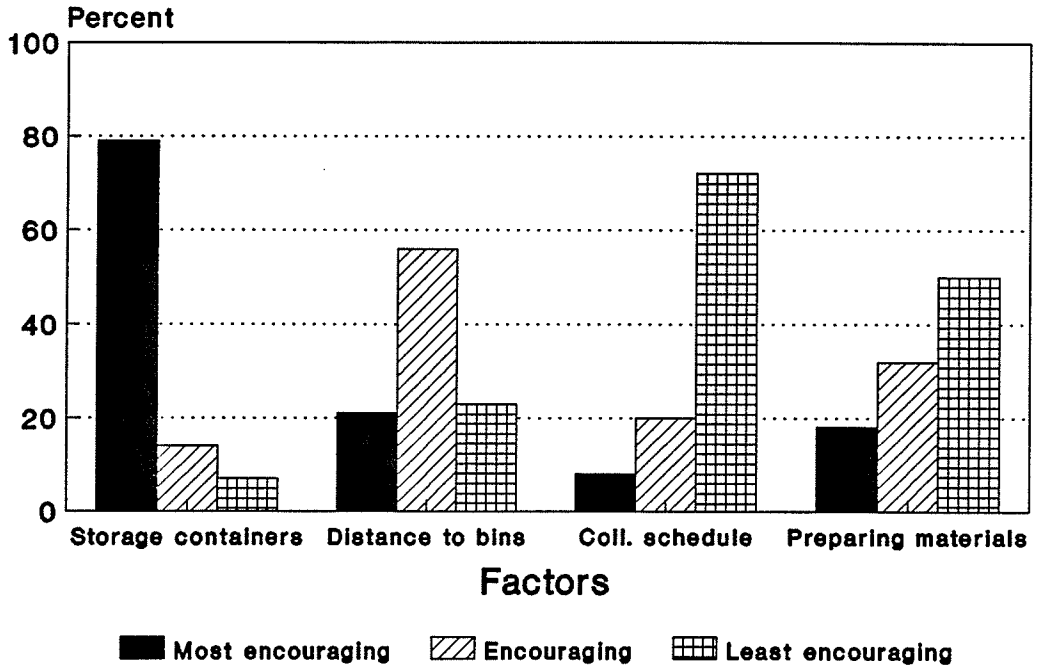


Figure 16: Factors encouraging recycling behaviour.

When respondents were asked to rank up to 3 preferred choices for Autobin locations (see Figure 17), 80% indicated that the front or back of the property was the most preferred choice. Seventy-one percent reported the opposite side of the street as the preferred choice. Forty percent of respondents reported six houses away as preferred choice and 43% indicated twelve houses away as preferred choice. The least preferred Autobin locations were nine houses away (55%) and 52% twelve houses away. These figures indicate that about half of the respondents were willing to travel twelve houses away to deposit their recyclables.

Overall, as the graph illustrates, respondents' most preferred locations were the front, back or opposite side of the street from their property. Respondents, generally, are opposed to travelling lengthy distances, for convenience reasons. However, the graph does

not show a clear pattern for respondents' most preferred locations. Generally, however, it can be concluded from the study results, that the maximum distance respondents would be willing to travel is fifteen houses away.

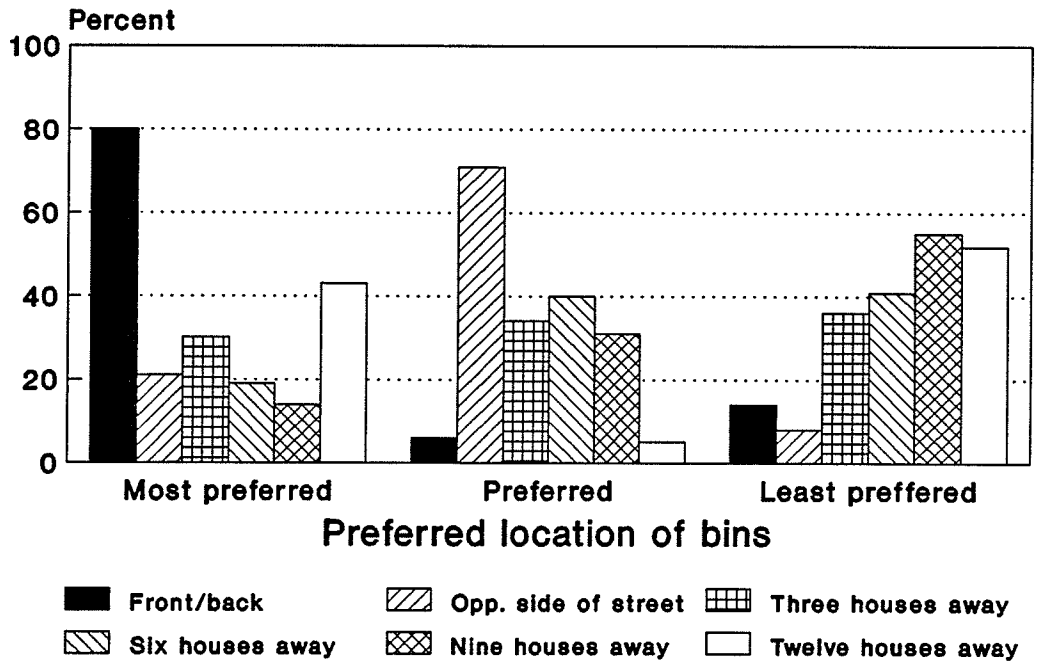


Figure 17: Respondents' preferred Autobin location.

Figure 18 illustrates respondents' preferred media informational sources. Respondents were asked to select up to three ways of receiving information during the implementation stages of the program. Fifty-four percent reported that they preferred to receive information via television campaigns, 46% preferred a 24-hour information hot-line, 44% preferred direct mail brochures and pamphlets, 42% preferred newspaper articles, 40% preferred radio programs and 36% preferred door to door canvassing. Only 22% preferred monthly newsletters and 7% preferred community meetings. In general, the three most popular choices were: television programs; the 24-hour information hot-line; and brochures

and pamphlets.

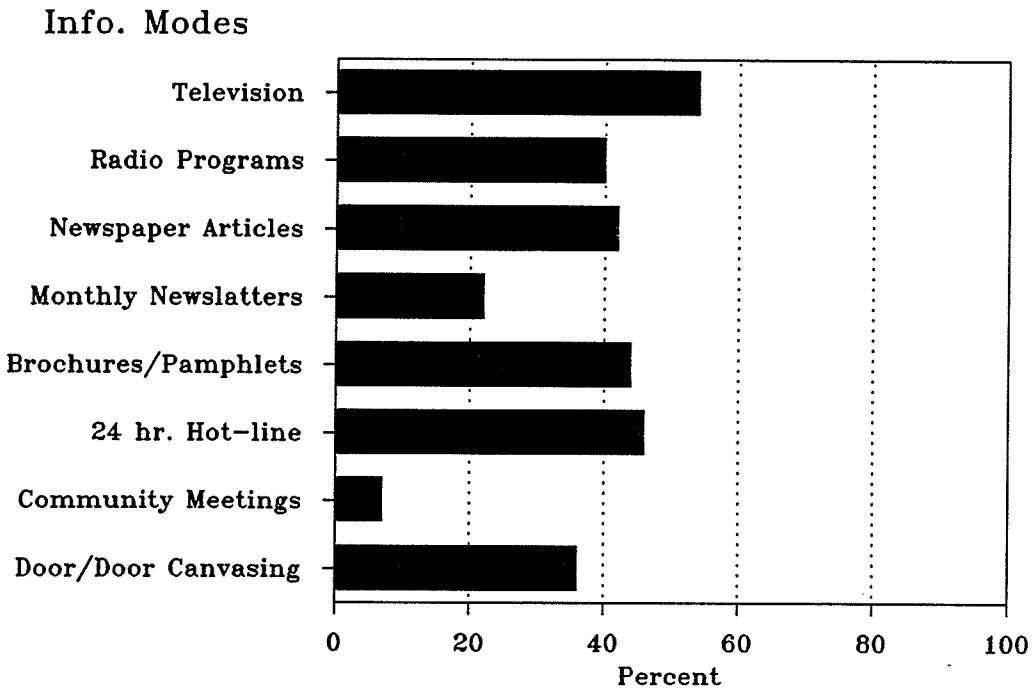


Figure 18: Media modes preferred by respondents' during implementation period of the recycling program.

When respondents were asked about funding schemes for the recycling program (see Figure 19), many claimed that property taxes (68%), levy charges on consumer products (71%), flat fees paid by participating households (78%) and garbage pick-up fees (77%) were unfair ways of funding the program. In contrast, nearly half of the respondents (51%) agreed that a tax on materials that cannot be recycled was fair way of funding a recycling program. Generally, respondents indicate that they were not in favour on any user-pay funding schemes for the proposed recycling program, however, nearly half of them indicated that it was fair to fund the program by charging taxes on materials that cannot be recycled.

Figure 19: Respondents' preferred funding scheme for the recycling program.

Figure 20 illustrates the amount respondents reported they were willing to pay per month for the recycling program. Thirty-one percent of the respondents didn't know how much the service was worth and 26% reported they were unwilling to pay a fee. In contrast, 18% were willing to pay $5 per month, 16% were willing to pay $2 per month, 7% were willing to pay $3 per month, and 2% were willing to pay $4 per month. Generally, more than half respondents (57%) either didn't know or were unwilling to pay for the service, while, less than half respondents (43%) were willing to pay for the service.

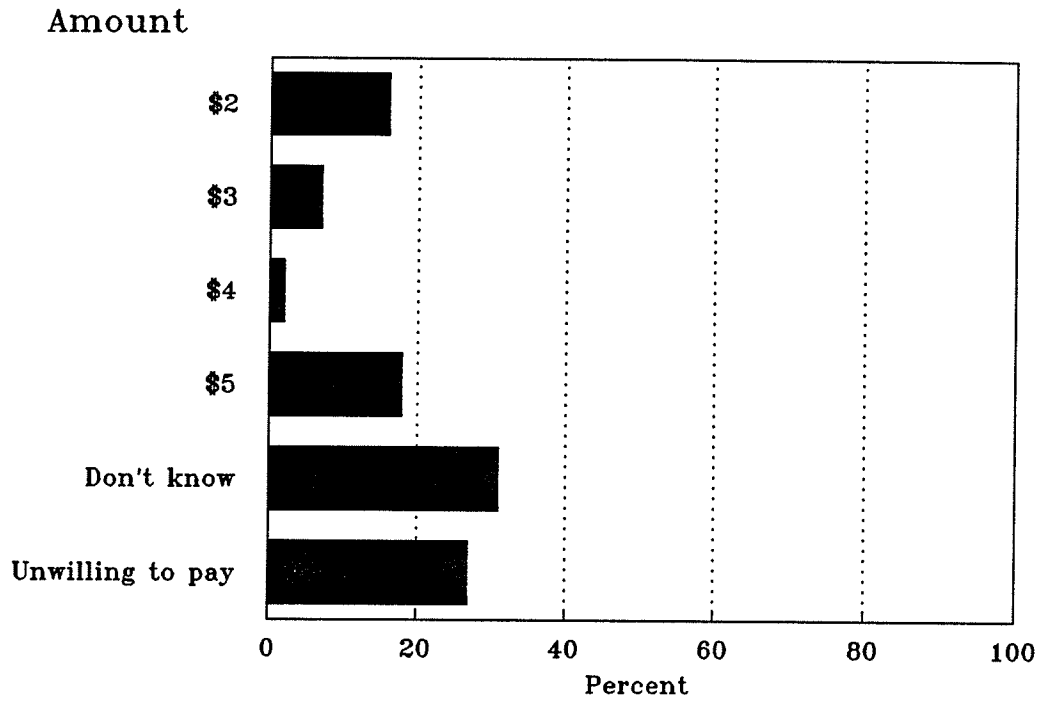


Figure 20: Respondents' willingness to pay for the recycling program.

5.3.1.1.3 Socio-Demographics Characteristics:

The final section of the survey was designed to profile the basic socio-demographic characteristics of the sample population for descriptive and comparative purposes. Table 10 presents a detailed summary of the findings. However, it should be noted that the target population included only individuals twenty years of age and older.

Slightly more of the respondents were females (54%), as compared with males (46%). More than half (60%) of the respondents were between 32-51 years of age and nearly 1 in 4 (24%) reported their age as between 20-34. Nearly 1 in 3 (33%) respondents had high school education; nearly 1 in 4 (23%) had completed some college or university education and about 1 in 7 (14%) reported they were college or university graduate. These findings do not

reflect the general population trends, nor do they suggest any significant changes in the age or education of the population in the study area. Rather, they are the result of the survey design which targeted heads of the household, 20 years of age and over.

Nearly 1 in 7 (15%) respondents reported their occupation as either labour or retired. Nearly 1 in 10 reported their occupation as clerical, technical, professional, home maker or unemployed.

About 1 in 3 (28%) respondents indicated that their total 1992 household income, before taxes, was between $30,000-39,999. However, 5% of the respondents refused to disclose their household income. Nearly half of the respondents (45%) reported that their 1992 total household income, before taxes, was between $30,000-49,999. Generally, this finding contradicts the 1986 Census Data that reported the average total household income for the area as $26,835. However, due to small sample size and 1986 Census Data information used, it is hard to conclude that household income has changed significantly.

A high proportion of the respondents, nearly 3 in 4, owned their homes. It seems that the low turnover rate in residents would positively assist both the promotional campaign and replacement rates for home storage containers, by uniform promotional campaign and lower container replacement costs. The majority of respondents (83%) reported a family size of 2 persons over 18 years of age. Nearly half (45%) of the respondents indicated they had no children under the age of 18 residing in their home. The housing density composition for the area, based on the sample group's findings, could be described on average as single dwellings with a low population density containing middle-aged people without any children and middle household incomes.

Table 10: Respondents' Socio-Demographic Characteristics.

Category	Variable	Survey Respondents (%)
Gender	Male	46
	Female	54
Age	20-34	24
	35-59	63
	60+	13
Education	Grade 8 or less	9
	Some high school	21
	High school graduate	33
	Some college/university	23
	College/university graduate	14
	Other	1
Occupation	Labourer	15
	Clerical	11
	Managerial	6
	Technical	10
	Professional	10
	Self-employed	8
	Student	6
	Home maker	10
	Unemployed	10
	Retired	15
House ownership	Rented	29
	Owned	71
Total household income (1992)	Under $9,999	6
	$10,000-19,999	13
	$20,000-29,999	22
	$30,000-39,999	28
	$40,000-49,999	17
	$50,000-59,999	4
	$60,000-69,999	2
	$70,000-79,999	1
	Over $80,000	2
Occupants (average)	Adults	2
	Children	0

Table 11 compares the study area's specific socio-demographic findings with Winnipeg's Area Characterization Profiles to determine if the sample population matched the general population of the study area as defined by the 1986 Census. Categories such as, occupation, total household income, and number of occupants were not compared for several reasons. First, this information was of a more general nature in Winnipeg's Area Characterization Profiles than in the survey sample. Second, the survey question regarding total household income was considered sensitive by some individuals and respondents were generally less willing to answer this question. Furthermore, in Winnipeg's Characterization Profiles, household income was reported in general terms as the average single household income.

Table 11 reports the differences (df.) between the sample results and Census Data. A positive difference indicates that the survey sample has a higher percentage than the study area, and a negative difference indicates that the survey sample has a lower percentage than the general population.

Significant differences were evident in the education variable, especially in the categories of no high school certificate (-32%) and high school graduate (-3%). Other notable differences occurred in the age variable, age group 35-59 (+29%) resulted in a positive difference, while 20-34 (-12%) and 60+ (-18%) age group resulted in a negative differences. Owing to a relatively small sample size, it is not possible to determine whether the study area's socio-demographic characteristics had changed with respect to these variables since 1986 Census Data (the 1991 Census Data had not been released).

Table 11: Comparison of selected Socio-Demographic Characteristics between the Survey sample and the 1986 Census Data.

Category	Variable	Survey Sample (%)	Census Data (%)	Df. (%)
Gender	Male	46	48	-2
	Female	54	52	2
Age[1]	20-34	24	36	-12
	35-59	63	34	29
	60+	13	31	-18
Education	Grade 8 or less	9	-	-
	Some high school[2]	21	62	-32
	High school graduate	33	9	24
	Some college/university	23	12	11
	College/university graduate	14	17	-3
	Other	1	0	1
Housing	Rented	29	35	-6
	Owned	71	65	6

Note
[1] The study area N = 26,540 (20 years and over)
[2] The study area: Grade 8 or less and some high school combined

Contingency chi-square table analyses were used as significance tests to determine whether there were any relationship between nominal variables in the sample population. The raw survey data was coded, and contingency tables were generated to illustrate the frequencies with which each variable combination occurred. Each table illustrates the actual observed frequencies which occurred and the values in the brackets are the observed values converted in percentages to illustrate the relationship between variables. Owing to a high number of respondents who recycle and generally the small sample size, it is difficult to test the relationships between variables.

Table 12 compares the variables of home ownership with recycling participation. Of the 139 respondents who owned their homes, 86% reported that they recycle. Of the respondents who rented their homes, 74% reported that they recycled. The table shows that there is a significant difference between respondents who owned their homes and those who rented. These findings agree with the Van Liere and Dunlap (1980) study, that home ownership and the concern for the environment have a positive correlation.

Table 12: Home Ownership and Recycling Participation.

	Ownership		
Recycle	Owned	Rented	
Yes	119 (86%)	43 (74%)	162
No	20 (14%)	15 (26%)	35
Total	139	58	197

Table 13 compares gender and participation in recycling activities. Eighty-seven percent of female respondents reported that they recycle, compared with 77% of male respondents. The table indicates that female respondents recycle more than male respondents. These findings agree with both the De Young (1984) and Ebreo (1990) studies which found that females were more environmentally conscious than males.

Table 13: Gender and Recycling Participation.

	Gender		
Recycle	Male	Female	
Yes	70 (77%)	92 (87%)	162
No	21 (23%)	14 (13%)	35
Total	91	106	197

Table 14 compares age with participation in recycling activities. The table reveals that a significant number of respondents in the 60+ age group reported that they recycle (92%), compared with the 35-59 age group (83%) and the 20-34 age group (72%). The table confirms that older respondents recycle more than other age groups. However, these findings also indicate that significant numbers, in all age groups, recycle. These results agree with Vining and Ebreo's (1990a) findings that few demographic variables distinguish recyclers from non-recyclers. One of the few significant variables being that recyclers were generally older than non-recyclers.

Table 14: Age and Recycling Participation.

	Age			
Recycle	20-34	35-59	60+	
Yes	35 (73%)	103 (84%)	24 (92%)	162
No	13 (27%)	20 (16%)	2 (8%)	35
Total	48	123	26	197

Table 15 compares education and participation in recycling activities. The table illustrates that respondents with high school diplomas (82%), some college/university (98%), and college/university graduates (85%) recycle more than those with educational levels of grade 8 or less (78%) or some high school education (66%). The table clearly shows that educated respondents recycle more than respondents with lower education. These results agrees with Vining and Ebreo's (1990) study, which found that altruistic factors, such as concern for environment, have no relationship to respondents' education.

Table 15: Respondents' education and recycling participation.

Education	Recycle		
	Yes	No	
Grade 8 or less	14 (78%)	4 (22%)	18
Some high school	27 (66%)	14 (34%)	41
High school graduate	53 (82%)	12 (18%)	65
Some college/university	44 (98%)	1 (2%)	45
College/university graduate	23 (85%)	4 (15%)	27
Other	1 (100%)	0 (0%)	1
Total	162	35	197

Table 16 compares respondents' occupations and participation in recycling activities. The most significant recyclers were the: technical (95%); home maker (95%); clerical (90%); self-employed (88%); student (82%); managerial (82%); and professional (80%) categories. Other individuals in occupations who recycle were: labourers (72%), unemployed (75%); and retired (72%). However, as the table indicates, all occupational categories included significant numbers of respondents that recycle. These results support the Vining and Ebreo (1990) study that altruistic factors, such as concern with the environment, have no relationship with the occupation of the respondents.

Table 16: Occupation and Recycling participation.

Occupation	Recycle		
	Yes	No	
Labourer	21 (72%)	8 (28%)	29
Clerical	19 (90%)	2 (10%)	21
Managerial	9 (82%)	2 (8%)	11
Technical	19 (95%)	1 (5%)	20
Professional	16 (80%)	4 (20%)	20
Self-employed	14 (88%)	2 (12%)	16
Student	9 (82%)	2 (18%)	11
Home maker	19 (95%)	1 (5%)	20
Unemployed	15 (75%)	5 (25%)	20
Retired	21 (72%)	8 (28%)	29
Total	162	35	197

5.3.1.2 Discussion:

Overall, the results suggest that respondents generally support recycling and are willing to participate in the prototype program. Although respondents report that they recycle, because they are concerned about: the environment, conservation, waste reduction, and saving resources for future generations, they may not participate in a recycling program unless it is convenient. Currently, significant numbers of respondents have not participated in any recycling programs, owing to a lack of convenience, an unwillingness to prepare and take materials to depots, or an unwillingness to subscribe to a user-pay privately run curbside program. About half of the respondents supported passing a mandatory by-law; however, the

other half were either unsure or against passing a by-law.

The survey results support the notion that providing free home storage containers was an encouraging factor, while remembering alternative collection day schedules and preparing materials, proved to be discouraging factors. Therefore, certain factors will require extensive promotion during implementation stage to encourage participation. Generally, they were in favour of the proposed location of the bins fifteen houses away.

The study results suggest that during the program implementation stage, respondents preferred television programs, a 24 hour information hot-line and direct-mail brochures and pamphlets to promote and create program awareness. Comments from the open-ended questions provided some useful suggestions, such as, the distribution of fridge magnets to display the collection schedule, the posting of schedules on bins, the promotion of the program at local gatherings, such as bingos, and churches, and the involvement of local community members in a planning and decision making group.

Possibly owing to the current economic climate, the sample group expressed concern related to funding schemes to support the recycling program. The survey findings suggest that a property tax, a levy on consumer products, a user-fee, or a fee for garbage pick-up were unfair funding schemes to support the recycling program. About half of respondents agreed that a tax on materials that cannot be recycled was a fair option. Generally, if the program is free, the respondents may be willing to participate, however, if a user-fee is charged, the overall participation rate may be negatively affected. A significant number of respondents were either unwilling to pay or unsure about how much the service was worth.

When 1986 Census Data variables were compared with the sample variables,

generally, the survey findings did not confirm the 1986 Census Data. Since the sample size was small, it is difficult to make any accurate predictions that might indicate a change in population over time.

The information gathered during this study conforms to previous research in recycling behaviour. Furthermore, it provides an adequate analysis for generalizations between the sample group's views and the attitudes towards implementing a prototype recycling program in the study area. The survey found that respondents' altruistic concern for the environment and their willingness to take part in the program, were motivating factors if they were provided with free home storage containers and recycling bins were conveniently located.

In conclusion, the survey including respondents' attitudes towards implementing a program, serve as an awareness and promotional tool for the pre-implementation stage of the program. It provides vital information to decision-makers regarding: respondents' willingness to participate, the preparation of materials, preferred bin locations, media preference, funding schemes and the amount of money respondents would be willing to pay to support the program. In addition, this information would also assist in forecasting: the potential amount of waste that could be diverted by the program, long-term capital expenditure savings, and educational and promotional needs.

5.4 Benefit-Cost Analysis:

This section details the cost and benefit calculations for the prototype program. Swartzman, Liroff and Croke (1982) defined benefit-cost analysis as a practical tool employed to provide a framework for structured information which can assist in making strategic

decisions about the economic viability of a project. They also emphasis that it identifies the areas in which explicitness or obscurity in decisions may occur and identifies areas in which further research may be desired. However, they caution that it may also lead to inequitable or short-sighted decisions, owing to the greater emphasis given to translating gains and losses to dollars terms. It may also lead to politically influenced decisions; meanwhile, strongly held views of non-monetary values may be ignored.

The framework for the analysis was developed from a combination of the Glass Packaging Institute (1988), City of Los Angeles Recycling Implementation Plan (1989), Decision maker's Guide to Recycling Plastics (1990) and City of Santa Rosa, Source Reduction and Recycling Element (1993) reports.

5.4.1 Benefit-Cost Assumptions:

Table 17 presents the detailed benefit-cost assumptions for the prototype program. It should be noted that these estimates are computed for decision making purposes only; the salvage values and the collection equipment depreciation have been ignored. In addition, in some cases, the variables may vary between + or -20%. The program is designed to serve Phase I's 10,237 single dwellings participating in the Autobin collection program. Each household would be provided with 3 stacking home storage containers to interim store their recyclables.

In one year, 249 days or 1,992 hours are accountable working days/hours. The program would not incur any administrative/technical/clerical costs, since it is assumed that resources would be reallocated within the North West Works and Operation District. Labour costs were computed according to the city's operator Grade III annual salary for a single crew

member operating a collection truck.

A ten percent allocation of Autobins and stacking home storage containers was assumed for backup/replacement use owing to breakage or loss. This backup/replacement norm was verified with other North American programs, such as, Los Angeles, California; Richmond, British Columbia; Orlando, Florida and Toronto, Ontario. The program's life was estimated at 14 years. Once benefits and costs were identified, the present value of each future cash flow was "discounted" to reflect present costs. The discount rate was determined by using the yield rate of a 14 year Canada Savings Bond at 7.52% (Globe & Mail, November 8, 1993, B8), an inflation rate (2.1%) and a risk premium base rate (0.4%) to get the discount rate of 10.02%. These numbers were verified with Suzzane Goldie, leasing officer with National Equipment Leasing Company, Winnipeg.

It is assumed that the collection truck would be replaced in 7 years, stacking home storage containers in 5 years, and Autobins in 15 years. The program would have no back-up collection equipment, it is assumed that solid waste collection equipment would assist the recycling component during breakage.

The revenues from the materials collected are assumed as follows: Newspapers (ONP) $0.015/lb ($30/tonne); aluminum containers $0.30/lb; and tin containers $0.03/lb. The targeted material prices were discussed in Chapter 3, local market analysis section. Revenues from ONP take into consideration hauling costs to the paper mill in Pine Falls. Aluminum and tin containers are assumed to receive the best market prices. All of the city's Public Works Districts pay a standard rate of $15.30 per tonne to dispose of collected solid waste at the city owned landfill sites, while, solid waste collection by automated trucks cost the North West Works and Operations District, on an average $28 per tonne (Pers. Comm.

John Friesen, January 13, 1994). These landfill disposal and collection costs would assist in projecting avoided disposal and collection costs. Furthermore, it is assumed that the materials would be processed by a private contracted processing facility before shipment to local markets. The contracted processing estimates for processing materials is assumed at $35/tonne (Pers. Comm. Bonnie Kulak, January 24, 1993, Kathy Sims, June 30, 1993, and Jim Fogg, July 28, 1993).

However, avoided collection costs may not be directly proportional to the reduction in solid waste collection. It is assumed that the net effect of the avoided costs would rely on the amount of material diverted by the prototype program. The avoided collection costs would not have any significant effect once the time necessary to service Autobins, and the trucks trips to the landfill are factored in. However, automated solid waste trucks would be able to collect more solid waste from the bins, which may lead to expanded truck routes.

The materials recovery revenues are based on the estimates examined in the material recovery section: the worst case scenario (50% ONP, 25% aluminum and tin containers), and the best case scenario (90% ONP, 50% aluminum and tin containers).

The savings in energy, reduced pollution, extended life of the local landfill sites, and the creation of employment opportunities are some of non-monetary benefits which are difficult to put in meaningful monetary terms. However, they are discussed because of their positive impact on the community.

Table 17: Detailed Benefit-Cost Assumptions for the Prototype Program.

1. Demographics	
Single Dwelling Households (1986)	10,237
Autobin Containers (Pick-ups) (1993)	683
Stacking home storage containers	10,237
Population (1986)	36,175
2. Work Year	
Days/year	249
Hours/year	1,992
Holidays/year	11
3. Labour Cost Factors	Existing job classification based on city's Operator Grade III
4. Backup/Standby/Replacement Factors	
Collection vehicles	0
Maintenance vehicles	0
Home storage containers (backup/replacement)	10%
Autobins (backup/replacement)	10%
Collection Crew	0
Administrative/Technical/Clerical support staff	0
5. Replacement Schedule and Economic Assumptions	
Annual costs are based on the following assumptions:	
Estimated program life	14 years
Inflation Factor (except where Constant 1993 Dollars indicated)	2.10%
Discount Rate (To calculate Net Present Value)	10.02%
Replacement Schedule	
Automated trucks	7 years
Stacking home storage containers	5 years
Autobin containers	15 years
6. Revenue/Benefit/Processing Materials Assumptions	
Newspapers (ONP)	$0.015/lb
Aluminum Containers	$0.30/lb
Tin Containers	$0.03/lb
Avoided Landfill Disposal Cost	$15.30/tonne
Avoided Collection Cost	$28/tonne
Contracted Processing Cost	$35/tonne
7. Material Recovery Assumptions	
Worst Case Scenario:	
ONP 50%; 25% aluminum and tin containers.	
Best Case Scenario:	
ONP 90%; 50% aluminum and tin containers.	

5.4.2 Capital and Start-up Costs:

Table 18 illustrates detailed capital and start-up costs for the prototype program. Fixed capital requirements include land, site preparation, buildings, an automated truck, Autobins, and home storage containers. However, land, site preparation, and buildings costs would not be incurred, since the program would not require processing facilities. It is assumed that the materials would be processed by a private processing facility and shipped to local markets.

The main fixed capital costs include purchasing 1 automated 29 yd. collection truck at $140,000, and 751 Autobins containers (including the 10% backup and replacement provisions) at $475 each. These containers would also incur assembly and placement costs of $25 each. Therefore, the total cost of these bins would be $375,500. Other capital costs include 11,261 stacking home storage containers, (including the 10% backup and replacement provisions) at $15.50 each for a total cost of $174,545.50. The program would also incur a initial start-up promotional and educational campaign, which is estimated at $44,472.37 (see Table 20). Therefore, the total capital costs are estimated at $734,517.87.

The table indicates that the cost of acquisition, assembly and placement of Autobins is the major cost, representing nearly half (51%) of total capital costs, followed by home storage containers, that represent nearly 1/4th (24%) and the collection truck nearly 1/5th (19%). On the other hand, the initial start-up promotional and educational campaign represents only 6% of total capital costs.

Table 18: Detailed Capital and Start-up Costs for the Prototype Program.

PARTICULARS	AMOUNT ($)	AMOUNT ($)
Fixed Costs		
Land, Buildings and Site Improvements		0
Equipment		
1 29 yd. automated truck[1]	140,000.00	
Autobins containers 751 containers, including 68 backup and replacement containers at $475 ea.[2]	356,725.00	
Autobin assembly and placement 751 Autobins at $25.00 ea.[3]	18,775.00	
Stacking home storage containers 11,261 containers, including 1,024 backup and replacement at $15.50 ea.[4]	174,545.50	
	---	690,045.50
Initial start-up promotional and educational campaign (see Table 20)		44,472.37
TOTAL CAPITAL COSTS		734,517.87

Note:
[1] Committee on Works and Operations (1990) estimate.
[2] Committee on Works and Operations (1990) estimate.
[3] Committee on Works and Operations (1990) estimate.
[4] Shamrock Industries Inc., (1993) estimate (including freight costs).

5.4.3 Annual Operating Costs:

Table 19 illustrates detailed annual operating costs for the prototype program. Operating costs are usually ongoing costs, such as: equipment leases; administration; labour; vehicle maintenance; annual promotional and educational campaigns; site maintenance; collected materials shipping costs; bin maintenance; and processing costs. There are two types of operating cost, fixed and variable. Fixed overhead costs do not fluctuate, while,

variable costs vary according to level of performance of labour and materials handled.

The program would not incur any fixed overhead costs, such as, mortgage, rent, lease, building and equipment insurance, because it is assumed that equipment would be purchased outright and the program would perform as part of the District. Variable costs include labour cost for a Grade III operator for a single crew member operating the automated collection truck, which is estimated at $37,651.33 (including all fringe benefits).

Vehicle maintenance costs are assumed to be identical to those for the present automated solid waste collection trucks. These costs were estimated at $27,581.33. The single crew driver's clothing and supplies costs were estimated at $600.

Autobins would require annual maintenance (cleaning, disinfecting and other relevant maintenance), which again was assumed to be identical to solid waste bin maintenance. These costs were $15 per bin for a total cost of $10,245. Since the recyclables collected would be contracted for processing, the program would not incur any shipping, processing and site overhead expenses.

From other program experiences, one time promotional and educational campaign are not adequate to maintain high participation and diversion rates. Therefore, based on the experiences of: Edmonton, Alberta; Vancouver, British Columbia; and Toronto, Ontario who allocate between $1-2 per participating household for annual promotional and educational campaign budgets, the study area will allocate $2 per participating households for such campaigns. The literature indicates that lower and middle income groups need well-defined promotional and educational campaign to create awareness among participants. The annual operating costs are therefore, estimated at $101,515.34.

Table 19 indicates that labour costs (43%) are the major total annual operating costs, followed by vehicle maintenance (27%), annual promotional and educational campaigns (20%) and Autobin maintenance (10%). Since the program would ship collected materials to a private processing facility to process and ship materials, there are no marketing, and site overheads expenses. Contracted processing costs are discussed in Table 21.

Table 19: Detailed Total Annual Operating Costs for the Prototype Program.

PARTICULARS	AMOUNT ($)	AMOUNT ($)
FIXED OVERHEADS		
Mortgage, Rent, Lease, Insurance		0
VARIABLE OVERHEADS		
Labour Costs: Driver's Annual Wages[1] ($14.96/hour)	31,116.80	
Related Cost (Fringe Benefits)		
38.88% of annual salary[2]	12,098.21	
		43,215.01
Collection Vehicle Operation/Maintenance[3]		
Vehicle Parts/Tires	16,733.00	
Vehicle Fuel Consumption (litres/year)	7,688.33	
Annual Vehicle License	1,260.00	
Annual Vehicle Insurance	1,300.00	
Clothing & Supplies[4]	600.00	
		27,581.33
Autobin Maintenance 683 @$15.00 ea.[5]		10,245.00
Marketing (cost of shipping materials)		0
Processing Costs		
Equipment Operation, Maintenance, Supplies		0
Site Overhead		
Site Maintenance, Utilities, Administration, Supplies, Travel, Legal, Accounting, Publications, etc.		0
Sub-Total		81,041.34
Annual Promotional and Educational Campaign[6]		20,474.00
TOTAL ANNUAL OPERATING COSTS		101,515.34

Note:

[1] Public Works and Operations (1993) estimate.

[2] City of Winnipeg Personal and Operational Department (1993) estimate. Fringe benefit calculations includes civic pension, Canada pension, group insurance unemployment insurance, vision care and (15.88% of base salary). Workmen compensation (4% of base salary). Sick leave, severance pay, vacation pay and dental plan (19% of base salary).

[3] Public Works and Operations (1993) estimate based on average maintenance costs for 3 automated solid waste collection trucks.

[4] Crew Clothing Assumptions: overalls, gloves, boots and other clothing costs.

[5] Autobin Maintenance Assumptions (identical to the solid waste bins).

[6] Annual Promotional/Educational Campaign Assumptions ($2 per participating household).

5.4.4 Initial Promotional and Educational Campaign Costs:

One of the most important aspects of any recycling program is its public image. A well planned initial promotional and educational campaign would have a strong, positive impact on overall program success. However, campaign strategy may vary within the city.

Table 20 illustrates start-up promotional and educational campaign features for the prototype program. Campaign materials would contain information, such as, collection schedules, bin placement, home storage container delivery and the material which would promote and encourage participation once the program was in operation. The campaign would be promoted extensively for the three months prior to implementation. All campaign material prices quoted include applicable taxes, production, typesetting, artwork and other related costs.

The main thrust of the campaign drive would be through outdoor billboards, transit shelters, community newspaper insert advertisements and through community meetings. The total cost of this aspect of the campaign is estimated at $26,371.49. The program would also be promoted through a number of radio and TV talk shows and through the free access channel. Regular briefings and press releases would be distributed to the local media to publicize the program.

At the grassroots level, it is assumed that local community organizations and volunteers would assist in the campaign. Initially, participating households would receive program information containing a fact-sheet flyer, letter of support from elected officials and a brochure containing program features and other related information. During distribution of home storage containers, a remainder brochure and a fridge magnet (displaying information

such as collection schedule, type and number of materials collected, and a telephone hotline number) would be distributed. The total cost of printing promotional and educational materials is estimated at $6,531.38.

Other campaign expenses include installing a telephone hot-line and logo design and production, which are estimated at $788.32. Of the total campaign costs, $6,738.24 (20%) for hiring a Public Relations firm to assist the Public Works Division staff in designing promotional and educational materials and 3,339.48 (10%) would be allocated for miscellaneous contingency expenses. The total start-up costs for the promotional and educational campaign are estimated at $44,472.37.

Table 20 shows that advertising costs through outdoor billboards, transit shelters, community newspaper inserts, and community meetings are the main campaign costs, and account for nearly 60% of the total campaign costs, while, printing promotional materials accounts for only 15% of the campaign total. Hiring a public relations firm and contingency expenses each account for 15% and 10% respectively.

Table 20: Detailed Initial Start-up Promotional and Educational Campaign cost assumptions for the Prototype Program.

PARTICULARS	AMOUNT ($)	AMOUNT ($)
ADVERTISING		
Outdoor Billboards @ $839.95/month ea.[1]	7,559.55	
Production Costs	936.25	
		8,495.80
Transit Shelters @ $374.50/month ea.[1]	11,235.00	
Production Costs	700.85	
		11,935.85
Community Newspaper inserts @328.32/insert ea.[2]		3,939.84
Community meetings @ $1,000 ea.[3]		2,000.00
Radio, TV spots, Local Press Briefings & Releases		0
TOTAL ADVERTISING COSTS		26,371.49
PROMOTION		
Direct Mail Campaign: Flyers, and Brochures[4]		
Flyers @$0.04/ea.	450.44	
Information and Reminder Brochures @$0.09/ea.	2,026.98	
Fridge Magnets @$0.36/ea.[5]	4,053.96	
TOTAL PROMOTIONAL COSTS		6,531.38
Logo Design and Production[6]	321.00	
Telephone Hot-line[7]	467.32	
Sub-Total		33,691.19
Hiring a Public Relations Firm[8]		6,738.24
Sub-Total		40,429.43
Continency Expenses[9]		4,042.94
TOTAL CAMPAIGN COSTS		44,472.37

Note:
[1] MediaCom Advertising Company estimate for 3 billboards and 10 transit shelters (1993).
[2] Canadian Publishing Company estimate for 12 1/4 page inserts (1993).
[3] Community Meetings Assumptions: presentation boards, overheads, and other related costs.
[4] University of Manitoba Print Shop estimate (1993): (including 10% back-up pieces).
[5] Original Printing, Toronto, Ontario estimate (1993). (The quote includes freight costs).
[6] Canada's Sign Solution Store estimate for designing and printing a logo (1993).
[7] Manitoba Telephone System estimate for installation, wiring and other related costs (1993).
[8] Hiring Public Relations Firm assumptions: 20% of the campaign total.
[9] Contingency expenses assumptions: 10% of the campaign total.

5.4.5 Annual Revenues and Benefits Estimates:

Table 21 details annual revenues and benefits projections for the prototype program. In the worst case scenario, the total annual revenues (less 3% contaminated materials and contracted processing costs) are estimated at $10,206.53. The net revenue for 1,111.26 processed tonnes was $9.18 per tonne. The total annual benefits are estimated at $43,247.63. In the best case scenario, the total net annual revenues (less 3% contaminated materials and contracted processing costs) were estimated at $21,014.32. This translates into a net revenue of $10.39 per tonne for 2,023.08 processed tonnes. The total annual benefits are estimated at $81,166.54.

The table shows that there are significant differences in projected total annual revenues between the two scenarios. However, in the best case scenario, significantly larger amounts of material are potentially recovered, leading to higher revenues, and in turn, significant avoided landfill disposal and collection savings compared with worst case scenario estimates. Furthermore, the net revenues per tonne differ slightly between the two scenarios.

Table 21: Detailed Annual Total Revenues and Benefits Projections for the Prototype Program.

PARTICULARS	PROJECTED RECOVERY RATE (%)	AVAILABLE ESTIMATED AMOUNT	PRICE ($/lbs.)	TOTAL ($)
WORST CASE SCENARIO				
ONP	50	2,266,337.0		
Less: Materials Disposed[1]		67,990.1		
		2,198,346.9	0.015	32,975.20
Aluminum containers	25	37,349.46		
Less: Materials Disposed[1]		1,120.48		
		36,228.98	0.30	10,868.69
Tin containers	25	221,982.64		
Less: Materials Disposed[1]		6,659.48		
		215,323.16	0.03	6,459.69
TOTAL GROSS REVENUE		2,449,899.04		50,303.58
Less Processing Costs[2] (1,145.63 tonnes)				40,097.05
TOTAL NET REVENUE				10,206.53
NET REVENUE PER TONNE (1,111.26 Tonnes)			$9.18	
Avoided Disposal Costs[3]				17,002.28
Avoided Collection Costs[4]				16,038.82
TOTAL ANNUAL BENEFITS				43,247.63

Table 21: Detailed Annual Total Revenues and Benefits Projections for the Prototype Program (Cont.)

BEST CASE SCENARIO

ONP	90	4,079,406.63		
Less: Materials Disposed[1]		122,382.20		
		3,957,024.43	0.015	59,355.37
Aluminum containers	50	74,698.92		
Less: Materials Disposed[1]		2,240.97		
		72,457.95	0.30	21,737.39
Tin containers	50	443,965.27		
Less: Materials Disposed[1]		13,318.96		
		430,646.31	0.03	12,919.19
TOTAL GROSS REVENUE		4,460,128.69		94,012.15
Less Processing Costs[2] (2,085.65 tonnes)				72,997.83
TOTAL NET REVENUE				21,014.32
REVENUE PER TONNE (2,023.08 tonnes)			$10.39	
Avoided Disposal Costs[3]				30,953.12
Avoided Collection Costs[4]				29,199.10
TOTAL ANNUAL BENEFITS				81,166.54

Note:

[1] Material contamination assumptions: 3% of the total materials recovered assumed to be unacceptable owing to high levels of contamination.

[2] Processing cost assumptions: Materials collected x processing costs ($35/tonne).

[3] Avoided disposal cost: materials recovered/tonnes (excluding contaminated material landfilled) x tipping fees to dispose solid waste (@15.30/tonne).

[4] Avoided solid waste collection cost assumptions: 50% of the material collected x solid waste collection and maintenance costs (@$28/tonne).

5.4.6 Economic Viability:

Once the capital, annual operating costs and annual benefits were identified, they were

annualized using a "Net Present Value" method. Since some benefits (or costs) occur in the present and some would occur in the future, this method enables comparison.

To conduct this analysis, the following factors were used: the operating life of the program (14 years); the inflation rate (2.1%); and the discount rate (10.02%). An IBM Lotus 123 version 3 was used to compute a single NPV value for the benefit-cost analysis. These calculations took into the consideration that in the years 5 and 10, stacking home storage containers were replaced, while in the year 8, the automated truck was replaced.

A summary of the 14 year Net Present Values (NPV) projections for the prototype program are illustrated in Table 22 (see Appendix IV for detailed calculations). In the both scenarios, the annual capital and operating costs remain identical, while the total benefits vary. In the worst case scenario, the average cost per tonne was estimated to be $96.31 and the average cost per household/month was $0.87. The benefit-cost ratio was computed to be 0.19. In the best case scenario, the average cost per tonne was at $41.94 and the average cost per household/month was $0.69; the benefit-cost ratio was computed to be 0.36.

In both cases, the net system costs are negative (expenditures exceed benefits) and the benefit-cost ratios are less than 1. However, the table indicates that in the best case scenario, the results are better than in the worst case scenario, owing to the higher tonnages of the materials recovered, leading to higher material revenues, and avoided disposal costs and collection savings. This analysis clearly indicates that in the program's life, expenditures would exceed benefits. In both cases, expenditures exceed benefits, therefore in both cases, the program are economically unfeasible.

In the future, if more types of materials are added to the collection or if either landfill

disposal costs (tipping fees) or collection costs increase significantly, it may lead to a substantial increase in benefits and the analysis may portray a different picture. However, given present conditions, the prototype program will initially require a substantial capital outlay supplemented by additional funding, to sustain its operation over time.

Table 22: Summary of the 14 year Net Present Value Projections for the prototype program.

PARTICULARS	WORST CASE SCENARIO ($)	BEST CASE SCENARIO ($)
Capital Costs	1,020,331.00	1,020,331.00
Operating Costs	832,186.00	832,186.00
Total Costs	1,852,517.00	1,852,517.00
Less Total Benefits	354,191.00	664,742.00
Net System Costs	1,498,326.00	1,187,775.00
Average Cost/Tonne/Year[1]	$96.31	$41.94
Average Cost/Household/Month[2]	$0.87	$0.69
Benefit/Cost Ratio[3]	0.19	0.36

Note:
[1] Average Cost per tonne per year: (net system costs)/(total estimated recovered tonnages)/(estimated program life).
[2] Average cost per household/month calculations: (net system costs)/(household) /(estimated program life-in months).
[3] Benefit-cost calculations: total benefits/total costs

Swartzman et al. (1982) agrees that this type of analysis may lead to biased or short-sighted decisions, owing to the great importance given to translating gains and losses to dollars terms, meanwhile, strongly held views of non-monetary values may be ignored. At present, the prototype program seems to be costly because this it lacks a "full cost accounting" approach to recycling. This analysis considers only the "variable" costs of

disposal (that is, tipping fees and avoided collection costs) and ignores the "capital and overhead" costs such as: an extension of the life of local landfill sites; a saving of natural resources; energy savings and pollution reduction; a reduction in worker's compensation; and employment opportunities. Although some of these benefits do not affect the community directly, it is important to consider them more closely because they have an impact on society as a whole.

From an environmental, resource conservation and economic point of view, it is difficult to quantify the extension of the landfill's life. Landfilling entails the following costs: pre-development, site development, annual operation and maintenance, closure, post-closure, and the searching or operating costs of a new landfill site (Reiterate, 1992, 6). There is no doubt that implementing the prototype program would extend the life of local landfill sites because of waste diversion. Local decision makers should take into consideration these potential direct savings by implementing the preliminary program. These savings would benefit the city directly by delaying new site location costs and decreasing disposal and collection costs.

The indirect savings of the program are associated with the demand for depleting virgin materials. Recycling leads to the conservation of both renewable and non-renewable resources. For example, roughly 16 harvestable trees can be saved, for every tonne of newspaper recycled (Pers. Comm. Jeff Goldman, July 28, 1993). In addition, reusing previously processed materials requires less energy and pollution than manufacturing products from virgin materials.

Table 23 illustrates the energy savings and pollution reduction achieved by substituting selected secondary materials from virgin resources. To produce new materials from

secondary aluminum materials (the largest saver of energy, air and water pollution) requires 95-97% less energy than producing aluminum from raw ore. Energy conservation savings and air and water pollution reduction from paper, plastic and glass secondary materials varies depending on the recovery process employed. The energy savings would benefit the private manufacturing sector, while pollution reduction would benefit the city and province alike, by providing safer living conditions.

Table 23: Energy Savings and Pollution Reduction from Substituting selected secondary materials for virgin resources.

MATERIAL	ENERGY SAVINGS BY PROCESSING RECYCLED MATERIALS	AIR POLLUTION REDUCTION	WATER POLLUTION REDUCTION
Paper	23-70%	35%	35%
Aluminum	95%	95%	97%
Plastics	88-90%	na	na
Glass	4-30%	20%	na

Source: Adapted from Letcher & Sheil (1986) and Chertow (1989).

There is a potential for savings in worker's compensation payments, which is an indirect benefit of the program. Since the collection truck would be operated by a single crew member, mechanical arms would collect recyclables from bins. Compared with other recycling programs, where on average, a two-man collection crew operates a collection truck, there is a higher potential risk for crew injuries. For comparison purposes only, the compensation costs associated with operating Phase I's 3 automated solid waste collection trucks was $974, compared with $12,290 for operating rear or side loading trucks during 1992 (Committee on Works and Operations report, June 10, 1993, 138). It is difficult,

however, to predict worker's compensation savings, without implementing the program, but the city would benefit directly from these savings, since it pays the compensation.

The potential employment opportunities are difficult to accurately estimate, since the study assumes that collected materials would be shipped to a private processing facility. Jobs opportunities may be created in private secondary processing facilities, which may, in turn, stimulate growth in the local economy.

If a "full cost accounting" approach to recycling was included in the benefit-cost analysis, it could change the overall picture and the benefits might then exceed the costs. Such an approach maximizes economic efficiency and decision-makers can determine the "true" benefits of diverting a tonne of waste from landfill in monetary terms. Therefore, implementation decisions should not be solely based on an economic perspective, but a "full cost accounting" approach to recycling should be taken into consideration.

5.5 Summary:

The material recovery estimate scenarios suggest that there are not sufficient volumes of aluminum and tin containers in the study area's waste stream to justify collection in a weekly rotating collection schedule. On the other hand, ONP volumes may exceed the capacity of the proposed collection truck. Therefore, an alternating collection schedule was not a viable option for the prototype program.

The program, therefore, should adopt a weekly commingling collection approach, where all targeted materials are collected on a single collection day. Using this approach, the targeted material volumes would be within the truck's handling capacity and furthermore, it would allow for the handling of additional materials in the future. In addition, the schedule

of same day as garbage collection, provides convenience for the users because they don't have to remember the type of materials to set out. However, this approach increases processing costs and leads to higher percentages of contaminated materials.

The collection equipment (automated truck, Autobins and stacking home storage containers) was found to be technically reliable. Autobins and stacking home storage containers were durable, and had sufficient capacity to interim store targeted materials. However, stacking home storage containers are expensive compared with single rectangular containers. In addition, if in the future additional materials were added to the collection, additional stacking bins would be required. Therefore, economically and practically, stacking home storage containers are no longer a viable option with the commingling approach. Therefore, if the commingling collection approach is adopted, a single rectangular box is the most viable option to interim store the targeted materials.

The automated truck was found to be compatible with Autobins. It's mechanical arms are flexible enough to align and manoeuvre Autobins. The truck would be able to service both back and front lanes efficiently.

Overall, respondents were willing to participate in the prototype program. They indicated that providing home storage containers was an encouraging factor, however, they raised concerns regarding a weekly alternating collection schedule and materials preparation. Furthermore, respondents reported that they would participate only if Autobins were placed at convenient locations. Generally, fifteen houses away was the preferred location.

Respondents preferred television programs, a 24 hour telephone hot-line and direct mailing of promotional materials as the best means to create awareness for the program.

Generally, respondents agreed that a property tax, a levy on consumer products, a user-fee, and a fee for garbage pick-up were unfair funding schemes for supporting the program. Generally, individuals reported that they were willing to participate if the program was free.

The survey results generally conformed with the literature review findings that respondents' positive attitudes towards the environment and their willingness to take part in the program would be enhanced if free home storage containers were provided, and if bins were conveniently located.

Comparing the sample's socio-demographic variables with 1986 Census Data indicates significant differences, however, it is difficult to predict, from the small sample size, whether the population has changed over time.

Both waste recovery estimates (benefit-cost and the 14 year period projections summary) indicate that the program would have a negative net present value (expenditures exceed benefits). In both cases, the benefit-cost ratio was less than 1. Therefore, in economic terms, the program is not viable. However, this analysis lacks a "full cost accounting" approach to recycling including items such as, the extension of local landfill sites, savings from natural resources, the reduction of energy and pollution, savings from worker's compensation and opportunities for employment. If these factors were taken into consideration, the economic viability analysis could portray a different picture. The beneficiaries in the final analysis would be the manufacturers of finished goods, the city, the provincial government and society as a whole.

Local decision makers cannot judge the viability of the prototype program on economic terms alone, but a "full cost accounting" approach to waste disposal should be taken

into consideration to determine the "true" benefits of implementing program before making any final decisions.

The next chapter fine tunes the prototype program and recommends a specific program for the study area. The chapter incorporates the information from the preceding analyses with the literature review findings.

CHAPTER 6

RECOMMENDED PROGRAM

This chapter discusses a recommended program, based on the preceding evaluation. The chapter is divided into two sections. The first section discusses the program features and the second section examines economic viability.

6.1 Program Description:

The recommended program would be identical to the prototype program, except in: household preparation requirements, provisions for home storage containers, and collection schedule. Participating households would voluntarily source separate, prepare and interim commingle store all targeted recyclables in a single 14 gal. rectangular home storage container, provided free of charge by the city. Prior to collection day, each household would be required to place all recyclables in communal Autobins, which would be painted a different colour than solid waste Autobins.

Initially, the program would collect ONP, aluminum and tin containers. Collection would operate on a five day cycle, identical to the current solid waste collection schedule. A single 29 yd. 14,500 lb. packer automated truck would collect the materials from Autobins and transport them to a designated local contracted processing facility where they would be prepared according to local market specifications and shipped to local markets.

6.1.1 Collection Equipment and Labour Requirements:

One 14 gal. rectangular-shaped home storage container would be provided to each of

the 10,237 households for interim storage of recyclables (see Figure 21). These containers would be made of durable high density polyethylene plastic, suitable for extreme temperatures. The technical reliability findings indicated that a single container would occupy less home storage space and be more economical, than stacking home storage containers, roll-out carts, bags or buckets. A single 14 gal. rectangular shaped container would cost approximately $5 per unit (Pers. Comm. Michelle Turner, August 5, 1993). Furthermore, when filled with an average amount of commingled materials, it would weigh roughly 18 pounds (Pers. Comm. Michelle Turner, August 5, 1993). This size of container could handle the volume of targeted materials and would have additional capacity to accommodate subsequent materials for future program expansion. The provision of a single container would lead to a $112,864.50 capital cost saving, over the stacking container system.

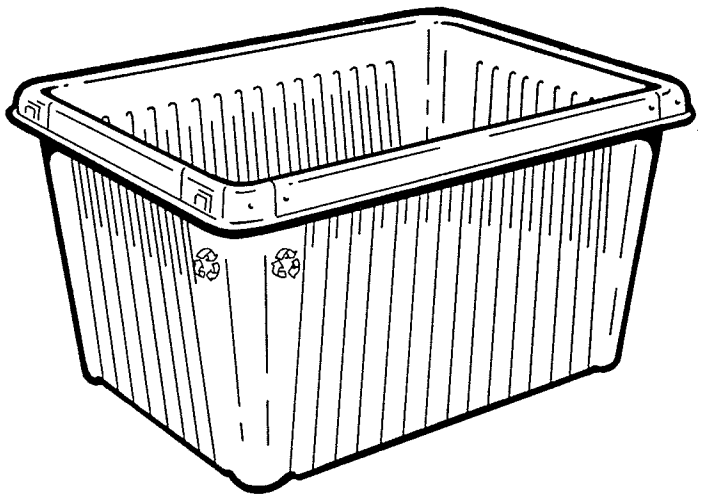


Figure 21: 14 gal. Rectangular Shaped Home Storage Container.

Source: Shamrock Industries, Inc. Shamrock Recycling Containers - Information pamphlet. 1993.

The 300 gal. Autobins, and the automated collection truck operated by a single crew would remain identical to the prototype program. Autobins were found to be durable, easily manoeuvrable by the collection truck and capable of handling the projected volumes of targeted materials. Furthermore, they would be able to accommodate new materials in the future.

For areas with back lane accessibility, communal recycling bins would be placed on the opposite side of the lane as solid waste Autobins. For areas without back lane accessibility, bins would be placed at a convenient curbside location. According to the prototype program calculations, one collection truck would be able service all Autobins in the study area in a five-day collection cycle.

6.1.2 Household Separation Requirements:

The household separation requirements would be identical to the preliminary program. The requirements to: source separate all targeted recyclables from regular household refuse; prepare recyclable materials by removing glossy advertisements from newspapers, clean, and remove labels from aluminum and tin containers; interim commingle store all targeted materials in a supplied container; and finally, place all recyclables in designated Autobins.

The literature review findings indicate that commingling allows for maximized collection efficiency and increased participants' convenience. It also increases the program's flexibility for adding new materials. However, it would not improve the truck's efficiency for servicing Autobins. Furthermore, this approach may lead to higher contamination levels of certain types of materials. According to the Resource Integration Systems Limited et al., (1989), approximately 10% of the processed materials would be unacceptable and would have

to be landfilled. Commingling also requires intensive processing, at a significantly greater level of effort compared with other collection approaches. The study assumes that the collected materials would be contracted to a private processing facilities to process and ship to local markets. It is assumed that contracting costs would be approximately $35 per tonne; the average rate charged for processing materials in other Canadian metropolitan areas (Pers. Comm. Bonnie Kulak, January 24, 1993, Kathy Sims, June 30, 1993, and Jim Fogg, July 28, 1993).

6.1.3 Number and Type of Materials:

Initially, the recommended program would target ONP, aluminum and tin containers. This is consistent with the literature review findings which recommend that fewer types of materials with well established local markets be targeted. However, the program would have the capacity to expand to add new materials as markets become established.

6.1.4 Collection Frequency:

The collection schedule would operate on a five day cycle, identical to the solid waste collection schedule (see Map 3). The material recovery estimates indicated that an alternating collection schedule was uneconomical, owing to the low volumes of certain types of targeted materials in the study area's waste stream. In addition, the public opinion survey findings indicated that respondents were not in favour of an alternating collection schedule.

The proposed collection schedule conforms with the literature review findings, that a single collection schedule would provide participants with the convenience of remembering a single collection day. Furthermore, they would easily be able to assimilate recycling into their regular refuse routine. This approach may lead to higher recovery and participation

rates.

6.1.4 Other Features:

The truck collection routes would be identical to the routes discussed in the prototype program. These routes were generally identical to solid waste collection truck routes (see Map 4); however, they would start at the point furtherest from private contracted processing facility and end at the point closest to their final destination, to minimize travelling distance.

It is assumed that administrative, technical and clerical support staff would be allocated from within North West Works and Operations District's departments to assist with the program.

The initial promotional and educational campaign would remain identical to the prototype program's campaign. The campaign would include advertising through outdoor billboards, transit shelters, community newspaper inserts and community meetings. The promotional campaign would include grassroots, word of mouth campaigns and in addition, local media would assist in publicizing the program. Public opinion survey findings suggest that the three preferred choices for information sources were: television programs, a 24-hour hot-line and direct mailing brochures and pamphlets. Therefore, the campaign would place a greater emphasis on these preferred media modes.

6.2 Benefit-Cost Analysis:

Cost assumptions (see Table 18), annual total operating costs (see Table 19) and initial start-up promotional and educational campaign estimates (see Table 20) would be identical to the prototype program estimates.

6.2.1 Capital and Start-up Costs:

Table 24 illustrates detailed capital and start-up costs for the recommended program. All capital cost estimates are identical to the prototype program estimates, except home storage container costs. They would cost $56,305.00. Therefore, the total capital costs of the recommended program would be $616,277.37.

The table reveals that purchasing and assembling Autobins would be the largest capital expense (61%), followed by the automated truck (23%), home storage containers (9%) and the initial start up promotional and educational campaign (7%). Compared with the prototype program estimates, the table shows that the recommended program's capital estimates would be significantly lower, owing to lower home storage containers costs.

Table 24: Detailed Capital and Start-up Costs assumptions for the Recommended Program.

PARTICULARS	AMOUNT ($)	AMOUNT ($)
Fixed Costs		
Land, Buildings and Site Improvements		0
Equipment		
1 29 yd. automated truck[1]	140,000.00	
Autobin containers 751 containers (includes 68 (10%) backup and replacement) at $475 ea.[2]	356,725.00	
Autobin assembly and placement 751 Autobins at $25.00 ea.[3]	18,775.00	
Single home storage containers 11,261 containers, including 1,024 (10%) backup and replacement at $5 ea.[4]	56,305.00	
	---	571,805.00
Initial, Start-up Promotional and Educational Campaign (see Table 20)		44,472.37

TOTAL CAPITAL COSTS		616,277.37
		=====

Note:
[1] Committee on Works and Operations (1990) estimate.
[2] Committee on Works and Operations (1990) estimate.
[3] Committee on Works and Operations (1990) estimate.
[4] Shamrock Industries Inc., (includes freight costs) (1993) estimate.

6.2.2 Annual Revenue and Benefit Estimates:

Table 25 illustrates detailed annual total revenues and benefits for the recommended program. In the worst case scenario, 1,031.06 tonnes (excluding 10% contaminated materials) were projected to be reclaimed and shipped to local markets. The total annual net revenue (less contracted processing costs) would be $6,576.38, or $6.38 per tonne and the total annual benefits were estimated at $38,390.39. On the other hand, in the best case

scenario, 1,147.22 tonnes (excluding 10% contaminated materials) were projected to be reclaimed and shipped to local markets. The total annual projected revenues (less contracted processing costs) were at $14,229.93, or $7.49 per tonne and the total annual benefits were estimated to be $72,148.51.

The recommended program's scenario indicates lower net revenues and benefits compared with the prototype program's estimates, owing to the higher percentage of contaminated materials that would have to be landfilled.

Table 25: Detailed Annual Total Revenues and Benefits Projections for the Recommended Program.

PARTICULARS	PROJECTED RECOVERY RATE (%)	AVAILABLE ESTIMATED AMOUNT	PRICE ($/lbs.)	TOTAL ($)
WORST CASE SCENARIO				
ONP	50	2,266,337.0		
Less: Materials Disposed[1]		226,633.7		
		2,039,703.3	0.015	30,595.55
Aluminum containers	25	37,349.46		
Less: Materials Disposed[1]		3,734.95		
		33,614.51	0.30	10,084.35
Tin containers	25	221,982.64		
Less: Materials Disposed[1]		22,198.26		
		199,784.38	0.03	5,993.53
TOTAL GROSS REVENUE		2,273,102.19		46,673.43
Less Processing Costs[2] (1,145.63 tonnes)				40,097.05
TOTAL NET REVENUE				6,576.38
NET REVENUE PER TONNE (1,031.06 Tonnes)			$6.38	
Avoided Disposal Costs[3]				15,775.19
Avoided Collection Costs[4]				16,038.82
TOTAL ANNUAL BENEFITS				38,390.39

Table 25: Detailed Annual Total Revenues and Benefits Projections for the Recommended Program (Cont.)

BEST CASE SCENARIO

ONP	90	4,079,406.63		
Less: Materials Disposed[1]		407,940.66		
		3,671,465.97	0.015	55,071.99
Aluminum containers	50	74,698.92		
Less: Materials Disposed[1]		7,469.89		
		67,229.03	0.30	20,168.71
Tin containers	50	443,965.27		
Less: Materials Disposed[1]		44,396.53		
		399,568.74	0.03	11,987.06
TOTAL GROSS REVENUE		4,138,263.74		87,227.76
Less Processing Costs[2] (2,085.65 tonnes)				72,997.83
TOTAL NET REVENUE				14,229.93
REVENUE PER TONNE (1,877.09 tonnes)			$7.49	
Avoided Disposal Costs[3]				28,719.48
Avoided Collection Costs[4]				29,199.10
TOTAL ANNUAL BENEFITS				72,148.51

Note:

[1] Contaminated material assumptions: 10% of the total materials recovered are assumed to be unacceptable owing to high levels of contamination.

[2] Processing cost assumptions: Materials collected x processing costs ($35/tonne).

[3] Avoided disposal costs: materials recovered/tonnes (excluding contaminated material landfilled) x tipping fees to dispose solid waste (@15.30/tonne).

[4] Avoided solid waste collection cost assumptions: 50% of the material collected x solid waste collection and maintenance costs (@$28/tonne).

6.2.3 Economic Viability:

Table 26 summarizes the 14 year net present value projections for the prototype and

the recommended program (see Appendix IV for detailed calculations). The capital and operating costs would remain identical; however, the total revenues and benefits would vary, owing to lower revenues and benefits projected in the recommended program. In the worst case scenario, the net system cost (less benefits) was $1,282,467.00. While, the average cost per tonne/year was estimated at $88.85, the average cost per household/month was estimated at $0.75. The benefit-cost ratio was computed to be 0.20. On the other hand, in the best case scenario, the net system cost (less benefits) was $1,005,985.00. The average cost per tonne/year was estimated at $38.28 and average cost/household/month was estimated at $0.58. The benefit-cost ratio was computed to be 0.37. In both cases, benefit-cost ratios were less than 1 (expenditures exceed benefits), which leads to the conclusion that in economic terms, the recommended program is not viable.

The recommended program estimates are significantly lower and signify refined financial indicators compared with the prototype program estimates. The table also shows that the recommended program's benefits are lower compared with the prototype estimates, owing to the higher percentage of contaminated materials. In the recommended program, the cost/tonne and cost/household/month indicate lower figures compared with the prototype program. However, the benefit-cost ratio's show insignificant differences between the two programs.

The literature review supports premise underlying that the recommended program could achieve higher participation and diversion rates by providing a single home storage containers, and opting for commingled collection. In general, the recommended program aims for improved economic efficiency by lowering capital costs, and providing increased convenience for the participants.

Table 26: Summary of the 14 year Net Present Value Projections for the Prototype and Recommended Programs.

Particulars	WORST CASE SCENARIO ($) The Prototype Program	The Recommended Program
Capital Costs	1,020,331.00	764,692.00
Operating Costs	832,186.00	832,186.00
Total Costs	1,852,517.00	1,596,878.00
Less Total Benefits	354,191.00	314,411.00
Net System Costs	1,498,326.00	1,282,467.00
Average Cost/Tonne/Year[1]	$96.31	$88.85
Average Cost/Household/Month[2]	$0.87	$0.75
Benefit-Cost Ratio[3]	0.19	0.20
	BEST CASE SCENARIO ($)	
Capital Costs	1,020,311.00	764,692.00
Operating Costs	832,186.00	832,186.00
Total Costs	1,852,517.00	1,596,878.00
Less Total Benefits	664,742.00	590,893.00
Net System Costs	1,187,775.00	1,005,985.00
Average Cost/Tonne/Year[1]	$41.94	$38.28
Average Cost/Household/Month[2]	$0.69	$0.58
Benefit-Cost Ratio[3]	0.36	0.37

Note:

[1] Average cost/tonne/year calculations: (Net system costs)/(total recovered tonnage estimates)/(Program life).

[2] Average cost/household/month calculations: (Net system cost)/(Households served)/(program life in months).

[3] Benefit-cost calculations: (Total benefits)/(Total costs).

The financial analysis was based on present fiscal economic terms, and does not take into account new materials added to collection, escalating landfill tipping fees, or increased costs in residential solid waste collection. If these factors are taken into account, it could reverse the present position. Furthermore, the analysis was done solely from a financial perspective, which contrasts with a "full cost accounting" approach based on maximizing economic efficiency. The broader perspective would consider non-quantifiable benefits, such as, local landfill's life extension, environmental preservation and resource conservation, energy savings, pollution reduction, worker's compensation savings, and employment opportunities. This broader approach implies that financial analyses alone are not sufficient for evaluating the recommended program. All other factors should be evaluated, before delivering the final decision.

Based on the current economic climate and tight budget environment, the recommended program estimates are costly, even though the program is innovative and efficient compared with other traditional programs. The public opinion survey indicated that respondents would participate if the program was free. To implement such a program, therefore, would require substantial governmental financial assistance.

6.3 Summary:

The recommended program would require participants to source separate, prepare and interim store commingled targeted materials in a single rectangular shaped 14 gal. plastic container provided free of charge by the city. Prior to collection day, each household would be required to place all their recyclables in one of the 683 communal Autobins. Each 300 gal. bin would serve approximately fifteen neighbouring households.

The program would adopt a regular weekly 5 day collection schedule, identical to the solid waste collection schedule. The materials would be collected from Autobins by an automated collection truck, identical to the automated solid waste collection trucks and transported to a contracted processing facility where the materials would be processed and then shipped to local markets.

The prototype program findings indicated one automated 29 yd. collection truck with 14,500 lb. payload and a single crew would be able to service all Autobins in less than five collection days. The recycling truck routes would be identical to solid waste collection routes, but would start at a point furtherest from, and end at the point closest to the processing facility. It is assumed that administrative, technical and support staff from other departments would assist in administering the program. The recommended program would be promoted by using promotional and educational campaigns as discussed in the prototype program.

The benefit-cost analysis of the recommended program is more refined than the prototype program estimates. However, in the worst and best case scenarios, the benefit-cost ratios are less than 1 (expenditures exceed benefits). Therefore, the recommended program is economically unjustifiable. However, it is important to recognize non-quantifiable benefits, which could significantly reverse this position. The program cannot be judged on financial analyses only, a "full cost accounting" approach to waste disposal should be taken into consideration by local decision makers, before delivering the final decision. Table 27 summarizes the key recommended program features.

The next chapter presents conclusions and recommendations based on the practicum results.

Table 27: Recommended Program Summary.

THE PROGRAM FEATURES
Program Location: Winnipeg's Phase I automated solid waste collection area. Number of households: 10,237 single family dwelling units. Collection Equipment and Labour Requirements: 683 (300 gal.) Autobins, and 1 automated 29 yd. packer truck with 14,500 lb payload capacity, operated by a single operator. The truck would be identical to the one used for solid waste collection. Container Provisions: Single, rectangular shaped 14 gal. plastic home storage containers for interim commingled storage of all targeted materials. Households would be responsible for placing all their recyclable materials in communal Autobins. Bins will be placed on the opposite side of solid waste bins for areas with back lane accessibility. For areas without back lane accessibility, bins would be placed on a convenient curbside location. Each bin would serve approximately 15 households. Material Preparation Requirements: Full segregation and preparation of all targeted materials for interim commingled storage in a single home storage container.

Table 27: Recommended Program Summary (Cont.)

THE PROGRAM FEATURES
Targeted Materials for Collection: Initially, the following materials would be collected: ONP, aluminum and tin containers. Collection Schedule: An automated truck would collect commingled materials from Autobins, on a regular weekly collection schedule, identical to regular solid waste collection. Truck Routes: Identical to solid waste collection routes, whereby every street would be traversed at least once. The routes, however, would start at the point furtherest and end at the point closest to the processing facilities. Initial Promotion and Education campaigns: Advertising, grassroots word-of-mouth campaigns and local media programs.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

This final chapter is divided into two sections. The first section presents a summary of conclusions, based on the major findings in the study. The second section presents recommendations for the implementation of the recommended program, and directions for further research.

7.1 Conclusions:

The purpose of this practicum was to conduct a feasibility study for integrating a prototype recycling program within Winnipeg's Phase I automated solid waste collection area. The following are conclusions based on the findings of the study.

1. The 1986 Census Data indicate that the study area consists of a significant number of single dwelling units, with wide back lanes and side walks, which potentially would have a major positive impact on high material recovery and participation rates. However, demographically, the area consists of an aging population, with fewer people per household, lower total household incomes, lower educational levels and higher unemployment rates compared with the community and city as a whole. These features indicate the need for well-defined educational and promotional campaigns.
2. Waste composition estimates, using the city of East York's low income/single detached estimates, indicate that paper and organic materials comprise nearly three fourths of the waste stream. Other materials, such as metals, glass, and plastics also contribute significantly to the waste stream. These estimates indicate that there exists

the potential to divert significant volumes of materials from the waste stream to recycling.

3. The automated solid waste collection system is more efficient and cost effective than traditional collection systems. Furthermore, the automated system has been well received by participants. Therefore, there is the potential to integrate a recycling component into the current collection system.

4. At present, the study area lacks a formal recycling program. However, a number of recycling programs are accessible to study area residents. These programs have been found to achieve insignificant waste diversion and participation rates, owing to the inconvenience of transporting materials, general design, and user-pay features. Therefore, these existing programs would have minimal impact on the implementation of the proposed program.

5. Local market analysis indicates there is a stable market for aluminum and tin containers and a potential for shipping old newspapers (ONP) to the paper mill at Pine Falls. On the other hand, materials such as old corrugated cardboard (OCC), PET beverage containers, HDPE containers, glass beverage containers, and liquor and wine bottles at present have limited markets. Therefore, local markets justify the collection of ONP, aluminum and tin containers. Additional materials may be added to the collection in the future when strong stable local markets exist.

6. In the alternating collection schedule, the worst and best case material recovery scenarios indicate there were not enough aluminum and tin containers to justify collection. On the other hand, in the best case recovery rate scenario, ONP collection may require more than one automated collection truck. In addition, in the public opinion survey, respondents reported that the proposed alternating schedule was a

discouraging factor which might affect overall participation and diversion rates. In general, the alternating collection schedule is unsuitable for the program. If the program adopts the commingling approach, the worst and best recovery scenarios indicate that volumes would be well within the limits of the truck's capacity.

7. Provisions for stacking home storage containers were found to be more expensive compared with a single rectangular-shaped box. In the future if the program expands, further capital expenses would be incurred for the provision of additional stacking bins. Moreover, in the commingled approach, it would be unnecessary for participants to source separate recyclables. This in turn, increases participant's convenience.

8. The public opinion survey indicated that respondents were generally willing to participate in the program, provided it was convenient and free of charge. Furthermore, the provision of home storage containers was considered an encouraging factor, while remembering an alternating collection schedule and materials' preparation were considered discouraging factors.

9. From purely economic analyses, both the prototype and recommended programs' benefit-cost ratios were less than one. Therefore, in both worst and best recovery scenarios, the programs are economically unjustifiable. However, the figures for the recommended program are more refined than the prototype program. The program should not be judged on economic considerations alone, a "full cost accounting" approach to recycling, which includes extension of local landfill sites, savings from natural resources, reduction of energy and pollution, savings from worker's compensation, and opportunities for employment benefits need to be considered to determine actual benefits before a final decision is delivered.

7.2 Recommendations and Further Research:

The following are specific recommendations and directions for further research which should be taken into consideration by local decision makers before designing, implementing, and operating the recommended program.

1. Since the study linked the automated collection system to recycling, local decision makers should compare the pros and cons of this approach with a curbside program before a final decision is passed.
2. Winnipeg needs a waste composition audit. At present, a number of local recyclers rely on the outdated Bird and Hale (1978) study to identify the components of the local waste stream. Accurate composition data is very important in a recycling program because it determines the availability of recyclables which in turn assists in determining the revenues for the program. There is a need for an accurate waste composition study so that the national data can be replaced by local analyses.
3. During the public opinion survey, the author and interviewers found evidence that non-residential waste, such as appliances, furniture and hazardous materials were disposed of in Autobins. Generally, this indicates that users, other than the study area residents, (perhaps commercial and industrial sectors) were taking advantage of the bins. It is recommended that this issue be probed in greater detail. Appropriate use of Autobins is essential for implementing a new component, such as a recycling component into the present program.
4. Owing to time and funding constraints, the public opinion survey was conducted using a small sample. There is potential for the survey to be expanded for further interpretation. On the other hand, the questionnaire was deliberately kept brief, so

that respondents would not feel discouraged or overwhelmed in attempting its completion, thereby, ensuring a better response rate. A questionnaire with a larger point scale could be used for more detailed statistical interpretation.

5. It is recommended that the general public, industry, business, and all levels of government participate in the planning of the recommended recycling program. The major stakeholders should not be left out until after all critical decisions have been made. Enlisting the major stakeholders can be accomplished by establishing a Recycling Advisory Committee. This committee can be made up of a broad cross section of community representatives who have specialized expertise in key areas.

6. Recycling is a highly complex activity consisting of a number of crucial components. Some of them are: administration, promotion, public education, collection, processing, and marketing. A recycling program should be operated like a business and every business should have a business plan. The recycling plan should include: goals and objectives; community strengths and weaknesses; available options to meet goals; a course of action; community groups; and timetables for implementation.

7. In order to create program awareness, it is recommended that a pilot program should be implemented to evaluate whether goals and objectives can be achieved. As the familiarity with the program grows, it can be expanded to other areas.

8. The recommended program was found to be efficient, technically reliable, user friendly and more cost effective than prototype. However, in economic terms, the program was found to be unfeasible owing to expenditures exceeding benefits. If the program decision is based on economic terms, it would lead to short-sighted decision. Therefore, it is recommended that a "full cost accounting" approach to recycling be evaluated to determine other benefits such as, an extension of the life of local landfill

sites; a saving of natural resources; energy savings and pollution reduction; a reduction in worker's compensation; and employment opportunities. This approach could significantly reverse this position and should also be evaluated.

9. One of the greatest barriers to the recommended program is its cost. With "cheap" landfill sites and the abundance of land available in Manitoba, there would never be a fair economic comparison between recycling and "cheap" landfilling. Furthermore, if in the future, additional types of materials are added to the collection or if either landfill disposal costs, that is, tipping fees or collection costs increase significantly, it may lead to a substantial increase in benefits and the economic analysis of the program may portray a different picture.

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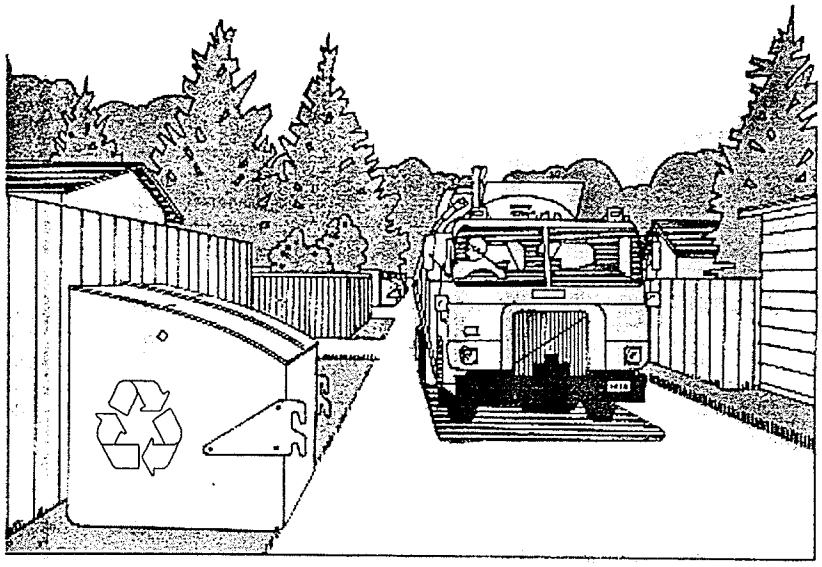
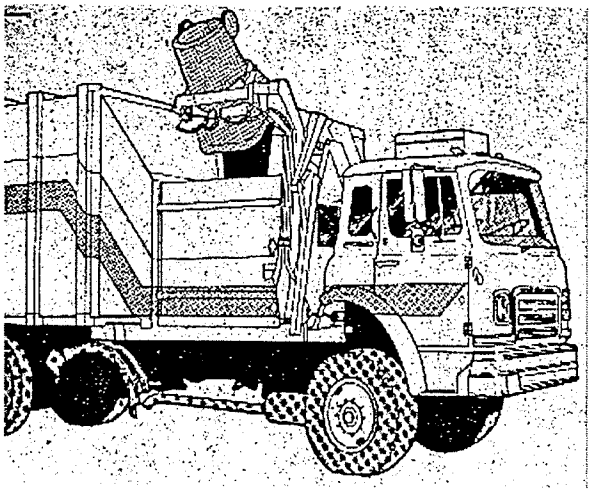
Appendix I

Public Opinion Questionnaire

1993





Prototype Recycling Program Public Opinion Survey

THE UNIVERSITY OF MANITOBA Winnipeg, Manitoba, Canada R3T 2N2 FACULTY OF ARCHITECTURE

Department of City Planning
201 Russell Building
(204) 474-9286

July 28, 1993

Dear 'Autobin' Participant:

My name is Salim S. Dharsee. I am a graduate student at the Department of City Planning at the University of Manitoba. I am trying to find out what you think about recycling and the type of automated recycling system you would be most likely to participate in. The answers you give to this confidential survey will be used in the completion of my Graduate research project and the complied results will be given to the City of Winnipeg to make decisions about the implementation of the recycling program in your community. All the survey results will be grouped together and answers by individuals will be kept **STRICTLY CONFIDENTIAL.**

If you have any questions, please call me at 275-6690; or you can call my supervisor, Professor Basil Rotoff at 474-9286. Also, please let me know if you would like to have a copy of the survey results after its completion.

Thank you, in advance, for taking the time to complete my survey.

Sincerely,

Salim S. Dharsee

SSD:cc

Enclosure

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I. GENERAL ATTITUDES & REASONS FOR RECYCLING. (Please check one box per statement.)

1. In your opinion, is recycling a worthwhile practice ?

Yes ☐ No ☐ Don't Know ☐

2. Do you recycle any of your household materials ?

☐ Yes (go to question 2 (b).

☐ No (go to question 5).

2b.) If yes, please check the materials your household recycles.

☐ Newspapers
☐ Metal cans
☐ Beverage containers
☐ Other containers

☐ Food & yard waste
☐ Hazardous wastes, such as, used oil, paint, and car batteries
☐ Home appliances

Other (Please Specify) _____

3. If you recycle, how important (or unimportant) are each of the following factors as reasons for your household to recycle?

	Important	Unimportant	Don't Know
Concern for the environment	☐	☐	☐
Conservation of energy	☐	☐	☐
Financial rewards	☐	☐	☐
Reduction of waste	☐	☐	☐
Saves resources for future generations	☐	☐	☐

4. How often do you participate in the following recycling programs ?

	Weekly	Bi-weekly	Monthly	Once or twice a year	Never
Privately run curbside program	☐	☐	☐	☐	☐
Buy-back depots	☐	☐	☐	☐	☐
Drop-off centres	☐	☐	☐	☐	☐

5. To achieve high participation rates in recycling programs, cities often pass mandatory recycling by-laws. In your opinion, should Winnipeg pass a by-law to make recycling mandatory?

Yes ☐ No ☐ Don't Know ☐

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II. PARTICIPATION IN THE PROTOTYPE RECYCLING PROGRAM.

The success of any recycling program depends on high participation. In an prototyperecycling program, each household separates, prepares and stores recycable items in the 12 gal. colour distinct home storage stacking containers supplied free of charge by the City. Weekly, each household places the items in specially marked communal 'Autobin' bins and located at a convenient location. Each bin would serve 15 surounding households.

Initially, the program would collect following types of materials: newspapers, aluminum and tin containers. The materials would be collected weekly on regular garbage collection day, but on alternating schedule (newspapers on the first week of the month, tin containers on the second week, newspapers on the third week and tin containers on the fourth week). The collection schedules would be posted on the 'Autobins' and households would be supplied with informational and promotional materials.

1. Would your household participate in such a program?

Yes	No	Maybe
☐	☐	☐

2. If your answer is no or maybe, what changes or additions to the program might convience you to participate?

_____

_____

_____

_____

_____

3. Would your household be willing to prepare the following materials for recycling?

	Yes	No	Maybe
Rinse glass, and metal cans	☐	☐	☐
Flatten aluminum/tin cans	☐	☐	☐
Separate glossy inserts from newspapers	☐	☐	☐

4. Rank the following factors which would encourage you to recycle (Rank top 3 choices); 1 being the most encouraging factor and 3 being least encouraging factor.

	Rank (1to 3)
Free home storage containers	☐
Distance to 'Autobin' recycling bins	☐
Remembering the collection day/schedule	☐
Sorting/bundling/cleaning recyclable materials	☐

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5. Rank your preferred locations for the 'Autobin' recycling containers (Rank top 3 choices); 1 being the most preffered and 3 being least preferred location.

- In the front or back of your property ☐
- On the opposite side of the street ☐
- Three houses away (15 metres away) ☐
- Six houses away (30 metres away) ☐
- Nine houses away (45 metres away) ☐
- Twelve houses away (A block away) ☐

6. How would you prefer to receive recycling information (Tick up to 3 choices).

- Television programs ☐
- Radio programs ☐
- Newspaper articles ☐
- Monthly newsletters ☐
- Mail brochures and pamphlets ☐
- 24 hour telephone information hotline ☐
- Community meetings ☐
- Door to door canvassing ☐

7. Sometimes the sale of materials collected from a recycling program does not cover the cost of operating the program. How would you rate each of the following as a way to pay for operating a recycling program?

	Fair	Unfair
Property Tax dollars	☐	☐
Add levy charges on consumer products	☐	☐
A flat fee paid by participating households	☐	☐
A tax on materials that cannot be recycled	☐	☐
A fee for garbage pick-up	☐	☐

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8. If your community recycling program was to be partially funded by user fees, how much would you be willing to pay?

- ☐ $ 2 per month
- ☐ $ 3 per month
- ☐ $ 4 per month
- ☐ $ 5 per month
- ☐ Don't know
- ☐ Unwilling to pay anything

9. Do you have any recommendations that might make an automated recycling program better?

_____
_____
_____
_____
_____

III. GENERAL INFORMATION.

This final section deals with general information about yourself. Everybody's answers will be grouped together. The information you will provide will be strictly confidential.

1. Age: _____

2. Sex: Male ☐ Female ☐

3. What is your highest level of education?

- ☐ Grade 8 or less
- ☐ Some high School
- ☐ High school graduate
- ☐ Some college/university
- ☐ College/university graduate
- ☐ Other _____ (Please specify)

4. What is your present occupation?

- ☐ Labourer
- ☐ Clerical
- ☐ Managerial
- ☐ Technical
- ☐ Professional
- ☐ Self-employed
- ☐ Student
- ☐ Home maker
- ☐ Unemployed
- ☐ Retired

5. Do you rent or own your present home? ☐ Rent ☐ Own

6. What was your household's total income before taxes in 1992:

- ☐ Under $ 9,999
- ☐ $ 10,000-19,999
- ☐ $ 20,000-29,999
- ☐ $ 30,000-39,999
- ☐ $ 40,000-49,999
- ☐ $ 50,000-59,999
- ☐ $ 60,000-69,999
- ☐ $ 70,000-79,999
- ☐ $ Over 80,000

7. How many people live in your household (including yourself)?

____ Adults (18 years and older) ____ Children (under 18 of age)

Thank you for your cooperation in completing this survey. This information will be helpful in developing a recycling program for your community.

Printed on  recycled paper

Appendix II

Respondents' Comments to open-ended questions

Question 1:

If your household would not or maybe participate in the automated recycling program, what changes or additions might convenience to participate?

- Collect all materials on a single day.
- Too much hassle.
- Garbage bins always full, same would happen to recycling bins.
- If bins are conveniently located.
- I would participate but the schedule is too complicated and having certain materials around for 3 weeks is a nuisance and inconvenience.
- Never.
- What's wrong with people? Too much money.
- I don't like Robotrash. It stinks!!!
- Rectify garbage collection first. These bins cause odour.
- Bins too far and confusing schedule.
- It's high time, Winnipeg should implement one.
- I'm senior. It is inconvenient to walk longer distance, especially during winter.
- If you can place bins in a location closer to our home.
- May be if I was going to be here for an longer period.
- Involve Public.
- NO!
- Educate participants using pamphlets.
- Educate the public very well (so that they want to recycle). Charge a user fee, that is fair and reasonable. Provide lots of information about the program.
- EDUCATE, EDUCATE, AND EDUCATE.
- Involve Community organizations.
- I'm elderly person. Please consider locating the bin near my place.

Question 2:

Do you have any recommendations that might make an automated program better?

- Make it free - Everyone will participate!
- Accessible to whole North-end area.
- Property taxes should support the program.
- Promote less through brochures, pamphlets and flyers.
- More materials should be collected.
- More Information.
- Full support for the proposed program. However, collect all materials on a single day for better participation.
- Need for curbside recycling like Red Box or Plan-it recycling in North-end.
- Promote program through neighbourhood school, community events, bingos, and churches meetings.
- Have bins located close to participating households, so we know where to deposit our recycling

materials.
- Collect more materials.
- Considering that the city would be receive money for certain materials. Therefore, the program should be free.
- The city should control spending. Do not waste our tax dollars, save money for the recycling program - we know if we want it, you can do it.
- Involve public in designing the program.
- Pamphlets and brochures should be printed in bilingual.
- The program should be free, single collection day and add more materials to the collection, identical materials collected by Plan-it recycling.
- Not satisfied with present garbage collection.
- Try history books first.
- Get on with it!
- Recycling schedule should collect all materials in a single day.
- Promote the program using door to door strategy.
- Collection schedule confusing, therefore, better promotion needed.
- There are no program in my neighbourhood.
- Should have been done earlier!
- Do something to help our environment. Please!!!!

Appendix III

Some Promotional and Educational Materials Samples

Items *ACCEPTABLE* For Recycling

Glass

- ☐ jars (eg. pickle, jam, mayonnaise)
- ☐ bottles

Note: The glass is recyclable if it is brown, green or clear, but it must be empty and clean.

Metals

- ☐ cans (eg. vegetable, soup, juice, pop)
- ☐ short lengths of pipe and tubing
- ☐ eavestroughs (short lengths — 1m)
- ☐ small car parts (4 kg maximum)

Paper

- ☐ newspaper and inserts

Magazines

- ☐ all glossy magazines
- ☐ catalogues

Note: No other types of paper.

Cardboard

- ☐ corrugated cardboard boxes (breakdown, flatten and tie)
- ☐ cereal and food boxes (remove and discard liner)
- ☐ milk cartons (rinse with hot water and flatten)
- ☐ shoe boxes (flatten)
- ☐ brown paper bags

Plastic (empty and rinse)

- ☐ soft plastic containers (eg. margarine and yogurt containers, household cleaner bottles)
- ☐ hard plastic containers (eg. pill bottles)
- ☐ pop bottles
- ☐ antifreeze containers (rinse and re-use contents in your vehicle)
- ☐ pails (eg. ice cream, water)
- ☐ toys
- ☐ soap bottles
- ☐ detergent or fabric softener bottles
- ☐ bags (eg. grocery, dry cleaning)

Items NOT ACCEPTABLE For Recycling

Glass

- ☐ ceramic/clay pots
- ☐ china ware/porcelain
- ☐ light bulbs
- ☐ windows
- ☐ herbicide, fertilizer, pesticide containers
- ☐ plate glass
- ☐ mirrors
- ☐ pyrex items
- ☐ blue glass
- ☐ red glass

Metals

- ☐ foil wrap
- ☐ aerosol cans
- ☐ varsol containers
- ☐ propane tanks
- ☐ gasoline/fuel containers
- ☐ automotive oil containers
- ☐ shock absorbers
- ☐ all batteries
- ☐ paint cans

Paper

- ☐ junk mail
- ☐ paper towels
- ☐ paper tissue
- ☐ toilet paper
- ☐ computer paper
- ☐ carbon paper
- ☐ loose leaf paper
- ☐ envelopes
- ☐ plastic laminated paper
- ☐ writing paper
- ☐ gift wrapping paper

Cardboard

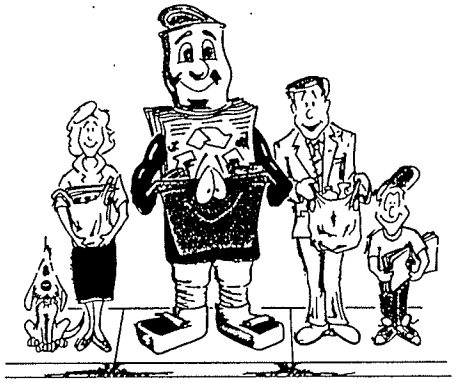
- ☐ egg cartons
- ☐ juice boxes (tetra paks)
- ☐ plastic coated packaging
- ☐ frozen juice containers

Plastic

- ☐ biodegradable/photodegradable bags
- ☐ foam plastic (eg. cups, meat trays, fast food containers)
- ☐ egg cartons
- ☐ milk bags
- ☐ plastic food wrap (eg. for left-overs or meat packaging)
- ☐ herbicide, fertilizer, pesticide containers
- ☐ diapers
- ☐ tooth paste containers
- ☐ dishes and cutlery
- ☐ gasoline containers
- ☐ motor oil containers

*No compostables: food scraps, grass clippings, or leaves

Think Recycle



Residents' Guide to Edmonton's

Blue Box Recycling Program

(Single Family Dwelling)

September, 1991

Brochure

Source: The city of Edmonton, Public Works Department. Edmonton, AB. 1993.

Source: The city of Edmonton, Public Works Department. Edmonton, AB. 1993.

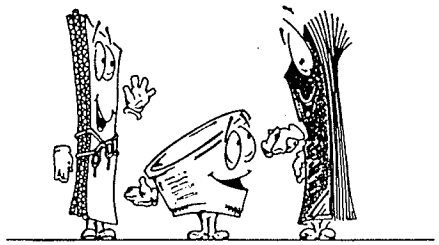
Recycling and You

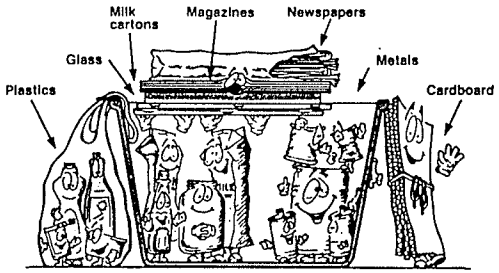
Congratulations! A City of Edmonton Blue Box has been assigned to your address. You and your Blue Box are vital to the success of curbside recycling in our community.

Recycling makes good environmental sense and it helps create jobs. The City, through BFI Recycling Systems and the Edmonton Recycling Society (ERS), has delivered the Blue Box to help make your recycling of household waste easier.

What can be placed in the Blue Box

Household metals, glass jars and bottles, newspapers and inserts, magazines, cardboard and plastics are currently being recycled. A complete list is provided on the reverse side.





Please follow these simple steps

- ☐ Remove caps and lids from all glass and plastic items. Put plastic caps with plastics and metal lids with metals.
- ☐ Rinse all cans, plastic containers, glass bottles and jars with cold water. Rinse all milk containers and cooking oil containers with hot water. Place dry items loose in the Blue Box.
- ☐ Labels can be left on all items.
- ☐ Separate and neatly organize cardboard, metal, glass, magazines and milk cartons. Flatten milk cartons.
- ☐ **Keep all items separate** (eg. don't mix magazines and newspapers or place items inside milk cartons.)
- ☐ Cans may be flattened to make more room in the Blue Box.
- ☐ No loose tin can lids, please! Leave lid attached to can.
- ☐ Flatten cardboard boxes, tie with string and place into your Blue Box or under it if they are too large. Keep dry.
- ☐ Put your newspapers into an **untied** plastic grocery bag and place on top of the Blue Box.
- ☐ Place plastic items into an **untied** plastic grocery bag and hook onto the clip attached to the corner of the Blue Box.
- ☐ If your Blue Box is full, place overflow materials into **untied** plastic bags and hook onto the clip attached to the corner of the box. Only one type of item in each bag. Please **do not use green garbage bags** because they can be mistaken for regular garbage.

Just a Reminder

Please note that the Blue Box is not a gift. It remains the property of the City of Edmonton to be used for recyclable materials. If you move, please leave it behind with this Residents' Guide so the next householder can be part of this important community project.

Blue Box Pick Up

Pick up of the Blue Box is on the same day and at the same location as regular garbage collection.

There are two types of collection vehicles, one for garbage and one for recyclable materials. The recycling truck may arrive before the garbage truck therefore you should have the Blue Box out before 7:00 a.m.

The Blue Box and recyclable materials should be placed one metre from the regular garbage containers. Please don't place the Blue Box on top or in front of the garbage containers.

Remember to collect your Blue Box after the recycling truck has passed to avoid loss of your Blue Box.

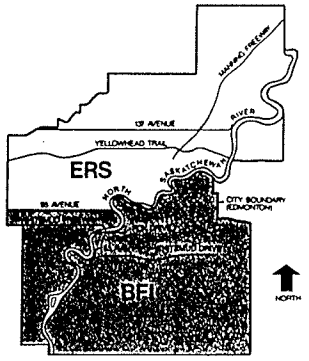
Use a waterproof felt pen to mark your address on the strip located on the short side of the Blue Box. This makes it easier to return should it be misplaced.

Recycling Hot Lines

If you have any questions contact:

ERS — 471-0071 City of Edmonton — 496-5678

BFI — 468-6801 Talking Yellow Pages — 493-9000



THE CITY OF Edmonton PUBLIC WORKS

Edmonton Recycling Society

Printed on Recycled Paper

BFI RecycleNOW

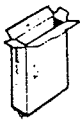
91-0952

Brochure (Cont.)

Pamphlet

Metro Toronto's Recycling Reminders

It's very important that only the correct items be placed out for recycling collection. If the wrong items are included, they could spoil the whole load of materials. Remember that not all products that have a recycling symbol ♻ are accepted in Metro Toronto's recycling program. **ONLY** include the "YES" materials listed below. **For more information, call Metro's Waste and Water Information Line at 392-4546.**

Yes	No
GLASS BOTTLES AND JARS. No lids or caps. Rinse well. 	OTHER GLASS. No dishes, window glass, mirrors, drinking glasses, porcelain figurines, clay flower pots, ceramics, light bulbs, glass pots and pans, crystal. 
METAL CANS. Those used for food and beverages only. No loose lids. Rinse well. 	OTHER METAL. No coat hangers, paint cans, aerosol cans, aluminum foil, pie plates, sheet metal, plumbing pipes, car batteries, metal pots and pans. 
PLASTIC BOTTLES AND JUGS. Includes anti-freeze jugs but not motor oil containers. No lids or caps. Rinse well. 	OTHER PLASTICS. No margarine or yogurt tubs, ice cream or cottage cheese containers, plastic wrap or bags, foam products, plastic toys or motor oil containers. 
CORRUGATED CARDBOARD (with the rippled layer). Clean cardboard only. Cut into pieces and tie into bundles no larger than 2 ft. by 2 ft. wide and 1 ft. thick. 	OTHER CARDBOARD. No waxed or coated boxes, egg cartons, pizza boxes, milk or juice cartons, cereal, cracker, shoe or tissue boxes, soap or detergent boxes. 
NEWSPAPERS AND MAGAZINES. Includes newspaper inserts, advertising flyers printed on newsprint, old telephone books and catalogues. Bundle with string or put in a plastic grocery bag and place beside corrugated cardboard. 	OTHER PAPER. No books, writing paper or envelopes, computer paper or advertising flyers <u>not</u> printed on newsprint. 

THE MUNICIPALITY OF METROPOLITAN TORONTO 1953

Metro Works Department

Collection Information:

East York	396-2800
Etobicoke	394-8350
North York	395-6205
Scarborough	396-7372
Toronto	392-7742
York	394-2600

Printed on post-consumer recycled paper ♻

Source: Metropolitan Toronto Public Works Department. Toronto, ON. 1993.

Door Hanger

This is your 1988-89 curbside recycling calendar.
Please save it as a reminder of your recycling pickup dates.
Thank you for recycling!

SOLANA RECYCLERS

Save This Card **route 2**

CURBSIDE RECYCLING PROGRAM

Calendar of Pickup Dates

1989

JULY						
s	m	t	w	th	f	s
						1
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23	24	25	26	27	28	29
30	31					

AUGUST						
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1990

JANUARY						
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MAY						
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JUNE						
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24	25	26	27	28	29	30

Important: Recyclables must be on the curb by 8:00 A.M.

Please see reverse side of this card for instructions on how to prepare your recyclables for collection

For further information contact:

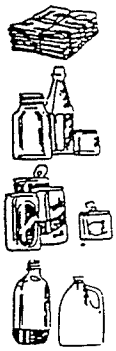
SOLANA RECYCLERS
(619) 436-7986

A non-profit organization

Source: California Department of Conservation, Division of Recycling. Sacramento, CA. 1993.

Door Hanger (Cont.)

HOW TO PREPARE YOUR RECYCLABLES FOR COLLECTION



NEWSPAPERS
Please bundle or place in brown paper bags.
NO magazines, junk mail or catalogs.

GLASS
All glass bottles and jars are accepted.
Clear and colored can be mixed together.
Please rinse; labels need not be removed.
No dishes, mirrors or window glass.

ALUMINUM
Aluminum beverage cans ONLY (no tin cans).
Crushing cans saves space!

PLASTIC BEVERAGE CONTAINERS
1 and 2 liter carbonated beverage bottles (any color), milk, water and juice jugs. Please crush to reduce volume.

HOW TO PARTICIPATE IN CURBSIDE RECYCLING

Store your glass in the green container provided by the City. Store your aluminum and plastic in separate boxes or bags. Place all recyclables on your curb on the days indicated by the calendar on the reverse side. **Recyclables will be collected by Solana Recyclers.**

In Case of Rain
Rain can damage the paper and render it non-recyclable. If it rains, please save paper until your next recycling collection day. Glass, aluminum, and plastic will be collected rain or shine.

Missed Pickups
If your recyclables were on the curb by 8:00 a.m. on your recycling day and have not been picked up by 4:00 p.m., please call 436-7986.

Theft
If you notice someone other than the recycling truck collecting your recyclables or container, please call 436-7986 or call the Encinitas Sheriff's station at 753-5591. Unauthorized collection or scavenging can seriously damage the viability of the program.

Moving
The recycling containers are for use in the curbside program only. If you move, please do not take the recycling containers with you; call 436-7986 to arrange to have them picked up.

THE CITY OF SOLANA BEACH

THANKS YOU FOR RECYCLING!

Source: California Department of Conservation, Division of Recycling. Sacramento, CA. 1993.

ROLLOUT

Official News For the Los Angeles Curbside Recycling & Automated Collection Program SUMMER 1991

L.A. Resource Program • City of Los Angeles • Bureau of Sanitation • Recycling and Waste Reduction Division

STREET BEAT

WHAT GOES IN *YOUR* YELLOW BIN?

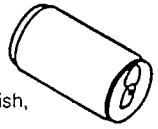
City Accepts Variety of Recyclable Items

The L.A. Resource Program has received lots of positive feedback from participants in the curbside recycling program. Residents like the convenience of curbside collection, and have told us they witness a reduction in their household waste streams due to recycling efforts.

However, enthusiasm to recycle has led residents to place non-recyclable items in their yellow bin, including articles which are considered refuse and hazardous waste.

Although many manufacturers label their product containers as recyclable or made from recyclable materials, these items are not automatically accepted by vendors under contract with the City. The *ONLY* recyclables accepted at this time throughout the L.A. Resource Program curbside collection are:

Aluminum and metal cans – Cans for soda, juice, soups, pet food, tuna fish, fruits and vegetables.



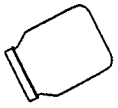
Glass bottles and jars (lids okay) -- All colors of bottles and jars for water, juice, baby food, sauces and dressings, mayonnaise, vegetables, etc.

Plastic beverage containers (caps & rings okay) -- Clear two-liter soda and water bottles, white jugs for water, milk and juice -- if you can drink from it, we can recycle it!

Newspaper and newspaper inserts -- clean and dry, placed in paper sacks or bundled with string. *NO plastic bags, please!*

Recycling truck drivers are instructed NOT to pick up bins which contain *contaminants* -- items not accepted in the program. Contaminants can hinder the recycling process, and make some items unacceptable for recycling. (See Box.)

Some recyclable items not currently collected in our program may be taken to your local recycling center. Look in your yellow pages under "Recycling," and call the center first to check what types of recyclables they accept. If there is not a center in your neighborhood, call 1-800-CITY-SAN for assistance.



Remember to *reduce, reuse and recycle* whenever and wherever possible to assist the City in its waste reduction efforts.

Attention Please: DO NOT Put These Things In Your Yellow Bin!

The following items can be taken to your local recycling center, reused, donated to charity, or disposed of properly.

CLEAN Paper: Cardboard boxes, corrugated cardboard, white paper, colored paper, computer paper, magazines, telephone books, junk mail, letters, cards, envelopes.

Plastics: Non-beverage plastic bottles, plastic foam food containers and packaging, plastic food wrap. Plastic grocery bags can often be returned to your local market.

Aluminum and Metal: Automobile or bicycle parts, foil wrap, aluminum siding, pots and pans, flatware, aerosol and paint cans, window screens and frames.

Other: Ceramics, pyrex, mirrors, wood and wood pulp, clothing and shoes.

REFUSE that Is NOT Recyclable: Please dispose of in trash containers -- Wax-coated milk and juice cartons, juice boxes, diapers, soiled paper boxes, soiled paper products.

HAZARDOUS WASTE: Please call (213) 237-1634 to find out about upcoming Household Hazardous Waste Roundups, where you can take such items as leftover paint, paint thinner, used motor oil, batteries, etc.

Source: California Department of Conservation, Division of Recycling. Sacramento, CA. 1993.

WE GET LETTERS!!

About our curbside recycling program, **Ken and Loy Whitman, Silverlake residents,** comment:

"We know that such efforts are often expensive and difficult to implement, and can thus be avoided. But it is no longer a matter of if something can be done - it is a matter of when. And we thank you for doing it now!"

Thanks for the pat on the back, folks!

Curious minds want to know...**Nicole Parker of Sherman Oaks,** asks:

"Why don't you collect and recycle cardboard? There are so many food boxes, storage boxes and other cardboard waste products that a normal household makes, that I would just think it would make sense to collect these for recycling rather than trashing our earth with them."

In the future, we hope to include mixed paper products such as cardboard in our curbside recycling program. However, because of difficulty in collection, storage and reprocessing, and weak markets, we do not have the resources to recycle mixed paper. Some private recycling centers do accept this material -- call and ask.

Los Angeles dentist Frank de Fazio made us smile. In reference to our automated refuse containers, he wrote:

"Thank you for giving our community the 'mother of all trash cans'. My wife and I have lived in the Hollywood Hills for over seventeen years and our neighborhood has never looked cleaner on trash pickup day...however, some members of our family are outraged over the new sanitation collection cans. A dozen raccoons who have lived with us for over fifteen years can no longer dump our garbage each night for their dinner."

The Recycling and Waste Reduction Division welcomes your comments and questions about the curbside recycling and automated collection program. Please write to us at 419 South Spring St., Suite 900, Los Angeles, CA 90013.

SCAVENGING IS AGAINST THE LAW

Scavenging of recyclables hurts the City's program by reducing the revenue from the sale of recyclables. This money is used to buy vehicles and bins so that we may expand our program citywide.

Also, the City has contracted with vendors who expect to receive all recyclables placed at the curb for City pickup.

Remember, if you see scavengers, do not confront them. If they have a vehicle, write down the license plate number and call 1-800-CITY- SAN.

Scavengers are subject to prosecution of six months in jail and/or a $500 fine.

REAL PEOPLE RECYCLE

Artist Creates Treasures From Trash

The Recycling and Waste Reduction Division is looking for real people or organizations to highlight and thank for their support in making Los Angeles a cleaner and better environment.

Unlike most people, when artist Nawili Ayo-Gray looks at garbage, she does not see trash. She sees another work in progress.

Los Angeles resident Ayo-Gray finds many "reuses" for items many would discard, and in the process helps the environment.

Ayo-Gray takes old things, like unusual pieces of fabric, and creates figurines, flowers, symbols or whatever takes her fancy, to use as patterns or appliques for new hats, clothes, quilts, sweaters, or bottles. Bottles? Yes, bottles. She transforms old glass bottles into unique works of art by applying new and used fabrics.

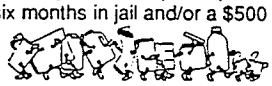
How does she do it? According to Ayo-Gray, nearly everything can be used again for something. An old bracelet is made into a new one, simply by wrapping bright fabric around it and gluing down the edges. Earrings are made from cardboard, and quilts from old dresses. Her list of re-creations continues to grow.

She is currently creating percussion instruments using plastic containers, old wooden beads and flip tops from aluminum cans. She plans to shred her junk mail and use it for papier-maché, to cover the instruments. Once covered, she will paint them.

"I enjoy recreating things from little or nothing," Ayo-Gray says. "It is very stimulating and therapeutic. I see beauty in everything, even in our waste. Ideas just seem to come to me. It is very challenging for me to create something that is both functional and aesthetically pleasing. Besides, it keeps things out of the landfill.

"In everyone's hurry to rid themselves of waste, they often throw out many things which can be reused. Local thrift stores are filled with unique items like old buttons and unusual fabrics from discarded clothes," explains Ayo-Gray.

New from old: Ayo-Gray's re-creations include hats, bracelets, earrings, vases, all from discards.



Ayo-Gray shares tips on reusing simple things.

Nawili was graduated from UCLA with a degree in Philosophy. She is a hair braider by trade, well-known in her neighborhood for creating elaborate hairstyles. Famous clients include actress Lisa Bonet *(The Cosby Show)*, jazz vocalist Nina Simone, and many other musicians.

Her braiding work has been featured in local newspapers, and Essence Magazine featured her as a West Coast specialist in braiding. The Smithsonian Institute Performing Arts Program "In Black American Culture" displayed her work in a 1982 colloquium about braiding.

By lending her artistry to discarded goods, Ayo-Gray demonstrates the credo "Reduce, Reuse, Recycle." By using her talents to help the environment, she gives us all something to think about the next time we start to throw away an object which still has some usefulness.

If you know a group or individual who is doing the environment a favor, please let us know. Call (213) 893-8888.

2

Source: L.A. Resource Program, Bureau of Sanitation, Recycling and Waste Reduction Division. Los Angeles, CA. 1993.

Residents Find Cure for "Landfill-itis"

The Bureau of Sanitation Recycling and Waste Reduction Division recently announced an important victory in the fight against trash. Curbside recycling and automated refuse collection have combined to reduce the amount of waste going to local landfills.

One look at the numbers shows the strength and expanse of curbside recycling. Presently, 212,000 households are included in the City's curbside recycling program. That's more households than there are people in Glendale, California.

> "We want residents to know about the positive impact they're having on the environment," said Drew Sones, Recycling Manager.

These households have joined together to recycle tons and tons of solid waste that would have had a lengthy stay at Lopez Canyon Landfill. In 1991 alone, 8,378 tons of newspapers have been given a new lease on life. That amount of paper is equal to 142,441 mature trees.

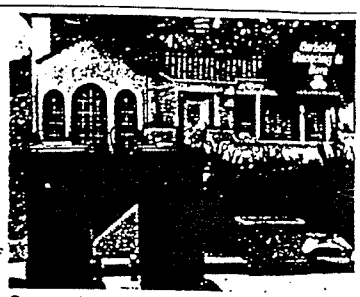
By recycling 4,621 tons of commingled aluminum, metal, plastic and glass products, residents have saved enough energy to supply 1,500 households with one year's worth of electricity.

"Recycling at curbside saves trees, energy and money," said Drew Sones, Recycling Manager. "We want residents to know about the positive impact they're having on the environment. We look forward to extending our program to all 720,000 City-serviced households," he added.

Meanwhile, 180,000 automated refuse containers have found 90,000 new homes in Los Angeles. These households have learned how to reduce, reuse, and recycle so that the remaining trash will fit easily into their automated containers.

Recycling and automated collection has saved 39,000 cubic yards of landfill space so far this year -- that's like filling up the inside of the Los Angeles Sports Arena to three-quarters of its capacity.

Residents also report another positive side effect of recycling and automated collection: An increased awareness about their environment. This trend will continue as the program rolls out to neighborhoods throughout Los Angeles.



Community groups: We can bring this booth to your next public event. See below for details.

We'd Love To Get Together With You!

Do you want your children and their schoolmates to get more involved in recycling? Do members of your local community group have questions about the city's recycling program?

A City of Los Angeles recycling spokesperson will be happy to attend your next meeting. To arrange for a speaker, call (213) 893-8888, Mon.-Fri., during business hours.

California Cuisine Gets a Face Lift

Environmental Beauty Tips: Make a "Face Salad" or "Hair Cocktail"

Cosmetic treatments don't have to be expensive, over-packaged, hard-to-recycle items.

The Recycling Division has "unearthed" some recipes you can make from items probably in your refrigerator or cupboard. These treatments are easy to make, use and recycle.

Beer Hair Rinse Cocktail

1 can or bottle Beer

After shampooing, rinse hair with 1 can beer. Towel dry and style as usual.

Beer contains proteins derived from malt and hops. These proteins coat hair and help repair damage.

Don't worry about smelling like a brewery--beer does not leave an odor. And when you're done, recycle the can or bottle in your yellow bin.

Tutti-Frutti Face Mask

1/2 cup Strawberries

Mash strawberries and smooth on face. Allow mask to dry for a few minutes and rinse off.

Strawberries are a natural astringent and will leave your face soft and tingly. Eat or compost any leftovers.

Crazy Cucumber Face Salad

1 Cucumber

Slice 1 cucumber. Place a slice over each eyelid to reduce puffiness or swelling.

Eyes will look less tired. Additional cucumber slices can be placed on your face to draw impurities from the skin. Eat or compost any leftovers.

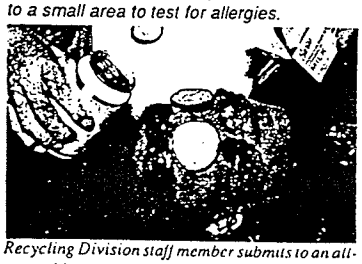
The Milky Way

1 cup homogenized Milk

Smooth milk under your eyes. Allow to dry and repeat. Rinse face.

Milk helps to remove dark circles and relieves puffiness.

NOTE: Always apply any cosmetic treatment to a small area to test for allergies.



Recycling Division staff member submits to an all-natural beauty treatment.

Free Soil Enhancement

Grasscycling: Learn How To Leave It On The Lawn

Each day, 840 tons of grass goes to the landfill -- that's 14 percent of the Los Angeles residential waste stream. Of course, grass, like many other household "wastes" can be recycled, as recommended by the Lawn Care Association.

"Grasscycling" is easy and it saves water. After you mow your lawn, you don't have to rake it, bag it, put in a can, drag it to the curb, and say a final farewell as the Bureau takes it to the landfill. Instead, leave your grass clippings on the lawn.

The City's Department of Recreation and Parks leaves its grass clippings on park lawns and has done so for many years.

Grass clippings contain over four percent nitrogen, two percent potassium and one-half percent phosphorous, and 25 percent protein. Leaving grass clippings on the lawn returns these valuable minerals to the soil. As a result, lawns are less thirsty and healthier.

Don't worry about thatch -- the rapid decomposition of grass clippings inhibits any detrimental effects. A thin layer of grass is actually beneficial because it helps retain moisture.

So give your lawn and yourself a break -- don't rake! Just leave it on the lawn.

Source: L.A. Resource Program, Bureau of Sanitation, Recycling and Waste Reduction Division. Los Angeles, CA. 1993.

Printed on recycled paper, of course!

1 (800) CITY-SAN

For further information about the curbside recycling and automated collection program, call:

Para información sobre el programa de reciclaje y collection automatizada, llame al:

IN THIS ISSUE:

LA RESOURCE PROGRAM

City of Los Angeles, Bureau of Sanitation
Recycling and Waste Reduction Division
419 S. Spring Street, Suite 900
Los Angeles, CA 90013

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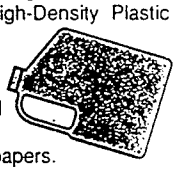
PLASTICS PILOT PROGRAM

Curbside Recycling Efforts EXPAND

The L.A. Resource Program now accepts plastic milk and water jugs, due to the growth of recyclables markets.

As markets develop for other recyclable goods, you can expect to see them collected at curbside. The Recycling and Waste Reduction Division is committed to market expansion efforts.

An indication of this is the start-up in February of a pilot program to monitor the collection of High-Density Plastic containers (HDPE), in addition to plastic beverage bottles, aluminum and metal cans, glass bottles and jars, and newspapers.



This pilot program tests the market for these goods, plus resident participation and how collection of these materials affects our recycling truck capacity.

Households outside of the HDPE pilot area can check with local recycling centers to see if colored HDPE bottles and other types of plastics are accepted.

It's As Easy As 1-2-3!

Your Guide To Deciphering Plastic Codes

Did you ever wonder what that numbered triangle symbol on the bottom of your plastic bottle means?

The numbers one through seven are used to identify different types of plastic resin, which makes plastic bottles and containers easier for remanufacturers to identify and separate for recycling.

Please note that although this symbol represents a recycling material, not all plastics are actively being recycled -- a market does not exist for most types.

This voluntary coding system was developed by the Society of the Plastics Industry, and in some states these codes are required on all recyclable plastic bottles and containers (effective in California January 1, 1992).

The L.A. Resource Program currently collects at curbside #1 bottles -- clear soda and water bottles, and #2 beverage bottles -- white plastic water, juice and milk jugs. See adjacent story about plastics pilot program.

The numbered symbols one through seven indicate the following types of plastic resins:

Collected in the curbside program:

1 PETE — Polyethylene Terephthalate

2 HDPE — High Density Polyethylene (citywide -- beverage bottles only)

Not collected in the curbside program:

3 V — Vinyl

4 LDPE — Low Density Polyethylene

5 PP — Polypropylene

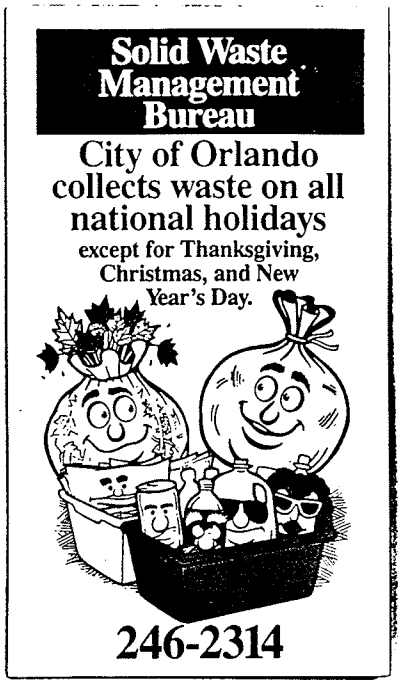
6 PS — Polystyrene

7 OTHER — Other -- a fusion of plastics, usually one layer of recycled and one layer of virgin plastic.

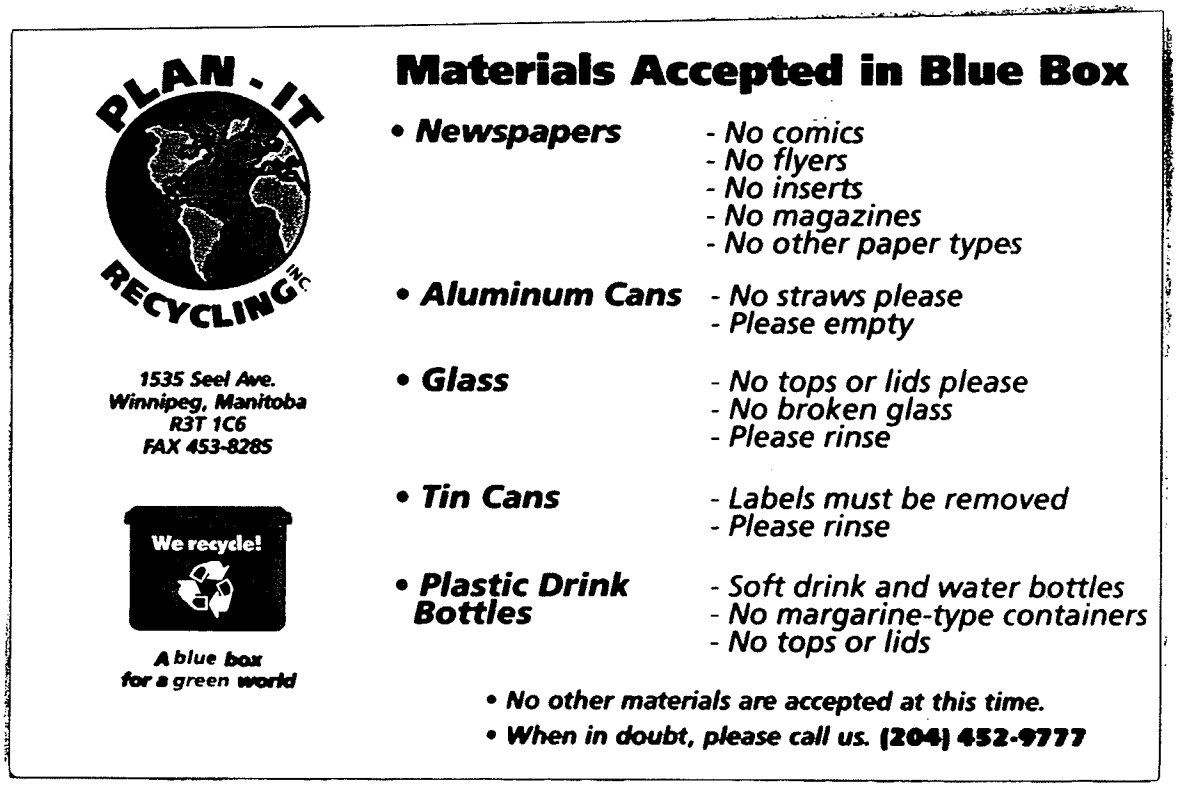
By calling around, you may be able to find a recycling center that will accept some of these items until our program expands to accept them. Please make an effort to help us reduce waste.

Source: L.A. Resource Program, Bureau of Sanitation, Recycling and Waste Reduction Division. Los Angeles, CA. 1993.

Fridge Magnets



Source: The City of Orlando, Solid Waste Management Bureau, Environmental Services Department. Orlando, FL. 1994.



Source: Plan-It Recycling Company. Winnipeg, MB. 1993.

Appendix IV

Detailed Net Present Value (NPV) calculations for the prototype and the recommended program

PROTOTYPE PROGRAM: Worst Case Scenario

Period	Capital Cost[1] ($)	Operating Cost[1] ($)	Benefits[1] ($)
0	734,518.87		
1	-	101,515.34	43,247.63
2	-	103,647.16	44,115.83
3	-	105,823.75	45,083.10
4	-	108,046.05	46,029.85
5[2]	193,658.86	110,315.02	46,996.47
6	-	112,631.63	47,983.40
7[2]	161,922.88	114,996.90	48,991.05
8	-	117,411.83	50,019.86
9	-	119,877.48	51,070.28
10[2]	214,865.20	122,394.91	52,142.76
11	-	124,965.20	53,237.76
12	-	127,589.47	54,355.75
13	-	130,268.85	55,497.22
14	-	133,004.50	56,662.66
NPV[2]	1,020,331.00	832,186.00	354,191.00

Best Case Scenario

Period	Capital Cost[1] ($)	Operating Cost[1] ($)	Benefits[1] ($)
0	734,518.87		
1	-	101,515.34	81,166.54
2	-	103,647.16	82,871.04
3	-	105,823.75	84,611.33
4	-	108,046.05	86,388.17
5[2]	193,658.86	110,315.02	88,202.32
6	-	112,631.63	90,054.57
7[2]	161,922.88	114,996.90	91,945.71
8	-	117,411.83	93,876.57
9	-	119,877.48	95,847.98
10[2]	214,865.20	122,394.91	97,860.79
11	-	124,965.20	99,915.87
12	-	127,589.47	102,014.10
13	-	130,268.85	104,156.39
14	-	133,004.50	106,343.68
NPV[2]	1,020,331.00	832,186.00	664,742.00

RECOMMENDED PROGRAM: Worst Case Scenario

Period	Capital Cost[1] ($)	Operating Cost[1] ($)	Benefits[1] ($)
0	611,277.37		
1	-	101,515.34	38,390.39
2	-	103,647.16	39,196.59
3	-	105,823.75	40,019.72
4	-	108,046.05	40,860.13
5[2]	62,470.60	110,315.02	41,718.19
6	-	112,631.63	42,594.28
7[2]	161,922.88	114,996.90	43,488.76
8	-	117,411.83	44,402.02
9	-	119,877.48	45,334.46
10[2]	69,311.35	122,394.91	46,286.49
11	-	124,965.20	47,258.50
12	-	127,589.47	48,250.93
13	-	130,268.85	49,264.20
14	-	133,004.50	50,298.75
NPV[2]	764,692.00	832,186.00	314,411.00

Best Case Scenario

Period	Capital Cost[1] ($)	Operating Cost[1] ($)	Benefits[1] ($)
0	611,277.37		
1	-	101,515.34	72,149.51
2	-	103,647.16	73,664.65
3	-	105,823.75	75,211.61
4	-	108,046.05	76,791.05
5[2]	62,470.60	110,315.02	78,403.66
6	-	112,631.63	80,050.14
7[2]	161,922.88	114,996.90	81,731.19
8	-	117,411.83	83,447.55
9	-	119,877.48	85,199.95
10[2]	69,311.35	122,394.91	86,989.15
11	-	124,965.20	88,815.92
12	-	127,589.47	90,681.05
13	-	130,268.85	92,585.35
14	-	133,004.50	94,529.65
NPV[2]	764,692.00	832,186.00	590,893.00

Note:

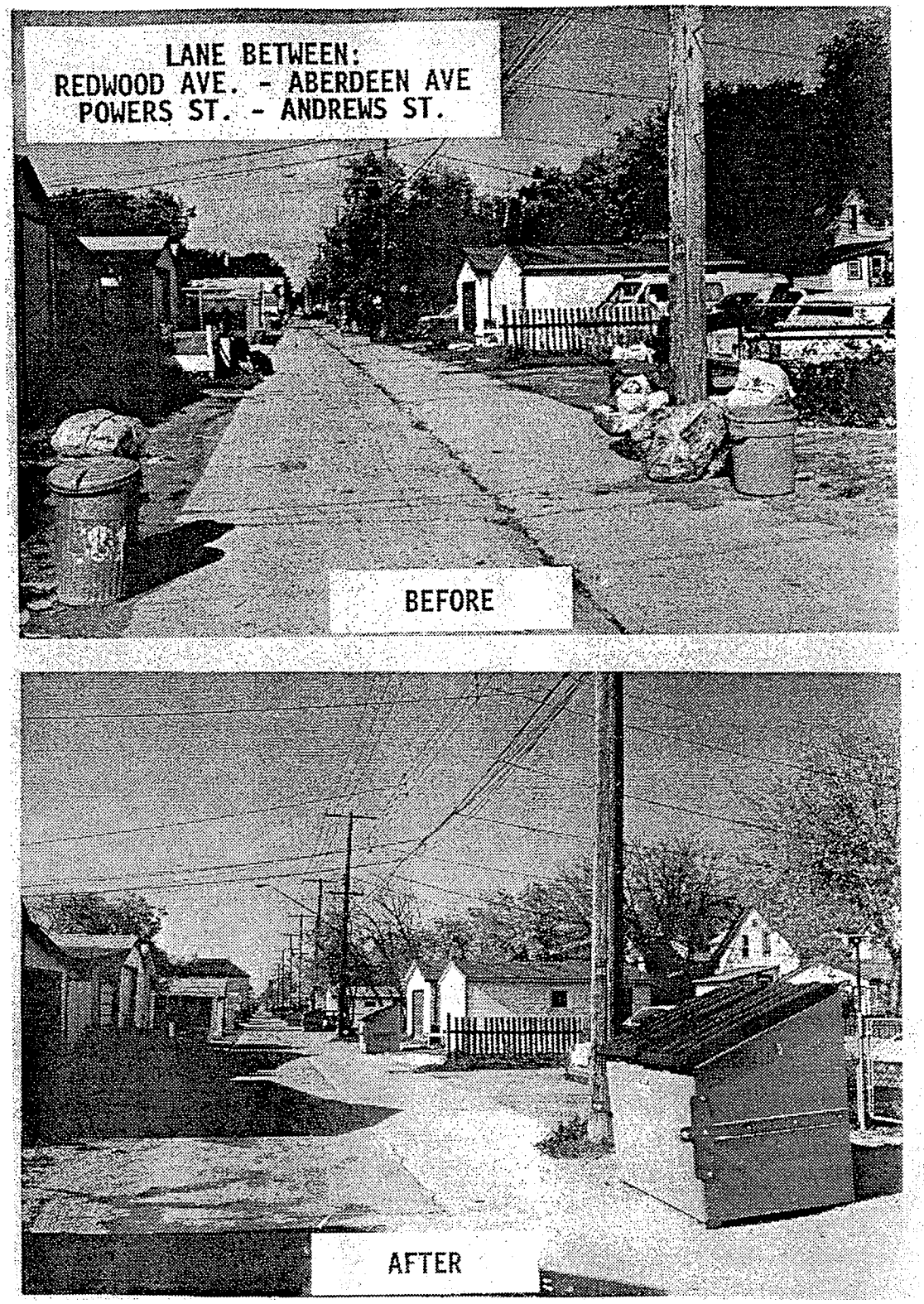
[1] Inflation factor 2.1% included.

[2] Year 5 and 10: Home storage containers are replaced. Year 7: Collection truck is replaced.

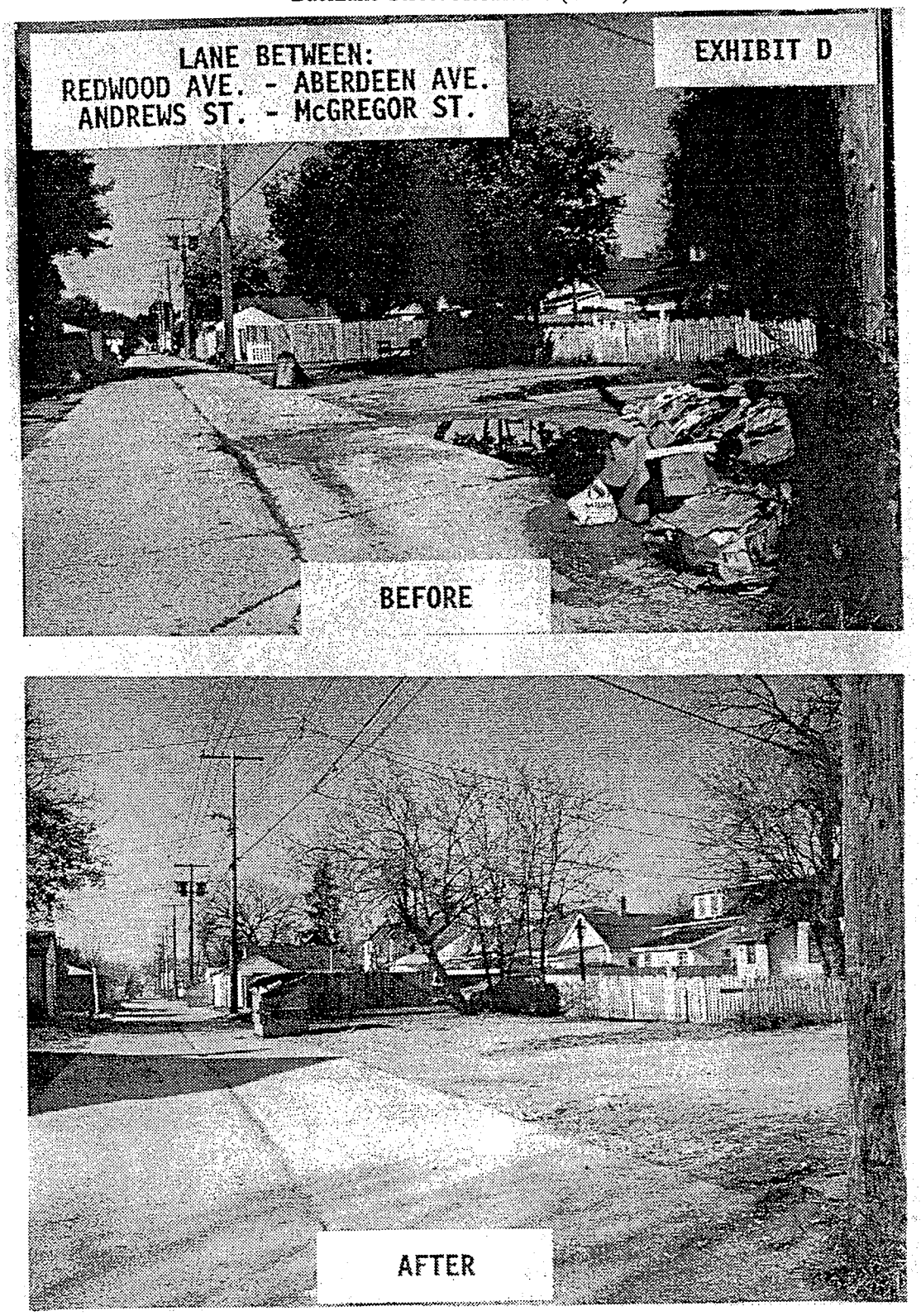
[3] NPV calculations: discounted at 10.02% for 14 years.

Appendix V

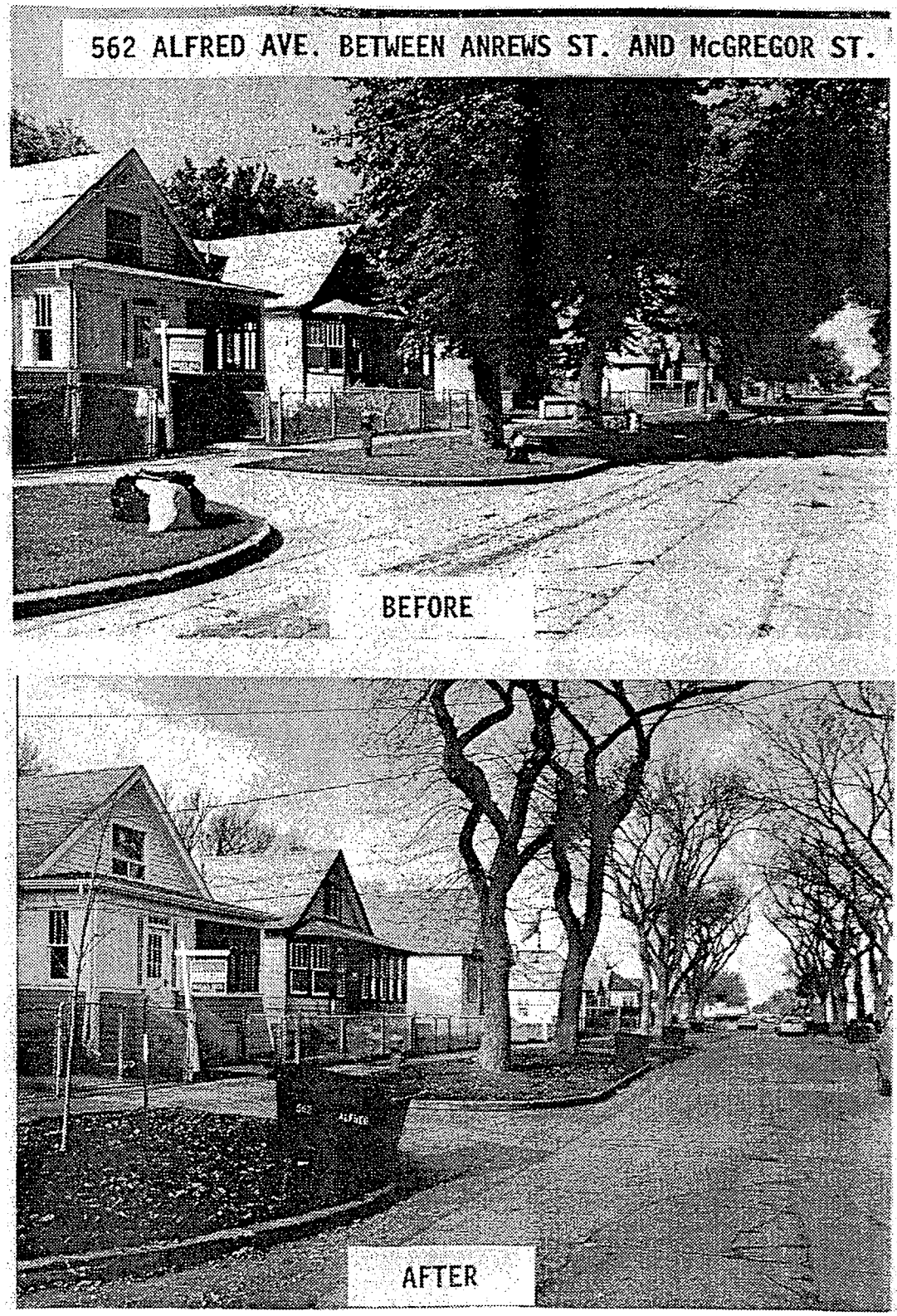
Street aesthetics before and after implemention of automated solid waste collection program



Source: City of Winnipeg North West Works and Operations District. Winnipeg, MB. 1993.



Source: City of Winnipeg North West Works and Operations District. Winnipeg, MB. 1993.



Source: City of Winnipeg North West Works and Operations District. Winnipeg, MB. 1993.