WASTE MANAGEMENT MASTER PLAN

CITY OF PETERBOROUGH

Cambium Reference No.: 1965-001

November 12, 2012

Cambium Environmental Inc.

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EXECUTIVE SUMMARY

The City of Peterborough, like all Ontario municipalities, is responsible for the collection, processing and disposal of the residential wastes generated within its boundaries. It has performed this service effectively over the years, expanding its mandate from 100% disposal prior to the late-1980's, to that of providing diverse municipal programming which encourages its residents to divert as much waste from landfill as possible. Peterborough has enjoyed an excellent reputation amongst its municipal waste management peers for the past 20 years, showing initiative and progressive thinking in waste diversion initiatives, the result of which has been a residential diversion rate of 50% and greater over the past ten years.

Peterborough's last Waste Management Master Plan (WMMP) was completed in 1993. It was a joint Plan for both the City and the County, which provided a 25-year planning tool for the Region. Many of the systems and recommendations from that WMMP have been successfully incorporated over the past 20 years. The diversion programs implemented over those years have matured to the point where little further increases in diversion rates are being realized today. Now was felt to be the right time for a new WMMP. Many new opportunities and technologies in the waste management field have emerged during the intervening decades. This WMMP considers these opportunities and identifies where the City could feasibly incorporate them into its programs to achieve substantially greater diversion from landfill.

This WMMP looks primarily at diversion of solid waste from residential sources, as this is the area the City has the most direct control over. However, the Industrial, Commercial and Institutional sectors are highlighted as areas of great potential which cannot and should not be ignored. Options for disposal/processing of the wastes still remaining after diversion are briefly outlined; however, it is not within the scope of this WMMP to make recommendations on disposal.

With an eye to the stated goals of increasing diversion, minimizing waste generation, and remaining fiscally responsible, this WMMP contains a number of key recommendations for the City's Waste Management Division to consider as it charts its course for the next 20 years.

Ambitious targets have been set so that our dependence upon landfilling or other means of disposal may be minimized. Given the changeable nature of the waste industry and the broad expanse of time it incorporates, the Plan should be viewed as a living document and reviewed regularly to ensure its continued relevancy to the municipality's social, environmental, legislative and financial state dictates.

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1.0 INTRODUCTION

Cambium Environmental Inc. (Cambium) has been retained by the Corporation of the City of Peterborough (City) to prepare a municipal solid Waste Management Master Plan (WMMP). This WMMP will be a tool which the City will use to develop the waste management policies, guidelines, and general best practices for both short and long term planning.

In 1989, the County of Peterborough (County) and City established a plan for waste diversion and reduction with an initial target of 40% and the hope of improved capture rates and participation as the programs continued to grow and improve. This target was soon met and surpassed.

In December 1993, a waste management master plan was completed for the City and the County. The plan, titled Peterborough County/City Waste Management Master Plan, Waste Management System Plan Report (Proctor & Redfern, December 1993) provided a joint County/City plan over a 25-year planning period. The final preferred system included components to assist the City and County in achieving a goal of diverting 50% of all waste generated from landfill disposal by the year 2000. Though the 25 year period is not yet up, it was felt that the City and County both should take a fresh look at their respective waste management systems, in light of new options and opportunities for diversion.

Under the Municipal Act, 2001, the City has the responsibility to plan for and manage municipally-generated solid waste within its boundaries. The focus of the WMMP will be to provide strategic direction for optimizing the current and future residential solid waste diversion programs to best meet the sustainability needs (i.e. social, economic, and environmental) of the City over the next 20 years.

1.1 BACKGROUND

Over the past 20 years, the City has successfully established a number of programs which have led to impressive diversion rates, and an excellent reputation amongst municipal peers. Now that many of these programs have matured, there is a need to investigate new and emerging technologies and opportunities such that the City's diversion rates can continue to climb.

For the preparation of this report, only 2010 data was collected and referenced which was complete and readily available when Cambium required the information necessary to undertake the review of the current waste management system. The use of the 2010 allowed for consistency throughout the report.

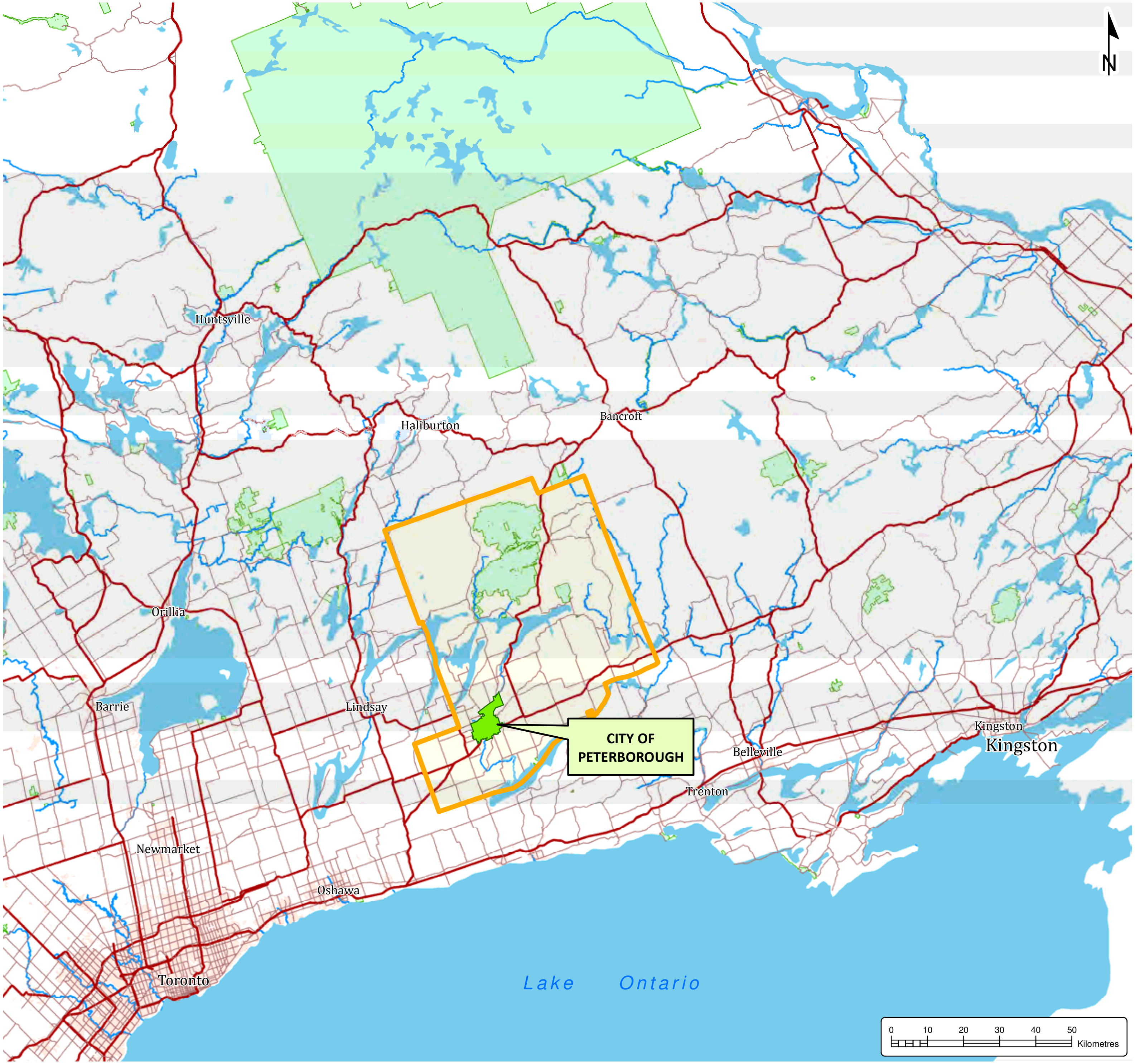
In 2010, the City of Peterborough reported a population of approximately 79,334 persons (26,240 single-family households and 8,675 multi-family households). It should be noted that the City of Peterborough does not include the County but the waste management services are shared in part with the County; therefore, the City will need to consider the County during the planning process. The City covers an area of approximately 1,283 square kilometres and is located just over one hour northeast of Toronto in the Kawartha Lakes Region (Figure 1).

The City manages the collection of residential and small Industrial, Commercial, and Institutional (IC&I) garbage. The garbage is hauled to the Peterborough County/City Waste Management Facility (PCCWMF) on Bensfort Road for disposal. In June 2002, the PCCWMF became the joint property of the County and City. The PCCWMF encompasses 158 hectares and is located on Bensfort Road approximately six km south of the City on part Lot 13, 14, and 15, Concession 14, within the Township of Otonabee South Monaghan.

The City is also responsible for the curbside collection of recyclable materials, which it does through a contracted weekly collection. Recyclables are collected on the same day as garbage and taken to the City's Materials Recycling Facility at 390 Pido Road for processing. The County also uses this facility for processing its recyclables.

WASTE MANAGEMENT MASTER PLAN
CITY OF PETERBOROUGH

500 George Street North
Peterborough, Ontario



Legend

- City of Peterborough
- Highway
- Other Road
- Watercourse, Permanent
- Water Body
- Provincial Park
- Built-Up Area
- County of Peterborough
- Outside of Province

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REGIONAL LOCATION PLAN

Project No.: 1965-001	Date: Month, Year
Scale: 1:1,500,000	Projection: NAD 1983 UTM Zone 17N

Created by:	Checked by:	Figure:
GMH	KSM	1

1.2 PLANNING AND CONSULTATION PROCESS OVERVIEW

The planning process used to develop this long term WMMP was consistent with the Ontario Ministry of Environment (MOE) Policy Statement on Waste Management Planning.

The Provincial Policy Statement on waste management planning sets out the following principles to be considered in any waste management planning process:

- Environmental protection is a shared responsibility.
- Integrated waste management systems that reflect local circumstances are in place.
- Diversion of materials from final disposal is maximized in consideration of the provincial 60% diversion target, including the creation of incentives where appropriate.
- Public and private sectors cooperate, where possible, to realize cost savings and maximize efficiencies.
- Waste management choices consider economic, social, and environmental costs.
- Investment in infrastructure is made to accommodate growth.
- Waste is managed as close to the source of generation as possible.
- Producer responsibility is incorporated into waste reduction and management.
- Decision-making is open and transparent.
- Informed citizens support waste management choices and participate in waste management programs.
- Maximum value from waste is recovered from the waste stream.
- Innovative waste management technologies and approaches are incorporated as appropriate to local circumstances to achieve sustainable solutions.

The steps followed in developing this WMMP included:

1) Understanding and assessing the current waste management system;
2) Developing a vision and goals for future waste management initiatives;
3) Understanding and assessing the options available to the City;
4) Selecting waste management system components; and,
5) Preparing the final plan document.

The community consultation included discussions with local stakeholders for the early identification of key issues and open houses to present the study results and recommended waste management system options. An outline of the public consultation process, as well as the results of the consultation activities are provided in Appendix A. Input from the public has been incorporated throughout this report.

In July 2011, the Director of Utility Services requested that a Steering Committee (SC) be established to review and update the City's Waste Management Master Plan. The SC, comprised of three City employees and one County representative including one City Councillor, provided strategic direction and made recommendations on the acceptance of a new plan to City Council.

1.3 ROLES AND RESPONSIBILITIES

Outlined in the Policy Statement on Waste Management Planning, each waste generating sector has roles and responsibilities in the management of solid waste. Each sector must actively participate in trying to achieve a more sustainable waste management system, while being environmentally responsible.

The following roles and responsibilities have been developed by the MOE as a guide for communities trying to attain a sustainable solid waste management community.

The Province

- Set and enforce environmental standards and requirements for waste diversion and disposal.
- Support municipalities and the private sector by providing the necessary tools for waste diversion and the disposal of waste.
- Issue approvals to waste disposal sites and waste haulers to ensure appropriate management.

Municipalities

- Plan for and provide direct waste management services to their residents, and in some cases, local businesses, including programs for waste diversion and disposal of waste.
- Plan for, site, and invest in necessary waste management infrastructure.
- Comply with provincial waste management standards and requirements.
- Fund and implement diversion programs under the Waste Diversion Act.

Private Sector Waste Management Industry

- Provide waste services to clients of the IC&I sectors, and in some cases, through contract to municipalities, waste services to residents.
- Comply with provincial waste management standards and requirements.

The IC&I Sectors

- Plan for, and help reduce, the amount of waste generated by their operations.
- Comply with provincial waste management standards and requirements.

Producers and Stewards

- Minimize the life-cycle impacts (i.e. environmental footprint) of products and their packaging through Design for the Environment.
- Fund and implement diversion programs under the Waste Diversion Act.

The Public

- Help reduce the amount of waste generated through their activities and choices.
- Engage in waste management decisions and participate in waste prevention and diversion programs.

Environmental Groups

- Promote the need to reduce waste and conserve our natural resources.
- Raise public awareness of waste management issues.

Under the Ministry of the Environment's Policy Statement on Waste Management Planning, municipalities are responsible for:

- Planning, siting and investing in waste management infrastructure
- Funding and implementing diversion programs under the Waste Diversion Act

1.4 GOALS AND OBJECTIVES OF THE PLAN

The City of Peterborough has developed a Guiding Principle that needs to be central to the establishment of the Goals and Objectives and any deliverables that are established subsequent to the Plan. The **Guiding Principle** is provided below:

Guiding Principle: The Peterborough County/City Waste Management Facility (PCCWMF) is a valuable resource. The City of Peterborough needs to minimize residual waste and optimize the use of the City's diversion and disposal facilities. The City of Peterborough needs to be a leader in sustainability and environmental stewardship.

Chart 1: Guiding Principle

Goals

The long-term WMMP is an essential step towards the provision of sustainable waste systems within the City of Peterborough. The WMMP began with the establishment of fundamental goals that are attainable and within the means of the residents to complete. The goals always relate back to the Guiding Principle and will help the City be a leader in sustainability and environmental stewardship. The fundamental goals of the WMMP are as follows:

Chart 2: Goals

Objectives

The fundamental goals are obtained by setting more specific achievable objectives. Through approval of Report USWM11-004 on October 17, 2011, the City has established key objectives for each of the three goals. The objectives are as follows:

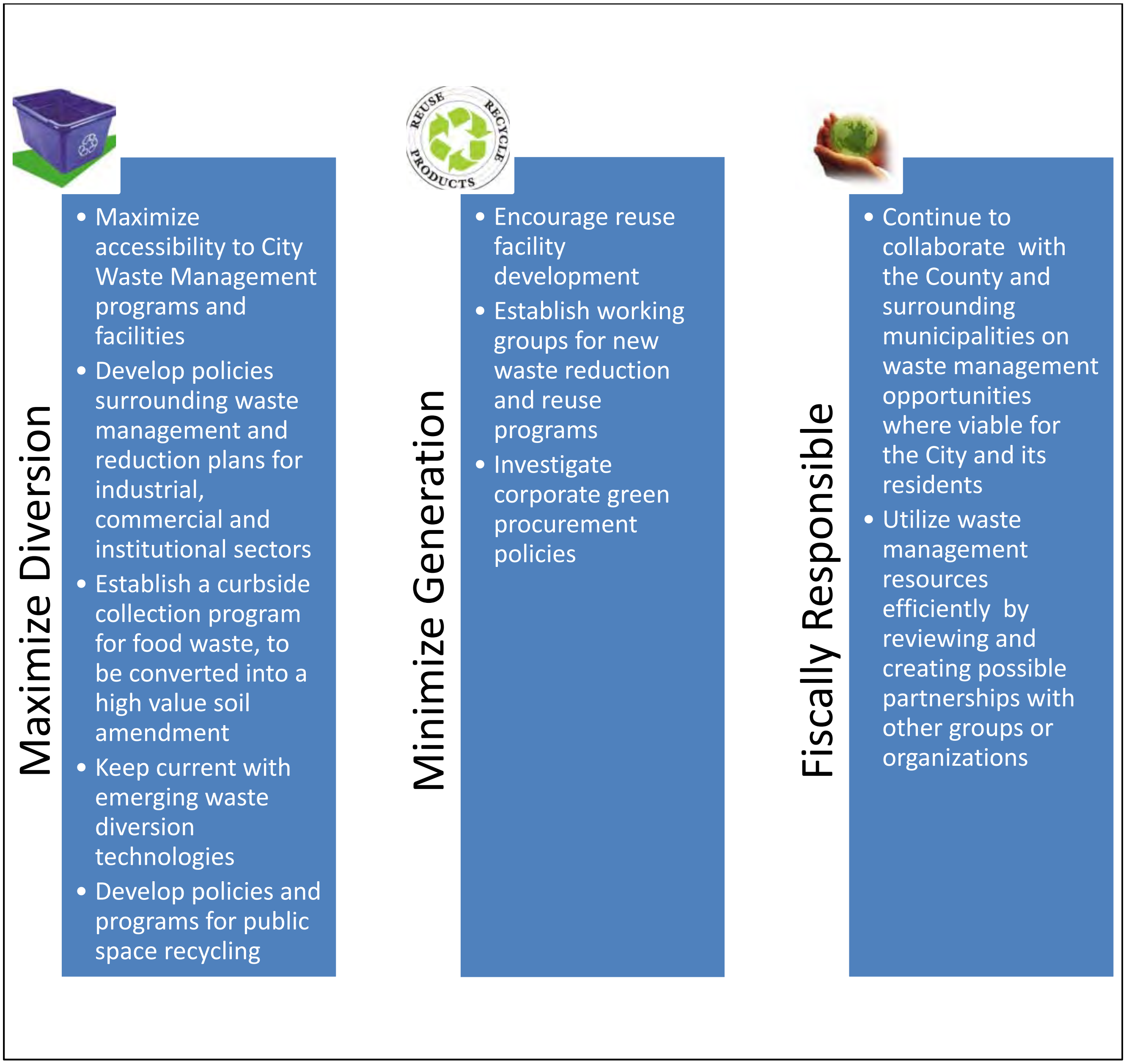

Chart 3: Objectives

Targets

Key targets have been generated from the goals and objectives that apply to all. These targets will allow the City to monitor their progress with the established Plan and verify deliverables. The targets will be adjustable with the changing economic and social trends and are provided as follows:

KEY TARGETS

- Expand the number and type of education and outreach and/or partnership activities year over year from 2010 levels.
- Meet all eight Waste Management Best Practices as outlined in the Blue Box Program Enhancement and Best Practices Assessment Project Report, 2007, prepared by KPMG LLP, a Canadian advisory services firm.
- Residential diversion rate will increase from 2010 level of 50% to 75% over 20 years, with a review of target every five years.
- Capture rates for blue box materials will increase 10% from 2006 levels (79.5%) over 20 years, with a review of target every five years.
- Participation rate of 50% in year 1 of the proposed SSO program with an increase for each year of the program.

As previously noted in the Key Targets, the fundamental Waste Management Best Practices (KPMG, 2007) include:

1. Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system;
2. Multi-municipal planning approach to collection and processing recyclables;
3. Establishing defined performance measures, including diversion targets, monitoring, and a continuous improvement program;
4. Optimization of operations in collections and processing;
5. Training of key program staff in core competencies;
6. Following generally accepted principles for effective procurement and contract management;
7. Appropriately planned, designed, and funded promotion and education program; and
8. Established and enforced policies that induce waste diversion.

Many of these best practices are already in place with the City. The development of this report will aid in formalizing the plans and approaches necessary to implement the best practices and seeing the programs through to completion.

1.5 PROBLEMS/OPPORTUNITIES

Since the 1993 Waste Management Master Plan (Proctor & Redfern, December 1993), the City has looked to pursue a more efficient solid waste management system.

There are several main issues facing the City waste management system including:

- Diminishing life capacity of the PCCWMP;
- Diminishing or uncertain life capacity of Materials Recycling Facility (MRF);
- Limited Monitoring and Reporting program in place to verify current capture and participation rates;
- No Source Separated Organics (SSO) program; and,
- Limited influence/role with IC&I waste sector and waste management.

2.0 RELEVANT LEGISLATION

There is federal, provincial, and municipal legislation that guides the waste management practices for every municipality and/or private sector operation. The key federal and provincial legislation, as it relates to waste management, is summarized below and is included in detail in Appendix B. The municipal by-laws are referenced in Sections 3.1 and 5.3.

2.1 FEDERAL LEGISLATION

Waste management is governed federally through the Canadian Environmental Protection Act (CEPA) and the Canadian Environmental Assessment Act (CEAA). The CEPA provides the legislative framework for the establishment of pollution prevention plans, identification of toxic substances, establishment of waste management facilities, import and export of waste, as well as to regulate the effects of government operations on and in relation to federal lands and aboriginal lands. The CEPA established the Environmental Registry as a means for the Canadian public to receive information on any waste management facility or system to be established or altered which requires public input and screening.

The Canadian Environmental Assessment Act (CEAA) applies to all projects where the Government of Canada has decision-making authority – whether as a proponent, land manager, source of funding, or regulator. All projects receive an appropriate degree of environmental assessment which ensures that the environmental effects of projects are carefully reviewed before federal authorities take action in connection with them so that projects do not cause significant adverse environmental effects.

Additional information on either the CEPA or the CEAA is included in Appendix B.

2.2 PROVINCIAL LEGISLATION

Waste management is regulated by the Province under the Environmental Protection Act (EPA) and the Ontario Environmental Assessment Act (EAA). The EPA provides the legislative framework for the establishment of waste management facilities. The establishment, management, alteration, and/or expansion of waste management facilities in the Province of Ontario requires an Environmental Compliance Approval (ECA; formerly referred to as a Provisional Certificate of Approval) under Part 5, Section 27 of the EPA. Key provincial legislation includes:

- Ontario Regulation (O. Reg.) 347 – General Waste Management;
- O. Reg. 101/94 – Waste Diversion Act;
- O. Reg. 101/07 – Waste Management Projects, under the EAA and amendments to the EPA for waste recycling, mining, alternative fuels, as well as new/emerging technologies;

- O. Reg. 103/94 – Industrial, Commercial and Institutional Source Separation Programs; and,
- O. Reg. 267/03 – Nutrient Management Act, regulating nutrients and use on agricultural land.

In addition, the MOE posts Guidelines that are used in a similar way to regulations when preparing ECA documents.

Additional information on the provincial legislation and guidelines for waste management are provided in Appendix B for reference purposes.

3.0 REVIEW OF CURRENT WASTE MANAGEMENT SYSTEM

3.1 SYSTEM OVERVIEW

The City provides curbside garbage (weekly), blue box (weekly), leaf and yard waste (35 weekly collections annually), and bulky goods (twice per year) collection services to 26,240 single-family homes and 8,675 multi-family households. Details of these services, as well as other diversion opportunities provided by the City, are listed below.

The City enacted a by-law in February 1993 that enforces a two bag/container limit for residences, and a four bag/container limit for businesses and lodging houses. The by-law (Chapter 594 Garbage Collection) also defines recyclable material and stipulates that it is illegal to dispose of recyclables as solid waste. In addition, the City developed a by-law (By-Law 09-108) that details all materials that are banned from the PCCWMF. A copy of these by-laws are included in Appendix B for reference purposes. It is recommended that the City review and consider updating these by-laws to reflect the current waste management planning goals and objectives within the next one to two years.

A total of 34,683 tonnes of residential waste was generated within the City in 2010 (City of Peterborough, 2011). Approximately 51.0% (17,823 tonnes) was diverted through programs such as blue box recycling, leaf and yard waste composting, MHSW collections, WEEE, and backyard composting. These programs and the remaining waste stream are discussed in more detail below.

The waste composition for the City in 2010 is included as Table 1.

Table 1 City of Peterborough Waste Composition (2010)

Material	Weight (tonnes)	Percentage of Waste Stream
Diverted		
Blue Box Recyclables (marketed only)	7,977	23.0%
Organics and Leaf and Yard Waste	7,011	20.2%
Other Recyclables (i.e. scrap metal, tires, etc.)	1,590	4.6%
Residential Deposit Return Program	437	1.3%
WEEE	266	0.8%
MHSW (recycled and reused)	79	0.2%
Residential Reuse	4	0.01%
Total Diverted	**17,364**	**50.1%**
Disposed		
Garbage	16,191	46.7%
Processing Residue	979	2.8%
MHSW Residue	150	0.4%
Total Disposed	**17,320**	**49.9 %**
Total Generated	**34,684**	**100.0%**

Notes: 1. *Source:* (City of Peterborough, 2011).
2. All diverted material weights listed above represent tonnes marketed, not collected.
3.Weights noted above are rounded.

A graphical representation of the City's waste composition is included in Chart 4.

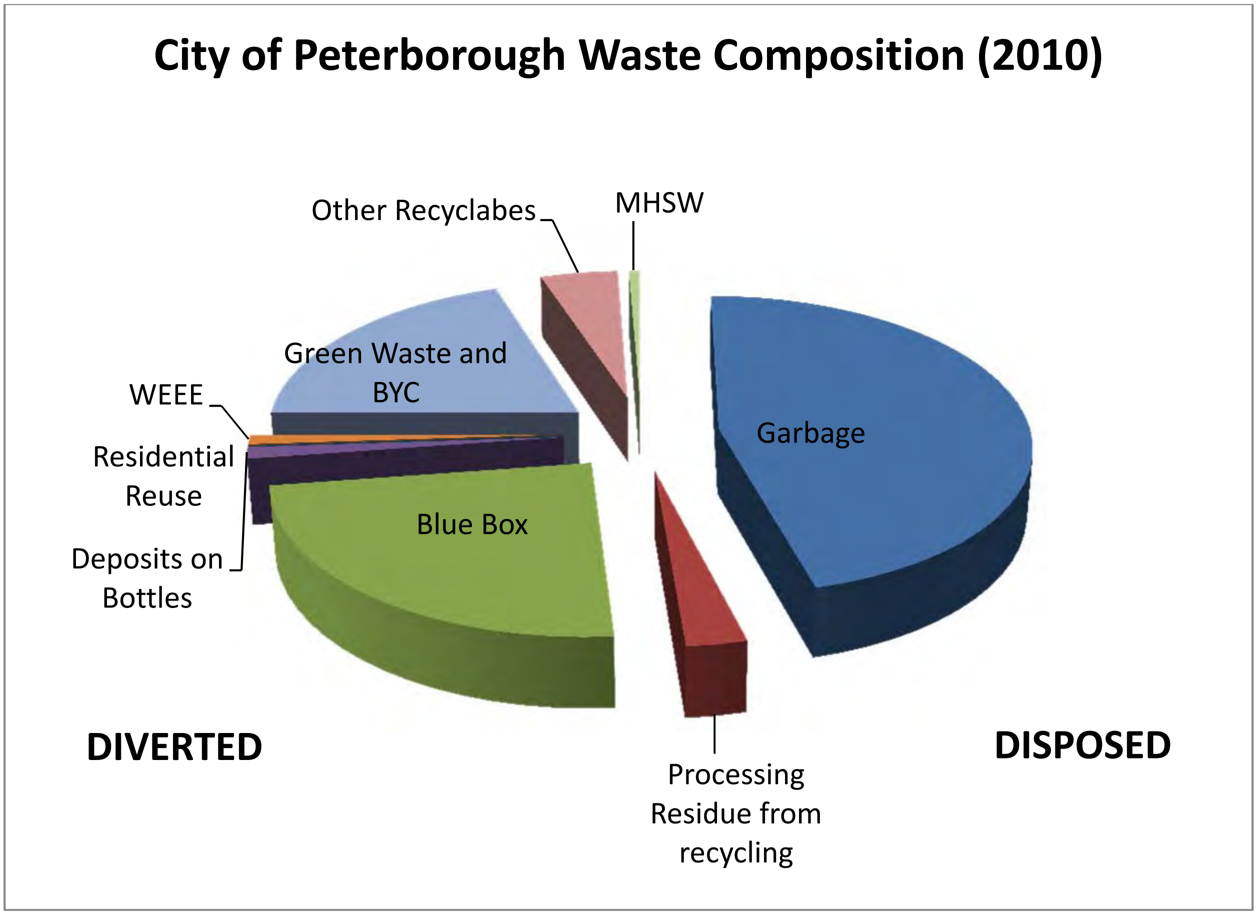

Chart 4: City of Peterborough Waste Composition (2010)

With the 2010 population of 79,334 persons, disposal quantities within the City averaged 218.3 kg per person per year and diversion quantities averaged 225 kg per person per year (City of Peterborough, 2011).

3.2 WASTE MANAGEMENT SYSTEM COSTS

Overall, the City's waste management system services in 2010 had a net operating cost of $2,869,232. The costs include all programs financed under the Waste Management Division, including solid waste collection and disposal, blue box collection and processing, green waste collection and composting, the Municipal Hazardous or Special Waste (MHSW) depot, promotion and education, salaries, and all other administrative expenses. The net cost to provide all waste management services to City residents in 2010 was $82.18 per household. The cost per household is based on a simple calculation and is not based in any way on the average assessment.

3.2.1 DIVERSION PROGRAM COSTS

City diversion programs – including blue box recycling, green waste collection, compost production and distribution, and the household hazardous waste and electronics depot – had a net operating cost of $1,198,352.50 in 2010. This includes all staff and administration expenses for each program, as well as all forms of recoveries, including sale of recyclables to markets and provincial funding. It does not include recoveries or expenses for recyclables handled at the landfill site. The net cost to provide these diversion programs to City residents in 2010 was $34.32 per household.

3.2.2 GARBAGE COLLECTION AND DISPOSAL COSTS

Garbage collection and disposal costs consider the weekly curbside collection of garbage from households and small businesses, the bi-annual collection of large articles, and the handling and disposal of these items at the PCCWMF. The City shares the costs and revenues for the PCCWMF with the County of Peterborough.

The total tonnage of waste received at the PCCWMF in 2010 was 60,248 from the City and County combined., and the gross cost to operate the facility was $3,101,900.15. This included all aspects of running the facility, including revenue-sharing with the County, consultant fees, salaries, contracted services, taxes, host royalties and much more. When recoveries are factored in, including rental property incomes, tip fees, revenue from sale of marketable materials and provincial funding for tire recycling, the City showed a net revenue of $580,686.00 at this facility in 2010. This does not take into account the annual payments of close to one million dollars into reserve funds to help finance potential future overruns and post-closure costs.

Collection costs for garbage and large articles totalled $1,130,150.00, bringing the net operating cost to handle garbage in the City to $549,464.00. When annual reserve fund costs are factored in, it brings the net cost to provide disposal programs to City residents in 2010 to $44.38 per household or 29% more than diversion program costs.

It should also be noted that disposal costs consider only the actual dollars paid out in a given year, and do not take into account other costs that are more difficult to quantify (long-term post-closure costs, search and development of new disposal options, environmental and societal costs, etc.).

A true-cost analysis of the City and County's disposal practices is highly recommended, so that valid comparisons can be made by decision-makers between future disposal and diversion options.

3.2.3 PROMOTION AND EDUCATION COSTS

As noted in the Blue Box Program Enhancement and Best Practices Report (KPMG, 2007), those communities in the 2005 WDO Datacall with recovery rates at or exceeding 60% were generally spending between $0.83 to $1.18 per household on the promotion of recycling. It was also suggested that there was a strong correlation between increased promotion and education (P&E) spending and increased recovery in Ontario recycling programs. In 2010, the City spent a total of $32,500.00, or $0.93 per household, on all waste management-related promotions. Of that, recycling/blue box-specific P&E expenses were $13,290.00 in 2010, or $0.38 per household, well under half of what Best Practices recommend.

3.3 CITY/COUNTY PARTNERSHIPS

An important aspect of solid waste management system planning for the City is the ongoing shared commitment between the City and County, specifically the shared responsibility of the PCCWMF and mutual use of the MRF. The City, in partnership with the County, owns and operates the PCCWMF which is located within the Township of Otonabee-South Monaghan. The City intends to move forward in partnership with the County to determine the most suitable option for waste disposal for both jurisdictions when capacity is no longer available at the PCCWMF.

The City and County have separate long term agreements with HGC Management Inc., the operator of the MRF, from January 17, 2008 for a period of seven years. The Pido Road MRF was constructed by the City in 1989. The City also owns and operates the Harper Road compost facility which is currently utilized to compost leaf and yard waste and the SSO pilot program materials from the City and the County. The MRF, if operated properly, could have a remaining life capacity of seven to ten years. There is also a chance that Stewardship Ontario may decide that the current operation is not sufficient for the service area and receiving stream within the next few years, and may require the City to look at alternatives.

A review of this relationship should be undertaken to ensure absolute clarity in agreements on the future direction of waste disposal requirements, policies and operations. The City and County need to work together to find a compatible and sustainable solution for both parties.

3.4 WASTE AUDIT/MONITORING

The City has performed a number of waste audits over the years. The data obtained through these audits is essential to assess waste composition; to determine the recovery performance of existing programs (capture rates); and, to assess opportunities and priorities for recovery improvement.

The last waste audits done in the City were completed in 2006, in partnership with Stewardship Ontario. There were four separate audits conducted over the year, one during each season. One hundred households were selected to participate, and these same households were audited each time. Audit results indicated that the participation rate in the garbage curbside collection program is virtually 100% with an average of 1.36 bags per week per household being set out. The participation rate in the blue box program was determined to be 99%. The average capture rate of blue box materials was found to be 79.5%. This is less than the blue box capture rate target of 85% for a municipality in the Medium Urban municipal grouping, as determined by the Continuous Improvement Fund (CIF) (Trow, 2010). It is anticipated that the capture rate may have increased to date, but there have been no additional audits to verify this information.

An identical set of audits is planned for the City during 2012, which will show whether capture rates have improved over the intervening years.

3.5 WASTE STREAMS

The following section provides a breakdown of the waste streams currently processed within the City. There are two main areas of waste: the diverted waste; and the waste that is not diverted which for the purposes of this report has been referred to as disposed waste.

3.5.1 DIVERSION

The material currently diverted by the City is discussed in further detail in this section to provide a better understanding of the level of effort already achieved by the City and residents to keep materials out of the landfill.

3.5.1.1 RESIDENTIAL BLUE BOX

The residential blue box made its start in the 1970s with a group called the "Peterborough Environment People”, or “PEP". The City paid rent for a Quonset hut at the west end of Hawley Street, which served as a depot for recyclables. This was open from 8 am to 12 pm on Saturdays for drop off of residents' glass and metal containers and newspapers.

At about the same time, Scott’s Plains Recycling Inc. had tried to develop a business making shipping pallets, which employed federal prisoners on parole and living in a local half-way house. The project was not successful so the directors of the Scott’s Plains Recycling Inc. made a proposal to the City to start a curbside collection coinciding with garbage pick-up and using the blue box. Premises were rented in an old factory building on Perry Street. It soon became obvious that the Perry Street location was too small and a facility built specifically for material recovery was required. Construction started in 1988 on the Pido Road facility. The weekly collection of recyclables by blue box began in 1987.

In February of 1993, participation in the blue box program was encouraged by including a definition of “recyclable” items in the City’s Garbage by-law, and making it illegal to dispose of recyclable items in the regular garbage. Definitions of allowable receptacles for recyclables, as well as garbage and green waste, were also included in the by-law. A copy of this By-Law can be found in Appendix B.

In January of 2008, the City moved from a five-stream system of recyclables collection, to a two-stream system. This was done to make collections at the curb faster, more efficient, and convenient for residents. A “Fiber” stream and a “Containers” stream are sorted and processed on two separate lines at the MRF. In 2010, the City of Peterborough recycled 8,460 tonnes of blue box material, for a blue box diversion rate of approximately 24%. An additional 437 tonnes are calculated to be diverted through the LCBO Deposit Return Program.

All residential blue box material collected is taken to the MRF located on Pido Road. Recyclable materials can also be dropped off at no charge at a 24 hour depot, located at the MRF.

3.5.1.2 ORGANIC WASTE

Organic – or biodegradable - waste has both general and specific types. The terms that are generally referenced in this Plan are as follows:

> **SSO** – Food waste and non-recyclable paper that is separated for composting or other organic waste processing. Some municipalities have widened the definition of SSO to include diapers, sanitary products and pet waste. Typically has greater processing requirement than leaf and yard waste, therefore it is identified as a separate component of organic waste.
>
> **Leaf and Yard Waste** - Refers to leaves, grass, weeds, trimmings, brush, and woody materials (twigs, branches, etc.).
>
> **Backyard Compost** - Composting of residential organic materials by a household, usually in the backyard. Typically includes only fruits, vegetables and other non-meat and non-dairy products from the kitchen. Generally considered a method of source reduction as it is done at the home.

Please refer to the Glossary of Terms and Abbreviations at the end of this document for further clarification, if required. A total of 7,027 tonnes of organic materials were diverted through a combination of the methods described below. This represents 20.3% of the total residential waste stream.

3.5.1.2.1 LEAF AND YARD WASTE DIVERSION

Leaf and yard waste material is transported to the composting facility on Harper Road for processing. An open windrow composting process is used. In 2010, a total of 4,941 tonnes of leaf and yard waste material was collected within the City, which represents approximately 14.2% of the total residential waste stream by weight. Of this, approximately 86% was collected by the City through the curbside program and the remaining 14% was dropped off by residents at the depot at the PCCWMF.

3.5.1.2.2 SOURCE SEPARATED ORGANICS DIVERSION

A total of 625 single-family households and three (3) restaurants are included in the City's SSO pilot program. 204.75 tonnes of SSO were collected by the City in 2010, which represents 7.1% of the total residential waste stream by weight. The City has noted that the majority of households in the pilot neighbourhood do not participate in this program, which began in 2001 and has lost some momentum over the years due to resident turnover and lack of promotion. SSO materials collected through this pilot program are transported to the composting facility on Harper Road where they are processed along with the leaf and yard waste. When completely composted, the material is screened, analysed, and made available to City and County residents through truckload deliveries or self-load options at Peterborough Green-Up and the PCCWMF.

3.5.1.2.3 BACKYARD COMPOSTER DIVERSION

Approximately 1882 tonnes of residential organics were assumed to be diverted through backyard composting and other at-home reduction efforts in 2010 (including an estimated 368 tonnes which were 'grasscycled'). This is based on the assumption that each composter diverts an estimated 100 kg/unit/year. The City had distributed 15,135 units at the end of 2010.

3.5.1.3 MUNICIPAL HAZARDOUS WASTE

The year-round MHSW Depot is located at 400 Pido Road in Peterborough and is open to all City and County residents, free of charge. Materials such as paint, batteries, used oil, solvents, fertilizers, pesticides, old pharmaceuticals, used syringes, propane tanks, fluorescent lights, and antifreeze are accepted at this facility from households and small businesses. It is open four days a week, from 8 am until 4 pm.

A total of 229 tonnes of MHSW material was collected in 2010. Of the 229 tonnes collected, 150.28 tonnes were disposed and 79.15 tonnes were recycled and reused, representing approximately 0.2% by weight of the entire residential waste stream.

3.5.1.4 WASTE ELECTRONIC AND ELECTRICAL EQUIPMENT

The following municipal depots within the City provide waste electronic and electrical equipment (WEEE) collection services and are registered collection locations with Ontario Electronics Stewardship (OES):

- MRF(400 Pido Road, Peterborough)
- PCCWMF (Bensfort Road, Otonabee South Monaghan)

Special single event days for the collection of WEEE materials are also held periodically by the City at select locations. A number of commercial retailers also provide WEEE drop off depots through the Ontario Electronics Stewardship Program for residents, if needed.

A total of 333 tonnes of WEEE material was diverted by the City in 2010, which represents approximately 1.0% by weight of the entire residential waste stream.

3.5.1.5 OTHER DIVERSION

In addition to the above noted diversion streams, the PCCWMF and MRF provided collection of various recyclable materials:

- Used Tires - 17.5 tonnes of tire material were diverted in 2010, which represents approximately 0.1% by weight of the entire waste stream.
- Scrap Metal - 190 tonnes of scrap metal material were collected in 2010, which represents approximately 0.5% by weight of the entire waste stream.
- Construction, Renovation and Demolition Waste - 1,383 tonnes of construction, renovation and demolition (CR&D) material were collected in 2010, which represents approximately 3.9% by weight of the entire waste stream.
- Drywall - 294 tonnes of drywall were diverted in 2010, which represents approximately 0.8% by weight of the entire waste stream.

3.5.2 DISPOSAL

The City of Peterborough disposed of 17,320 tonnes of residential waste in 2010, which is calculated as 218.3 kg per person and represents approximately 49% by weight of the entire waste stream. This consisted of: 12,134 tonnes collected from single- and multi-family households; 4,058 tonnes collected at the landfill depot; 979 tonnes of recycling and compost processing residues; and, 150 tonnes that were disposed from the MHSW Depot (Waste Diversion Ontario, 2011).

> In comparison with other municipalities within the Medium Urban municipal grouping, the City's per capita waste generation rate is approximately 20% lower than the average (Table 2).

Table 2 2010 Waste Disposed for the Medium Urban Municipal Grouping

Program Name	Waste Disposed (kg/capita)
City of Guelph	193.59
City of Barrie	216.89
City of Peterborough*	**218.30**
City of Sarnia	247.02
City of Sault Ste. Marie	298.87
City of Brantford	330.57
City of Thunder Bay	341.43
AVERAGE FOR MEDIUM URBAN GROUPING	263.48

Source: (Waste Diversion Ontario, 2010).
**2010 WDO Datacall*

Households within the City are permitted to set out a maximum of two lifts of garbage per week for collection at curbside.

The PCCWMF will continue to provide waste disposal capacity for the County and City for approximately 12 to 15 years (from January 2011). Historically an assumed annual waste disposal rate of 60,000 tonnes (including IC&I and divertible material) and an assumed apparent waste density of 0.65 tonnes/ m^3 were applied (Genivar and Urban & Environmental Management Inc., 2011).

To determine future waste management needs, Cambium reviewed the future growth projections with the City and consulted the City's Official Plan Review. Based on these reviews, the City has projected a population growth of 88,000 by 2031. This projection coincides with the Greater Golden Horseshoe (GGH) Places to Grow Growth Plan policies. From this anticipated growth, we reviewed the tonnages and utilized the residential waste generation rate without divertible material of 218.3kg/capita and it can be projected that the annual residential waste disposal rate in over the next 20 years will be as follows in Table 3:

Table 3 Residential Waste Generation Projection Rates to 2031

	2010	2016	2021	2026	2031
Population	79,334	81,436	83,594	85,810	88,041
Residential Waste (tonnes)	17,320	17,779	18,250	18,734	19,221

4.0 OPPORTUNITIES FOR INCREASING DIVERSION

This section summarizes the potential gaps between the City's current diversion of its various waste streams (based on 2006 waste audit data) and the goals and objectives identified in this Plan.

The City of Peterborough is considered an urban municipality, having over 150 multi-residential and many IC&I developments. Provincially, the City falls on the medium sized charts for comparison purposes with other cities of similar land uses and population densities.

As previously mentioned in Section 3.4, the City conducted its most recent formal waste audit in 2006. The findings from this audit were used in the diversion opportunity analysis, along with data from the 2010 WDO Datacall.

4.1 DIVERSION OPPORTUNITY ANALYSIS

By completing the analysis of diversion opportunity, it allows the City to review the amount of waste and recycling collected, the composition of this material, and the manner in which the material is received (i.e. in a garbage bag or blue box). Cambium has provided a summary of this information in tabular form for ease of understanding and presentation, in Table 4.

From the 2010 WDO Datacall report, the total residential waste and recycling generated in the City in 2010 was about 34,684 tonnes which includes backyard composting (BYC), the Beer Store (LCBO deposit, stewardship returns), WEEE, Reuse, CR&D recycling, MHSW, tires, scrap metal, leaf and yard, SSO, blue box material, and garbage. Of this total, 17,823 tonnes of the material was diverted while the remaining was disposed.

The 2006 Waste Audit indicated that organics comprised 30% of the total waste stream (City of Peterborough, 2006). A study entitled *Residential Waste Composition Study* (Ministry of the Environment, 1991) indicated that organics material comprises approximately 37% of residential solid waste in Southern Ontario. The number of 37% was used to estimate the total amount of material available in the waste stream.

To determine the amount of MHSW material remaining in the waste stream, the MHSW Program Plan (Stewardship Ontario, 2009) was used. This Plan provides for the end-of-life management of all MHSW materials under the Stewardship Ontario Program Plan. The Plan included an analysis of all MHSW material sold, available for collection, and reported collected and transported in Ontario over an eight-month period in 2008 and 2009. The total MHSW material available for collection Ontario-wide was reported to be 40,612 tonnes over eight months. This tonnage was then interpolated to determine the tonnage of MHSW material that would be available for collection annually within the City of Peterborough only. The result was that approximately 397 tonnes of MHSW material is available for diversion within the City annually.

Normally, to determine the amount of tires remaining in the waste stream, the Used Tires Program Plan (Ontario Tire Stewardship, 2009) would be applied. The purpose of this study is to foster the implementation of a sustainable used tire stewardship program in Ontario. This study included an analysis of the estimated uses of scrap tires within Ontario. The total used tires that are currently being recycled or disposed Ontario-wide was reported to be 106,500 tonnes. In the City of Peterborough, the Used Tires Program is very successful and there are many surrounding municipalities also participating in this program as well as local businesses. Tires are banned from disposal at the PCCWMF. It is assumed for this reason that 100% of the waste tires generated within the City of Peterborough are diverted from the landfill.

Table 4 Estimate of Divertible Materials Remaining in Waste Stream

Material		Current Diversion[1] Tonnes	Current Diversion[1] Capture Rate (%)	Current Diversion[1] % Diverted	Potential Diverson (Tonnes)	Tonnes Remaining in Waste Stream[2]	Potential Increase in Diversion (%)
Blue Box (including unmarketed material)	Paper	5,474	82.0%	15.8%	6,674	1,200	3.5%
	Plastics	1,497	50.0%	4.3%	2,994	1,497	4.3%
	Metals	491	73.4%	1.4%	669	178	0.5%
	Glass	998	89.9%	2.9%	1,110	112	0.3%
Stewardship Returns	Beverage Containers through Stewardship programs	437	100.0%	1.3%	437	-	0.0%
Residential Reuse	Toys, clothing, small appliances, building materials and other household items	4	N/A	0.0%	4	-	0.0%
WEEE[3]		333	72.2%	1.0%	461	128	0.4%
Organics[4]	Leaf and Yard Waste	4,900	98.0%	14.1%	5,000	100	0.3%
	SSO (food waste)	210	3.5%	0.6%	6,010	5,800	16.7%
	BYC (backyard compost)	1,810	100.0%	5.2%	1,810	-	0.0%
MHSW (recycled/reused)[5]	Used oil, batteries, etc.	79	19.9%	0.2%	397	318	0.9%
Other Recyclables	Tires	18	100.0%	0.1%	18	-	0.0%
	Other – carpet, mattresses, CR&D, etc.[6,7]	1,573	40.8%	4.5%	3,852	2,279	6.6%
	Totals	17,823	-	51.4%	29,435	11,613	33.5%

Total Waste Generated	**34,683**
Remaining Refuse	**5,248**
Percentage Divertible[8]	**85%**

(shaded) target materials for increased diversion

Notes:

1. *Source: 2010 Waste Diversion Ontario Datacall for the City of Peterborough*
2. *Source for Remaining Blue Box: capture rates from the 2006 waste audit for the amount of blue box material remaining in the waste stream*
3. *Source for Remaining WEEE: 70,659 tonnes of WEEE available for collection Ontario wide in 2004 (Table 2 of WEEE Study (WDO, 2005))*
4. *Source for Remaining Organics: 37% of waste stream is assumed organics (Page 1-3 of Residential Waste Composition Study (MOE, January 1991))*
5. *Source for Remaining MHSW: 40, 612 tonnes of MHSW available for collection Ontario wide over 8 months in 2008 and 2009 (Table 4.7 of Final Consolidated MHSW Program Plan (Stewardship Ontario, 2009))*
6. *Source for Remaining CR&D: 10 to 30% of waste stream is CR&D (Building for the Future: Strategies to Reduce Construction and Demolition Waste in Municipal Projects (May 11, 1998))*
7. *Tonnages of mattresses and carpet are unknown at this time and as such a conservative estimate was used based on information from a PCCWMF operator.*
8. *Assumes 100% capture rate*

The potential diversion of 29,435 tonnes of material assumes that 100% capture rate is achieved and is provided here in order to illustrate what ultimately is possible. The purpose of the analysis is to clearly identify what is achievable for the City financially and realistically.

The analysis in Table 4 shows that the key opportunity for increasing diversion is through organics, specifically with SSO (food waste). Approximately 17% of the remaining waste stream is comprised of food waste. An additional 3.5% and 4.3% diversion can be achieved through capturing the available tonnes in the paper and plastics components of the blue box program, respectively. Likewise, there is an additional 5.0 to 8.0% diversion achievable with the removal of other recyclables such as mattresses, carpet and CR&D materials from the current waste stream. Overall, the percentage divertible is estimated to be 85%.

The total diversion potential is estimated to be 85% (assuming 100% capture rate).

5.0 OVERVIEW AND EVALUATION OF WASTE MANAGEMENT PLAN COMPONENTS

A set of diversion options were developed within pre-determined areas of interest in line with the already established goals, objectives, and measurable targets approved by the City and its public stakeholders.

The main areas of interest included the following:

- Goals, Targets, and Advocacy;
- Collection Services;
- Support and Incentive Options;
- Public Engagement and Education;
- Monitoring and Reporting;
- IC&I Recycling and Diversion Programs; and,
- Multi-Residential Recycling and Diversion Programs.

Within each of these target areas, a list of waste diversion options was identified. Each of the options was analyzed for the suitability with the City's waste management system.

5.1 EVALUATION METHODOLOGY

As previously noted, the City Steering Committee reviewed the list of waste diversion options against an established set of criteria. The criteria used in the evaluation included:

- Economic feasibility – how economically feasible is the program and how does it compare against the others on a cost per tonne basis.
- Environmental effects (including waste diversion) – what are the main environmental effects of the option (primarily represented as waste diversion).
- Social impact/acceptability – how accepted is the option, measured by feedback received or as commonly received in other jurisdictions.
- Overall impression (includes sound approach/technology and ease of implementation) – has this approach/technology worked in other similar jurisdictions.

The preferred waste diversion system is considered to be the one with the desired balance of advantages and disadvantages relative to the established goals and objectives. The evaluation was based on the priorities of the City and in consideration of the technical data available to date, advice from technical experts and input received from stakeholders (i.e. public, agencies, etc.).

5.2 COMMUNITY INVOLVEMENT

The City solicited involvement from the community at several critical points in the development of this document. The City hosted a public information centre (PIC) and designed an online survey to obtain information from local stakeholders, including permanent and seasonal residents, with respect to current and future waste management. The consultation program was designed to solicit information on current behaviours and to gain insight into the feasibility of waste diversion options based on user preference.

Notably, there is widespread support for the following program enhancements:

- maximize waste reduction;
- maximize waste re-use;
- maximize recycling;
- continue to maximize diversion of yard wastes; and,
- implement collection and processing of SSO.

5.2.1 PUBLIC INFORMATION CENTRE

Two PICs were held during the preparation of the Plan. The first PIC was hosted by the City at the Peterborough Public Library on Thursday October 27, 2011 from 2 pm to 3:30 pm and 6 pm to 7:30 pm. Notice of the date, time, and location for the PIC event was published in the Peterborough This Week and on the City website. A copy of the online survey was made available in hard copy at the PIC for residents to complete, and written comments could be submitted by attendees, if desired.

The first PIC was attended by City and Cambium representatives, who were available to provide information and answer questions at the request of attendees. An open house format was used for the PIC, with a poster board display containing pertinent information related to the development of the waste management master plan. In total, the afternoon and evening session of the PIC were attended by 18 people, in addition to City and Cambium representatives. Twelve copies of the survey were completed by attendees at the PIC event and were included in the tally with the same survey completed online.

The second PIC was held at the Green Expo on October 20, 2012 from 9am to 6pm at the Lansdowne Place Mall in Peterborough. Notice of the date, time, and location for the PIC event was published in the Peterborough This Week and on the City website.

A booth was set up with handouts and comment sheets for members of the public to provide input. The second PIC was attended by representatives from the City and Cambium with the ability to answer questions for the public where necessary. The display contained pertinent information related to the development of the waste management plan. An online survey was available for the day of the PIC and printed surveys were also available for those that preferred the hand written option or were unable to stay to complete on the day of the PIC. Many people that would not normally have received the information participated in the feedback process and the second PIC was quite successful. In total, 60 surveys were completed at the time the report was issued with additional two comments sent via email of which the suggestions have been incorporated into the report.

The general public were asked to provide input on the draft WMMP which was posted on the City website but if they had not reviewed the document, City and Cambium staff provided a brief summary of what the WMMP entailed and the key recommendations identified in the report. The residents were asked to identify the top three diversion recommendations and the most preferred and least preferred disposal options such that the City may utilize this information going forward. The findings were as follows:

The top three diversion recommendations were:

- Identify recycling options for materials currently going to landfill incl. mattresses, carpet, textiles (72.7%)
- Develop an organics collection program (58.2%)
- Reduce garbage pickup and provide weekly recycling and organics pickup (56.4%)

The most preferred disposal options include:

- Increase waste diversion (81.8%)
- Use of alternative waste derived fuel technologies (42.8%)

The least preferred disposal options include:

- Exporting for any reason (landfill or incineration) (51.9%)
- Establishing a new landfill (29.8%)

General comments from the survey results in the second PIC are included in Appendix A for review.

5.2.2 ONLINE SURVEY

An on-line survey was available for residents to complete at the beginning of the project from July 28, 2011 through to May 9, 2012. In total, 189 people completed the survey. A summary of the survey results, including all comments received is included in Appendix A.

Notable results from the survey included:

- The age demographic with the highest response to the survey was the 19 to 35 age range (35.7%) followed by the 36 to 50 year age range (34.6%).
- Approximately 80% of respondents resided in a single family home.

- 94% of respondents were permanent residents of the City of Peterborough.
- Greater than 83% of respondents generate one bag or less of garbage per week.
- Greater than 70% respondents generate two or more full blue boxes of recyclable material each week.
- Approximately 62% of respondents compost at home on a year round (42.3%) or seasonal basis.
- For the most part, respondents were satisfied or very satisfied with the current service levels for garbage and recycling.
- Respondents were less satisfied with the current service level for green waste; approximately 30% of respondents indicated that they were “unsatisfied” or “very unsatisfied” with the current service level. Comments provided suggested that many residents feel that green waste services should be increased to curbside collection of organics.
- 70% of respondents indicate that they use the MHSW and WEEE depots on an annual or seasonal basis, while 26.2% stated that they don’t use these facilities at all.
- 68% of respondents stated that they would like to see the City reach a waste diversion target of 65%, which is 5% greater than the provincial goal.
- The five most preferred choices for increasing waste diversion were, in order of most to least popular: collection of food waste at the curb; increase the items that can be recycled in the blue box; establish a municipal reuse centre; reduce the number of bags permitted; and, mandate the use of clear bags.
- Greater than 81% of respondents indicated that they would participate in a curbside food waste collection program if it were offered by the City.
- 92% of respondents indicated that they would be willing to change personal behaviours to reduce waste generation, including: buying products with less packaging; participating in curbside food waste collection; and, using reusable shopping bags, among others.
- 65% of respondents would support the collection of garbage every second week (bi-weekly), if an enhanced recycling and food waste program were implemented. Approximately 25% indicated that they would not be in favour of this initiative.
- 59% of respondents were very concerned about potential impacts of landfilling waste, including; groundwater, biological, and surface water impacts, as well as odours and air emissions.
- The public identified that the top five criteria to evaluate future waste management options should be: positive environmental effects; positive social impact and acceptability; proven technology; cost/affordability; and, ease of implementation.

- Responses indicated approximately 64% of respondents would prefer waste management funding be obtained through municipal property taxes rather than user fees.

5.3 EVALUATION OF DIVERSION OPTIONS

A summary of the evaluated and recommended diversion options selected for the City, based on the current technology, trends, and conditions, is included in the following section. The most suitable options to increase waste diversion in the City have been divided into six areas for discussion purposes:

- Promotion and Education (P&E)
- Enhancement of Diversion Programs
- System Optimization
- Multi-residential Recycling and Diversion
- Policy and Enforcement
- IC&I Waste Recycling and Diversion

In addition to the evaluation criteria discussed in Section 5.1, it is important to note that the implementation of the waste diversion options is likely to occur over several years, with some options requiring substantial lead time for public notification, planning, financing, and preparation. With this in mind, each option has been assigned a timeframe with respect to implementation.

All options evaluated that are not considered to be viable at this time are available for reference in Appendix C. It is important to note that this plan is a living document, and that this list of options should be reviewed by the City on an ongoing basis, to ensure that the most appropriate options are implemented as conditions change and the needs of the community bend to environmental, financial, and political fluctuations.

5.3.1 PROMOTION AND EDUCATION (P&E)

The City is committed to developing creative, efficient, and cost effective methods to promote waste diversion and management initiatives and to educate residents and businesses about the importance of maximizing waste diversion. A variety of factors contribute to the patterns of waste generation and disposal, including; product choices, consumption patterns, economic influences, multi-level policies and regulations, public attitudes, and busy lifestyles. As such, education programs for waste reduction should promote behavioural and social change, as well as communicate the correct information to allow people to make these changes.

An effective P&E program will:

- Create more awareness of the various waste issues.

- Achieve the eight Waste Management Best Practices established as one of the City's Key Targets. The report that provides the complete list of Waste Management Best Practices is included in Appendix D.
- Expand the number and type of education and outreach and/or partnership activities year over year, from 2010 levels.
- Enhance the community's knowledge and understanding of waste issues.
- Influence the community's values and attitudes.
- Encourage more responsible behaviour by the community.

As with all forms of education, it is understood that people learn and are motivated in different ways; therefore, messages to change behaviours surrounding waste generation, diversion, and disposal are most effective if they are reinforced throughout all venues (i.e. at home, work, and/or school). To this end, the P&E program should strive to involve business groups, residents, schools, the media, and community organizations. It is anticipated that with effective communication and education, combined with the correct supporting programs, the community will be motivated to take responsible action to reduce, reuse, and recycle their waste in a sustainable manner.

Several options were explored for the P&E program. The list of potentially suitable P&E options was reduced to the following three options for further evaluation:

Promotion and Education	**Objective Satisfied**				
Strategy Enhancement Option	**1**	**2**	**3**	**Diversion Potential**	**Ranking**
Enhanced P&E Continue with current campaigns but also move into other outreach programs, social media, at various levels such as websites, twitter, Facebook (radio, newsprint, advertisements, signage, and prizes), presence at local events and open houses within the community, surveys, targeted campaigns, Sustainable Peterborough goals, IC&I recycling programs. Aim for an increase in blue box capture rates of 10% over 20 years.	✓	✓		2% to 3%	1
Staff Training - Attend training and workshops, industry meetings (MWA, SWANA etc.)	✓	✓		1%	1
Schools Programming Enhancement, expand and formalize	✓	✓		1%	2

Note: Objectives are 1) Maximize Diversion; 2) Minimize Generation; and, 3) Fiscally Responsible

As illustrated above, enhanced P&E and training were the most preferred options for the City at this time, and are discussed in detail in the following sections. Only options that receive a ranking of 1 (most suitable) are recommended at this time to be the City's top priorities. Each year the options will be re- assessed in light of current conditions to ensure that the options moving forward are relevant. A summary of the strengths and challenges for all P&E challenges is provided in Table 5.

5.3.1.1 ENHANCED P&E – GENERAL

Enhanced P&E includes the use of existing City, public, or provincial tools and resources to promote waste diversion, with enhancements to target the particular conditions of the City to increase the diversion rate. Examples of resources that can be used to encourage participation in waste diversion initiatives include:

- Media: City website, blogs, advertisements, articles, press releases, radio spotlights, new social sites;
- Educational Resources: local events and targeted campaigns; and
- Promotional Materials: permanent and mobile signage, stickers/labels, calendars, supporting other City programs including Sustainable Peterborough.

These promotional resources can be focussed toward the topic of waste diversion in general, or can be directly related to problematic materials or particular diversion targets that are not being met (i.e. increasing the diversion of plastics, or addressing blue box materials contamination).

Enhancing Peterborough's general P&E program will serve to increase the population's general knowledge of waste diversion programs, and is anticipated to increase waste diversion by up to 3%. The cost to adequately enhance the program is estimated to be approximately $80,000 per year, at a minimum.

The current budget of $60,000 per year for general P&E should be increased to $75,000 per year to allow for more television, radio and social marketing campaigns, which will reach new and expanded audiences. Best practices suggest $1.18 per household, which equates to over $41,000.00 for recycling promotions alone. Additional promotional materials, entry fees, etc. for public recycling events and multi-residential working group will require another $5,000 per year.

5.3.1.2 ENHANCED P&E – LARGE FUTURE CAMPAIGNS

In addition to the general P&E program that the City runs each year, special campaigns for new programs and initiatives being introduced will need to be accounted for in the appropriate annual budgets. As these new programs become a permanent part of the City's Waste Management System, additional general P&E funding to maintain awareness and participation in them will need to be considered.

Some examples of specific P&E campaigns that may fall outside the general programming budget include:

- Source Separated Organics program
- Expanded schools programming
- A multi-residential promotional campaign

- IC&I diversion programs

The P&E program will relate to all diversion options presented in the City WMMP and, as such, these sections may overlap in content. P&E is directly linked to all aspects of waste management be it collection, processing, or end use and final disposal. The more informed waste management system users are, the better the waste management system will be.

5.3.1.3 STAFF TRAINING

Currently the City has a small budget for training courses, workshops and seminars for staff, to ensure that the City is informed and up-to-date on the upcoming trends, technologies, and options available for waste management and diversion. Ensuring that all relevant City staff are informed of these aspects is essential to the success of waste management and for the development and implementation of a thriving P&E program. Training also allows for networking opportunities with peer groups, which will provide valuable insight into the application and success of P&E programs used elsewhere. It is estimated that the portion of a P&E budget assigned to staff training should be approximately $5,000 per year in order to keep up with the latest technologies.

Table 5 P&E Strategies – Summary of Strengths and Challenges

Option		Strengths	Challenges
On-Going General P&E		• Reach a broad audience • Flexible presentation • Cost effective • Support for waste diversion programs	• Preparation of materials can be time intensive • Materials may become dated quickly • Continual modification to materials is required to maintain public interest
Future P&E Campaigns	SSO	• Rejuvenate participation in existing programs (green waste, blue box) • Measurable organic diversion	• Staff time/costs • Additional waste stream overwhelming for residents • No facility
	Multi-Residential Programs	• Measurably increase diversion • Allows for open communications	• Staff time/costs • Limited participation from landlords/tenants
	School Programming	• Cost effective • Reach a broad audience • Work within the existing P&E programs	• Staff time/costs • Providing necessary tools to maintain feedback and interest
	IC&I Programs	• Measurably increase diversion • Develop a working group	• Staff time/costs • Ongoing support and feedback for new programs
Staff Training		• Learn new and innovative ways to help reduce waste	• Staff out of office • Costs

5.3.2 ENHANCEMENT OF DIVERSION PROGRAMS

As with the P&E evaluation process, a number of options were reviewed to enhance diversion programs currently used or planned for the City, which led to the selection of six main options. The identified six options were further evaluated for suitability to the current needs and conditions of the City's residents and waste management system. Each option was reviewed to determine which would improve upon diversion rates in the most environmentally, socially acceptable, and financially feasible manner.

Four of the options were identified as most viable for the City at this time. Enhanced diversion options are being established to assist with the key targets developed by the City to achieve the Goals and Objectives of the proposed Plan and the specific targets that relate to enhanced diversion include:

1. Improving the residential diversion rate from the 2010 level of 50% such that the target of 75% over 20 years will be an achievable goal, with a review of target every five years.
2. Improving the capture rates for blue box materials such that the rates will increase 10% from 2006 levels over 20 years, with a review of target every five years.
3. Setting the participation rate to 50% in year 1 of the proposed SSO program with an increase for each year of the program.

A summary chart is provided below for illustration purposes.

Enhancement of Diversion Programs	Objective Satisfied				
Strategy Enhancement Option	**1**	**2**	**3**	**Diversion Potential**	**Ranking**
Establish new and enhance existing markets as practical for materials e.g. textiles, pet waste, wood waste, durable goods, shingles, carpeting, mattresses, CR&D	✓		✓	5% to 8%	1
Waste Exchange/Reuse Center - Establish a waste exchange and reuse centre with a non-profit partner to enable residents to donate and exchange reusable goods. Common for reuse centre to be established at landfill or transfer station.		✓	✓	1% to 3%	1
SSO Collection - Establish a residential curbside collection and processing program for SSO materials.	✓			17%	1
Public space recycling - Install recycling containers in high traffic areas, especially where evidence of container use is pronounced. Includes outdoor parks, trails, and public facilities. Investigate public/private opportunities.	✓		✓	1% to 3%	1
Expand the list of eligible Blue Box materials	✓		✓	<1%	3
Special events diversion and recycling - Establish a City policy for events which makes recycling mandatory. Make it part of the permitting process.	✓		✓	<1%	3

Note: Objectives are 1) Maximize Diversion; 2) Minimize Generation; and, 3) Fiscally Responsible

Because the City already accepts as wide a range as is possible in its blue box program, expanding the list of blue box eligible items was not considered to be relevant. Implementing a program for special events diversion and recycling, while worthy endeavours, did not score high enough in their potential for diversion to be ranked as #1 priorities The most suitable (Ranked #1) options are discussed in the following sections and summarized in Table 6.

5.3.2.1 ESTABLISH NEW AND ENHANCE EXISTING MARKETS

Currently the City collects many materials for diversion through the blue box, MHSW, and WEEE, as well as other diversion programs such as drywall and CR&D programs at the PCCWMF on Bensfort Road. However, there are still more items that could be separated and diverted from landfill. These include but are not limited to:

- textiles
- asphalt shingles
- pet waste
- wood waste
- carpeting
- mattresses
- durable goods
- food waste (organics)

Textiles

Textile refers to clothing, curtains, linens, towels, table clothes and other fabric items. Textiles can be separated from waste collection and, instead of disposal at the landfill, the material can be sent to various charitable organizations for reuse and recycling for such uses as polishing cloths and pet bedding at animal shelters. The City is currently investigating as many options as possible for removing this waste type from the disposal stream. Participation will depend on the level of knowledge, understanding and effort by the residents (i.e. curbside collection or drop off locations).

Asphalt Shingles

One substantial ongoing issue at the PCCWMF is that of the disposal of asphalt shingles. Asphalt shingles can be sourced back to contractors for use in road asphalt. Recycled Asphalt Shingles (RAS) is a product that contains approximately 30% asphalt cement by mass weight. Sources of RAS include trimmings from shingle insulation and decommissioned shingle roofs. Reuse of these materials leads to financial savings through avoidance of disposal costs, saving of air space, and reduction of the amount of virgin asphalt binder required in hot mix asphalt.

The University of Waterloo's Centre for Pavement and Transportation Technology, CPATT, is committed to working with public and private sector partners to develop sustainable technologies with respect to the transportation industry. A white paper was prepared as a result of a recent study involving Miller Paving Limited, CPATT, and Materials Manufacturing Ontario (MMO). There is more interest every day on the asphalt shingle and the RAS end use market. The City would need to identify and work with a producer such as Miller Paving with equipment that is able to remove the nails and grind the shingles to make them suitable for recycling.

Pet Waste

Pet waste is an issue for many municipalities. When residents walk their dogs, they tend to use plastic bags to collect the waste and the combined package is disposed of. A conventional plastic bag mummifies the feces until the plastic bag breaks down, which can take hundreds of years.

Cat waste presents a host of other issues, including toxoplasmosis, which is a protozoa found in cat feces that can wash into streams, rivers, and oceans through septic systems, sewage pipes, yards, and landfills, that can infect birds, rodents, shellfish, and sea otters, causing illness and even death in these creatures. Some residents with cats dispose of waste by flushing it down the toilets. The excess clumping litter made of clay and/or silica can cause impacts to the drains as it can build up over time.

The City has many options moving forward to deal with pet waste, including:

- promotion of eco-friendly cat litters made of corn and free of clay or silica;
- Biodegradable pet bags for collecting waste in public. These are only relevant if used in conjunction with pet waste digesters;

Installation of pet waste composters or digesters in public areas, and/or the promotion of installing these units in people's own yards. It should be noted that pet waste should not be placed in the BYC nor should pet waste be included in an approved SSO program without further review, as there are pathogens that will not be readily removed during this process. Pet waste composters and digesters are designed to specifically alter the waste using enzymes which results in a benign residue. Should there be a program that becomes available to the City which processes both biosolids and SSO, the City may be able to revisit the pet waste diversion for incorporation into that program.

Wood Waste

Unlike metals and plastics, wood is renewable and represents an inexhaustible resource if properly managed. In 2004, a study was completed by Natural Resources Canada (NRCan) which concluded that 875,000 tonnes of wood waste was disposed of from CR&D projects in Canada each year (Forest Echo, 2011). As much as 20 to 30% of the wood used in new home construction ends up as waste material or, worded differently, for every new 2,500 square foot home constructed, it is estimated that there will be two metric tonnes of wood waste (Forest Echo, 2011).

Builders and home owners can integrate reclaimed wood during their renovations such as old doors, trim and flooring from the deconstruction of older homes. An example of a supplier for these materials is the ReStore in

Peterborough and www.legacyvintage.com out of Cobourg, Ontario. The facility in Cobourg specializes in reuse and recycling of vintage homes and historical building components.

A program should be developed to encourage wood waste diversion by homeowners and the IC&I sector. The diversion program should support local, existing reuse initiatives (reuse centre and charitable organizations), that are further described in Section 5.3.2.2. The success of the program would be contingent on there being adequate space for storage of wood waste at the reuse centre, and the hours of operation being supportive of the CR&D industry. If these conditions are satisfied, the participation by the residents and the IC&I sector is likely to be positive.

In addition to direct reuse, clean wood waste can be recycled for use as a bulking agent with the leaf and yard waste compost facility, sold as mulch, animal bedding, reused for furniture or composite wood products or used to produce biomass energy.

The City does already divert a portion of its wood waste through its CR&D recycling program. The program was touched on in Section 3.5.1.5 and is discussed further below. Currently, CR&D waste is separated when entering at the PCCWMF and diverted or at the source by general contractors with sorting and separation undertaken by M&M Disposal at the recycling facility in the Township of Douro-Dummer.

Mattresses

Based on discussions with landfill staff, there is currently about 50 mattresses per day being disposed at the PCCWMF. When reviewed with historical amounts and projected over the coming years, it can be anticipated that the number of mattresses disposed will be 10,000 to 15,000 per year. One mattress equates to $0.75m^3$ of air space and the City should look at adding this item to the list of banned materials on the by-law.

Carpet

Cambium also recommends that the City review the option of adding carpet as an item that should be banned from landfill disposal. It is bulky and consumes a large amount of air space. There are a number of companies that are capable of separating the carpet materials down to the original fibres for recycling and within reasonable distances to the City.

Construction, Renovation, and Demolition Waste (CR&D)

The diversion opportunity analysis completed in Section 4.1, indicates that approximately 9.5% of all waste generated in the City is considered to be from a CR&D source. Approximately 4.5% of CR&D (including scrap metals) is currently diverted through existing programs. Due to the nature of CR&D waste, this waste stream is well suited to recycling initiatives; however, the waste stream is comprised of a variety of components (i.e. wood, metal, and interior and exterior building materials), which requires the waste to be sorted to make it suitable for reuse. Some of the CR&D waste is not reusable or recyclable due to size, condition, or other factors, and the only suitable option for this waste is disposal.

Several options were considered to increase the diversion of CR&D waste, which included:

- Promotion of sustainable policies including zero waste principles and extended producer responsibility (EPR). To explain further, the City would promote the use of Leadership in Energy and Environmental Design (LEED) construction and sustainable policies with CR&D projects, the preparation of a waste reduction plan for each project, or sorting the waste at the site prior to disposal (e.g. drywall from wood from metals). In addition, the City would try to promote deconstruction versus demolition thereby saving bricks, windows, doors, stair rails, mantels, and so forth for reuse in other homes. For EPR, the City would support using manufacturers and suppliers that are considerate of packaging and disposal requirements (e.g. use minimal recyclable packaging, biodegradable packaging);
- Including proper CR&D waste handling as a condition for construction, renovation and demolition permits. Once again, the City could promote careful deconstruction versus demolition of buildings through the requirement of a waste reduction plan in the building permit process;
- Establish and promote a reuse centre at the PCCWMF and promote the use of local reuse centres already established within the City; and,
- Provide CR&D waste collection for small amounts of residential CR&D waste for a fee, similar to the current large article collection system.

A program to manage CR&D should be prepared in conjunction with an overarching plan for management of waste generated in the IC&I sector. It is anticipated that enhancements to the CR&D program could result in an increase in the residential diversion rate of the City of 5.0%, assuming 100% capture. Implementation costs would involve policy development through building permits and enforcement protocols, as well as promotion and education materials, advertisements, and marketing materials. Operational costs would be staff time to enforce and monitor (audit) the collection and diversion of this waste type.

5.3.2.2 WASTE EXCHANGE/REUSE CENTRE

An effective way to minimize waste is to encourage reuse of products and materials that have not reached the end of their effective life. Currently, the City does offer “Reusable Exchange Weekends” on a monthly basis from May through September. Through this initiative, residents are encouraged to place usable items that are no longer wanted at the curb, where any passerby is able to select items for reuse, free of charge. It also encourages reuse through a Take It Back feature on its website and through periodic articles and promotions. None of these initiatives generate any quantitative data on the volume of material that is ultimately diverted, or at least postponed, from landfilling.

As previously mentioned, builders and home owners can integrate reclaimed wood during their renovations such as old doors, trim and flooring from the deconstruction of older homes. While one builder or home owner may not An example of a supplier for these materials is the ReStore in Peterborough and www.legacyvintage.com out of Cobourg, Ontario. The facility in Cobourg specializes in reuse and recycling of vintage homes and historical building components.

It is recommended that the City investigate the possibility of establishing a waste exchange and reuse centre at the existing PCCWMF for residents and the IC&I community to utilize. The City could possibly work with post-secondary institutions and/or local charitable organizations for the operation and management of the centre. Such a facility may be used as a central location for residents, or as a transfer station that is coordinated with a local community or not-for profit program such as Habitat for Humanity and Re-Store, the Canadian Diabetes Association, St Vincent de Paul or the Salvation Army as well as the Lakefield Animal Shelter and other private charity organizations. A permanent facility such as this would draw large numbers of users once people became aware of it, and larger volumes of materials would be diverted from the tip face. It would even be possible to quantify the amount, by having people weigh out their materials.

5.3.2.3 SSO COLLECTION

Organics typically make up about 37% of residential waste. The study entitled *Residential Waste Composition Study* (Ministry of the Environment, 1991) supporting this percentage is included for reference purposes in Appendix D. The organics waste stream is generally divided into two types: 1) leaf and yard waste and 2) food waste. The diversion opportunity analysis indicates that virtually all leaf and yard waste generated in the City is diverted through its Green Waste Collection program, which equates to 14.1% of all waste generated in the City. As there is a by-law in place to enforce the Green Waste program, it is anticipated that the capture rate will continue to be close to 100%. . It is in the area of food waste (SSO) where the City can realize the greatest potential for gains in diversion – approximately 17%, according to the diversion opportunity analysis in Table 4.

The City currently has a small pilot area where SSO is collected for composting. Some municipalities are working jointly with private companies such as Durham with Miller to collect and process their SSO materials. Other municipalities such as the District of Muskoka have their own compost facilities that they operate and process the SSO as well as leaf and yard and biosolids materials. Costs vary from municipality to municipality depending on the feedstock to be included in the program (biosolids, fats, oils greases (FOG)), what the end product is to be, what type of technology will be applied, the collection process, whether the residents will use green bins or bags, and so forth. Based on a study undertaken by FCM, collection costs are estimated to be approximately $100/tonne and processing costs range from $40 to $150/tonne depending on the complexity of the system.

To accommodate the processing of food waste, the City would require significant upgrades to its existing composting system. The use of alternate technologies, exploring public/private partnerships, or export of the SSO to a suitable processing facility in another jurisdiction would need to be investigated.

A comprehensive review and survey of Canadian SSO and household organics facilities was completed by the Recycling Council of Alberta (RCA) and Municipal Waste Integration Network (MWIN) in April 2006 (RCA & MWIN, April 2006). A component of that study was to estimate capital and operating costs for typical compost technologies. The RCA/MWIN study developed capital and operating costs based on the actual quantity of organics that may be generated within municipalities of various populations and on real data from operational facilities in Canada. Total costs for capital and operation of compost facilities ranged from $40 to $60 dollars per tonne per year ($/tonne/yr) for a turned windrow process and up to $100 to $150 /tonne/yr for an anaerobic in-vessel facility (RCA & MWIN, April 2006). These estimates exclude collection costs. Figure 2 illustrates the locations of current composting, waste management, and MRF facilities already approved and operating within the province in relation to the City of Peterborough.

Facilities Reference List

1	Navan Landfill	19	IMS Site
2	Ottawa Landfill	20	Halton Recycling
3	Eastern Ontario Waste Handling Facility	21	Gravenhurst Landfill Site
4	Algonquin Power Energy From Waste	22	Stisted (Muskoka) Landfill Site
5	Durham York Energy Centre	23	Rosewarne Landfill Site
6	Nepean Landfill (Closed)	24	Kingston Area Recycling Centre
7	Norterra Organics Processing Facility	25	Quinte Waste Solutions
8	Ottawa Valley Waste Recovery Centre	26	County of Northumberland MRF
9	Trail Road Landfill	27	Peterborough MRF
10	Leaf and Yard Waste Depot	28	Manco Recycling Centre
11	Clarington Compost Facility	29	Belleville MRF
12	Pickering Compost Facility	30	Renfrew MRF
13	Miller Leaf Composting Site	31	Wesleyville Recycling and Renewable Energy Facility
14	Dufferin Transfer Station	32	Halton Recycling MRF
15	Region of Peel Integrated Waste Management Facility	33	Orenda Recycling Centre
16	Kawartha Biogas	34	Columbus Recycling Centre
17	Lindsay Ops Landfill	35	Two-Tyme Recycling
18	Community Environmental Recycling Centre		

WASTE MANAGEMENT MASTER PLAN

Province of Ontario

Legend

- Available Landfill Site
- Composting Faciltity
- Energy from Waste Facility
- Material Recovery Facility
- Landfill/Composting
- Highway
- Water Area
- Provincial Park
- County Boundary
- Built-Up Area

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PROVINCIAL FACILITIES LOCATION PLAN

Project No.: 1965-001	Date: July 2012
Scale: 1:3,000,000	Projection: NAD 1983 UTM Zone 17N

Created by: SNS	Checked by: KSM	Figure: 2

5.3.2.4 PUBLIC SPACE RECYCLING

Consistent with the anticipated increase in diversion through continued promotion of the existing blue box program, providing recycling opportunities in public spaces would serve to further increase that diversion. The City has numerous parks and recreational areas that are widely used by residents and tourists alike. While some of these locations have already been equipped with designated receptacles for waste and recyclables, the majority of public spaces currently provide either only garbage collection or no collection at all.

Public space recycling is considered to be consistent with the best management practices target that was established and reported at the beginning of the Plan. A public space recycling program will help the City achieve the diversion target of 75% that it has set for the next 20 years. It also serves to reinforce the public's awareness of the importance that the municipality places on waste management and recycling.

Table 6 Diversion Program Enhancements – Summary of Strengths and Challenges

Option	Strengths	Challenges
New Markets for Diversion	• Increased landfill capacity • Increasing divertible material types will directly affect diversion rate • Positive public perception • Create niche job opportunities for processing and salvage	• Processing infrastructure required for some materials • Staff time • Costs for recycling
Waste Exchange / Reuse Centre	• Positive public perception • Win/win for public and City • Possibility to work with non-profit organization to offset costs	• Tracking impact of activities • Costs associated with implementing
SSO Program	• Large increase in diversion possible • Converted to a beneficial end product (compost) • Growing social acceptance	• High capital and operating costs • No policy to force participation • No local processing facility
Public Space Diversion	• Positive message to the public and visitors to the area • Increased diversion • Potential for advertising on bins for other diversion programs	• Initial capital costs • Staff time • Cross contamination

5.3.3 SYSTEM OPTIMIZATION

The waste services currently provided by the City involve a number of optimization measures that make waste collection, disposal, and diversion convenient for residents, such as:

- a 24 hour recycling depot;
- a weekly two stream recycling program;
- a year round depot for all MHSW and WEEE; and,
- weekly leaf and yard waste collection (seasonal).

A number of options were reviewed that can be expected to further optimize services for residents, to increase participation in waste diversion initiatives, and to create cost efficiencies. Four options were chosen for further evaluation:

System Optimization	Objective Satisfied				
Strategy Enhancement Option	**1**	**2**	**3**	**Diversion Potential**	**Ranking**
Pick-Up Frequency and Collection Optimization - Implement bi-weekly pick-up of garbage once an SSO program is established (weekly collection of organics)	✓	✓	✓	3%-7%	1
Regular Waste Audits - Complete waste regular waste audits to confirm composition, identify problem areas and to determine available material for recovery.	✓	✓	✓	N/A	1
True System Costs - Complete waste flow and full-cost accounting tools using gap or similar analysis, to show where best savings can be found through diversion.			✓	<1%	3
Waste Management Utility - Explore the possibility of a waste management utility, whereby all waste management activities are operated and funded as a separate utility.			✓	<1%	3

Note: Objectives are 1) Maximize Diversion; 2) Minimize Generation; and, 3) Fiscally Responsible

The full list of options that were evaluated are included in Appendix C and will be reviewed annually by the City as environmental, financial, and political conditions change and impact the needs for different strategies.

Following the evaluation process, it was concluded that modifying the pick-up frequency and completing regular waste audits are the most suitable options in the short term to optimize current and future waste management in the City. A summary of the strategies is included in Table 7.

5.3.3.1 PICK-UP FREQUENCY AND COLLECTION OPTIMIZATION

The current weekly collection frequency of waste is adequate for the City, based on the diversion programs that are presently offered. If the City implements curbside collection of SSO, the collection frequency should be reviewed and modified to optimize participation in this program. The two stream recycling collection and SSO collection should both occur every week. These diversion programs combined should leave very little else in the garbage stream of participating residents, thereby making bi-weekly garbage collection viable. The less-frequent collection of garbage would further encourage participation in the diversion programs.

In most municipal waste management systems, the collection of waste and recycling is the most expensive aspect. A 1995 study undertaken by the Solid Waste Association of North America (SWANA) indicates that about 50% of waste management costs are incurred through collections (SWANA, 1995). Modifying the pick-up frequency has successfully improved the level of participation in diversion programs in other municipalities and has also reduced the costs of collection.

Some additional ways to improve and optimize collection include: routing optimization, using automated collection equipment and possibly modifying the types of collection vehicles to accommodate different waste streams and programs on the same truck.

5.3.3.2 REGULAR WASTE AUDITS

The City completed a full waste audit in 2006 and is undertaking an updated waste audit in 2012 to verify waste composition and diversion data. It is recommended that the City perform waste audits on a more frequent basis following the implementation of the options within this Plan, in order to determine if the recommended strategies are bringing the City closer to meeting the targets identified in Section 1.4.

> It is recommended that the City maintain ongoing seasonal waste audits to track the progress of the strategies to be implemented with the Plan.

Audits can be used to track the performance of the diversion strategies and programs recommended in this Plan, following their implementation. The audits highlight areas that should be targeted for increased P&E, based on observations of divertible materials that continue to be seen in the waste stream instead of the recycle stream. In this way, audits improve on the efficiencies of waste collection and processing by confirming that only residues and unmarketable material are shipped to the PCCWMF. Conducting waste audits demonstrates the City's commitment to diversion and sustainability, and a desire to improve the performance of the waste system.

Table 7 System Optimization – Summary of Strengths and Challenges

Option	Strengths	Challenges
Pick-up Frequency	• Cost savings • Increased diversion	• Mixed public response to curbside collection • Long term implementation
Regular Waste Audits	• Document waste composition • Allow for accurate tailoring of P&E programs to target key materials • Measure success • Provide valuable feedback	• Staff time • Voluntary participation • cost

5.3.4 MULTI-RESIDENTIAL RECYCLING AND DIVERSION

O. Reg. 103/94 requires any owner of a building containing six or more residential units to implement a source separation program for waste, provided that the building is located within a municipality with a population greater than 5,000 persons. If these buildings are located in a municipally serviced curbside collection area, such as the City of Peterborough, the municipality is responsible for the collection of the waste. Research has shown that many building owners that are obligated to provide source separation programs are unaware of the requirements of O. Reg 103/94 (KPMG, 2007); therefore, an effective P&E campaign directed toward multi-residential property managers could go a long way toward increasing waste diversion rates from this sector.

Even established multi-residential recycling and waste diversion programs throughout the Province face a number of cultural and structural challenges not experienced by curbside programs. The result is poor recycling participation and waste diversion rates from multi-residential buildings. In general, reasons for low waste diversion rates have been linked to language barriers, transience, lack of ownership, peer pressure/anonymity, inconvenience, material contamination, lack of financial incentives, lack of support by building management, and ineffective existing infrastructure (GENIVAR, May 2010).

A list of options for the multi-residential sector was reviewed, and five options were selected for further evaluation, as identified in the table below. All other options reviewed are included in Appendix C for future consideration. Waste management legislation, social acceptance, environmental conditions, and financial implications all change; with these changes, the City will need to re-evaluate the Plan regularly. A summary of the strengths and challenges is included in Table 8.

Multi-Residential Recycling and Diversion	Objective Satisfied				
Strategy Enhancement Option	**1**	**2**	**3**	**Diversion Potential**	**Ranking**
SSO Collection - Establish a Green Cart collection for SSO in MR buildings so service consistent with SF households (Phase 2 of SSO Program)	✓			2% to 3%	1
Multi-Residential Working Group - Establish a Multi-Residential Working Group with City and superintendent reps that meets on a regular basis to discuss waste diversion challenges and strategies	✓	✓	✓	<1%	2
Feedback to buildings - Provide feedback to residents on how their particular building is doing (using graphics, etc.)	✓			<1%	3
Designated goods diversion (e.g. Electronics, batteries, textiles) Establish specific collection programs in multi-residential buildings to divert designated goods for recycling/reuse	✓			1%	3
Waste diversion info provided to new and existing tenants - Establish protocol with building owners to provide waste diversion educational packages to new and existing tenants on an annual basis	✓			<1%	3

Note: Objectives are 1) Maximize Diversion; 2) Minimize Generation; and, 3) Fiscally Responsible

A single option was determined to be most suitable for implementation in the City at this time; SSO collection for multi-residential buildings. The City should include multi-residential buildings in the development of the SSO program such that all implications, including full financial and environmental costs and benefits, are accounted for when establishing the program. The program would require consultation with representatives on behalf of landlords and tenants, SSO green carts suitable for the various buildings within the City, as well as communication efforts and targeted P&E programs specific to the multi-residential housing sector.

It is generally recommended that the City include multi-residential developments in the P&E program, with a focus toward informing owners and property managers of obligations under O. Reg. 103/94 and outreach to residents with a demographically appropriate information package.

Table 8 Multi-Residential Recycling – Summary of Strengths and Challenges

Option	Strengths	Challenges
SSO Collection	• Could be included in the phased in development of City-wide SSO program • Large quantities of organics can be collected in one location • Positive public perception (equal services and requirements as single family households)	• Participation • Cross-contamination • Cost

5.3.5 POLICY AND ENFORCEMENT

The successful implementation of many of the diversion options presented in the Plan will be dependent on local, regional or provincial policy support, and local enforcement. Adequate staffing with trained personnel is critical to the enforcement of policies that will ensure efficiencies in procurement and contract management as well as operations and collections. Existing policies and enforcement enable the City to have the current impressive diversion strategies already in place; however, increased enforcement of key programs (CR&D, IC&I) will be required to meet the goals and objectives proposed within this Plan and to achieve the aggressive but achievable diversion targets.

Several policy based approaches were reviewed to encourage participation in the blue box program. Participation in the blue box program is already high; however, policy approaches considered to further increase participation included clear bags for garbage, a bag-tag system, landfill/disposal bans, and the enforcement of mandatory recycling and source separation by-laws (materials bans). Sustainable procurement programs and policies were also explored as options to increase the diversion rate.

The policy and enforcement options evaluated are provided below.

Policy and Enforcement	Objective Satisfied				
Strategy Enhancement Option	**1**	**2**	**3**	**Diversion Potential**	**Ranking**
Stronger enforcement of Landfill/Disposal Bans - Designated materials are prohibited from being disposed at the landfill or disposal facility	✓			1% to 2%	2
Stronger Enforcement of Curbside Bans and lift limits at the curb	✓	✓		<1%	2
Green Procurement and Sustainable Procurement Programs within the City - Develop a corporate policy that encourages green procurement (work with Sustainable Peterborough policies)			✓	<1%	2
Joint Procurement Policy with other municipalities - Wherever feasible, consider making joint purchases with other neighbouring municipalities to take advantage of volume discounts			✓	<1%	2
Bag-Tag/Pay-as-you-throw - Financing strategies used to promote waste diversion including full or partial Bag Tag systems, variable and hybrid variable rates, pay by collection frequency, variable carts rates, weight-based garbage collection, possibly supported by RFID technology	✓	✓	✓	1%-4%	3

Note: Objectives are 1) Maximize Diversion; 2) Minimize Generation; and, 3) Fiscally Responsible

The policy and enforcement initiatives considered during this review were not ranked in the top options for immediate action. The City already has mandatory recycling as part of its garbage collection, as well as landfill bans for specific materials. A reduced bag limit is recommended for consideration following the successful implementation of the SSO program. Enforcement of the bans and bag limits should be audited on a regular basis to ensure the bans and bag limits are being enforced and the message is clear and consistent.

The Bag-Tag/Pay-As-You-Throw option scored low in our ranking, due to a perceived reluctance by the public to accept a fee-for-service program. However, it is strongly recommended that variations on this theme be considered by the City. A bag-tag or clear bag system has been used in other municipalities with proven success at increasing diversion, and this is something the City may wish to explore in the future.

As previously noted in Section 3.1, the City enacted a by-law (Chapter 594 Garbage Collection) which defines green waste and recyclable material and stipulates that it is illegal to dispose of recyclables as solid waste. The City also developed bylaw 07-027 which clearly lists a number of materials that are banned from being disposed of as garbage at the County/City facility. Chapter 594 excludes several other materials from the definition of garbage. Copies of these by-laws are included in Appendix B for reference purposes.

Materials banned from disposal at the PCCWMF include:

- hazardous waste
- blue box materials
- clean wood waste
- drywall
- green waste (leaf and yard materials)
- scrap metal
- tires
- explosive or highly combustible material
- building materials
- automobile parts
- hot material
- industrial waste

> It is recommended that the City review and update its existing waste management bylaws.

"Green procurement" decisions include consideration of resource sustainability, environmental impact, waste reduction, and local production in municipal purchasing decisions. One option for green procurement is that of extended producer responsibility (EPR) and supporting legislative changes to endorse more EPR by reducing the amount of waste generated at source. The EPR framework assigns responsibility to producers to generate less waste materials including packaging, disposable items, and items that are not readily recyclable or disposed of. EPR means that product manufacturers are responsible for the full life cycle costs associated with their products including the environmental costs of production and managing the product at the end of its life, whether that be for reuse, for recycling, or safe disposal. Packaging bans, fees (such as for plastic bags), and levies have proven useful in motivating producers and consumers to reduce the generation of waste at the source, or at the point of purchase for some waste types.

Much of the waste managed by the City is produced outside the local area, and is transported into the City by commercial establishments, businesses, and residents in the form of various consumer products and packaging. In some jurisdictions in Ontario, political lobbying is being undertaken or considered to motivate the Government of Ontario to impose the principles of EPR on manufacturers and producers of products to reduce the volume of waste generated at the source of production.

Waste related impacts can be reduced through the implementation of other green procurement policies, such as making "green" purchasing decisions. For a product to be considered "green" it should be made from recycled or sustainable materials, have a limited amount of packaging, and be sourced as locally to the end use of the product as possible. Green procurement policies encourage product producers to use alternative sources of raw materials, such as recycled materials. In so doing, overall support to waste minimization and diversion measures is generated, by providing a market for the materials being recycled.

The City should consider implementing green procurement policies at municipal facilities, which would include the consideration for resource sustainability, environmental impact, waste reduction and local production in municipal purchasing decisions. Green procurement policies can include sourcing and using environmentally friendly products in the work place, such as natural cleaning supplies, biodegradable bags and 100% recycled paper.

To reduce the cost of these items, the City could initiate a purchasing partnership with a neighbouring municipality such as the County, to buy green products in bulk for a lower fee or reduced shipping costs. The City already has several joint purchasing policies in place and is seeking opportunities to increase purchasing efficiency through new partnerships.

The City should continue to enforce and implement policies for sustainability and has adopted the Sustainable Peterborough Plan which promotes the preparation of waste management plans and reduction policies in support of building permits.

5.3.6 IC&I WASTE RECYCLING AND DIVERSION

Statistics Canada estimates that approximately 67% of waste generated in Canada is from non-residential sources, which is consistent with the same statistical comparison for the Province of Ontario, where 66% of waste is non-residential (Statistics Canada, 2010). City staff reported that 57% of the waste stream for the City was from non-residential or IC&I in 2010. Given that such a significant percentage of all waste generated is from non-residential sources, it is imperative that waste management planning be cognisant of opportunities to increase waste diversion in the IC&I sector.

As noted by the Federation of Canadian Municipalities (FCM, March 2004), the majority of IC&I waste is composed of recyclable or compostable material, with 85% of the typical composition of waste comprised of mixed paper, corrugated cardboards, food waste, plastics, and ferrous metals. All of these materials are divertible, with the proper infrastructure in place. Assuming a capture rate of 85% for divertible IC&I materials, the City could expect to realize an overall diversion rate increase of 38% through waste diversion in the IC&I sector alone.

There are several policies and programs in place in Ontario which could target IC&I waste for increased diversion. Five regulations, referred to as the 3Rs Regulations, were made under the Environmental Protection Act in March 1994 to promote waste diversion among designated IC&I and CR&D generators:

- O. Reg. 101/94: Recycling and Composting of Municipal Waste; *amended by O. Reg. 251/11*.
- O. Reg. 102/94: Waste Audits and Waste Reduction Workplans; *No amendments*.
- O. Reg. 103/94: Industrial, Commercial and Institutional Source Separation Programs; *amended by O. Reg. 230/11*.
- O. Reg. 104/94: Packaging Audits and Packaging Reduction Workplans; *No amendments*.
- O. Reg. 105/94: Definitions (Amendments to Regulation 347); *amended by O.Reg. 234/11*.

These Regulations apply to IC&I waste generators, including: hospitals, hotels and motels, office buildings, restaurants, retail shopping establishments and complexes, educational institutions, manufacturing, and demolition and construction projects. The Regulations prescribe source separation requirements for businesses of different sizes and are mostly targeted toward large IC&I generators. Policies and programs should be considered to increase waste diversion for smaller businesses that are not required to comply under the Regulations. Some municipalities have had success in encouraging waste diversion from the IC&I sector by implementing by-laws requiring IC&I facilities to implement recycling programs.

With this in mind, it is recognized that the current level of staffing within the City's Waste Management Division would not be sufficient to implement, monitor or enforce IC&I diversion programs.

A short list of options were evaluated for improved diversion in the IC&I sector:

IC&I Waste Recycling and Diversion	Objective Satisfied				
Strategy Enhancement Option	**1**	**2**	**3**	**Diversion Potential**	**Ranking**
SSO Implementation - Implement a user-pay SSO program for IC&I sector (Phase 3 of SSO program)	✓			TBD	2
Build IC&I Database - Make database for use to manage and monitor solid waste programs	✓	✓			3
Designated goods diversion - Specific diversion programs established small IC&I to divert designated goods for recycling/reuse and expand to larger IC&I gradually.	✓				3

Note: Objectives are 1) Maximize Diversion; 2) Minimize Generation; and, 3) Fiscally Responsible

Based on the evaluation, all options were determined to be only marginally suitable for the City to pursue at this time. This WMMP is generally based upon the residential waste stream and detailed data on IC&I waste volumes and composition within the City is not known. It is recommended that further study of waste generated and disposed from the IC&I sector should be undertaken to determine current disposal and diversion rates.

While SSO implementation in the IC&I sector is not feasible at this time, this program could be extended to IC&I after it is developed and implemented for residential waste in the City. At that time, it is recommended that the City seek local and regional partners to develop a strategy for managing and handling divertible IC&I waste to realize some, if not all, of this potential diversion opportunity.

Some basic options that should be considered when planning for waste management related to IC&I waste include:

- Increase staffing levels;
- building an IC&I database to manage and monitor solid waste programs;
- enhancing the City's website with a section dedicated to IC&I waste management and diversion matters;
- developing a targeted P & E strategy for IC&I that would provide support and tools to generators on how to maximize recycling opportunities;
- implementing financial penalties for poor performance or failure to meet recycling or compostables targets;
- terminating waste collection and/or landfill service for failure to participate in the recycling program, or to meet identified minimum targets for waste diversion;
- promoting the diversion of designated goods (i.e. MHSW, WEEE, textiles) through the implementation of specific collection programs for small IC&I generators to divert such goods for recycling or reuse; and,
- requiring generators to complete and submit Recycling Plans to the City for review and approval.

5.3.7 ANTICIPATED DIVERSION AND ASSOCIATED COSTS

There are many options available to increase waste diversion in the City and the list previously reviewed will provide the City with some flexibility to choose the most suitable options for their area.

Several key goals should be considered as the driving force for an increase in waste diversion, including;

- preserving waste disposal capacity at the PCCWMF and other active waste disposal sites;
- providing up to date and accessible services for residents;
- increasing the efficiency of the waste management system; and,
- generating opportunities for cost savings.

Table 9 below includes a list of the preferred waste diversion options, as determined through the evaluation of all options discussed in Section 5.3. The options have been ordered according to the projected implementation timeline (i.e. short, and long term) and then by greatest to least potential for increased diversion within their strategy grouping.

Table 9 Anticipated Cost and Diversion Rate Increase by Diversion Option

Strategy	Option	Increased Diversion Potential (%)	Annual Net Cost Per Household	Implementation Timeline
Promotion and Education (P&E)	Enhanced P&E	2% to 3%	\$2 to \$3[1]	S
	Staff Training	1%	\$0.5 to \$1[1]	S
Enhancement of Diversion Programs	SSO Collection	17%	\$20.00 [2]	S – M
	Establish New and Enhance Existing Markets	1% to 3%	TBD	S
	Waste Exchange/Reuse Center	1% to 3%	\$1.00 [3]	S – M
	Public Space Recycling	1% to 3%	\$2.23 [4]	S
System Optimization	Pick-Up Frequency and Collection Optimization	3%-7%	7% savings [5]	M
	Regular Waste Audits	N/A	\$1.79[6]	S
Multi-residential Recycling	SSO Collection	2% to 3%	\$0.67 [7]	M - L

Note: S = short term (1-2 years); M = medium term (3-5 years); L = long term (>5 years); TBD = to be determined

1. Based on discussions with the City

2. (Lura Consulting Inc., August 2007)

3. (Stantec, March 2011a)

4. (Urban and Environmental Management Inc., February 2012)

5. (2cg, October 2011)

6. Based on waste audit cost data provided by the City of Peterborough.

7. (Stantec, June 2010)

5.4 DISCUSSION OF WASTE DISPOSAL OPTIONS

The City is currently focusing significant effort on increasing waste diversion in order to extend the life of the current landfill and improve upon the amount of air space remaining. Notwithstanding this effort, waste continues to be generated and the City is aware that they need to start assessing alternatives for waste disposal while pursuing aggressive waste diversion targets.

As part of the public consultation process for this Plan, a survey was distributed to residents on the City website and at PICs to determine the public opinion on the preferred waste disposal method for the City. The following two notable comments on waste disposal were provided from the City's survey:

- 59% of respondents are very concerned about potential impacts of landfilling waste, including; groundwater, biological, and surface water impacts, as well as odours and air emissions.
- The public identified that the top five criteria to evaluate future waste management options should be: positive environmental effects; positive social impact and acceptability; proven technology; cost/affordability; and, ease of implementation.

The general public also indicated that they wanted to see an increase in diversion. Accordingly, the City views diversion as the primary goal, but disposal will always be a vital and important component of the future waste management system.

The PCCWMF will continue to provide waste disposal capacity for the County and City for approximately 12 to 15 years (from January 2011) based on an assumed annual waste disposal rate of 60,000 tonnes (City and County combined) and an assumed apparent waste density of 0.65 tonnes/m^3 (Genivar and Urban & Environmental Management Inc., 2011). The assumed annual waste disposal rate noted above includes waste from all sources, including residential and IC&I waste.

To prepare for filling the existing disposal capacity at the PCCWMF, the City will be required to complete an environmental assessment (EA) under the Environmental Assessment Act (EAA) to gain additional disposal capacity, or to manage residential waste in an alternative way (i.e. thermal treatment, anaerobic digestion). The City intends to move forward with the EA process in partnership with the County to determine the most suitable option for waste disposal for both jurisdictions into the future.

It is recommended that the City undertake a formal review of waste disposal technologies on a regular basis (i.e. every three to five years) as part of its solid waste management planning program, which will lead into the EA process.

Some of the options and technologies that currently exist and should be investigated in the EA process include:

1. Expanding capacity at current facility;
2. Developing a new landfill;
3. Anaerobic digestion (AD); and,
4. Thermal treatment.

Most of these waste disposal options would be subject to major studies, municipal and provincial approvals and possibly federal approvals. The intent of the studies and approvals is to make sure that the expansion or creation of a new facility, and subsequent operation, does not have a negative impact on the environment. Components of the environment considered in the required studies include natural, cultural, social and economic aspects. Significant supporting studies are prepared to assess potential impacts to the components of the environment, as presented above, which may result from each disposal option. Public and aboriginal consultation is a fundamental component of the EA process.

The following major studies and approvals would be required, at a minimum:

- An individual EA must be completed and then approved by the province under Part II of the EAA and Ontario Regulation 101/07 Section 2(1)1; and,
- Approval under the EPA and Ontario Regulation 232/98, related to landfill site investigations and design.

In the case of waste disposal site expansions and new site development, the time required to complete an EA and obtain all of the necessary approvals is approximately five to eight years. Due to the considerable time commitment required to complete the EA and approvals process, it is recommended that the City work with the County to initiate the process within the next five years.

6.0 WASTE MANAGEMENT PLAN IMPLEMENTATION

Key targets have been developed, which will serve to help the City reach their goals and objectives, as identified in Section 1.4. As a review, the key targets are as follows:

KEY TARGETS

- Expand the number and type of education and outreach and/or partnership activities year over year from 2010 levels.
- Meet all eight Waste Management Best Practices as outlined in the Blue Box Program Enhancement and Best Practices Assessment Project Report, 2007, prepared by KPMG LLP, a Canadian advisory services firm (as outlined in Section 1.4).
- Residential diversion rate will increase from 2010 level of 50% to 75% over 20 years, with a review of target every five years.
- Capture rates for blue box materials will increase 10% from 2006 levels (79.5%) over 20 years, with a review of target every five years.
- Participation rate of 50% in year 1 of the proposed SSO program with an increase for each year of the program.

The development of this Plan has included:

- review of the existing waste management system;
- identifying gaps in the current system, from infrastructure and operations points of view; and,
- evaluation of various options and strategies to improve the waste management system and remain in line with the key targets.

The Plan is a living document and, as such, the options and strategies should be reviewed annually with the key targets reassessed every five years to ensure that the City remains in line with the current regulatory and social circumstances, while meeting the needs of residents and those in the IC&I sector.

In this section, ongoing monitoring protocols are recommended to the City for the Plan to remain effective and relevant. There is a brief discussion of proposed community engagement, possible partnerships and ongoing collaboration, to ensure that the Plan is well received by waste system users. Suggestions on ways to review and assess the progress and success of the implementation of the programs identified in the Plan are provided.

The City has identified some methods to move toward Green Economic Development, with guidance from Peterborough Green Up initiatives and the Sustainable Peterborough Plan, and some of these ideas are promoted through this Plan. As the provincial and federal governments take greater interest in municipal waste management, more options may become available for the City to work with these levels of government for additional economic development strategies.

6.1 MONITORING AND IMPLEMENTATION SCHEDULE

It is recommended that an annual review of the proposed diversion strategies and the list of diversion options available to the City (as provided in Appendix C) be undertaken. Every five years, it is recommended that the City undertake a detailed assessment of the goals, objectives and key targets as future social, environmental and regulatory environments may or may not be applicable to the original targets established upon commencement of the planning process.

Ongoing monitoring of the progress of this Plan is proposed as follows:

- feedback from online surveys;
- feedback from public events;
- feedback from operations and contract staff; and
- waste audits conducted regularly.

An implementation schedule should be developed by the City to ensure that the steps taken to develop and execute the Plan are making the intended impact.

6.2 COMMUNITY ENGAGEMENT

There are many methods that the City can adopt to involve and engage the community in the implementation of this Plan. With the planning process that accompanied the preparation of this document, City and Cambium staff were involved in presenting to the public via newspaper ads, radio advertisements, and online surveys and through two public information centres. There has been an increasing trend in participation in waste management planning among major stakeholders and public infrastructure development in recent years. The City is aware of this increased interest, and has been looking at ways to embrace this change.

The following four steps will be used to engage the community in the adoption and implementation of this Plan. The success of reaching the goals and objectives outlined in the Plan is contingent upon a high level of participation from the community, including the public, municipal partners, and the IC&I sector.

6.2.1 INFLUENCE AND INFORM

Some governments have been utilizing the "community engagement ladder" and with each government and individual department, this ladder varies but generally stated this term means, "*if you give a person the tools necessary to make an effective and informed decision, they will make the legitimate choice*". The City is able to influence or inform the members of the public and affected community through the use of various tools, including:

- media management,
- advertising;
- new social media websites;
- public events; and
- seminars.

The purpose of informing and influencing the stakeholders would be to provide them with the necessary information to increase their awareness of a specific program (e.g. SSO program, enhanced diversion, or CR&D diversion) or with general knowledge to influence their use of the system (e.g. informing residents of the issue of blue box materials contamination).

Educational or one-way campaigns would be recommended for new enhanced diversion programs such as adding textiles to the recycling or asphalt shingles. For large scale new programs or waste system modifications, such as SSO or possibly the development of a new facility to manage the organics stream, the City would require a more in-depth approach such as the consultation process discussed in the next section.

6.2.2 CONSULT AND INVOLVE

By consulting and involving major stakeholders, and/or residents and members of the public, the City is able to fully appreciate and understand the issues, concerns and values presented. The consultation approach is normally practiced when there are issues that may involve perceived uncertainties or gaps in truth that need to be clarified by City staff, or in instances involving technical information that needs to be presented to the public and stakeholders in layman's terms. Areas of concern and stakeholder values and questions are constructively discussed between the City and respective parties through workshops, public information centres, surveys and committee meetings.

6.2.3 PARTNER AND COLLABORATE

In some large projects, municipalities have selected to use a collaborative approach which involves cooperation between major stakeholders, operations staff, senior management and consultants. This approach, which is referred to as "value engineering", is a worthwhile tool that enables the City to meet with interested parties to find common ground at various stages of a project. By partnering and collaborating with the community on larger projects and possibly establishing a committee to achieve this, all parties are represented and it becomes a consensus decision making process.

As previously noted in Section 1.1, the City shares waste management services with the County and, as such, should consider partnership and collaboration with the County with any future waste management planning strategies. Currently, the City has an ongoing relationship with the County through the ongoing management of the PCCWMF, use of the MRF, and provision and promotion of diversion programs. It is recommended that the City continue with the current relationship and look for opportunities to collaborate with the County on other waste management strategies in the future.

Community partnerships and collaboration are also possible. An example of a community based partnership is to encourage and facilitate diversion and reuse among the large student population in the City. It is recommended that the City work with the post-secondary institutions by establishing a working group to find efficient and economical solutions to reuse and recycle the items that are currently tagged and disposed of. It should be noted that there are funding opportunities that may exist for collaboration of this type, which are further discussed in Section 6.5.

6.2.4 EMPOWER

Through a community engagement and consultation process, the City ultimately provides the residents and community with the tools necessary to act responsibly and decide through their actions what the future of waste management will be and how they can impact decisions in the years to come. The residents need to be involved and actively participate today in order to minimize costs, financially and environmentally, for the years to follow. The City can influence and inform, consult and involve, partner and collaborate, but the residents have the ultimate power to make the changes necessary.

6.3 GREEN ECONOMIC DEVELOPMENT

As recently seen and heard in the newspapers and on television reports, the Province of Ontario is proposing to move towards a zero waste future. Initiatives will be introduced to aid in the reduction of solid waste, increase diversion and to build a more green and sustainable economy through the Green Energy Act. The recommendations made in this Plan are consistent with these initiatives, and support moving toward a zero waste future.

The City can use this Plan, and the recommendations proposed within, as a starting point to build their economic development plan. The green and sustainable options selected through the development of this Plan will create jobs, reduce disposal costs, and will possibly have a positive payback for the community turning what typically would be deemed a liability into an asset.

6.3.1 JOB CREATION

With the proposed waste diversion and management options outlined in this Plan, several new job opportunities will be created. For example, the proposed facility for organics processing, reuse centre and possible option for increased diversion of CR&D materials will create a minimum of one position for each option discussed, be it through policy and enforcement, promotion and education staffing, or directly at the new facilities in operations. A recent report completed by Lura Consulting (2010) indicates that the biggest source of job creation and further economic spin-off for the community would be realized by supporting provincial EPR programs and the reduction and recycling of CR&D materials.

6.3.2 FINANCIAL RECOVERY FROM DIVERSION

From a financial outlook, by diverting more materials as proposed in Section 5.3.2, the City will be maintaining the waste disposal capacity available at the PCCWMF for disposal of non-recyclable, non-reusable or non-divertible material. The increased diversion will save the City funds over the long term by postponing the capital investment required to obtain approvals for a new waste disposal option before the capacity at the existing facility is depleted. The potential sale of reuse material and the new markets identified for sale of divertible materials (e.g. recyclables, CR&D) may also provide additional financial support to the City. Funding opportunities for the development of a reuse centre may exist with the federal or provincial government. While no financial gain is necessarily implied, there could also be green economic benefit by collaborating with the post-secondary institutions in the City for reuse strategies.

In addition, cost savings could be realized through the development and implementation of a new facility for organics processing, be it composting, anaerobic digestion or thermal treatment, from which energy could be generated and used internally or sold, as discussed in the following section.

6.3.3 ENERGY PRODUCTION

Some composting systems have been adapted to collect heat from the organic material during the composting and curing process as a source of renewable energy. Heat capture is achieved through glycol, air or water and can be used to generate energy from compost. Captured heat could be used for direct heating of on-site buildings or for generation of electricity for other uses. This type of system should be considered when SSO collection begins.

Advancements in composting mixed materials have been made in recent years, and studies are currently being done on processes that involve the combination of SSO; leaf and yard waste; fats, oils and greases (FOGS) from IC&I; as well as biosolids and septage. Due to the recent advancements in this area, this system is an available option for processing organics for the City.

Other technologies such as anaerobic digestion (AD)and thermal treatment of waste are also options to be considered. Establishing an AD facility directly at the wastewater treatment facility is an option that could be explored, such that the biosolids haulage is eliminated from the financial statements, saving the City a tremendous amount in operating costs. A facility of this type is able to process SSO including pet waste as well as FOG. A new AD facility would be a large capital expenditure but would also create new jobs that would be sustained into the future.

The various forms of thermal treatment available are changing rapidly and the technology is improving each and every day. The ability for a municipality to financially justify constructing a thermal treatment facility is getting better with changes to government funding and legislation. Depending on the thermal treatment method selected, the City could process all organic waste and create many new jobs as well.

Both AD and thermal treatment would create energy which would off-set the capital and operating costs of these facilities and provide the City with a return on investment. The provincial government is highly supportive of green energy, as promoted through the Green Energy Act and feed-in-tariff (FIT) program.

6.4 MEASURING SUCCESS

At the present time, the City does not have dedicated staff to monitor and measure the performance of each aspect of the waste management system. Ideally, the City would be able to designate a staff member to review all waste audit information, complete the WDO datacall reports, and review and track waste disposal and diversion reports submitted by the collection and processing contractors; all of which would indicate how the programs are performing. The program's effectiveness can be measured by reviewing the following:

- Waste diversion rate which is to increase from 50 to 75% over 20 years (by 2030);
- Capture rate for blue box material which is to increase by 10% from 2006 values;
- Disposal tonnage actually received at the PCCWMF; and
- Per capita waste generation rate (residential).

It is recommended that the City consider conducting a review of staffing requirements to accommodate the monitoring and tracking of the proposed strategies and options as outlined in the Plan.

6.5 FUNDING PROGRAMS

There are several opportunities available to municipalities for funding, and each opportunity or initiative has specific deadlines and requirements. Some of these initiatives may not be directly relevant to the City at this time; however, one or more of these programs may be applicable and relevant for collaborating with a post-secondary institution or establishing a public/private business partnership.

FCM Green Municipal Fund: Offers a range of resources and services that specifically address the sustainable community development needs of municipal governments. The Fund provides financing and knowledge to support the development of communities that are more environmentally, socially and economically sustainable.

Building Canada Fund: The Building Canada Fund in Ontario is a result of the Building Canada Infrastructure Framework Agreement signed between the governments of Canada and Ontario on July 24, 2008. This agreement represents more than $6 billion in joint federal and provincial funding to help address infrastructure needs and priorities across the province. The priority funding categories for the Fund are Core National Highway System (NHS) routes, drinking water, wastewater, public transit and green energy. Other eligible investment priority areas include environmental projects (solid waste management), projects that support economic growth and development (short-line rail and short-sea shipping, connectivity and broadband, tourism and regional and local airports), as well as projects that contribute to the ongoing development of safe and strong communities (disaster mitigation, culture, sport, local roads and bridges, and brownfield redevelopment). Funding is used to support public infrastructure owned by provincial, territorial and municipal governments and entities, as well as private industry, in certain cases.

Eastern Ontario Development Program: Promotes socio-economic development in Eastern Ontario by creating, building and developing the necessary conditions to increase business and employment opportunities in the region.

Investing in Business Innovation: Boosts private sector investment in start-up businesses to accelerate the development of new products, processes and practices and to bring them to market. Funding is also available for angel investor networks and their associations to attract new investment and support the growth of angel investment funds.

Technology Development Program: Supports research and innovation organizations, the private sector, post-secondary institutions and not-for-profit organizations to work together to accelerate the development of large-scale, advanced technologies that will result in new market opportunities for southern Ontario businesses.

7.0 KEY RECOMMENDATIONS

The City currently has a very successful waste management diversion program in place with the achievement of over 50% diversion. This Plan was commissioned to proactively investigate additional options and strategies to move toward improving the diversion from 50% to 75% over the next 20 years. This target is very aggressive, yet the review of waste composition and the potential gains from program enhancements completed in the development of this Plan have shown 75% to be an achievable target for the City.

It is important to note that the WMMP is a living document and the key recommendations and strategies are meant to be reviewed and adjusted according to current trends in governance and social behaviours. It is recommended that the City completes a review of the goals, objectives and targets every five years to ensure that they are still representative of the current needs of the City and its residents.

The following list details the key recommendations and findings as supported throughout the report.

7.1 DIVERSION

The top nine diversion options listed in the following Table 10 were identified through this study, as explained in Section 5.3. These are felt to be the best options to implement at this time, in terms of diversion potential, economic viability, and social acceptance. These recommendations are provided in the order of most diversion potential to least diversion potential.

In addition to the nine key recommendations in Table 10, the City would be well advised to consider these additional recommendations as noted throughout the plan:

- Develop a working group with landlords and tenants to assist with P&E and aid in the development of SSO programs and other programs currently in place for multi-residential recycling (see Section 5.3.4);
- Review and update the current waste management by-laws (see Section 5.3.5);
- Review staffing requirements to accommodate diversion programs for the development, monitoring and enforcement in the IC&I sector given that the City could expect to realize an overall diversion rate increase of 38% through waste diversion in the IC&I sector alone (see Section 5.3.6);
- Continue to investigate joint initiatives with surrounding municipalities and other organizations (see Section 6.2.3);
- Review staffing requirements for the waste management division (see Section 6.4); and
- Investigate and review opportunities available to the City that may align with certain new and existing funding programs for municipalities (see Section 6.5).

Table 10 Summary of Key Recommendations - Waste Diversion

Item #	Recommendation	Brief Summary	Increased Diversion Potential (%)	Timeline
1	SSO Collection and Processing – Enhanced Diversion	Implement the SSO Program for approx. $20.00/hh	17%	Short – Medium term
2	Establish New and Expand Existing Markets	New markets for: textiles, bulky items, asphalt shingles, pet waste, CR&D, and wood waste.	5% to 8%	Short term
3	Pickup Frequency and Collection Optimization	With new software and routing, the City could realize 7% savings annually.	3% to 7%	Medium term
4	SSO Collection and Processing – Multi-residential	Implement the collection of SSO to the current program for $0.67/hh.	2% to 3%	Medium - Long term
5	Enhanced Promotion and Education	Increase the P&E budget to enhance programs by $2.00 to 3.00/hh.	2% to 3%	Short term
6	Waste Exchange/Reuse Center	Consider establishing at the existing PCCWMF for $1.00/hh	1% to 3%	Short – Medium term
7	Public Space Recycling	Public space recycling to assist with enhanced diversion for $2.23/hh	1% to 3%	Short term
8	Staff Training	Increase training budget for training of staff for $0.50 to $1.00/hh.	1%	Short term
9	Regular Waste Audits	Measure the success of the City’s waste diversion system for $1.79/hh.	N/A	Short term

Note: Costs referenced in Table 9.

7.2 DISPOSAL

The following Key Recommendations will bring the City closer to identifying the most suitable means of waste disposal once capacity is no longer available at the PCCWMF.

- Conduct a true cost analysis of the landfill operations at the PCCWMF (see section 3.2.2)
- Investigate Suitable Options for Future Landfill Capacity
    - Monitor existing landfill capacity, landfill expansions and potential greenfield locations over time to allow the widest selection of suitable options.
- Undertake a Formal Review of Waste Management Technologies (see Section 5.4)
    - The City should monitor the progress of alternative technologies such as thermal treatment, AD facilities, and other established technologies. The review should be focussed toward technologies that have been proven to be both cost effective and reliable in North American municipalities that are of a similar size as Peterborough.
    - Reviews should be completed on a regular basis (every 3 to 5 years).
- Commence an EA Process (see Section 5.4)
    - The EA process should be initiated in cooperation with the County in order to identify the most suitable solution for waste disposal.
    - It is recommended that the City initiate the EA process a minimum of 8 years prior to reaching capacity at the PCCWMF, to ensure that sufficient time is allocated for necessary supporting studies.

8.0 CLOSING

Please note that this report is governed by the attached Qualifications and Limitations. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned at (705) 742-7900 ext. 226.

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REFERENCES

2cg. (October 2011). *City of St. Thomas Integrated Waste Management Master Plan .*

2cg Waste Management Consulting Sevices. (2011). *A Waste Recycling Strategy for the City of Peterborough.*

Canadian Environmental Assessment Agency. (2011, 05 10). Retrieved 08 15, 2011, from http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=5BDC800F-1.

City of Peterborough. (2006). *City of Peterborough Waste Audit Report.*

City of Peterborough. (2011). *2010 Waste Diversion Ontario Municipal Datacall.*

FCM. (March 2004). *Solid Waste as a Resource Guide for Sustainable Communities.* Ottawa: Federation of Canadian Municipalities.

Forest Echo. (2011). *Utilizing Wood Waste From CR&D and Urban Forestry.* Ottawa: Forst Echo.

Genivar and Urban & Environmental Management Inc. (2010). *2009 Annual Monitoring Report, Peterborough County/City Waste Management Facility.*

Genivar and Urban & Environmental Management Inc. (2011). *2010 Annual Monioriong Report, Peterborough County/City Waste Management Facility.*

GENIVAR. (May 2010). *Maximizing Residential Waste Diversion in Connection with the Mayor's Tower Renewal Pilot Feasibility Study.* City of Toronto.

KPMG. (2007). *Blue Box Program Enhancement and Best Practices Assessment Project Final Report.*

Lura Consulting. (2010). *Identifying Opportunity in the Green Economy - Waste Industry.*

Lura Consulting Inc. (August 2007). *Owen Sound: Planning for Sustainability Long-term Waste Management Plan 2007-2031.*

Ministry of the Environment. (1991). *Residential Waste Composition Study.*

Ontario Electronic Stewardship. (n.d.). *Recycle Your Electronics*. Retrieved August 23, 2011, from Recycle Your Electronics: http://www.recycleyourelectronics.ca

Ontario Tire Stewardship. (2009). *Used Tires Program Plan.*

OTS. (2009). *Ontario Tire Stewardship*. Retrieved February 10, 2012, from https://www.ontariots.ca/?q=home

Plasco Energy Group. (2011). *A Partnership for a Zero Waste Ottawa*. Retrieved April 24, 2012, from http://www.zerowasteottawa.com

Proctor & Redfern. (December 1993). *Peterborough County/City Waste Management Master Plan.*

RCA & MWIN. (April 2006). *Municipal Solid Waste Options: Integrating Organics Management and Residual Treatment/Disposal.* Recycling Council of Alberta and Municipal Waste Integration Network.

Region of Durham and Region of York. (2012). *Durham York Energy Centre*. Retrieved April 24, 2012, from http://www.durhamyorkwaste.ca/

REIC Perth. (2000, November). Waste Composition Studies 2000 City of Peterborough. Ontario, CA.

Stantec. (June 2010). *Solid Waste Management Strategy - County of Simcoe.*

Stantec. (March 2011a). *City of Cornwall Solid Waste Management Master Plan.*

Statistics Canada. (2010, December 22). *Waste Disposal by Source, Province and Territory*. Retrieved April 27, 2012, from New Brunswick, Quebec, Ontario and Manitoba: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/envir25b-eng.htm

Stewardship Ontario. (2009). *Municipal Hazardous or Special Waste Program Plan.*

SWANA. (1995). *Integrated Solid Waste Management: Six Case Studies of System, Cost and Energy Use: Summary Report.*

Trow. (2010). *Guidebook for Creating a Municipal Waste Recycling Strategy.*

Urban and Environmental Management Inc. (February 2012). *City of Kawartha Lakes Growth Management Strategy and Municipal Master Plan Project.*

Waste Diversion Ontario. (2005). *Waste Electronic and Electrical Equipment Study.*

Waste Diversion Ontario. (2010, September 11). *Waste Diversion Ontario.* Retrieved January 28, 2011, from 2009 Blue Box Data by Municipal Group: http://www.wdo.ca/content/?path=page82+item35932

Waste Diversion Ontario. (2011). *2010 Waste Diversion Ontario Municipal Datacall - County of Peterborough.*

Waste Diversion Ontario. (2011, September 11). *Waste Diversion Ontario.* Retrieved January 28, 2011, from 2010 Blue Box Data by Municipal Group: http://www.wdo.ca/content/?path=page82+item35932

GLOSSARY OF TERMS

Adverse effect	One or more of the following: **(a) impairment of the quality, quantity, value or use of the natural environment;** **(b) injury or damage to plant or animal life, any person or property;** **(c) impairment of the health, safety or well-being of any person** **(d) rendering any property or plant or animal life unfit for human use; and** **(e) loss or changes to costs, revenues or economic opportunities for businesses and communities.**
Agricultural waste	Waste, other than sewage, resulting from farm operations, including animal husbandry and where a farm operation is carried on in respect of food packing, food preserving, animal slaughtering or meat packing.
Air	Open air not enclosed in a building, structure, machine, chimney, stack or flue.
Alternative method	Alternative methods of carrying out the undertaking are technically feasible and economically viable conceptual designs by which the undertaking could be implemented.
Alternative waste treatment	The processing of waste to recover resources and/or reduce its environmental impact.
Anaerobic digestion	A biological process using microbes to break down organic material in the absence of oxygen. Digestion takes place in an enclosed chamber, where critical environmental conditions (e.g., moisture content, temperature and pH levels) can be controlled to maximize microbe generation, gas generation, and waste decomposition rates.
Approval	Permission granted by an authorized individual or organization for an undertaking to proceed. This may be in the form of program approval, Certificate of Approval or Provisional Certificate of Approval.
Approved site or facility	A landfill site or waste management facility with a current valid Certificate of Approval.
Approved site or facility	A landfill site or waste management facility with a current and valid Certificate of Approval.
Aquifer	A geologic formation that is saturated with water.
Asbestos waste	A non-hazardous waste in solid or liquid form, originating from the removal of asbestos-containing construction or insulation materials (ACMs) or the manufacture of asbestos-containing products.
Ash	The non-combustible, solid by-product of incineration or other combustion process.

“At-source”	A waste minimization or management activity occurring at the source of waste generation.
Attenuate	To weaken, to lessen, to make smaller (e.g. to lower the concentration of a contaminant in ground water).
Background concentration	The amount of a chemical in the soil, groundwater, air or sediment in the environment that would be considered representative or typical of conditions in a given area or locality.
Backyard compost (BYC)	Composting of residential organic materials by a household, usually in the backyard. Generally considered a method of source reduction.
Bag tag	A clearly identifiable sticker approved for sale by resolution of the Council of the Municipality and used to indicate that a fee has been paid.
Baling	The process of compacting and binding mixed solid wastes to form a compressed block or bale.
Berm	In a landfilling site/facility, a narrow elevated earthen mound which surrounds the waste deposit area.
Best practices	Waste system practices that affect Blue Box and other recycling programs and that result in the attainment of provincial and municipal Blue Box and other material diversion goals in the most cost-effective way possible.
Bi-weekly collection	The collection of material set out at curbside one day every two weeks.
Biodegradation	A natural process of breaking down materials by decomposition/decay by the action of organisms.
Biogas	Gas formed during the anaerobic decomposition of organic material, mainly consisting of methane and carbon dioxide.
Biological treatment	A treatment technology that uses bacteria to process organic waste.
Biomass	Plant material, vegetation, or agricultural waste used as a fuel or as an energy source.
Bio-medical waste (BMW)	Waste products produced from healthcare premises such as hospitals, dispensaries etc. It is also known as Health Care, Medical or Clinical Waste.
Blue box	A plastic container, often blue in colour, for conveying acceptable recyclable materials. Also refers to a municipal curbside recycling program.
Bog	Wet spongy ground, a poorly drained usually acid area rich in accumulated plant

	material, frequently surrounding a body of open water, and having a characteristic flora (as of sedges, heaths, and sphagnum).
Borehole	A hole drilled or pounded into the earth that is used to determine soil, rock, and/or groundwater characteristics. A borehole can be used as a potable drinking water well, or as a groundwater observation/monitoring well.
Buffer area	The part of a landfilling site that is not a waste fill area.
Buy-back	A staffed facility that usually purchases post-consumer recyclable containers and materials, such as aluminum cans, glass, and newspapers from the public. May consist of mobile units. They seldom perform materials processing.
Canadian Council of Ministers of the Environment (CCME)	A council made up of environmental ministers from provincial and federal levels of government that proposed nationally consistent environmental standards and objectives to achieve high levels of environmental quality for waste management, air pollution and toxic chemicals across Canada.
Candidate site	A property identified as suitable for consideration as a potential site for a waste management facility.
Capture rate	The amount of materials recovered from the waste stream for recycling, typically measured in tonnes per person per year.
Cell	In respect of a landfilling site, means an area of a landfill that has been organized to receive waste and where to waste will be compacted and sealed by cover material so that the waste is not exposed to the atmosphere.
Centralized composting	A process using a central facility within a defined area to compost organic material.
Certificate of Approval (C of A)	A license or permit issued by the Ministry of the Environment for the operation of a waste management site/facility.
"Clean" recyclable or compostable material	Material collected in a source-separated program, where contamination is minimal.
Cleanfill	Clay, gravel, sand and soil that is not mixed with any waste or organic material and has been excavated from areas that are not contaminated with manufactured chemicals. This material is sometimes referred to as virgin excavated natural material.
Co-collection	The collection of recyclables and organics together with municipal garbage in one truck; separated later for recycling and composting/digestion or disposal.
Coefficient of variation	A statistical measure which permits a comparison of the amount of variation within sets of sample results which have different means. It is calculated by expressing the

	sample standard deviation as a percent of the sample mean.
Collection	The process of picking up waste, recyclables, or compostable material from a household or business.
Commingled	Recycling programs where a number of different materials are mixed together, not collected separately.
Commingled recyclables	Materials recovered from the waste stream for recycling which are dry (e.g. paper, cardboard, plastic, glass)
Commercial waste	Waste originating from commercial businesses, and includes asbestos waste.
Commingled containers	Mixed food and beverage containers, usually plastic, metal and glass.
Community recycling centre (CRC)	A waste management facility that offers waste management services to small businesses and residents. A CRC is a place to drop off items such as electronics, white goods, household hazardous waste, leaf and yard waste, and blue box recyclable items.
Compactor vehicle	A collection vehicle using high-power mechanical or hydraulic equipment to reduce the volume of solid waste.
Composite liner	A liner system for a landfill consisting of an engineered soil layer and a synthetic sheet of material.
Composting	The controlled microbial decomposition of organic matter, such as food and yard wastes, in the presence of oxygen, into humus, a soil-like material. Humus can be used in vegetable and flower gardens, hedges, etc.
Composting facility/site	A facility/site licensed to process organic (i.e. plants) waste to produce compost
Construction, renovation & demolition waste (CR&D)	Solid waste produced in the course of residential, commercial, industrial, or institutional building construction, demolition or renovation (e.g. lumber, concrete, brick, plaster, glass, stone, drywall, wire, paint, etc.)
Contaminant	Any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of these, resulting directly or indirectly from human activities that may cause an adverse effect.
Contaminant attenuation zone	A portion of land that is located adjacent to a landfilling site, and is in the subsurface or extends into the subsurface. An attenuation zone is used to or is intended to attenuate contaminants from the landfilling site.

Contamination	A chemical which is present in soil, water, air, sediment, or other material at a concentration greater than background, or which is not naturally occurring in the soil, water, air, sediment or other material.
Control order	A direction by the Ministry of the Environment requiring a person/organization to change an existing operation to minimize adverse effect.
Controlled dump	A planned landfill that incorporates, to some extent, some of the features of a sanitary landfill: siting with respect to hydro-geological suitability, grading, compaction in some cases, leachate control, partial gas management, regular (not usually daily) cover, access control, basic recordkeeping, and controlled scavenging.
Corporations supporting recycling (CSR)	A Canadian, not-for-profit, private sector organization that works in municipalities and industries to aid in developing sustainable municipal recycling and waste diversion systems.
Cover material	Material used in sealing waste cells in landfilling operations.
Criteria	Numerical values for the concentrations of chemical substances in soil, water, air, and sediments that relate to the suitability of a site, for specific uses and land-use categories.
Curbside recycling	A program whereby individual residents separate recyclable materials from general wastes, and place them at the curb in bundles or designated containers for collection and further processing.
Decommissioning	The activities associated with closing all or part of a facility (e.g. the removal of process equipment, buildings and accessory structures, and the remediation of the surface).
Digestion	The biochemical decomposition of organic matter.
Deposit/refund system	Systems to collect fees on items when sold; fees are reimbursed when the used product is returned.
Design and operation (D&O)	A document (plan/report), required for obtaining a Certificate of Approval, which describes in detail the function, elements or features of a landfill site/facility, and how a landfill site/facility would function including its monitoring, and control/management systems.
Design capacity	The total volume of waste that has been calculated as having the potential to be disposed of at a landfill site for a particular landfill engineering design. This is typically measured in cubic metres.
Discharge	A volume of groundwater, surface water or leachate flowing past a given point over a time period. This is typically measured in cubic metres per second.

Disposal	Final placement or destruction of wastes. Disposal is typically accomplished through use of approved sanitary landfills or incineration with or without energy recovery.
Disposal bans	Regulation prohibiting disposal of materials or products (e.g., yard waste, or lead-acid batteries) in landfills and/or incinerators; typically targets items that contribute substantial volume or toxicity to the solid waste stream.
Disposal facilities	Facilities for disposing of solid waste, including landfills and incinerators, intended for permanent containment or destruction of waste materials.
Diversion rate	A measure of the effectiveness/efficiency of a program aimed at diverting materials in the waste stream from disposal. This is typically measured in tonnes of waste diverted per person per year.
Drivers	Considerations such as legislation, regulations, policies and other influencing factors.
Drop-off/depot	Facilities (staffed or unstaffed) where the public brings recyclable materials, organics, or garbage for management by the municipality. Separate drop boxes may be available for different materials, such as newspaper, glass, or metal.
Dump	A waste disposal site where waste is deposited without cover material being applied at regular intervals (i.e. A site not approved to accept waste).
Ecological receptor	A plant or wildlife species that may be affected due to exposure to a contaminant.
Ecological/ environmental risk assessment (ERA)	A scientific method used to examine the nature and magnitude of risks from the exposure of plants and animals to contaminants in the environment.
Effluent	A liquid discharged into a surface water body, onto the surface of the land, or into the local sewer system.
Engineered facility	Anything man made that is intended to be a functional element or feature of a landfilling site for more than five years. The following things are examples of common elements or features of engineered facilities: • **berms,** • **drainage ditches,** • **liners,** • **covers,** • **pumps,** • **facilities to detect, monitor, control, collect, redirect or treat leachate, surface water or ground water, and** • **facilities to detect, monitor, control, collect, redirect, treat, utilize or vent landfill gas.**

End use	The use of the landfill after reaching its capacity. Determination of the ultimate end use of the Site will be addressed in consultation with the public and other stakeholders.
Energy recovery	The process of using wastes to generate energy, and can include capturing of methane gas from a landfill site.
Environment	As defined by the *Environmental Assessment Act*, environment means: (a) air, land or water, (b) plant and animal life, including human life, (c) the social, economic and cultural conditions that influence the life of humans or a community, (d) any building, structure, machine or other device or thing made by humans, (e) any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities, or (f) any part or combination of the foregoing and the interrelationships between any two or more of them.
Environmental assessment (EA)	A systematic planning process that is conducted in accordance with applicable laws or regulations aimed at assessing the effects of a proposed undertaking on the environment. Includes evaluation of need, alternatives, impacts, and mitigative, remedial, monitoring and/or compensatory measures.
Environmental audit	A systematic process of objectively evaluating the degree to which an activity or undertaking is consistent with established criteria. These criteria are typically derived from a company's policies, procedures, and practices put into place to safeguard the environment. May also include health & safety practices, training, waste management, and transportation factors.
Environmental impact assessment (EIA)	An evaluation designed to identify and predict the impact of an action or a project on the environment, human health and wellbeing. It can include risk assessment as a component, along with economic and land use assessment.
Environmental site assessment (ESA)	A systematic process of determining whether a specific property is or may be subject to actual or potential contamination.
Evaluation criteria	Evaluation criteria are considerations or factors taken into account in assessing the advantages and disadvantages of various alternatives being considered.
Exports	In solid waste programs, municipal solid waste and recyclables transported outside the municipal jurisdiction or locality where they originated.
Exposure	Contact between a contaminant and an individual or population. The exposure may occur through pathways such as ingestion, dermal absorption (through the skin), or inhalation.

Extended producer responsibility (EPR)	A policy to shift the responsibility of a product's life cycle away from the municipality to the producers and to provide incentives for producers to consider the environmental impacts into the selection of materials and the design of the product.
Feedstock	The input material to be processed at a waste management facility.
Ferrous metals	Metals derived from iron or steel; products made from ferrous metals include appliances, furniture, containers, and packaging like steel drums and barrels. Recycled products include processing tin/steel cans, strapping, and metals from appliances into new products.
Fibre	Paper materials, such as cardboard, newsprint, and mixed papers.
Fill	Earth, sand, gravel, construction rubble, waste or any other material, originating on-site or off-site.
Fill area	In a landfill site, area receiving waste.
Flaring	The burning of landfill gas/methane captured and emitted from collection pipes at a landfill.
Flow control	Legislation that limits free market access to specific wastes and ensures their disposal at a particular processing or ultimate disposal facility.
Fluidized-bed incinerator	A type of incinerator in which the stoker grate is replaced by a bed of limestone or sand that can withstand high temperatures. The heating of the bed and the high air velocities used, cause the bed to bubble, which gives rise to the term "fluidized".
Fly ash	A highly toxic particulate matter captured from the flue gas of an incinerator by the air pollution control system.
Food waste collection	The collection of household organic waste such as food scraps and non-recyclable paper (tissues, paper toweling, etc.). It does not include yard waste. Food waste requires greater processing requirements than yard waste, so it is identified as a separate collection component.
Full cost accounting	Assigning all known waste management costs to the waste management program, including those shared with other operations or programs. May also be applied to landfills.
Garbage	Black/green bag or reusable container of waste set at the curb for disposal in the landfill. It has no practical or feasible further use; it cannot be recycled or biologically treated.
Grasscycling	Leaving grass clippings on the lawn and allowing them to decompose naturally instead of collecting them for composting, digestion, or disposal.

Green bin program	Diversion of organic wastes including food waste, non-recyclable paper and sometimes including diapers, sanitary products and pet waste. Term often used interchangeably with SSO.
Groundwater	Water beneath the earth's surface that fills underground pockets (known as aquifers), supplying wells and springs.
Half life	The time required for the concentration of a contaminant to diminish to half its original value.
Haul route	Public/private roadway(s) used by vehicles transporting waste to and from a landfill site.
Hazard	The adverse impact on health or property which results from the presence of, or exposure to, a contaminant.
Hazardous waste	Any residual hazardous materials which by their nature are potentially hazardous to human health and/or the environment, as well as any materials, wastes or objects assimilated to a hazardous material. Hazardous waste is defined by Ontario Regulation 347 and may be explosive, gaseous, flammable, toxic, radioactive, corrosive, combustive or leachable.
Heavy Metals	Metals of high atomic weight and density that are toxic to living organisms, such as mercury, lead, and cadmium.
Hierarchy (for waste)	A hierarchical method of solid waste management. The following practices are ranked in order of preference: source reduction; reuse; recycling; energy and material recovery; and landfill disposal.
High density polyethylene (HDPE)	A material used to make plastic rigid containers, milk and juice jugs, margarine tubs and detergent bottles. The plastic is translucent or opaque and does not crack when bent. Referred to as No. 2 Plastic.
Household hazardous waste	Substances labelled as corrosive, flammable, poisonous, or explosive originating from household use, which requires special handling for disposal.
Household waste (or domestic waste)	Solid waste composed of garbage and rubbish, which normally originates in a private home or apartment house.
IC & I waste	Waste originating from the industrial, commercial and institutional sectors.
Imports	Municipal solid waste and recyclables that have been transported to a jurisdiction or locality for processing or final disposition (but did not originate in that jurisdiction or locality).

Incineration	The use of solid waste as a fuel in a combustion process with the aim of reducing the volume of waste.
Industrial waste	Waste generated at an industrial operation; may be liquid, sludge, solid or hazardous waste.
Inert waste	Waste that is non-toxic, non-putrescible waste such as dirt, glass and wood that will not undergo any significant physical, biological or chemical changes once it is landfilled.
Inspection	Includes an audit, examination, survey, test and inquiry.
Institutional waste	Waste generated at institutions such as schools, libraries, hospitals, prisons, etc.
Integrated solid waste management (ISWM)	A strategic initiative for the sustained management of solid waste through the use of a comprehensive integrated format generated through sustained preventive & consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner.
Integrated waste management system	Waste composed of material other than plant or animal matter, such as sand, dust, glass, and many synthetics.
In-vessel composting	Composting involving a closed tank or unit with physical controls.
Lagg	The perimeter of the Mer Bleu bog
Land	Surface land, including all subsoil, which is not enclosed in a building or covered by water.
Landfill gas	The gases produced from the wastes disposed in a landfill; the main constituents are typically carbon dioxide and methane, with small amounts of other organic and odour-causing compounds.
Landfill mining	Materials are recovered from a landfill by excavation. Organic matter may be reused as a daily cover, and material, such as wood, metal, brick, plastics and glass, may be recovered and recycled.
Landfill site	An approved, engineered site/facility used for the long-term or permanent disposal of waste. See also “approved site or facility” and “engineered facility”.
Landspreading	A procedure whereby organic material is applied directly to land (usually agricultural) to improve the physical and chemical properties of soil.
Leachate	Liquid that drains from solid waste in a landfill and which contains dissolved, suspended and/or microbial contaminants from the breakdown of this waste.

Leachate pond	A pond or tank constructed at a landfill to receive the leachate from the area. Usually the pond is designed to provide some treatment of the leachate, by allowing settlement of solids or by aeration to promote biological processes.
Leaching	The process by which contaminants in the soil or wastes are dissolved and/or removed by water percolating or filtering through the soil.
Leaf & yard waste	Refers to leaves, grass, weeds, trimmings, brush, and woody materials (twigs, branches, etc.).
Liner	A protective layer, made of soil and/or synthetic materials, installed along the bottom and sides of a landfill to prevent or reduce the flow of leachate into the environment.
Litter	Any material left or abandoned in a place other than a receptacle or place intended for receiving such material.
Magnetic separation	The use of magnets to separate ferrous materials from mixed municipal waste stream or mixed recyclables stream.
Mandatory separation	A regulation requiring waste generators to separate designated recyclable or compostable materials from the waste stream for recycling.
Manual landfill	A landfill in which most operations are carried out without the use of mechanized equipment.
Manual separation	At a materials recovery facility, the separation or sorting of different materials in the waste stream by hand. Also referred to as hand sorting.
Markets	Persons, corporations, organizations or partnerships willing to purchase or accept in exchange for a fee, recyclable material processed through or at a recycling facility.
Market development	Policies or measures used by organizations or governments to stimulate demand for secondary materials (i.e., procurement policies, regulations, or mandated recycled content).
Massburn incinerator	A type of incinerator in which solid waste is burned without prior sorting or processing.
Materials recovery (or recycling) facility (MRF)	A facility where recyclable materials are processed through shredding, baling, pulverizing, separating, sorting, or otherwise treated or altered to facilitate further transfer, processing, utilization or disposal.
Maximum waste loading	For a landfilling site, the total waste disposal volume divided by the area of the waste fill area.

Mechanical separation	The physical separation of wastes by material type, size or density using trommels, cyclones, and various screens.
Methane gas	An odourless, colourless, highly-combustible gas often produced by the decomposition of waste in a landfill site. Methane is explosive in concentrations ranging from 5% to 15% by volume in air.
Microorganism	Any living organism that can only be seen with the aid of a microscope.
Mining	In a landfill, the excavation of previously buried waste to recover recyclable materials or soil for reuse.
Mixed MSW	A residual waste stream from the residential sector after some recyclables have been source separated. In some Canadian locations this stream is composted.
Mixed waste	Unsorted materials that have been discarded into the waste stream.
Mixed-waste processing	Through manual or mechanical means, some recyclable material is removed from waste. The remaining fraction may be used to make a fuel product, be composted, or both.
Modular incinerator	A relatively small type of pre-fabricated solid waste combustion unit.
Monitoring	A scientifically designed system of continued or periodic measurements or observations of environmental or operating conditions.
Monofill	A landfill intended for one type of waste only.
Multi residential buildings (MR)	Buildings which contain multiple self-contained residential dwelling units (typically greater than 6 units).
Municipal hazardous or special waste (MHSW)	Includes the following materials that are considered hazardous waste materials generated from the municipal sector (paints, solvents, adhesives, pesticides, acids/bases, aerosols, fuels and batteries). Also sometimes referred to as Household Hazardous Waste (HHW).
Municipal solid waste (MSW)	A waste type that predominantly includes household waste (domestic waste), except industrial and agricultural wastes, with sometimes the addition of commercial wastes collected by a municipality within a given area. The C & D debris and special wastes like hazardous wastes – usually not categorized under MSW - may also enter the municipal waste stream to an extent. It is sometimes also defined to mean all solid wastes that a city authority accepts responsibility for managing in some way.
Municipal solid	The controlled decomposition of municipal solid waste, including some form of

waste composting	preprocess to remove non-compostable material.
Natural environment	The air, land and water, or any combination or part thereof, of the Province of Ontario.
Non-ferrous metals	Non-magnetic metals such as aluminum, lead, and copper. Products made all, or in part, from such metals include containers, packaging, appliances, furniture, electronic equipment, and aluminum foil.
Non-hazardous waste	Non-hazardous wastes include all solid waste that does not meet the definition of hazardous waste and includes designated wastes such as asbestos waste.
Old corrugated cardboard	Bulky cardboard that is typically found in boxes used for shipping and packaging. It is made from two (2) strips of cardboard with a wavy, or "corrugated," strip running through the centre.
Ombrotrophic bog	A bog that receives most of its water and nutrients in the form of atmospheric precipitation.
On-site composting	Composting conducted at or near the (generation) source of the organic material.
Ontario electric stewardship (OES)	The Industry Funding Organization (IFO) for Waste Electrical and Electronic Equipment. Companies that are designated as stewards for Waste Electrical and Electronic Equipment can discharge their legal obligations under the Waste Diversion Act by registering, reporting and paying fees to OES.
Ontario tire stewardship (OTS)	The Industry Funding Organization established to develop a diversion program for Used Tires. Companies that are designated as stewards for Used Tires can discharge their legal obligations under the Waste Diversion Act by registering, reporting and paying fees to OTS.
Open dump	An unplanned "landfill" that incorporates few, if any, of the characteristics of a controlled landfill. There is typically no leachate control, no access control, no cover, no management, and many scavengers.
Operator	The person in occupation or having the charge, management, or control of a waste management system or a waste disposal site.
Organic waste	The organic fraction of the waste stream, consisting of material that is biodegradable, typically food, yard waste, and paper.
Overburden	The surface of the land which rests on bedrock, which consists of unconsolidated soil material.
Owner	Includes: **(a) a person that is responsible for the establishment or operation of a**

waste management system or waste disposal site, or
(b) the person that owns the land in or on which a waste disposal site is located.

Packer truck	Vehicle used for waste collection which compacts waste towards the rear of the truck.
Pay as you throw/User pay	A program in which every individual unit, bag or container set out for collection is paid for directly by the resident, commonly by the purchase of bag tags. Other examples of user pay systems would be the utility based system and the subscription based system.
Peripheral area	The area controlled by the site owner/operator between the property boundary of the waste disposal site and the actual fill area. This area may contain the buffer areas (as required). Together, the peripheral area and the fill area make up the waste disposal site.
Pest	Any injurious or noxious insect, fungus, bacterial organism, virus, weed, rodent or other troublesome plant or animal.
Pesticide	Anything that is designed to control, destroy, attract or repel a pest, typically in the form or a chemical, organism or device.
Pollutant	A contaminant other than heat, sound, vibration or radiation, and includes any substance from which a pollutant is derived.
Polyethylene terephthalate (PET)	A type of plastic that is clear or coloured transparent with high gloss. It is used for carbonated beverage bottles, peanut butter jars, and some household cleanser cleaners. Bottles have a raised dot on the base. PET is referred to as No. 1 Plastic.
Post-consumer materials	Materials that a consumer has finished using, and which may be sold, given away, or be discarded as wastes.
Practicable	Any action or activity that can be accomplished. Consideration is often given to the technical, physical and financial resources that are or can reasonably be made available.
Primary leachate collection system	A leachate collection system located below the waste fill zone.
Primary liner	The uppermost liner below the waste fill zone.
Private/self–haul	The waste generator (residence or business) can take garbage and recyclables to the waste facility directly or pay a private contractor to collect their waste materials.
Promotion and Education materials	Materials prepared and distributed by a municipality to help promote the proper participation in waste management and waste diversion programs.

Property value protection plan	Plan that addresses the potential effect of the landfill expansion on local property values.
Processing	Preparation of solid waste for sale to markets through such activities as hand sorting, magnetic and/or mechanical separation or shredding, composting, or digestion.
Procurement	The purchase of goods or services, usually by an organization or government. Procurement policies or regulations may establish requirements for purchasing goods that contain a minimum level of recycled content and/or are recyclable.
Putrescible waste	Waste containing readily degradable matter such as food or animal matter, including dead animals or animal parts, or unstable or untreated biosolids.
Pyolysis	The chemical decomposition of a substance by heat in the absence of oxygen, resulting in the production of various hydrocarbon gases and carbon-like residue.
Radiosonde	A miniature radio transmitter that is carried aloft (as by an unmanned balloon) with instruments for sensing and broadcasting atmospheric conditions.
Ramsar convention	Program which designates wetlands of international importance.
Receptor	The person, plant or wildlife species that may be affected due to exposure to a contaminant.
Recovery rate	Proportion of material recovered from the total waste stream.
Recyclables	Any material destined for recycling. In a curbside recycling program, includes materials such as: glass, metal food and beverage cans, aluminum foil, rigid shell plastic containers, newspaper, cardboard, fine paper, boxboard.
Recycling depot	A designated location within a municipality where recyclable material (Blue Box, organics, scrap metal, clean lumber, etc.) can be dropped off into segregated bins.
Release	Restoration of the land surface to a state appropriate for future use. Act of remediating may include: stabilization, contouring, conditioning, reconstruction and revegetation of the land surface.
Rendering	Processing of animal wastes at high temperatures to produce oil, fats, or animal feed.
Residential/Single family (SF) waste	Waste generated from single family households, considered a demographic group of residents spatially delimited physical structure.
Residual waste	Waste which cannot be reduced, reused or recycled further. It is also referred to as garbage, which must ultimately be disposed in a landfill site.

Restore the natural environment	When used with reference to a spill of a pollutant, means restored all forms of life, physical conditions, the natural environment and things existing immediately before the spill of the pollutant that are affected or that may reasonably be expected to be affected by the pollutant, and "restoration of the natural environment", when used with reference to a spill of a pollutant, has a corresponding meaning.
Reuse	The use of a product, such as a refillable beverage bottle, more than once, possibly with slight modification.
Risk management	The implementation of a strategy or measure(s) to control or reduce the level of risk that has been estimated by a risk assessment.
Rock	An aggregation of one or more naturally occurring minerals, typically two millimetres or larger in size.
Sanitary landfill	An engineered method of disposing off solid waste on land, in a manner that meets most of the standard specifications, including sound siting, extensive site preparation, proper leachate and gas management and monitoring, compaction, daily and final cover, complete access control, and recordkeeping.
Scrubber	An emission control device in an incinerator, used primarily to control acid gases, but also to remove some heavy metals.
Secondary leachate collection system	A leachate collection system located below the primary leachate collection system, intended as a back-up system.
Secondary liner	A liner located below the primary liner, intended as a back-up system.
Service area	The area from which a landfill site is allowed to accept waste materials for disposal or processing.
Service life	The period of time during which a properly maintained engineered facility will function and perform as designed.
Site life	The period of time during which the landfill can continue to accept wastes.
Site remediation	The treatment of a contaminated site by removing the contaminated solids/liquids or treating them onsite.
Site specific risk assessment (SSRA)	A scientific method used to examine the nature and magnitude of risks from the exposure of humans, plants and animals to contaminants in the environment at a specific site.
Soil	Unconsolidated particles smaller than 2 millimetres in size resulting from the breakdown of rock or organic matter by physical, chemical or biological processes, and includes foundry sand, and includes a mixture of soil and rock where fifty percent

or more by volume of the mixture is soil.

Source of contaminant Anything that discharges a contaminant into the natural environment.

Source reduction (also waste reduction at source) The conservation of materials and energy by preventing the formation of wastes such that no treatment, reuse, or disposal is required of excess or discarded materials. Source reduction is a subset of waste reduction.

Source separation The separation of materials suitable for recycling or composting from solid waste at the source of generation (e.g., households, businesses).

Source separated organics (SSO) This includes residential organic waste such as food waste and non-recyclable paper that is segregated for composting or other organic waste processing. Some municipalities have widened the definition of SSO to include diapers, sanitary products and pet waste.

Source separated recyclables (SSR) A system whereby residents store recyclable parts of the waste stream in a separate bag, box or bin at home, so that it is relatively uncontaminated when dropped off at the recycling centre or picked up at the curb.

Special wastes Wastes that are ideally considered to be outside the MSW stream, but sometimes enter it and must often be dealt with by municipal authorities. These include household hazardous waste, medical waste, construction, renovation and demolition debris, war and earthquake debris, tires, oils, wet batteries, sewage sludge, human excreta, stoichiometric condition slaughterhouse waste, and industrial waste.

Stakeholders Individuals or groups with a key involvement and other interested parties.

Stewards Businesses that produce or import products that are sold to consumers that include packaging and/or end of product life wastes.

Stewardship Ontario The Industry Funding Organization (IFO) established to develop diversion programs for both the Blue Box and MHSW Programs.

Substance Any solid, liquid or gas, or any combination of any of them.

Teratogenicity The ability of a chemical to cause a change in the normal development process of an unborn organism, resulting in permanent alterations in the biochemical, physiological or anatomical functions of the organism.

Thermal treatment Technologies that process waste using high temperatures to reduce the quantity of material requiring disposal, stabilize the material requiring disposal, and recover energy and potentially material resources.

Threshold The concentration or dose of a chemical above which an adverse impact can be expected to occur.

Total waste disposal volume For a landfilling site, the maximum volume of waste, including the volume of any daily or intermediate cover materials, to be deposited at the site in the fill area.

Toxicity The ability of a chemical to cause injury to humans or the environment. Acute toxicity occurs soon after exposure, while chronic reactions are experienced long after the exposure.

Transfer station Facility where material is transferred from collection vehicles to larger trucks or rail cars for longer distance transport.

Trommel A rotary cylindrical screen, typically at a downward angle, that separates the materials of different physical size. Trommel screens are used to separate mixed recyclables, municipal solid waste components, or to screen finished compost from window and aerated static pile systems.

Vectors and vermin Disease-carrying organisms such as insects, rodents, birds (especially gulls and crows) and other harmful or nuisance species (e.g. bears).

Vermicomposting Worms digest organic wastes.

Virgin materials Any basic material for industrial processes that has not previously been used, for example, wood pulp trees, iron ore, crude oil, and bauxite.

Volatilization The process by which a chemical converts from a liquid or solid phase into a gaseous phase and disperses into the air.

Waste Includes ashes, garbage, refuse, domestic waste, industrial waste, or municipal refuse and such other materials as are designated in the regulations.

Waste audit Exercise of determining the quantity and composition of waste which is disposed.

Waste composition The various component materials of the waste stream, typically described as a percentage of the entire waste stream by weight.

Waste disposal site Includes:

- **(a) any land upon, into, in or through which, or building or structure in which, waste is deposited, disposed of, handled, stored, transferred, treated or processed, and**
- **(b) any operation carried out or machinery or equipment used in connection with the depositing, disposal, handling, storage, transfer, treatment or processing referred to in clause (a).**

Waste diversion The redirection of generated wastes away from disposal through reuse, recycling, or recovery. It does not include source reduction.

Waste diversion credits	Financial incentive provided by municipalities to encourage or to reward waste diversion based on tonnage diverted from the waste stream.
Waste Diversion Ontario (WDO)	A non-crown corporation created under the Waste Diversion Act (WDA) on June 27, 2002. WDO was established to develop, implement and operate waste diversion programs for a wide range of materials (Blue Box Waste, Used Tires, Used Oil Material, Waste Electrical and Electronic Equipment and Municipal Hazardous or Special Waste) under the WDA.
Waste diversion rate	Waste diversion rate is the percentage of waste diverted from landfill through means of diversion programs (Blue Box, composting, etc). Waste diversion rate is determined by dividing the total quantity of waste diverted by the total amount diverted and disposed.
Waste electrical and electronics equipment	Any broken or unwanted electrical or electronic appliances including computers, phones and other items that have reached the end of their usable life.
Waste exchange	System for transferring waste material from one company to another that can use it. For example, packaging foam received by one company can be transferred to a stuffed toy manufacturer for use as stuffing.
Waste fill area	In a landfill site, area receiving waste.
Waste fill zone	The three-dimensional zone receiving waste.
Waste generation rate	The amount waste generated by a person(s) on a daily basis, typically measured in tonnes per person per year.
Waste generator	The person, business, institutional facility or industry which created the waste.
Waste management system	Any facilities or equipment used in, and any operations carried out for, the management of waste including the collection, handling, transportation, storage, processing or disposal of waste, and may include one or more waste disposal sites.
Waste minimization	Measures or techniques, including plans and directives, that reduce the amount of wastes for disposal to the greatest degree practical. (Getting as close to zero waste as practical.) Methods to achieve minimization include source reduction, reuse, environmentally sound recycling, and recovery.
Waste recycling strategy	A Best Practice initiated by Waste Diversion Ontario and funded through the CIF to optimize Blue Box programs. It includes forecasting waste and recyclable material generation, planning how to optimize recycling of identified materials and implementing and monitoring a plan to improve overall Blue Box capture rates and performance.

Waste reduction	The decreasing to some extent of the waste stream, requiring disposal through source reduction, reuse, recycling, or recovery. It is often confused with the more limited "source reduction," which deals with policies and approaches only from the curbside on, not further upstream.
Waste stream	The waste output of a community, region, or facility. Total waste can be categorized into different waste stream components (e.g., wet organic waste, construction waste, household hazardous waste, or white goods).
Waste-to-energy (WTE) plant	A facility that uses solid waste materials (processed or raw) to produce energy. WTE plants include incinerators that produce steam (for district heating or industrial use), or generate electricity and also include facilities that convert landfill gas to electricity.
Waste transfer station/facility	A facility where waste is transferred from small collection trucks into larger waste hauling vehicles for transportation to a waste diversion, processing or disposal site.
Water	Surface water and ground water, or either of them.
Water surplus	The water surplus provides an estimate of the volume of water available from precipitation to infiltrate into the site and for surface runoff during a 12 month period.
Water table	A level below the earth's surface at which the ground becomes saturated with water.
Wet/Dry	The wet stream contains organics plus other wet materials that are typically sent to a composting facility. Dry contains all recyclables plus other dry materials. MRF facilities are designed to separate dry recyclables from residual materials which cannot be recycled or for which there are no or limited markets.
Wet/Dry collection	The separation of residential solid waste into at least two components for collection: wet wastes, which are organic and collected for composting; and dry wastes, which are sorted at a central facility where the recyclables are removed for further processing.
White goods	Refers to household appliances such as refrigerators, stoves, freezers, washers, dryers, dishwashers, dehumidifiers, water tanks, air-conditioning units, heat pumps.
Windrow composting	Composting process whereby piled organic material is placed in a series of rows, usually two metres deep. The rows are turned periodically for natural aeration.
Yard waste collection	The collection of leaves, brush, grass and other yard waste for composting.
Zero waste	The philosophy of taking a cradle-to-cradle approach to managing waste where "industry has to redesign products and processes to reduce waste before it is made, as well as designing products for greater reuse."

ABBREVIATIONS

AAQC	Ambient Air Quality Criteria
AD	Anaerobic Digestion
AHP	Analytical Hierarchy Process
AMO	Association of Municipalities of Ontario
AMRC	Ontario's Association of Municipal Recycling Coordinators
ANSI	Area of Natural Scientific Interest
ASL	Automated Side Loader
APC	Air Pollution Control
AWT	Alternative Waste Treatment
BEST	Businesses for an Environmentally Sustainable Tomorrow
BEI CHP &RS	The bei cellulose hydrolysis process and reactor system
BMT	Biological and Mechanical Treatment
BMW	Bio-Medical Waste
BNQ	Le Bureau de normalisation du Québec
BOD	Biological Oxygen Demand
BOT	Build-Operate-Transfer
BRBA	Buy Recycled Business Alliance in the U.S.
CR&D	Construction, Renovation and Demolition
CBSM	Community-Based Social Marketing
CCF	Central Composting Facility
CCI	Canada Compost Inc.
CCME	Council of Ministers of the Environment
CDM	Clean Development Mechanism
CEC	Community Environmental Centre
CFCs	Chlorofluorocarbons
CIF	Continuous Improvement Fund
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee of the Status of Species at Risk in Canada
CRT	Cathode Ray Tube
CV	Calorific Value
DfE	Design for the Environment
E&E Fund	Effectiveness and Efficiency Fund
EA	Environmental Assessment
EAA	Environmental Assessment Act
EAB	Environmental Approvals Branch
EASR	Environmental Assessment Study Report

EBR	Environmental Bill of Rights
ECO_2	Equivalent Carbon Dioxide
ECS	Eddy Current Separator
E-E	Eco-Emballages
EFW	Energy From Waste plant
EIA	Environmental Impact Assessment
EMC	Environmental Management Centre
ENGOS	Environmental Non-profit Organizations
EPA	Environmental Protection Act
EPP	Environmentally Preferable Procurement
EPR	Extended Producer Responsibility
ERA	Environmental Risk Assessment
ESTs	Environmentally Sound Technologies
FCM	Federation of Canadian Municipalities
H_2S	Hydrogen Sulphide
GAP	Generally Accepted Practices (or Principles)
GERT	Greenhouse Gas Emission Reduction Trading
GFNCR	Greening of Facilities National Capital Region
GHG	Greenhouse Gas
GIS	Geographic Information System
GIPPER	Governments Incorporating Procurement Policies to Eliminate Refuse
GMF	Green Municipal Funds
HDPE	High Density Polyethylene (Plastic bottles and jugs commonly used for containing detergents)
HHW	Household Hazardous Waste (Also referred to as Municipal Hazardous or Special Waste (MHSW))
hshold or hhld	Household
IC&I	Industrial Commercial and Institutional
IFO	Industry Funding Organization
ISWM (P)	Integrated Solid Waste Management (Plan)
IWM (M) (P)	Integrated Waste Management (Master) (Plan)
JMC	Joint Management Committee
LFG	Landfill Gas
LGA	Local Government Area
MBG	Mixed Broken Glass
MC	Moisture Content
MF	Multi-Family residence
MGB	Mobile Garbage Bin
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment

MR	Multi-Residential buildings
MRC	Materials Recycling Centre
MRF	Materials Recycling Facility
MSW	Municipal Solid Waste
MTCE	Metric Tonnes of Carbon Equivalent
NaPP	National Packaging Protocol
NCC	National Capital Commission
NGO	Non-Governmental Organization
NIR	Near Infrared
NO_X	Oxides of Nitrogen
NORA	Northern Ontario Recycling Association
NPRI	National Pollutant Release Inventory
NRC	National Recycling Coalition
O&M	Operations and Maintenance
OBB	Old Boxboard (post-consumer)
OCC	Old Corrugated Cardboard (post-consumer)
ODWQS	Ontario Drinking Water Quality Standards
OES	Ontario Electric Stewardship
OMG	Old Magazines
ONP	Old Newspaper
OTS	Ontario Tire Stewardship
OUOMA	Ontario Used Oil Management Association
P&E	Promotion and Education
PAYT	Pay As You Throw
PDO	Public Drop-Off
PET	Polyethylene terephthalate.
PM	Particulate Matter
PM_{10}	Airborne Particulate matter with a mass median diameter less than 10 um
PP	Polypropylene
PROs	Producer Responsibility Organizations
PS	Polystyrene
PS (P)	Private Sector (Participation)
PSA	Public Service Announcement
PVC	Polyvinyl chloride
PVPP	Property Value Protection Plan
RDF	Refuse Derived Fuel
REIC	Renewable Energy Institute of Canada
RMDZ	Recycling Market Development Zones
RMOC	Regional Municipality of Ottawa-Carleton

ROW	Right-of-way
SF	Single Family
SUBBOR	Super Blue Box Recycling Corporation
SO	Stewardship Ontario
SO_x	Sulphur Oxides
SPM	Suspended Particulate Matter
SSO	Source Separated Organics
TC	Trigger Concentration
ToR	Terms of Reference
tpy	Tonnes per year
TSD	Technical Supporting Documents
UOMPP	Used Oil Material Program Plan
UTPP	Used Tire Program Plan
VENM	Virgin Excavated Natural Material
VOCs	Volatile Organic Compounds
WCV	Waste Collection Vehicle
WDA	Waste Diversion Act
WDO	Waste Diversion Ontario
WEEE	Waste Electrical and Electronics Equipment
WMF	Waste Management Facility
WMMP	Waste Management Master Plan
WRAC	Ontario Waste Reduction Advisory Committee
WRIC	Waste Resource Innovation Centre
WSI	Waste Services (CA) Inc.

Appendices

Appendix A

Public Consultation Process

City of Peterborough

NOTICE OF STUDY COMMENCEMENT
TO PREPARE A WASTE MANAGEMENT MASTER
PLAN FOR THE CITY OF PETERBOROUGH

THE STUDY

The City of Peterborough, through their consultant Cambium Environmental Inc. (Cambium), has initiated a study to prepare a Waste Management Master Plan. The current Waste Management Master Plan (WMMP) was completed in 1993 as a joint City/County of Peterborough plan. Considering the age of the current plan and that the County of Peterborough (County) has initiated a County-focused WMMP, the City of Peterborough (City) is seeking the development of a City-focused WMMP, which will have a progressive and cooperative approach for a sustainable system providing service over a long-term planning period.

The Study will review the current waste management system including the infrastructure, collections, and processing. The Study will identify the areas of the waste management system that are working, the areas that need improvement, and the areas that need to be added to or removed from the City's current operation. The Study is heavily dependent on public input and will require assistance from the residents to move forward. Any and all recommendations stemming from the Study will be presented to the public during open house meetings and all input will be incorporated to develop the capital and operating budget for waste management over the next twenty year period.

As previously stated, public consultation is key to the preparation process. Upon confirmation of the meeting dates, locations and times, notices will be posted.

The City of Peterborough website:
http://www.peterborough.ca/living/city_services/waste_management
will be updated frequently to provide information on the current status of the Study.

COMMENTS

You are encouraged to provide comments on the Study. All comments received will be included in the Study. An online survey will be available through the City website for your immediate participation. Comments and information provided by you will assist the Project Team in finding solutions for the City and the waste management options available.

Please contact the undersigned if you have any questions, comments or wish to be added to the project mailing list.

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City of Peterborough
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Cambium Environmental Inc.
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City of Peterborough

NOTICE OF PUBLIC INFORMATION CENTRE
FOR A WASTE MANAGEMENT MASTER PLAN STUDY
FOR THE CITY OF PETERBOROUGH

The City of Peterborough has initiated a study to prepare a Waste Management Master Plan. The Study is reviewing the current waste management system, including the infrastructure, collections, and processing. It will identify the areas of the waste management system that are working, the areas that need improvement, and the areas that need to be added to or removed from the City's current operations.

Public Information Centre #1

Public Library Auditorium - 345 Aylmer St. N.

Date: Thursday October 27th

Times: 2:00 p.m. – 3:30 p.m.
6:00 p.m. – 7:30 p.m.

Members of the Cambium Environmental Project Team and City Staff will be available to answer any questions and accept comments. Light refreshments will be provided.

An online survey is available through the City website, and attendees at the Public Information Centre may fill out a paper survey. All comments provided will be considered by the Project Team when evaluating options for the City's future waste management system.

Go to http://www.peterborough.ca/wmstudy to complete the on-line survey at any time during the study. This site will also be updated regularly to provide information on the status of the Study.

Please contact the undersigned if you have any questions, comments or wish to be added to the project mailing list.

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Welcome

City of Peterborough
Waste Management
Master Plan

Public Meeting No. 1

Please:

- Sign in
- Feel free to ask questions
- Fill out a questionnaire
- Help yourself to refreshments

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Waste Management Master Plan (WMMP)

The WMMP will:

- Provide overall direction for the waste management system
- Address diversion and disposal needs for the next 20 years
- Identify opportunities to improve the current system
- Identify opportunities to reduce the amount of waste needing disposal

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WMMP Schedule

The WMMP will take approximately 13 months to complete. A final document is anticipated by August 2012.

<u>Step 1:</u> Understanding and Assessing the Current Waste Management System

- Review of existing facilities & services

<u>Step 2:</u> Establish Goals and Objectives

- Based on provincial and municipal priorities, objectives, and targets
- **Public Information Centre No. 1**
  - Survey /Questionnaire

YOU ARE HERE

<u>Step 3:</u> Identify and Assess Options

- Evaluate alternative methods
  - Determine options and their potential contribution towards sustainable waste management
  - Develop criteria; assess options
  - Discussion of 3 broader categories for discussion with the public
    - Maximize Diversion
    - Minimize Generation
    - Cost Effectiveness/Affordability (Fiscal Responsibility)

<u>Step 4:</u> Develop the WMMP Document

- Public Information Centre No. 2
  - Survey/Questionnaire
- The WMMP document will:
  - Include results of analysis
  - Identify the existing system
  - Present a framework for future waste management

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Waste Management Context

Description of Waste Generation

- Population of 79,334
  - Unaccounted for student increase (September to May)
- Area of 1,283 km²
- 26,240 single family households
- 8,675 multi-family households
- Waste tonnage reported in 2010:
  - 34,683 tonnes of residential waste generated by City
  - 17,364 tonnes of this waste was diverted through diversion programs
  - 60,248 tonnes of waste entering the landfill (City and County combined)
- City waste diversion rate of 50%

Waste Management Facilities

- 1 active landfill (City / County)
- Household Hazardous Waste Facility
- Materials Recovery Facility
- Composting Facility

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Key WMMP Considerations

- Decreasing remaining disposal capacity at Peterborough County/City Waste Management Facility (PCCWMF) landfill site
- Limited Monitoring and Reporting program in place to verify current capture and participation rates;
- There is currently no Source Separated Organics (SSO) program in place;
- Diminishing life capacity at the Material Recovery Facility (MRF) on Pido Road; and
- Limited influence/role with IC&I waste sector and waste management.

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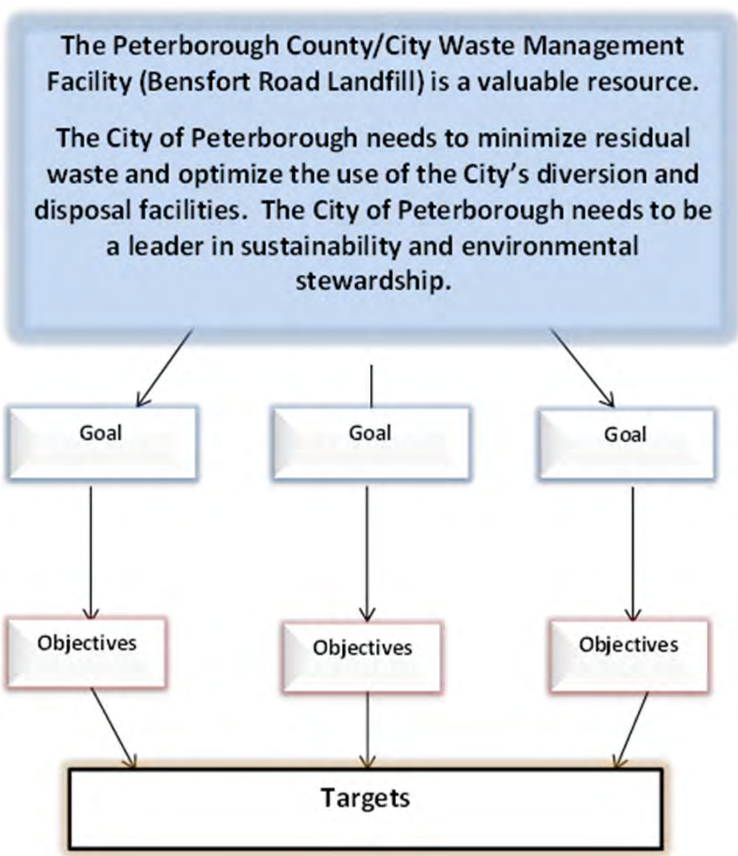
Guiding Principle of the Plan

The long-term Waste Management Master Plan (WMMP) is an essential step towards the provision of sustainable waste systems within the City of Peterborough. The WMMP begins with the establishment of a Guiding Principle, from which fundamental goals can be identified. Specific, achievable objectives are then set out, which will steer the City towards its intended targets.

The initial **Guiding Principle** of Peterborough's Waste Management Master Plan is as follows:



Goals and Objectives

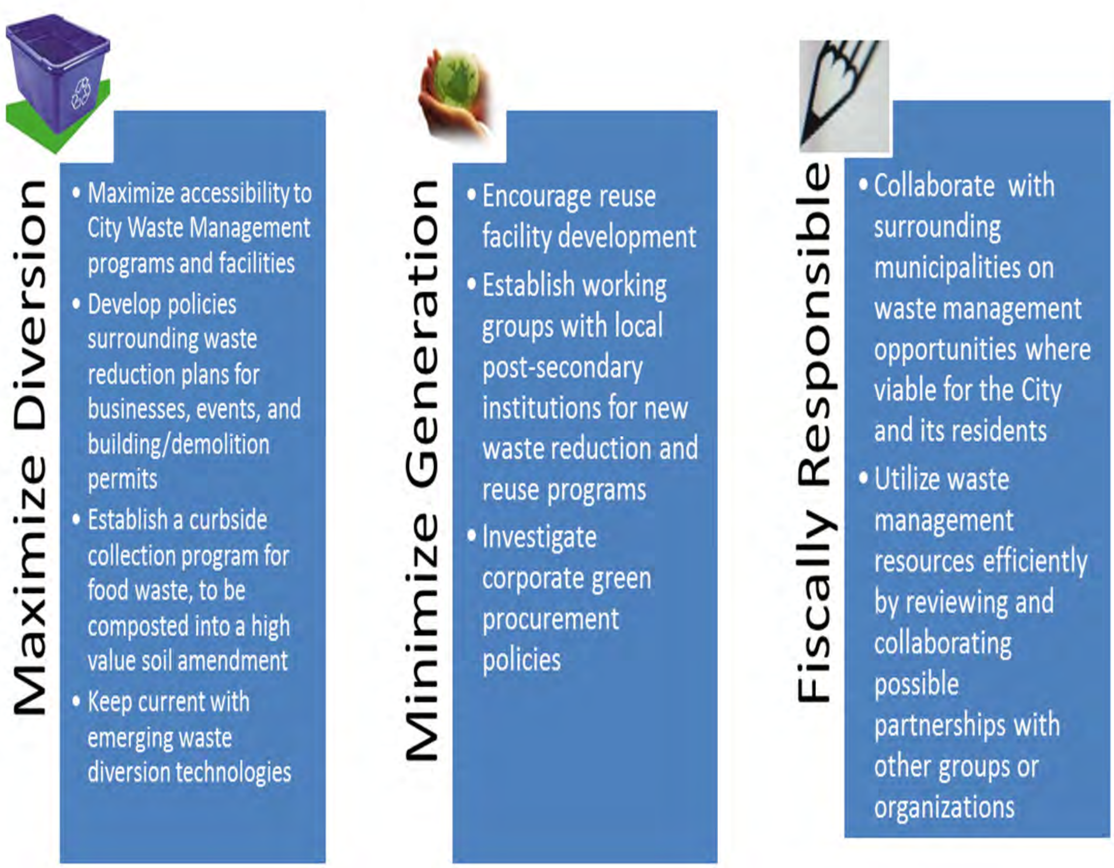
GOALS

The City's WMMP Steering Committee focused on three main areas for this WMMP, and set out three corresponding **goals**: to maximize the amount of residual material that we are able to divert from the landfill; to minimize the amount of residual material that is generated in the first place by the residents; and to operate and manage all of the City's required waste management systems in a fiscally responsible manner. The fundamental goals of the WMMP are as follows:

Goals and Objectives

OBJECTIVES

The fundamental goals will be achieved by setting more specific and measurable **objectives**. The City has established key objectives for each of these three goals:



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Targets

Key **TARGETS** have been generated from the goals and objectives that apply to all. These targets will allow the City to monitor their progress with the established Plan and verify deliverables. The targets will be adjustable with the changing economic and social trends and are provided as follows:

1. Expand the number and type of education and outreach and/or partnership activities year over year from 2010 levels.
2. Meet all 8 Waste Management Best Practices as outlined in the KPMG Blue Box Program Enhancement and Best Practices Assessment Project Report, 2007.
3. Residential diversion rate will increase from 2010 level of 50% to 75% over 20 years, with a review of target every five years.
4. Capture rates for blue box materials and green waste will increase 20% from 2006 levels over 20 years, with a review of target every five years.
5. Participate and continue to support producer responsibility awareness.

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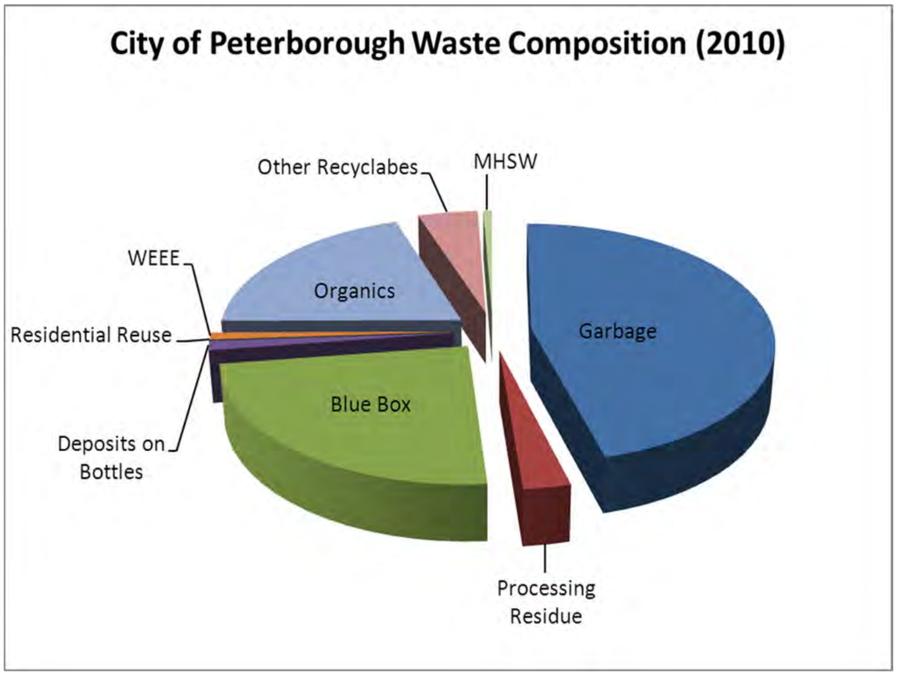
City Residential Waste Composition



A total of 34,683 tonnes of residential waste was generated within the City limits in 2010

- Approximately 17,364 tonnes was diverted from landfill through programs such as blue box recycling, leaf and yard waste composting, MHSW collections, and backyard composting

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Waste Diversion

- Provincial target is 60%
- Current diversion rate 50%
- Diversion target of 75% by 2030 (to be reviewed every 5 years)
- Current diversion programs:
  - Weekly curbside blue box collection from 26,240 households
  - Seasonal curbside collection of leaf and yard waste
  - Bi-annual curbside collection of bulky items
  - Municipal Hazardous and Special Waste (MHSW)
  - Waste Electronics and Electrical Equipment (WEEE) or "used electronics"
  - Other (scrap metal, tires, appliances)
  - SSO Pilot Study
    - 625 single family households and 3 restaurants

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Materials Recycling Facility (MRF)

- MRF was constructed by the City in 1989
- Located at 390 Pido Road
- Accepts all blue box materials from the City and the County
- Free disposal of blue box materials available 24/7
- The City and the County have separate long term agreements with the operator of the MRF (HGC Management Inc.)
  - Agreements expire December 31, 2014

City Composting Facility

- Owned and operated by the City at Harper Road
- Accepts all leaf and yard waste collected in the City as well as SSO from Pilot Study
  - ~20% of residential waste by weight in 2010
- Offers compost for sale throughout Peterborough County
- Open windrow system mixes compost with wood chips

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How Does the City of Peterborough Stack Up?

A waste audit was completed for the City in 2006, which illustrated the following:

- Participation rates:
  - Curbside garbage collection: 79% (2 bags per household)
  - Blue box program: 74%
- Average capture rate of blue box materials was 79.5%
  - Less than average of 85% for similarly sized municipalities
- The blue box program is better than average in cost efficiency (2010 Datacall)
  - ~$147.75/tonne compared with ~$222/tonne average
- The City disposes of slightly less waste than the average (2010 Datacall)
  - City residents dispose ~219 kg/capita compared with a ~268 kg/capita average

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Options for Waste Reduction

- Increase blue box items allowed
- Collect food waste at curbside
- User pay system
- Reduce bag allowance
- Clear garbage bags and contents monitoring
- City reuse centre
- Alter consumer choices to reduce packaging
- Increase Household Hazardous Waste Depot hours of operation

Reducing the amount of waste generated will help to conserve landfill capacity at the PCCWMF…

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Options for Future Waste Management

The PCCWMF landfill has an estimated 12 to 15 years of capacity remaining

Options for future waste disposal include:

- Increase waste reduction (extend site life)
  - Accomplished through waste diversion initiatives and changes in consumer behaviour
- Landfill expansion or search for new site
- Export of waste
  - Waste could potentially be landfilled or treated thermally by others
- Thermal Treatment with potential for energy generation
  - An advanced technology that would allow energy to be recuperated from waste
- Other ideas? Tell us your thoughts.

Open House Session

- Please help yourself to refreshments
- Please take a moment to complete a questionnaire (or take one home)
  - Questionnaire's can also be completed on the City website
- Please ask questions or provide your comments to meeting organizers

Thank you for attending and participating in the City of Peterborough Waste Management Master Plan Public Meeting No. 1.

Keep Informed

Further information can be obtained on the City Waste Management Webpage:

http://www.peterborough.ca/Living/City_Services/Waste_Management.htm

Or contact the City or its Consultant directly:

City of Peterborough
Contact: Virginia Swinson, B. Sc.
Waste Reduction Programs Coordinator
vswinson@peterborough.ca

Cambium Environmental Inc.
Contact: Kelly Murphy, P. Eng.
Senior Project Manager
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CAMBIUM ENVIRONMENTAL

CITY OF PETERBOROUGH
WASTE MANAGEMENT MASTER PLAN

PUBLIC MEETING NO. 1
Thursday October 27, 2011
Peterborough Public Library
2:00 pm – 3:30 pm *and* 6:00 pm – 7:30 pm

CAMBIUM
ENVIRONMENTAL

Please Sign In

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THE PETERBOROUGH EXAMINER

Open house held to gather input on city's waste management master plan

By KENNEDY GORDON, Examiner Staff Writer
Updated 5 days ago

Laurin Fulton, a Trent University student, fills out the citys new waste management master plan during an open house session held at the public library Thursday, Oct. 27, 2011. The city is developing an overall strategy for trash and recycling programs. KENNEDY GORDON/PETERBOROUGH EXAMINER/QMI AGENCY

Dave Bucholtz is getting used to talking trash.

The environmental consultant spent the early part of the fall working on Peterborough County's waste management master plan — an ongoing effort — but was back at it Thursday night as part of the team tackling the city's garbage and recycling program.

"We're busy," said Bucholtz, who works for Cambrium Environmental.

Cambrium and the city held an open house Thursday night at the Peterborough Public Library, sharing the plan with the public and gathering input as the city's waste management master plan moves forward.

"We're here to get ideas," Bucholtz said.

The team, which includes city waste reduction program co-ordinator Virginia Swinson, will use the meeting to put together a draft plan that should be available by next spring.

> *"We're here to get ideas."*
>
> *Dave Bucholtz, Cambrium Environmental*

The session was wide open, meaning visitors could share ideas, offer criticisms and make suggestions about waste management and recycling in the city.

"I'm curious what people will want to say," Swinson said. "Things have changed over the years and we have to move forward."

Wayne Jackson, the city's utility services director, was also on hand.

After touring the displays, participants were asked to fill out a survey about their waste management use and perceptions.

Swinson said educating the public remains key — many people continue to throw away things that can be recycled, and more can be done to reduce and reuse, she said.

The event attracted people who wanted to learn more and offer input.

"This might become part of my environmental studies course," said Trent University student Laurin Fulton as she filled out a survey.

The city is also offering the survey online at www.peterborough.ca/wmstudy.

This open house is the only one the city will hold, Bucholtz said.

The waste management master plan will result from a detailed study of city waste operations and look at improvements suggested by consultants, staff and the public.

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THE PETERBOROUGH EXAMINER

City's recycling efforts paying off with market prices for materials on the rise

By BRENDAN WEDLEY, Examiner Municipal Writer
Updated 4 hours ago


SUE REEVE QMI Agency file photo

Putting items in the blue box has been helping the city's pocketbook as well as the environment with the price of recyclable materials increasing over the past few years.

Aluminum's sale price has increased to an average of about $1,850 per tonne this year from about $1,200 per tonne in 2009. The type of plastic used for water bottles and other items, called PET plastic, sold for an average of $682 per tonne this year, up from $187 per tonne in 2009. Steel's sale price jumped to an average of $344 per tonne this year, from $89 per tonne in 2009.

The city's expecting to collect an additional $227,000 from the sale of recyclable materials, with projected revenue of a little more than $1.

> *"It's simply the case of getting good dollars for our materials. We've just had a banner year in terms of markets."*
>
> *Virginia Swinson, waste diversion manager with the city*

9 million next year.

"We have commodities that we're selling…. Prices can be high or they can plummet," said Virginia Swinson, waste diversion manager with the city. "It's simply the case of getting good dollars for our materials.

"We've just had a banner year in terms of markets."

The city had planned to collect almost $1.7 million from the sale of recyclable material this year, but now it estimates the final amount by the end of this year will be almost $2.3 million.

Even with the added revenue this year, the city's net cost for recycling services would be about $145,000 after about $2.43 million in expenses.

If the city reaches its goal of a little more than $1.9 million from the sale of recyclables next year, the net cost of recycling services would be $554,363.

The city doesn't sell each type of recyclable material individually.

It sells the recyclable materials as a basket of goods at a flat rate based on a provincial average for the value of the different materials, Swinson explained.

"It works out to everyone's favour," she said. "It's a nice, easy and fair way of doing it."

The average price per tonne of recyclable materials was $175 this year, $124 in 2010 and $80 in 2009, Swinson said.

In addition to the rising prices, the revenue has been buoyed by the increasing amount of materials being collected through the Blue Box program.

The amount of recyclable materials collected increased to an estimated 9,400 tonnes this year from 8,866 tonnes in 2008. It's projected to grow to about 9,450 tonnes next year.

The rising revenue from recyclable materials is helping the city offset declining revenue from less garbage being dumped at the county-city landfill.

The city's draft 2012 budget shows the city expects tipping fee revenue to decrease by $521,750 next year compared to the amount the city budgeted to collect this year. The city and county share the revenue from tipping fees at the landfill, which means the city's share of the reduction would be $260,875.

The city estimates 57,550 tonnes of garbage will be dumped at the landfill this year, down from 74,218 in 2007. It projects the landfill will receive 58,710 tonnes of waste next year, which would be the first increase after three consecutive years of less garbage going to the landfill.

It's difficult to determine why the amount of garbage going to the landfill is declining, Swinson said.

"It could be the economy," she said. "We believe that some waste is actually going outside of the community. Some of the larger haulers have transfer facilities."

About half of the garbage comes from municipal waste collection. The rest of the garbage, which is subject to tipping fees, comes from commercial haulers that collect garbage from large businesses and from individuals bringing their garbage to the landfill.

Less waste means less revenue from tipping fees. But there's also an upside for the municipality.

"Less material means the life of the landfill will be extended," Swinson said. "That's the good side of it."

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Moose Hide Books presents: Book Launch; Peaceful Warrior, Annish's journey, by Jan Porter

Nov. 14, 2011

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WMMP 2011

1. Do you currently live in the City of Peterborough?

	Response Percent	Response Count
Yes	**89.5%**	**188**
No	10.5%	22
	answered question	**210**
	skipped question	**2**

2. What is your age?

	Response Percent	Response Count
19-35	**35.7%**	**66**
36-50	34.6%	64
51-65	24.9%	46
65+	4.9%	9
	answered question	**185**
	skipped question	**27**

3. What type of dwelling do you reside in?

	Response Percent	Response Count
Single-family home	**79.3%**	**146**
Multi-family dwelling (apartment, condominium, townhouses)	20.7%	38
answered question		**184**
skipped question		**28**

4. Indicate your residency in the city of Peterborough.

	Response Percent	Response Count
Permanent	**94.0%**	**173**
Student	6.0%	11
answered question		**184**
skipped question		**28**

5. How many people normally live in your household?

		Response Percent	Response Count
1		9.8%	18
2		**40.8%**	**75**
3		16.3%	30
4		21.2%	39
5		7.6%	14
More than 5		4.3%	8
		answered question	**184**
		skipped question	**28**

6. What day is your waste, recycling and green waste collected?

		Response Percent	Response Count
Tuesday		**33.2%**	**61**
Wednesday		15.8%	29
Thursday		17.9%	33
Friday		28.3%	52
Not sure		2.2%	4
Not applicable (reside in an apartment)		2.7%	5
		answered question	**184**
		skipped question	**28**

7. On average, how many FULL cans/bags of garbage does your household generate each week?

	Response Percent	Response Count
less than 1	**41.8%**	**76**
1	**41.8%**	**76**
2	13.7%	25
3 or more	2.7%	5
	answered question	**182**
	skipped question	**30**

8. On average, how many FULL blue boxes does your household fill each week?

	Response Percent	Response Count
less than 1	11.5%	21
1	17.6%	32
2	**53.3%**	**97**
3	14.3%	26
more than 3	3.3%	6
	answered question	**182**
	skipped question	**30**

9. When your blue boxes are full, how do you deal with extra recyclables?

	Response Percent	Response Count
Take extra to the drop-off depot on Pido Road	14.9%	27
Set to curb in a separate receptacle (non-blue box)	**36.5%**	**66**
Store until next collection day	29.8%	54
Throw them in the garbage	1.7%	3
My blue boxes are never too full	17.1%	31
	answered question	**181**
	skipped question	**31**

10. Would you prefer larger blue boxes?

	Yes	No	Response Count
For your Containers	**59.1% (107)**	40.9% (74)	181
For your Fibers	49.7% (84)	**50.3% (85)**	169
		answered question	**182**
		skipped question	**30**

11. Do you compost at home?

	Response Percent	Response Count
Yes, year-round	**42.3%**	**77**
Yes, seasonally	19.2%	35
No	38.5%	70
	answered question	**182**
	skipped question	**30**

12. If Yes, what do you typically put in your composter?

	Response Percent	Response Count
Food scraps	28.1%	32
Yard wastes	8.8%	10
Both	**63.2%**	**72**
	answered question	**114**
	skipped question	**98**

13. How satisfied are you with the current service levels for garbage, green waste and recycling? "1" being Very Unsatisfied, and "5" being Very Satisfied:

	1	2	3	4	5	Response Count
Garbage	1.7% (3)	4.4% (8)	6.7% (12)	28.9% (52)	**58.3% (105)**	180
Recycling	1.1% (2)	4.0% (7)	15.3% (27)	32.8% (58)	**46.9% (83)**	177
Green waste	17.5% (30)	12.9% (22)	12.3% (21)	19.3% (33)	**38.0% (65)**	171
					answered question	**180**
					skipped question	**32**

14. If you chose "1" or "2" for any of the services in Question 13, please comment further on the reasons for your dissatisfaction.

	Response Count
	67
answered question	67
skipped question	145

15. How do you normally find information about the City's solid waste management services?

	Response Percent	Response Count
Waste Reduction Calendar	**50.0%**	**87**
Waste Management Brochures	18.4%	32
Newspaper ads	30.5%	53
Through friends and neighbours	18.4%	32
City website	48.3%	84
City council meetings	2.3%	4
Other (please specify)		20
answered question		**174**
skipped question		**38**

16. Please indicate how often you use the City's existing waste management facilities, with "0" being Never, "1" being Annually, "2" being Seasonally, "3" being Monthly, "4" being Weekly, and "5" being Daily.

	0	1	2	3	4	5	Response Count
Landfill Site (Bensfort Road)	**37.5% (66)**	31.3% (55)	25.0% (44)	5.1% (9)	0.6% (1)	0.6% (1)	176
Household Hazardous Waste and Electronics Depot (Pido Road)	26.2% (45)	**40.7% (70)**	29.7% (51)	2.3% (4)	0.6% (1)	0.6% (1)	172
24-hour Recycling Drop-Off Depot (Pido Road)	**44.1% (75)**	21.8% (37)	25.3% (43)	7.1% (12)	1.2% (2)	0.6% (1)	170
						answered question	**176**
						skipped question	**36**

17. Please provide any comments you have on the current waste management services provided by the CIty today(garbage, green waste, blue box collections, Household Hazardous Waste and Electronics Depot, Landfill site).

	Response Count
	76
answered question	**76**
skipped question	**136**

18. The City's current rate of waste diversion (residential) is 50%. The provincial goal is 60%. What level of waste diversion would you like to see the CIty set as a goal?

	Response Percent	Response Count
Current level of 50%	6.0%	8
55%	6.0%	8
60%	20.3%	27
65%	**67.7%**	**90**
	Other (please specify)	49
	answered question	**133**
	skipped question	**79**

19. Please rate each of the following waste diversion options according to your preference, with "1" being highest preference and "5" being lowest preference.

	1	2	3	4	5	Response Count
Increase the items you can recycle in the blue box	**50.3% (86)**	22.8% (39)	10.5% (18)	5.8% (10)	10.5% (18)	171
Collect food waste at the curb for composting	**57.5% (100)**	8.6% (15)	7.5% (13)	5.2% (9)	21.3% (37)	174
Implement a User-Pay system for garbage	18.0% (30)	15.0% (25)	12.6% (21)	13.2% (22)	**41.3% (69)**	167
Mandate the use of clear bags for garbage	20.2% (34)	6.0% (10)	23.8% (40)	13.1% (22)	**36.9% (62)**	168
Reduce the number of bags of garbage permitted	24.8% (41)	15.2% (25)	15.8% (26)	10.3% (17)	**33.9% (56)**	165
Increase the Household Hazardous Waste Depot hours of operation	13.1% (21)	18.1% (29)	**33.8% (54)**	13.8% (22)	21.3% (34)	160
Municipal Reuse Centres	**27.3% (44)**	24.2% (39)	25.5% (41)	11.8% (19)	11.2% (18)	161
Increase the cost of landfilling	11.7% (19)	16.0% (26)	24.7% (40)	20.4% (33)	**27.2% (44)**	162
					answered question	**175**
					skipped question	**37**

20. What would you be willing to do personally to reduce your garbage generation?

	Response Percent	Response Count
No change	8.0%	14
Buy products with less packaging	70.7%	123
Only buy products in packages I can recycle	50.0%	87
Compost at home	48.9%	85
Participate in a curbside food waste collection	**73.6%**	**128**
Use reusables shopping bags	72.4%	126
	Other (please specify)	28
	answered question	**174**
	skipped question	**38**

21. Would you participate in a curbside food waste collection if it were offered in the City?

	Response Percent	Response Count
Yes	**81.7%**	**143**
No	10.9%	19
Not sure	7.4%	13
	answered question	**175**
	skipped question	**37**

22. Would you be in favour of biweekly garbage collection, if an enhanced recycling program and a new weekly food waste collection were implemented?

	Response Percent	Response Count
Yes	**65.5%**	**114**
No	24.7%	43
Not Sure	9.8%	17
	answered question	**174**
	skipped question	**38**

23. How would you describe your level of concern for the potential environmental impacts associated with landfilling garbage?

	Response Percent	Response Count
Very concerned	**59.4%**	**104**
Somewhat concerned	36.6%	64
No concerned at all	4.0%	7
	answered question	**175**
	skipped question	**37**

24. If you indicated a concern, which things concern you the most? Choose as many as apply.

	Response Percent	Response Count
Groundwater impacts	**88.2%**	**142**
Surface waste impacts	61.5%	99
Biological impacts	73.9%	119
Traffic impacts	8.7%	14
Litter and Debris	40.4%	65
Odours, air emissions	47.8%	77
Public Safety	25.5%	41
	Other (please specify)	23
	answered question	**161**
	skipped question	**51**

25. Please rate the following criteria for evaluating future waste management options from 1 to 7 (with "1" being the highest importance, "7" the lowest):

	1	2	3	4	5	6	7	Response Count
Postive social impact and acceptibility	9.0% (12)	**27.6% (37)**	12.7% (17)	14.2% (19)	11.2% (15)	5.2% (7)	20.1% (27)	134
Positive environmental effects	**64.5% (91)**	10.6% (15)	7.8% (11)	3.5% (5)	5.7% (8)	2.8% (4)	5.0% (7)	141
Proven technology	3.9% (5)	**23.4% (30)**	18.8% (24)	15.6% (20)	20.3% (26)	10.9% (14)	7.0% (9)	128
Cost/Affordability	10.8% (15)	19.4% (27)	**24.5% (34)**	17.3% (24)	10.1% (14)	7.9% (11)	10.1% (14)	139
Ease of implementation	4.3% (6)	8.7% (12)	16.7% (23)	19.6% (27)	19.6% (27)	**21.7% (30)**	9.4% (13)	138
Extent of local control	5.7% (8)	11.3% (16)	7.8% (11)	14.2% (20)	16.3% (23)	**25.5% (36)**	19.1% (27)	141
Scalability - can be expanded over time	10.4% (16)	8.4% (13)	16.2% (25)	14.3% (22)	13.6% (21)	16.9% (26)	**20.1% (31)**	154
							answered question	**167**
							skipped question	**45**

26. How would you prefer to have waste management programs and services funded locally?

	Response Percent	Response Count
Municipal property taxes	**64.4%**	**96**
User fees	35.6%	53
	Other (please specify)	30
	answered question	**149**
	skipped question	**63**

27. Any more general comments?

		Response Count
		50
	answered question	**50**
	skipped question	**162**

NOTICE OF PUBLIC INFORMATION CENTRE
Waste Management Master Plan
City of Peterborough

THE STUDY
The City of Peterborough, through their consultant Cambium Environmental Inc. (Cambium), has completed a draft of their 20-year Waste Management Master Plan (The Plan).

The Plan reviews the current waste management system, including waste infrastructure, collections, and processing, and makes recommendations on how to improve areas of the waste management system that focus on diversion.

PUBLIC CONSULTATION
Development of the Plan is heavily dependent on public input. Before the Plan is finalized, the City is seeking comments from residents of the City. Recommendations in the Plan will be presented during one final public presentation, and input received from members of the public will be incorporated into the final version of the Plan.

The final Public Information Centre (PIC) will be held in conjunction with the Green Expo Event, taking place at the Lansdowne Place Mall on Saturday October 20th from 9:30 a.m. to 6:00 p.m. Residents are encouraged to visit the City/Cambium booth, review the materials on display, and provide comments.

A copy of the draft Plan can be found on the City website. Comments may be sent at any time to one or both of the undersigned until Monday October 22nd, 2012.

http://www.peterborough.ca/wmstudy

Please contact the undersigned if you have any questions or comments.

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Welcome

City of Peterborough
Waste Management
Master Plan

Public Meeting No. 2

Please:

- Feel free to ask questions
- Fill out a questionnaire
- Help yourself to refreshments

Waste Management Master Plan (WMMP)

The WMMP will:

- Provide overall direction for the waste management system
- Address diversion and disposal needs for the next 20 years
- Identify opportunities to improve the current system
- Identify opportunities to reduce the amount of waste needing disposal

WMMP Schedule

The final document is anticipated by November 2012.

Step 1: Understanding and Assessing the Current Waste Management System
- Review of existing facilities & services

Step 2: Establish Goals and Objectives
- Based on provincial and municipal priorities, objectives, and targets
- **Public Information Centre No. 1**
  - Survey /Questionnaire

Step 3: Identify and Assess Options
- Evaluate alternative methods
  - Determine options and their potential contribution towards sustainable waste management
  - Develop criteria; assess options
  - Discussion of 3 broader categories for discussion with the public
    - Maximize Diversion
    - Minimize Generation
    - Cost Effectiveness/Affordability (Fiscal Responsibility)

Step 4: Develop the WMMP Document
- Public Information Centre No. 2 ← **YOU ARE HERE**
  - Survey/Questionnaire
- The WMMP document will:
  - Include results of analysis
  - Identify the existing system
  - Present a framework for future waste management

CAMBIUM

Waste Management Context

Description of Waste Generation
- **Population of 79,334**
  - **Unaccounted for student increase (September to May)**
- **Area of 1,283 km²**
- **26,240 single family households**
- **8,675 multi-family households**
- **Waste tonnage reported in 2010:**
  - **34,683 tonnes of residential waste generated by City**
  - **17,364 tonnes of this waste was diverted through diversion programs**
  - **60,248 tonnes of waste entering the landfill (City and County combined)**
- **City waste diversion rate of 50%**

Waste Management Facilities
- **1 active landfill (City / County)**
- **Household Hazardous Waste Facility**
- **Materials Recovery Facility**
- **Composting Facility**

CAMBIUM

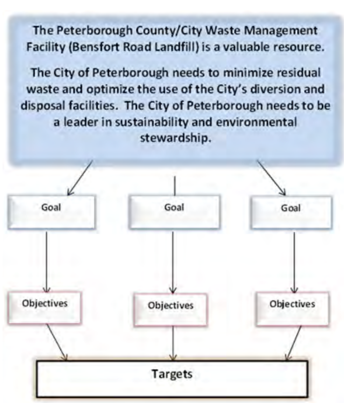
Key WMMP Considerations

- Decreasing remaining disposal capacity at Peterborough County/City Waste Management Facility (PCCWMF) landfill site
- Limited Monitoring and Reporting program in place to verify current capture and participation rates;
- There is currently no Source Separated Organics (SSO) program in place;
- Diminishing life capacity at the Material Recovery Facility (MRF) on Pido Road; and
- Limited influence/role with IC&I waste sector and waste management.

Guiding Principle of the Plan

The long-term Waste Management Master Plan (WMMP) is an essential step towards the provision of sustainable waste systems within the City of Peterborough. The WMMP begins with the establishment of a Guiding Principle, from which fundamental goals can be identified. Specific, achievable objectives are then set out, which will steer the City towards its intended targets.

The initial **Guiding Principle** of Peterborough's Waste Management Master Plan is as follows:



Goals and Objectives

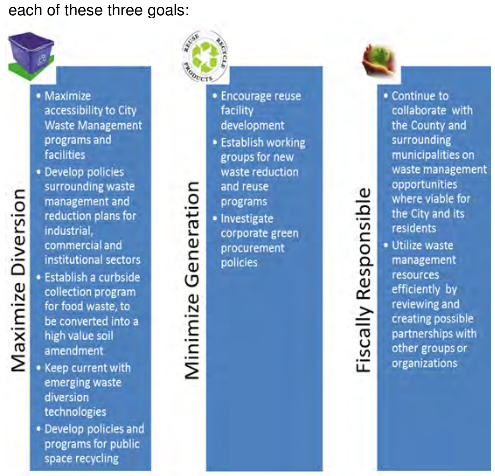
GOALS

The City's WMMP Steering Committee focused on three main areas for this WMMP, and set out three corresponding **goals**: to maximize the amount of residual material that we are able to divert from the landfill; to minimize the amount of residual material that is generated in the first place by the residents; and to operate and manage all of the City's required waste management systems in a fiscally responsible manner. The fundamental goals of the WMMP are as follows:

Goals and Objectives

OBJECTIVES

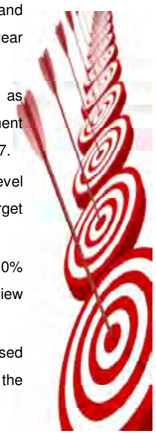
The fundamental goals will be achieved by setting more specific and measurable **objectives**. The City has established key objectives for each of these three goals:



Targets

Key **TARGETS** have been generated from the goals and objectives that apply to all. These targets will allow the City to monitor their progress with the established Plan and verify deliverables. The targets will be adjustable with the changing economic and social trends and are provided as follows:

1. Expand the number and type of education and outreach and/or partnership activities year over year from 2010 levels.
2. Meet all 8 Waste Management Best Practices as outlined in the KPMG Blue Box Program Enhancement and Best Practices Assessment Project Report, 2007.
3. Residential diversion rate will increase from 2010 level of 50% to 75% over 20 years, with a review of target every five years.
4. Capture rates for blue box materials will increase 10% from 2006 levels (79.5%) over 20 years, with a review of target every five years.
5. Participation rate of 50% in year 1 of the proposed SSO program with an increase for each year of the program.



City Residential Waste Composition

A total of 34,683 tonnes of residential waste was generated within the City limits in 2010

- Approximately 17,364 tonnes was diverted from landfill through programs such as blue box recycling, leaf and yard waste composting, MHSW collections, and backyard composting

Waste Diversion

- Provincial target is 60%
- Current diversion rate 50%
- Diversion target of 75% by 2030 (to be reviewed every 5 years)
- Current diversion programs:
  - Weekly curbside blue box collection from 26,240 households
  - Seasonal curbside collection of leaf and yard waste
  - Bi-annual curbside collection of bulky items
  - Municipal Hazardous and Special Waste (MHSW)
  - Waste Electronics and Electrical Equipment (WEEE) or “used electronics”
  - Other (scrap metal, tires, appliances)
  - SSO Pilot Study
    - 625 single family households and 3 restaurants

Materials Recycling Facility (MRF)

- MRF was constructed by the City in 1989
- Located at 390 Pido Road
- Accepts all blue box materials from the City and the County
- Free disposal of blue box materials available 24/7
- The City and the County have separate long term agreements with the operator of the MRF (HGC Management Inc.)
  - Agreements expire December 31, 2014

City Composting Facility

- Owned and operated by the City at Harper Road
- Accepts all leaf and yard waste collected in the City as well as SSO from Pilot Study
  - ~20% of residential waste by weight in 2010
- Offers compost for sale throughout Peterborough County
- Open windrow system mixes compost with wood chips

How Does the City of Peterborough Stack Up?

REDUCE
REUSE
RECYCLE
RETHINK!

A waste audit was completed for the City in 2006, which illustrated the following:

- Participation rates:
  - Curbside garbage collection: 79% (2 bags per household)
  - Blue box program: 74%
- Average capture rate of blue box materials was 79.5%
  - Less than average of 85% for similarly sized municipalities
- The blue box program is better than average in cost efficiency (2010 Datacall)
  - ~$147.75/tonne compared with ~$222/tonne average
- The City disposes of slightly less waste than the average (2010 Datacall)
  - City residents dispose ~219 kg/capita compared with a ~268 kg/capita average

CAMBIUM

Key Diversion Recommendations

1. Develop an organics collection program for residential and apartment buildings.
2. If an organics collection program is implemented, reduce garbage pickup frequency to every two weeks and provide weekly recycling and organics pickup to reduce collection costs and encourage diversion.
3. Enhance Promotion and Education programs to keep residents informed about what they can and cannot recycle, reuse and compost.
4. Enhance City staff training to ensure they are aware of current regulations, technologies and market trends.
5. Establish recycling options for materials currently going to landfill including carpets, mattresses, textiles (clothes, linens).
6. Establish a Waste Exchange/Reuse Centre at the landfill.
7. Develop an enhanced Public Space Recycling Program to provide recycling opportunities in parks and City facilities.
8. Optimize routing with new software and GPS tracking to reduce collection costs.
9. Undertake regular waste audits to ensure residents are understanding and participating in the recycling and organics programs.

CAMBIUM

Key Disposal Recommendations

The PCCWMF landfill has an estimated 12 to 15 years of capacity remaining

- Investigate Suitable Options for Future Landfill Capacity
  - Monitor existing landfill capacity, landfill expansions and potential greenfield locations over time to allow the widest selection of suitable options.
- Undertake a Formal Review of Waste Management Technologies
  - The City should monitor the progress of alternative technologies such as thermal treatment and AD facilities. The review should be focussed toward technologies that have been proven effective in the North American context.
  - Reviews should be completed on a regular basis (every 3 to 5 years).
- Commence an EA Process
- Other ideas? Tell us your thoughts.

Open House Session

- Please help yourself to refreshments
- Please take a moment to complete a questionnaire
- Please ask questions or provide your comments

Thank you for attending and participating in the City of Peterborough Waste Management Master Plan Public Meeting No. 2.

Keep Informed

Further information can be obtained on the City Waste Management Webpage:

http://www.peterborough.ca/Living/City_Services/Waste_Management.htm

Or contact the City or its Consultant directly:

City of Peterborough
Contact: Virginia Swinson, B. Sc.
Waste Reduction Programs Coordinator
vswinson@peterborough.ca

Cambium Environmental Inc.
Contact: Kelly Murphy, P. Eng.
Senior Project Manager
kelly.murphy@cambium-env.com

City of Peterborough Waste Management Master Plan

Public Consultation Survey No. 2

The City of Peterborough is currently undergoing the development of a Waste Management Master Plan (WMMP) to review existing waste services and systems, and to develop plans for the next 20 years. The City appreciates any and all input residents will have into this process. Please complete and return this questionnaire using the contact information provided at the end of the survey. **Comments must be returned by October 22, 2012.**

The City has finalized and posted the Draft version of the WMMP for all to review on the website and copies are available at this public meeting for review. The WMMP developed key recommendations to reduce, reuse, and recycle and divert materials away from landfill.

1. The following are the Key Recommendations from the City's Waste Management Plan to enhance diversion from landfill. Please choose three that you believe to be the most important.

Develop an organics collection program for residential and apartment buildings.	___
If an organics collection program is implemented, reduce garbage pickup frequency to every two weeks and provide weekly recycling and organic pickup to reduce collection costs and encourage diversion.	___
Enhance Promotion and Education programs to keep residents informed about what they can and cannot recycle, reuse and compost.	___
Enhance City staff training to ensure they are aware of current regulations, technologies and market trends.	___
Establish recycling options for materials currently going to landfill including carpets, mattresses, textiles (clothing, linens)	___
Establish a Waste Exchange/Reuse Centre at the landfill.	___
Develop enhanced Public Space Recycling Program to provide recycling opportunities in parks and City facilities.	___
Undertake regular waste audits to ensure residents are understanding and participating in the recycling and organics programs.	___

The County/City has approximately 12-15 years of landfill capacity remaining. The more material we can divert from our landfill, the longer its lifespan will be. However, a new home for our remaining garbage will eventually be needed. The key recommendation from the WMMP was to continue to investigate and explore the City's options in cooperation with the County and move forward with an Environmental Assessment (EA).

City of Peterborough Waste Management Master Plan

Public Consultation Survey No. 2

2. **Please rank the following future waste disposal options by checking the box you feel is most appropriate for each (1 being most preferred; 7 being the least preferred).**

Most preferred → Least Preferred

Waste Disposal Options	1	2	3	4	5	6	7
Increase amount of waste diversion – Reduce, Reuse, Recycle (and extend the life of existing landfill)							
Expansion of existing landfill on Bensfort Road (if approved)							
Establish a new landfill facility within the City/County							
Export waste outside City/County boundaries (landfill or incinerate)							
Use of Alternative Waste Derived Fuel Technologies (using waste for energy generation incl. incineration, gasification)							

Other general comments:

____

If you would like further information, please provide your details below:

Name:____

Address: ____

Phone Number:______________________ E-mail :__________________________

City of Peterborough Waste Management Master Plan

Public Consultation Survey No. 2

If you have any questions regarding the Waste Management Master Plan, please contact:

City of Peterborough
Virginia Swinson, B. Sc.
Waste Diversion Section Manager
500 George Street North,
Peterborough, Ontario, K9H 3R9
Phone: (705) 742-7777 ext. 1725
Fax: (705) 876-4621
vswinson@peterborough.ca

Cambium Environmental Inc.
Kelly Murphy, P. Eng.
Senior Project Manager
52 Hunter Street North
Peterborough, Ontario K9H 1G5
Phone: (705) 742-7900 ext.226
Fax: (705) 742-7907
kelly.murphy@cambium-env.com

Working together, we can make a difference.

CITY OF PETERBOROUGH
WASTE MANAGEMENT MASTER PLAN

Public Information Centre. 2
Saturday October 20, 2012
9:00 am – 6:00 pm

CAMBIUM ENVIRONMENTAL

Name	Street Address	Email Address
Many forms completed but some did not wish to sign names		
See list from Survey Monkey		
Bill Mullin, Business Development Manager Lystek International Inc.	1425 Bishop Street N., Unit 16, Cambridge, ON N1R 6J9	bmullin@lystek.com
Michael Walters, Project Manager R.W. Tomlinson Limited		mwalters@tomlinsongroup.com
Ed McLellan	1442 Firwood Crescent, Peterborough, ON K9K 1J1	
Melanie Kawalec	500 George Street North, Peterborough, ON K9H 3R9	mkawalec@peterborough.ca

Name:	Address:	Phone Number:	E-mail:
Dawn Reid-Sims	697 Water Street	705-741-1016	beans2@cogeco.ca
Sharon Sevingny	217 Mcclennan St.	705-749-0943	rssevigny@sympatico
Elaine Goselin	221 Prince St., Peterborough, K9J 2A3	705-745-6156	
Jacque Bellamy	1118 Water St. Peterborough	705-749-9995	don5@sympatico.ca
George James			george@canadianacollections.com
Corinne Adams	Arndan Ave. Peterborough		c.radams@cogeco.ca
Katherine Jordan	441 Gordon Ave., Peterborough, ON	705-748-5848	ka.aspinall.jordan@gmail.com
Philip Shaw	801 hargrove trail	705-874-1688	pshaw@hotmail.com
Andrew Shaw	1634 Ravenwood Dr.	705-743-7210	shawandrew8@gmail.com
Tegan Moss	530 Sherbrooke St. Peterborough ON K9J 2P3	705-931-4744	moss.tegan@gmail.com
Corinne MacFadyen		705-743-4399	
Martin Parker	1494 Westbrook Drive	705-745-4750	mparker19@cogeco.ca
Michael			michael.scorer@cogeco.ca
Michele Swan	1177 normandy street, Peterborough		sswan2@cogeco.ca
Janelle Hendreson	478 cameron street peterborouhg ontario	705-760-9176	
Chanel Sim	456 cameron st	705-875-5429	ruthy.chanel@live.com
Susan Sauve	575 Gilchrist St.	705-743-9996	sueian575@gmail.com
Chris Dillon	170 edinburgh st		chrisdillon1@hotmail.com
Jon Harris	815 Hewitt Drive	705-743-6128	jonharris1970@hotmail.com
Ron Hargreaves	923 Philip St.	705 745 2128	ron.hargreaves@sympatico.ca
Brianna Salmon	237 Prince St Peterborough K9J2A6	705-933-0010	brianna.salmon@greenup.on.ca

Page 5, Q1. Other general comments:

1	need to send (mail) her info on cat litter, waste, composting	Oct 23, 2012 10:21 AM
2	Energy from waste the only sensible alternative	Oct 23, 2012 10:10 AM
3	people need to have a relationship with their waste to really get the issue offer tours to the waste dump	Oct 20, 2012 3:24 PM
4	I am interested to know how I can help with sustainability in my community including the encouragement of native trees and shrubs.	Oct 20, 2012 2:56 PM
5	Develop city incentive programs to encourage waste stream reduction and reuse - such as biogas	Oct 20, 2012 2:18 PM
6	Developing waste diversion programs is the way I believe that the City of Peterborough can most appropriately respond to high demands for waste disposal facilities. More appropriate systems for organics disposal ought to be foremost in developing a plan which not only reduces landfill materials, but improves community awareness. Examining programs like those offered in Nova Scotia can help Peterborough to develop an advanced approach to waste management.	Oct 20, 2012 1:44 PM
7	We cab only recycle so much. Still will be a need for responsible landfills. Incinerators are paper monsters and need a continual source of organic material with paper being the best. Would defeat paper diversion programs. Over packaging due to health unit regulations. Look at more efficient collection method. eg a combo truck which collect garbage on one side and recylables on the other. Smaller blue boxes for seniors who generate low volumes.	Oct 20, 2012 1:35 PM
8	We need organic recycling like Toronto. Government should enforce or pass a bill to re-use not recycle containers for juice, water etc. Make a deposit for return like beer bottles.	Oct 20, 2012 1:30 PM
9	I feel that education is the most effective way of reducing our global waste problems, but it has to start early so that it translates into a lifestyle. Leading by example is the only way to get people to take notice.	Oct 20, 2012 1:01 PM
10	We need to adopt a incinerator type of waste disposal system in Peterborough just as Japan has adopted it and other countries. Also, we need to abolish the use of polymer plastics and move to strictly bio-degradable plastics.	Oct 20, 2012 11:51 AM
11	I think the city and county need to sharpen their programs already in place at the current landfill sites. They need to be a little tougher on the mixed materials coming in.	Oct 20, 2012 11:04 AM
12	Peterborough is incredibly behind in its waste diversion efforts by not having organic waste pick up. Even small towns of 1200 have organic waste pick up. People new to the community have been incredibly surprised that there is no organic waste. We really need this now.	Oct 20, 2012 10:59 AM
13	Emulating the system that have in Nova Scotia would be great. The organics collection is key, with no plastic bags permitted. I would really like to see dog poo permitted in the organics in biodegradable bags.	Oct 20, 2012 10:56 AM

Page 5, Q1. Other general comments:

14	Force residents to understand that space for waste management is finite, therefore need to continually be reducing the amount waste generated	Oct 20, 2012 10:46 AM
15	Rethink, Reduce, Reuse, Regift, Recycle	Oct 20, 2012 9:50 AM

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WMMP 2012
Political

Design Survey | Collect Responses | Analyze Results

View Summary
Browse Responses
Filter Responses
Crosstab Responses
Download Responses
Share Responses

New Report | Edit Report

Response Summary for "New Report"

Total Started Survey: 57
Total Finished Survey: 55 (96.5%)

Select a page to view below or view all pages:

#2.

PAGE: 2

1. The following are the Key Recommendations from the City's Waste Management Plan to enhance diversion from landfill. Please choose THREE that you believe to be the most important.

Create Chart | Download

	Response Percent	Response Count
Develop an organics collection program for residential and apartment buildings.	58.2%	32
If an organics collection program is implemented, reduce garbage pickup frequency to every two weeks and provide weekly recycling and organic pickup to reduce collection costs and encourage diversion.	56.4%	31
Enhance Promotion and Education programs to keep residents informed about what they can and cannot recycle, reuse, and compost.	47.3%	26
Enhance City staff training to ensure they are aware of current regulations, technologies, and market trends.	18.2%	10
Establish recycling options for materials currently going to landfill including carpets, mattresses, textiles (clothing, linens).	72.7%	40
Establish a Waste Exchange/Reuse Centre at the landfill	30.9%	17
Develop enhanced Public Space Recycling Program to provide recycling opportunities in parks and City facilities.	27.3%	15
Undertake regular waste audits to ensure residents are understanding and participating in the recycling and organics programs.	30.9%	17
	answered question	55
	skipped question	2

Select a page to view below or view all pages:

« #2.

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WMMP 2012
Political

Design Survey | Collect Responses | Analyze Results

- View Summary
- Browse Responses
- Filter Responses
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- Download Responses
- Share Responses

New Report | Edit Report

Response Summary for "New Report"

Total Started Survey: 57
Total Finished Survey: 55 (96.5%)

Select a page to view below or view all pages:

#4.

PAGE: 4

2. Please rank the following future waste disposal options by checking the box you feel is most appropriate for each (1 being most preferred; 7 being least preferred).

Create Chart Download

	1 Most Preferred	2	3	4	5	6	7 Least Preferred	Response Count
Increase amount of waste diversion - Reduce, Reuse, Recycle (and extend the life of the existing landfill).	81.8% (45)	7.3% (4)	7.3% (4)	3.6% (2)	0.0% (0)	0.0% (0)	0.0% (0)	55
Expansion of existing landfill on Bensfort Road (if approved).	3.9% (2)	13.7% (7)	33.3% (17)	11.8% (6)	17.6% (9)	9.8% (5)	9.8% (5)	51
Establish a new landfill facility within the City/County.	0.0% (0)	14.9% (7)	8.5% (4)	17.0% (8)	17.0% (8)	12.8% (6)	29.8% (14)	47
Export waste outside City/County boundaries (landfill or incinerate).	5.8% (3)	1.9% (1)	9.6% (5)	11.5% (6)	5.8% (3)	13.5% (7)	51.9% (27)	52
Use of Alternative Waste Derived Fuel Technologies (using waste for energy generation including incineration and gasification).	42.6% (23)	27.8% (15)	14.8% (8)	5.6% (3)	3.7% (2)	1.9% (1)	3.7% (2)	54
							answered question	**56**
							skipped question	**1**

Select a page to view below or view all pages:

#4.

[redacted]

Appendix B

Relevant Legislation

FEDERAL LEGISLATION

Waste management is governed federally through the Canadian Environmental Protection Act (CEPA) and the Canadian Environmental Assessment Act (CEAA). The CEPA provides the legislative framework for the establishment of pollution prevention plans, identification of toxic substances, establishment of waste management facilities, import and export of waste, as well as to regulate the effects of government operations on and in relation to federal lands and aboriginal lands. The CEPA established the Environmental Registry as a means for the Canadian public to receive information on any waste management facility or system to be established or altered which requires public input and screening.

The Canadian Environmental Assessment Act (CEAA) applies to all projects where the Government of Canada has decision-making authority – whether as a proponent, land manager, source of funding, or regulator. All projects receive an appropriate degree of environmental assessment which ensures that the environmental effects of projects are carefully reviewed before federal authorities take action in connection with them so that projects do not cause significant adverse environmental effects.

CANADIAN ENVIRONMENTAL PROTECTION ACT

The CEPA declaration is as follows:

"It is hereby declared that the protection of the environment is essential to the well-being of Canadians and that the primary purpose of this Act is to contribute to sustainable development through pollution prevention."

The CEPA provides the government of Canada with some, but not necessarily all, of the following duties:

- facilitate the protection of the environment by the people of Canada;
- establish nationally consistent standards of environmental quality;
- provide information to the people of Canada on the state of the Canadian environment;
- apply knowledge, including traditional aboriginal knowledge, science and technology, to identify and resolve environmental problems;
- protect the environment, including its biological diversity, and human health, from the risk of any adverse effects of the use and release of toxic substances, pollutants and wastes;
- protect the environment, including its biological diversity, and human health, by ensuring the safe and effective use of biotechnology;
- endeavour to act expeditiously and diligently to assess whether existing substances or those new to Canada are toxic or capable of becoming toxic and assess the risk that such substances pose to the environment and human life and health;

- endeavour to act with regard to the intent of intergovernmental agreements and arrangements entered into for the purpose of achieving the highest level of environmental quality throughout Canada; and
- ensure, to the extent that is reasonably possible, that all areas of federal regulation for the protection of the environment and human health are addressed in a complementary manner in order to avoid duplication and to provide effective and comprehensive protection.

The CEPA established the Environmental Registry as a means for the Canadian public to receive information on any waste management facility or system to be established or altered which requires public input and screening.

CANADIAN ENVIRONMENTAL ASSESSMENT ACT

The Canadian Environmental Assessment Act (CEAA) applies to projects where the Government of Canada has decision-making authority – whether as a proponent, land manager, source of funding or regulator. All projects receive an appropriate degree of environmental assessment which ensures that the environmental effects of projects are carefully reviewed before federal authorities take action in connection with them so that projects do not cause significant adverse environmental effects.

The degree of assessment depends largely on the scale and complexity of the likely effects of the project. The assessment ensures that development in Canada or on federal lands does not cause significant adverse environmental effects in areas surrounding the project and the assessment is also used to ensure that there is an opportunity for public participation in the environmental assessment process.

After nation-wide consultations, in June 1992 the CEAA was passed and the Act provided four (4) types of environmental assessments: screening (including class screenings), comprehensive study, mediation, and assessments by a review panel.

Through a **screening**, a responsible authority documents the environmental effects of a proposed project and determines ways to eliminate or minimize (mitigate) harmful effects through modifications to the project plan. Projects with known effects that can be easily mitigated may be assessed through a **class screening**. There are two types of class screenings: models used to streamline a screening; or replacement class screenings that are used instead of a project-specific assessment.

Large-scale and environmentally sensitive projects usually undergo a more intensive assessment called a **comprehensive study**, which includes mandatory opportunities for public participation. **Mediation** is a process in which the Minister of the Environment appoints an impartial mediator to assess a project and help interested parties resolve issues. This approach may be used when interested parties agree, are few in number, and consensus appears possible.

Assessments by a **review panel** appointed by the Minister of the Environment may be required when the environmental effects of a proposed project are uncertain or likely to be significant or when warranted by public concerns. Review panels offer individuals and groups, with different points of view, a chance to present information and express concerns.

Projects undergoing a comprehensive study, a mediation or review panel, must include a consideration of alternative means of carrying out the project, as well as the project's purpose and effects on the sustainability of renewable resources. (Canadian Environmental Assessment Agency, 2011)

PROVINCIAL LEGISLATION

O. REG. 347 (GENERAL – WASTE MANAGEMENT)

O. Reg. 347 under the EPA is the primary regulation for controlling the handling, disposal, and management of hazardous and non-hazardous wastes within the Province of Ontario. Under Regulation 347, wastes are classified into categories that direct handing requirements and specify control measures for disposal facilities.

Standards for the location, maintenance, and operation of landfill sites are detailed in Section 11 of O. Reg. 347. Section 9 of the Regulation additionally states that the terms and conditions of the Certificate of Approval can, on a site specific basis, override the standards of the Regulation.

O. REG. 101/94 (WASTE DIVERSION ACT)

O. Reg. 101/94 outlines municipal responsibilities with respect to blue box recycling systems in Ontario. These requirements pertain to collection methods/frequency, materials being recycled, promotion, and reporting.

The Waste Diversion Act (WDA) was passed into law on June 27, 2002. The purpose of the WDA is to promote the reduction, reuse, and recycling of waste in Ontario and to provide for the development, implementation, and operation of waste diversion programs. Under the WDA, programs have been established for blue box waste (under Ont. Reg. 273/02), tires, Waste Electrical and Electronic Equipment (WEEE), and Municipal Household or Special Waste (MHSW).

In June 2004, the MOE released “Ontario’s 60% Waste Diversion Goal – A Discussion Paper”. The Discussion Paper outlines achieving a target of 60% waste diversion from disposal by 2008. The MOE identified seventeen (17) potential action items that would assist the Province in achieving 60% diversion, if implemented. These options were subsequently discussed through a province-wide consultation process and an assessment of the costs and environmental impacts of each option considered. While the results of the consultation and assessment processes were never released publicly, it was the Province’s intention that the discussion paper and its action items form the basis of policy decisions regarding Ontario’s future waste management system.

No steps were taken by the Province to formally establish the 60% waste diversion target or any other mandatory diversion target for municipalities. However, many of the larger Ontario municipalities and those with leading waste diversion programs have moved to adopt the 60% diversion target for the residential waste stream that they manage. While no municipalities have identified that they have successfully achieved this diversion target, several are proactively implementing diversion programs in order to meet this goal.

On June 12, 2007, the MOE released a proposed "Policy Statement on Waste Management Planning". The MOE posted the Policy Statement on the Environmental Registry for a 45 day public review and comment period. This Policy Statement outlines the requirement for municipalities with a population of less than 100,000 (i.e., City of Peterborough), to develop a municipal waste plan. A key aspect of the Policy Statement includes the requirement for municipalities to maximize diversion of materials from disposal, including a commitment to meet the provincial target of 60% diversion from waste disposal.

O. Reg. 101/94 makes it mandatory for municipalities with over 5,000 people to implement and operate a curbside recycling program (i.e., Blue Box program). The Blue Box program must allow for the source separation and collection of a core suite of materials for recycling and includes newsprint, paper, cardboard, steel, glass, aluminum, and PET food and beverage containers. This regulation also requires municipalities to provide a backyard composter program and leaf and yard waste collection and composting. The City currently provides these programs consistent with the regulation.

The City is currently meeting legislative requirements regarding diversion programming (i.e., blue box materials and recycling; tire, WEEE, MHSW diversion programs).

There are several proposed changes to waste management legislation that could potentially impact the City. In October 2008 the MOE began a review of the WDA. The purpose of the review was to investigate issues affecting waste diversion and to contemplate using the principles of Extended Producer Responsibility (EPR) as the basis for Ontario‘s waste diversion framework.

The potential impacts to the City can be described as follows and particularly as they relate to the possibility that producers could become fully responsible for waste diversion in the residential and IC&I sectors:

- potential loss of control of the recycling program;
- impact on infrastructure;
- disposal bans;
- disposal levies; and,
- program costs.

In April 2009, Waste Diversion Ontario (WDO) released a report entitled ―Blue Box Program Plan Review Report and Recommendations. This review was requested by the Minister of the Environment on October 16, 2008. The Minister directed WDO to undertake the Blue Box Program Plan (BBPP) review using the principles of extended producer responsibility to form the review framework. The review resulted in 20 recommendations under each of the ten (10) issues that were identified by the Minister of the Environment. Overall the review implications for the BBPP and Regulation 273/02 could affect the City's Blue Box program by requiring a change in the quantity, number, and type of materials accepted, requiring higher diversion targets, and ensuring environmentally responsible end-market destinations for recyclable materials. There may be the potential for increase funding which may offset any cost associated with implementing these changes. These potential legislative changes have been considered in the development of the City's WMMP.

Leaf & Yard Waste Management

O. Reg. 101/94 (Recycling and Composting of Municipal Waste) requires that municipalities that have a population of 5,000 shall establish, operate, and maintain a leaf and yard waste system. This system includes 'the provision of home composters to residents by the municipality at cost or less, the provision of information to residents, publicizing the availability of home composters, explaining the proper installation and use of home composters and the use of compost, and encouraging home composting.'

Municipalities with populations greater than 50,000 are also required to provide a leaf and yard waste collection system that is reasonably convenient to the generators of leaf and yard waste and that the waste must be either applied directly to land, transported to be applied directly to land, composted, or transported to be composted.

Burning of clean wood and brush is allowed at some member municipality landfills under conditions specified in their Certificates of Approval (C of A) in accordance with Ministry of the Environment Guideline C-7 (Burning at Landfill Sites - April 1994).

Industrial, Commercial and Institutional Wastes

There are currently two pieces of legislation which are applicable to IC&I waste. The first is O. Reg. 102/94 which requires certain IC&I facilities to conduct Waste Audits and produce Waste Reduction Work Plans. O. Reg. 103/94, Industrial, Commercial and Institutional Source Separation Programs, requires owners of the IC&I facilities identified in Reg. 102/94 to have source separation programs in place for certain wastes.

Source Separated Organics (SSO) Composting

Organic waste makes up approximately one-third of Ontario's waste stream and consists of:

- Leaf and yard waste;
- Household "green bin" waste;
- Food from restaurants, hotels, schools and hospitals;
- Residue from food processing operations and supermarkets; and
- Spoiled food;
- Sewage biosolids and septage; and

- Pulp and paper mill biosolids.

Currently there is no Provincial legislation banning food waste from landfill, or making composting of food waste mandatory and most organic waste in Ontario is sent for disposal in landfills or is land applied.

If a municipality chooses to implement curbside collection of Source Separated Organics (SSO), the central composting facility and testing of feedstock and resulting compost are currently regulated by the MOE's Interim Guidelines for the Production and use of Aerobic Compost in Ontario, November 2004.

The MOE is proposing to update the Interim Guidelines for the Production and Use of Aerobic Compost in Ontario (2004) to include the most up-to-date best management practices and standards. The MOE issued a proposed Guideline for Composting Facilities and Compost Use in Ontario dated November 2009 for consultation until January 2010.

The updated document will provide guidance on facility siting, design, equipment use and operating procedures, including feedstock control and odour prevention, would help minimize environmental impacts, such as odours, as well as improve the quality of finished compost.

It also introduces higher allowable feedstock metal levels and three categories of compost (Categories AA, A, and B). As mentioned in the Biosolids Management section, this proposed guideline creates an opportunity to co-compost food waste with biosolids if desired.

At the date of completion of this WMMP, a final decision or approval on the proposed Guideline had not been finalized by the MOE.

O. REG. 101/07 (WASTE MANAGEMENT PROJECTS)

In March 2007, the MOE announced the enactment of O. Reg. 101/07 (Waste Management Projects) under the EAA and amendments to the EPA for waste recycling, mining, alternative fuels, and new/emerging technologies. The regulatory changes were created for the purpose of reducing the time and resources required under select circumstances for the approval of continued operations of small rural landfills through capacity expansions or landfill mining.

The new regulation establishes three classes of waste management projects. Those projects, both public and private, with the highest impact are designated for the full EAA process and include:

- A new Environmental Screening process applies to projects with predictable effects that can be "readily mitigated."
- Projects classified as having minimal impacts, such as landfill expansions to less than 40,000 cubic metres, do not require approval under the EAA and are not designated as subject to the requirements of the EAA.

- Recycling facilities of any size will not have to go through the EA process provided that less 1,000 tonnes per day of waste is disposed.
- Proponents can pilot new waste technologies without having to undergo an EA providing they are small and can meet the MOE's air emission standards. It may make it easier to recycle certain wastes that currently do not meet existing exemptions criteria such as waste paint, crumb rubber batteries, and electronics.
- Converting certain wastes into alternative fuels will no longer require waste management approvals but must still meet the MOE's air emission standards.

O. REG. 267/03 (NUTRIENT MANAGEMENT ACT)

The Nutrient Management Act (NMA) and O. Reg. 267/03 (O. Reg. 267/03) made under that act, will impact waste management activities within the City because this legislation regulates nutrient use on agricultural land within the province. Some wastes (typically sewage sludge) that are routinely landfilled can also be land-applied as a nutrient source or soil amendment, subject to the conditions of the NMA and its Regulations. Similarly, some organic processing by-products from composting may be land-applied subject to regulation under the NMA.

Any nutrient containing materials of non-agricultural origin, including sewage biosolids that are spread on agricultural land are referred to as non-agricultural source materials (NASM). NASM land application standards and requirements are enforceable under the NMA and if an adverse effect occurs or may occur, the EPA or the Ontario Water Resources Act may also apply.

O. Reg. 267/03, which regulates NASM application to agricultural land, was updated September 18, 2009. Generators of NASM, such as wastewater treatment plants and food processing facilities, are regulated under the Environmental Protection Act and Regulation 347 until the nutrient material arrives at the farmer's gate where it becomes subject to the Nutrient Management Act, 2002 and O. Reg. 267/03.

Since land application of sewage biosolids and other NASMs to agricultural land is controlled provincially, it is possible for biosolids from one municipality to be spread on approved land in another municipality.

GUIDELINES FOR THE PRODUCTION OF AEROBIC COMPOST IN ONTARIO, 1991

Requirements for composting are listed in the Ministry of the Environment's Interim Guidelines for the Production and use of Aerobic Compost in Ontario, dated 1991. Under these guidelines, the inclusion of biosolids has been difficult for municipalities to meet due to very restrictive metal levels for the compost feedstock. Any resulting compost including biosolids would be controlled just as strictly as the original biosolids.

The MOE issued a proposed Guideline for Composting Facilities and Compost Use in Ontario dated November 2009 for consultation until January 2010 which includes less stringent allowable feedstock metal levels and three categories of finished compost (Categories AA, A, and B). If this Guideline is finalized without changes, there is a greater probability of co-composting biosolids if desired. Material characterization would be required to determine the acceptable level of dilution with low-metal feedstocks. Compost produced with biosolids has the potential of meeting the requirements of the middle category of compost, Category A, involving some labeling and usage restrictions. If the compost falls into Category B, its use would be controlled just as strictly as the original biosolids.

PROPERTY MAINTENANCE

Chapter 594
GARBAGE - COLLECTION

CHAPTER INDEX

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"CHAPTER 594
SOLID WASTE COLLECTION

Article 1
INTERPRETATION

594.1.1 City - defined
"City" means The Corporation of the City of Peterborough.

594.1.2 Garbage container - defined
"container" means a garbage container, a green waste container, or a recyclable material container.

594.1.3 Dwelling unit - defined
"dwelling unit" has the same meaning as that in the Zoning By-law of the City.

594.1.4 Garbage - defined
"garbage" means any dry waste other than green waste, recyclable material, building materials, automobile parts, hot, explosive or highly combustible material, hazardous waste as defined in Ontario Regulation 347, or waste resulting from industrial processes.

594.1.5 Garbage container - defined
"garbage container" means

(a) a galvanized metal or rigid plastic container with a maximum capacity of 120 litres, being larger at the top than at the bottom, having a handle and fitted lid, and not exceeding 23 kg., including contents;

(b) a polyethylene plastic bag of 1.5 gauge minimum thickness, fastened at the top and not weighing in excess of 23 kg., including contents;" (95-102)

(c) a securely tied compact parcel of cardboard which is not recyclable material, not exceeding 91 cm x 61 cm x 61 cm in dimension and 23 kg. in weight.

594.1.6 Green waste - defined
"green waste" means any plant material such as tree branches, shrub trimmings, grass clippings, bedding plants, weeds, or leaves.

594.1.7 Green waste container - defined

"green waste container" means

(a) a galvanized metal or rigid plastic container with a maximum capacity of 120 litres, being larger at the top than at the bottom, having a handle and fitted lid, and having two clearly identifiable labels attached defining the contents as "Green Waste" and not exceeding 23 kg., including contents;

(b) a wet strength kraft paper bag without ties, having a minimum total wall thickness of 0.23 mm, a flat base when unfolded, and not exceeding 23 kg., including contents; (95-102)

(c) an open, circular wooden basket with handles and tapered sides having a volume of 1 bushel, more or less, and not exceeding 23 kg., including contents; and

(d) tree branches or shrub trimmings not greater than 50 mm in diameter, securely tied in a bundle with string or twine made from natural fibres, not exceeding 100 cm. x 60 cm x 60 cm in dimension and 23 kg. in weight.

(e) a woven bag with drawstring or other closure, made entirely from biodegradable undyed natural fibre, and not exceeding 23 kg. including contents" (94-156)

594.1.8 Lodging house - defined
"lodging house" has the same meaning as that in the City's Licensing By-law governing the licensing and regulation of lodging houses (Chapter 490, City of Peterborough Municipal Code).

594.1.9 Occupant - defined
"occupant" means the person in possession of a building or unit, and includes an owner or tenant.

594.1.10 Person - defined
"person" includes a corporation, partnership, or association.

594.1.11 Recyclable material - defined
"recyclable material" means any material designated by the City as being acceptable for collection by the City or its agent for the purpose of recovery. Without limiting the generality of the foregoing, it shall include newspaper, unwaxed corrugated cardboard, boxboard, magazines, household fine paper, soft cover books, aluminum foil, and containers made of metal, glass and plastics." (95-102)

594.1.12 Recyclable material container - defined
"recyclable material container" means

(a) a blue rigid plastic container without a lid having a suitable identification, being larger at the top than at the bottom and having a maximum height of 35 cm and a top dimension of 40 cm x 50 cm, and not exceeding 23 kg., including contents; and

(b) a secure bundle of newspapers or corrugated cardboard not exceeding 60 cm x 30 cm x 20 cm in dimension and not exceeding 23 kg. in weight.

594.1.13 Solid waste - defined
"solid waste" includes garbage, green waste and recyclable material.

594.1.14 Supervisor - defined
"Supervisor" means a Supervisor of solid waste collection appointed by resolution of Council.

Article 2
GENERAL PROVISIONS

594.2.1 Materials - prohibited
No person shall place out for collection any material which is not solid waste.

594.2.2 Solid waste - for collection - container required
No person shall place solid waste out for collection except in a container.

594.2.3 Garbage containers - maximum permissible
Except as provided in Sections 594.2.4 and 594.2.5, not more than four (4) garbage containers will be collected from any building or unit on any collection date. (95-102)

"594.2.4 Garbage containers - maximum permissible - dwelling unit
Not more than two (2) garbage containers will be collected from a dwelling unit on any collection day, excepting the collection day next following December 25 in each calendar year, when not more than four (4) garbage containers will be collected. (95-102)

594.2.5 Garbage containers - maximum permissible - lodging house
Not more than four (4) garbage containers will be collected from a lodging house licensed for less that ten (10) lodgers on any collection day, excepting the collection day next following December 25 in each calendar year, when not more than six (6) garbage containers will be collected.

594.2.6 Containers - placement - permissible locations
Containers shall be placed separately by the occupant in front of his or her building or unit, just off the travelled portion of the street so as not to interfere with traffic, or at any other convenient location as may be approved by a Supervisor.

594.2.7 Containers - removal after collection - time
Any container not collected shall be removed by the occupant by 8 o'clock in the afternoon of the day of collection.

594.2.8 Containers - placed for collection - times
Containers shall be placed out for collection by the occupant not later than 7 o'clock in the forenoon of the day of collection and not earlier than 6 o'clock in the afternoon of the previous day.

594.2.9 Scavenging - prohibited
No person, other than the occupant, or the City or its agent, shall remove the contents of any container placed out for collection pursuant to the provisions of this Chapter.

594.2.10 Collection - private property - conditions
Notwithstanding anything else contained in this Chapter, the City, or its agent, may, under conditions satisfactory to the City Engineer and the City Solicitor respecting access, container locations, and the execution of an indemnification agreement, enter upon private property for the purpose of collecting garbage, green waste or recyclable material.

594.2.11 Supervisor - enforcement
Every Supervisor shall have the authority to enforce the provisions of this Chapter.

Article 3
SEVERABILITY

594.3.1 Severability
If any section of this Chapter may be bound by any court of law to be illegal or beyond the power of Council to enact, such section shall be deemed to be severable and all other sections of this Chapter shall be deemed to be separate and independent therefrom

Article 4
ENFORCEMENT

594.3.1 Fine - for contravention
Any person who contravenes this Chapter is guilty of an offence and shall be liable upon conviction to a fine imposed by law, and the same shall be recoverable pursuant to the Provincial Offences Act." (94-54)

THE CORPORATION OF THE CITY OF PETERBOROUGH

BY-LAW NUMBER 07-027
AS AMENDED BY BY-LAW 09-108

(note: all amendments are in bold and underlined)

BEING A BYLAW FOR THE PURPOSE OF REGULATING THE DISPOSAL OF WASTE, INCLUDING ESTABLISHING OF TIPPING FEES FOR THE PETERBOROUGH COUNTY-CITY WASTE MANAGEMENT FACILITY

WHEREAS Council of the City of Peterborough wishes to enact a By-law for the purposes of regulating the disposal of waste;

AND WHEREAS Section 391 of the *Municipal Act, 2001* provides that a municipality may pass by-laws imposing fees or charges;

AND WHEREAS solid waste tipping fees will be included in the By-law;

AND WHEREAS the City of Peterborough held a public meeting on December 11, 2006 at City Hall, 500 George Street North, Peterborough, in accordance with Regulation 244/02 under the *Municipal Act, 2001*;

NOW THEREFORE the Council of the City of Peterborough enacts as follows:

1. INTERPRETATION

In this By-law:

“City” means the City of Peterborough;

“Director” means the Director of Utility Services for the City of Peterborough and where applicable includes a person designated by the Director to perform a task or exercise a power in his or her place and stead;

“garbage” means dry waste other than recyclable materials, organic materials and hazardous waste;

“green waste” has the meaning set out in Schedule “A”;

“hazardous waste” means hazardous waste as defined in R.R.O. 1990, Regulation 347, as amended from time to time, pursuant to the Environmental Protection Action, R.S.O 1990, cE19, which includes:

a) hazardous industrial waste;
b) acute hazardous waste chemical;
c) hazardous waste chemical;
d) severely toxic waste;
e) ignitable waste;
f) corrosive waste;
g) reactive waste;
h) radioactive waste, except radioisotope wastes disposed of in a landfilling site in accordance with the written instructions of the Atomic Energy Control Board or the Canadian Nuclear Safety Commission;
i) pathological waste;
j) leachate toxic waste;
k) PCB waste as defined in Regulation of 362 of Revised Regulations of Ontario, 1990;

“recyclable materials” means those materials set out in Schedule “A”;

“waste” means anything for which the holder has no further use and which the holder has discarded and includes, but is not limited to garbage and recyclable material;

"waste management facility" means the Peterborough County/City Waste Management Facility, formerly known as Bensfort Landfill Site, located at 1260 Bensfort Road, Township of Otonabee, South Monaghan, County of Peterborough. For the purpose of this by-law, the waste management facility includes the landfill site and the Public Drop-off Depot.

2. GENERAL PROVISIONS AND PROHIBITIONS

2.1 No person shall, at the waste management facility:

(a) deposit waste outside the posted hours of operation;

(b) deposit waste or recyclable materials at any place other than the place respectively designated for the receipt of such waste;

(c) deposit hazardous waste;

(d) deposit any waste which originated from outside the County or City of Peterborough. If requested, the person shall provide proof of the origin of the waste prior to depositing the waste;

(e) refuse to remove, at the person's expense, any waste which has been deposited by the person which is not in compliance with this by-law;

(f) remove or scavenge any deposited waste without the prior written approval of the Director;

(g) deposit waste which has been transported to the facility except when such waste has been properly secured or covered in canvas, tarpaulins or nets, so fastened down around the edges as to prevent any of the contents from leaving the vehicle during transport.

2.2 Not withstanding Section 2.1 (b), any load which contains less than 10% by volume of recyclable materials may be deposited at the place designated for the receipt of garbage.

3. FEES

3.1 No person shall deposit waste at the waste management facility without paying the appropriate fee for that type of waste, as set out in Schedule "B".

3.2 If any cheque provided in payment of a fee payable under Subsection 3.1 is returned marked "Not Sufficient Funds", the amount of the fee shall remain unpaid, and together with the administrative charge for NSF cheques, determined in accordance with the City's Financial Policies shall be a debt to the City owing by that person recoverable by action or other means open to the City.

4. ENFORCEMENT PROCEDURES

4.1 In the event that a person deposits, or attempts to deposit waste, not in compliance with this by-law:

(a) The person may be refused access to the waste management facility;

(b) The person shall receive a written warning on the first such occasion;

(c) The person shall pay surcharges in the following amounts on any subsequent occasions:

(i) $100 on the first subsequent occasion;

(ii) $200 on the second subsequent occasion;

(iii) $300 on the third and any other subsequent occasions.

5. **SCHEDULES**

The following Schedules attached hereto form a part of this By-law:

Schedule “A” –Recyclable Materials; and

Schedule “B” – Waste Management Tipping Fees.

6. **PENALTY**

Any person who contravenes this by-law is guilty of an offence and, upon conviction, is liable to a fine or penalty provided for in the ***Provincial Offences Act***, as amended.

7. **EFFECTIVE DATE**

This **amended** By-law shall come into force and take effect on **Tuesday, September 1, 2009.**

By-law 07-027 read a first, second and third time this 26th day of February, 2009.
By-law 09-108 read a first, second and third time this 10th day of August, 2009.

SCHEDULE "A"

TO BY-LAW 07-027
RECYCLABLE MATERIALS

The following materials are banned from disposal at the waste management facility but are accepted for recycling at the facility's Public Drop-off Depot:

"blue box materials" means recyclable materials as collected in the City of Peterborough Blue Box Collection program, as amended from time to time, namely:

a) clear and coloured glass from food & beverage bottles and jars; aseptic containers;
b) metal cans and foil; including food & beverage cans, aluminum foil & trays;
c) empty metal paint and aerosol cans;
d) gable top drink cartons and tetra paks including milk and juice cartons and tetra pack containers for juice, milk, soup;
e) plastic soft drink and water containers made out of polyethylene terephthalate (PET or PETE #1);
f) plastic bottles and jugs made out of high density polyethylene (HDPE #2);
g) tubs and lids (#5);
h) polystyrene and styrofoam containers (#6) including clear trays abd clamshells marked with the #6 only; plant pots up to 12 inches in size, cell-paks, carrying flats; foam meat trays, plates, cups, take-out containers and egg cartons only;
i) film plastic bags including bread, milk , fresh and frozen produce bags, bulk food, dry cleaning, toilet-tissue packaging, and cereal box liners;
j) boxboard, including cereal, crackers, detergent, toothpaste, shoe boxes;
k) corrugated cardboard consisting of triple-layer cardboard boxes. Waxed, stained, painted or contaminated cardboard must be discarded as garbage;
l) paper including envelopes, direct mail advertising, paper egg cartons, greeting cards and all remaining paper and paper products generated by households
m) newspapers & magazines, including inserts, catalogues, white envelopes, computer paper; writing papers, telephone directories, manuals & softcover books;

"clean wood waste" includes untreated lumber and wood products such as pallets and raw lumber, but does not include painted wood, paneling, pressboard or similar treated products;

"drywall" includes drywall scraps or drywall material, which may contain paint and screws, segregated from supporting building material;

"green waste" means leaves, grass clippings; trees, excluding stumps; garden roots and cuttings; hedge and shrub trimmings; brush cuttings; twigs and branches; natural Christmas trees; other plant material;

"scrap metal" includes metal auto parts, large appliances, bicycles, tools, etc; and

"tires" means tires without wheel rims.

SCHEDULE “B”

TO BY-LAW 07-027
WASTE MANAGEMENT TIPPING FEES

1. GARBAGE

	Rate
a) **Load of 100 kg or less**	$5.00 flat rate
b) **Load over 100 kg**	$90.00 per metric tonne ***2010 Budget Cycle***
c) **Asbestos**	**$200.00 per metric tonne**

2. RECYCLABLE MATERIALS

	Rate
a) **Load of 100 kg or less**	FREE
b) **Load over 100 kg**	$45.00 per metric tonne
c) **On-road, off-road, and farm tires**	**FREE**
e) **Appliance containing Freon**	$15 fee per appliance to certify removal of freon

3. UNCONTAMINATED GRANULAR MATERIAL AND NON-HAZARDOUS CONTAMINATED SOIL TIPPING FEE

	Rate
a) Granular materials determined by the Director to be suitable as cover material at the waste management facility, and deposited in the area specified by the Director, for such use;	FREE
b) Non-hazardous contaminated soil, tested for suitability by owner of the material; determined by the Director to be suitable as cover material at the waste management facility, and deposited in the area specified by the Director for such use.	$20.00 per metric tonne

4. ELECTRONIC OR HAZARDOUS MATERIALS

All loads of waste electronic and electric equipment or municipal hazardous and special waste must be taken to the Household Hazardous Waste Drop-off Depot for recycling or proper disposal.

	Rate
a) **Monitors**	**FREE**
b) **Fluorescent Light Tubes**	**FREE**

Appendix C

Waste Diversion Options

Strategy Enhancement Options for Diversion

Strategy Category	Strategy No	Strategy Enhancement Option	Enhancement Factors: Diversion Potential	Enhancement Factors: Implementation Costs	Enhancement Factors: Operation Costs	Evaluation of Strategy Enhancement Options: Economic Feasibility	Evaluation: Environmental Effects	Evaluation: Social Acceptance	Evaluation: Ease of Implementation	Timeline	Total	Ranking
Promotion and Education	1	**General P&E** City Website, City to move into social media while continuing with current media campaigns, mywaste.ca, and outside calendars/websites, Media (Ads, Articles, Press Releases, Radio, etc.), Calendar and Promotional Materials and Products, Enhanced In Your Area (media, signage, and prizes), Materials - Design and Production (signage, mobile signs, and stickers/labels), local presence at events and open houses within the community, increased and targeted education (ie. paper/plastics), provide feedback to residents with audits, composting campaign and enhanced promotion of backyard composting, green procurement and sustainable procurement programs, re-use exchange programs, support producer responsibility and Sustainable Peterborough goals, support IC&I recycling programs, development of review protocol with collection program to aim for 20% increase in capture rates from 2006 levels over 20 years with a review every five years.	2-5%	-	$100,000	◕	◑	●	●	S	17	1
	2	**Schools Programming** Enhancement, expand and formalize		$10,000	$20,000	◕	◔	◕	◕	S	14	3
	3	**Training** Attend training and workshops, industry meetings (MWA, SWANA etc.)		-	$5,000	●	◑	◑	●	S	16	2
Enhanced Diversion	4	**C&D Waste Collection** City would provide residents option to receive collection services for small quantities of C&D materials. City could establish collection based upon building or demolition permit application.	5%	Policy Improvements	Enforcement	●	◕	◕	◕	S	17	1
	5	**MHSW / Electronics** Continue to improve upon the collection system	1-2%	Cost Neutral	Cost Neutral	●	◑	●	◑	S	16	2
	6	**Scrap metal collection and recycling** Continue to improve upon the collection system	<1%	Policy Improvements	Enforcement	●	◔	●	◑	S	15	2
	7	Other areas of recycling including **textile recovery, pet waste, wood waste, durable goods and shingles** - Continue to expand upon the current collection system	1% to 3%	Policy Improvements	Enforcement	◕	◕	●	◕	S	17	1
	8	**Waste Exchange Center -** City establishes waste exchange program ranging from reuse centres to on-line waste exchange programs enabling residents to donate and exchange reusable goods. Common for reuse centre to be established at landfill or transfer station.	1% to 5%	$20,000	Staff Time	◕	◕	●	◑	S	16	2
	9	**SSO Collection** City to establish a curbside collection and processing program for SSO materials.	17%	Estimates of $500,000 to $1,500,000 from FCM	Estimates of $600,000 to $1,000,000 from FCM	◑	●	●	◕	S	17	1
	10	**Expand the list of eligible Blue Box materials**	<1%	Secure Markets	Education	●	○	●	◑	S	14	3
System Optimization	11	**Pick-Up Frequency** Explore bi-weekly pick-up of waste once an SSO program is established	3-7%	TBD	TBD	●	●	◔	●	S	17	1
	12	**Audit & Report** Complete waste regular waste audits to confirm composition and to determine available material for recovery. Compare with other municipalities and the County/Townships	-	-	$12,000	◕	◑	◕	◕	S	15	2
	13	**System & Costs** Complete waste flow and full-cost accounting tools using gap or similar analysis. Explore waste management utility by operating all waste management activities as a separate utility.	<1%	Staff Time	Staff Time	◑	◑	◕	◑	S	13	3
	14	**Public space diversion and recycling** Work with parks and recreation to install and collect recycling containers in high traffic areas, especially where evidence of container use is pronounced. Includes outdoor parks, trails, and public facilities.	1% to 3%	$2,400	Staff Time	●	◕	●	◕	S	18	1
	15	**Special events diversion and recycling** City establishes policy or incentives for events coordinators and contractors to make recycling at special events	<1%	General P&E	Staff Time	◕	◕	◕	◔	S	14	3
Multi-Residential Recycling and Diversion	16	**Feedback to buildings** The use of "barometers" and other graphic representations to tell residents how their building is doing in the area of recycling and waste diversion	3-5%	General P&E	Staff Time	●	◔	◕	◑	S	14	3
	17	**Garbage chute closure support** City would provide support to buildings opting to close garbage chutes to make recycling as convenient as waste disposal		-	Staff Time	●	◕	◔	○	S	12	3
	18	**Designated goods diversion (e.g. HHW, Electronics, Textiles)** Specific collection programs are established in multi-residential buildings to divert designated goods for recycling/reuse		General P&E	Collection	◕	◕	◑	◑	L	14	3
	19	**Waste diversion info provided to new and existing tenants** Building owners are required to provide waste diversion educational packages to new tenants and existing tenants on an annual basis		General P&E	Staff Time	●	○	●	◑	S	14	3
	20	**Multi-Residential Working Group** City establishes a Multi-Residential Working Group that meets on a regular basis to discuss waste diversion challenges and strategies		General P&E	Staff Time	●	◕	◕	◕	S	17	1
	21	**GreenCart Implementation** Support GreenCart implementation in MR buildings so service consistent with SF households		General P&E	Collection and bins	◑	●	●	◔	L	15	2
Policy and Enforcement	22	**Clear bags for excess garbage** Residents are required to place any garbage beyond one bag, enforced as above	4%	Policy Improvements	Enforcement	●	◕	○	◑	L	13	3
	23	**Contract incentives/penalties (for recycling, organics, garbage contracts)** Develop contract language and approaches that will reward desired performance or incentive increased waste reduction, recycling and organics performance	<1%	Policy Improvements	Enforcement	◕	◑	◔	○	L	10	3
	24	**Curbside Materials Bans** Designated material is banned from being collected with garbage at the curbside. example may include grass. The collection crew has the authority to refuse to collect the garbage if containing banned materials. Commonly banned materials include electronic waste, recyclable materials, wood waste.	3%	Policy Improvements	Enforcement	●	◕	◑	◑	S	15	2
	25	**Stronger Enforcment** of bans and lift limits at the curb										
	26	Stonger enforcement of **Landfill/Disposal Bans** Designated materials are prohibited from being disposed at the landfill or disposal facility										
	27	**Pay-as-you-throw and Sustainable Financing Strategies** Financing strategies used to promote waste diversion including Full or Partial Bag Tag systems, variable and hybrid variable rates, pay by collection frequency, variable carts rates, weight-based garbage collection, possibly supported by RFID technology	1% to 3%	$25,000	P&E and Administration	◕	◕	◑	◔	S	13	3
IC&I Recycling and Dive	28	**Build IC&I Database** Make database for use to manage and monitor solid waste programs	TBD	Staff Time	Staff Time	●	◔	◕	◔	L	13	3
	29	**Designated goods diversion (e.g. HHW, Electronics, Textiles)** Specific diversion programs established small IC&I to divert designated goods for recycling/reuse and expand to larger IC&I gradually.		Policy Improvements	Enforcement	◕	◕	◑	◑	L	14	3
	30	**SSO Implementation** Support SSO implementation at IC&I's so service consistent with residential		-	Staff Time	◕	●	◕	◑	S	16	2

Residual Disposal Options | **Management of Residual Waste Options**

Strategy Category	Strategy No	Strategy Enhancement Option	Diversion Potential	Implementation Costs	Operation Costs	Economic Feasibility	Environmental Effects	Social Acceptance	Ease of Implementation	Timeline	Total	Ranking
Disposal	1	**Expand or build new municipally operated landfill Site**	-	$6 million to $12 million	$500,000 to $1 million	◑	◑	○	◑	L	7	
	2	**Export Waste** Garbage is shipped/transfered to a private waste disposal facility (landfill or thermal) for disposal.	-	$20,000	$1.2 million to $1.7 million	◑	◑	◑	●	L	9	
	3	**Disposal using Energy from Waste** Establishing a thermal treatment facility within County to operate as EFW	-	$50 million to $200 million	$50 to $120 per tonne	○	◑	○	◑	L	6	

Legend

Short Term	S
Long Term	L
Rating of 1 out of 5	○
Rating of 2 out of 5	◔
Rating of 3 out of 5	◑
Rating of 4 out of 5	◕
Rating of 5 out of 5	●

Appendix D
Supporting Reports

FILE COPY 1415

RESIDENTIAL WASTE COMPOSITION STUDY

VOLUME I OF THE ONTARIO WASTE COMPOSITION STUDY

JANUARY 1991

Ontario

Environment
Environnement

ISBN 0-7729-8005-5

RESIDENTIAL WASTE COMPOSITION STUDY

VOLUME I
OF THE ONTARIO WASTE COMPOSITION STUDY

JANUARY 1991
Reprinted JANUARY 1993

Cette publication technique
n'est disponible qu'en anglais.

PIBS 1415

RESIDENTIAL WASTE COMPOSITION STUDY

VOLUME I OF THE
ONTARIO WASTE COMPOSITION STUDY

Report Prepared By:

Gore and Storrie Limited
in association with
Decima Research Limited

Report Prepared For:

Waste Management Branch
Ontario Ministry of the Environment

JANUARY 1991
Reprinted JANUARY 1993

PIBS 1415

DISCLAIMER

This report was prepared for the Ontario Ministry of the Environment as part of a ministry-funded project. The views and ideas expressed in this report are those of the author and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsements or recommendation for use.

INFORMATION FOR THE READER

The results of the work will appear in three volumes.

Volume I contains the results of the residential portion of the Ontario Waste Composition Study and are presented herein. The emphasis in Volume I is on the development and testing of a method that municipalities can use to estimate per capita generation rates of residential refuse.

The following kinds of information on municipal waste are also included in Volume I: inorganic chemical analyses of vacuum cleaner bag dust (Town of Fergus and Borough of East York); moisture content of combustible materials separated from residential refuse (Town of Fergus and Borough of East York); BTU content of several mixed plastic wastes; waste composition and per capita generation rates of several schools (Borough of East York); and a survey of disposal of white goods and bulky items in several Ontario municipalities.

Volume II will report the results of the Commercial Waste Composition Study.

Volume III will be a " user friendly " manual that will outline the procedures for conducting residential and commercial waste composition studies in municipalities of Ontario.

ABSTRACT

Volume I, The Residential Waste Composition Study, is the first of three volumes representing the Ontario Waste Composition Study.

The Residential Study focuses on developing a cost effective method for carrying out a waste composition analysis. This method facilitates the collection of waste composition data and per capita waste generation data.

The Residential Waste Composition Study took place in the following municipalities. The Town of Fergus (population 6,757) between July 15 and August 31, 1989; The Borough of East York (population 101,085) between October 24 and December 28, 1989; and The City of North Bay (population 51,313) from February 21 - 28 , 1990.

The method used in the study is based on the hypothesis that the characteristics of a residential waste stream are related to the socioeconomic lifestyles of people and the demographic characteristics of a municipality.

Statistics Canada information about the population of a municipality provides subunits of the population, known as Enumeration Areas (EAs). Each EA on average contains 600 people. Using the most recent Statistics Canada Census data each EA of the studied Municipalities were stratified according to income level (high, medium, or low). Within every income category each EA was further classified according to housing type. Statistics Canada reports on the number of single detached, apartments and other residences for each EA. From the income and housing type information, an income/housing sample matrix table was designed, defining the EAs to be sampled.

Based on a random numbering sample selection procedure for residential dwellings of a defined EA, the study team followed a sampling program in which refuse was collected, sorted into various waste composition categories (i.e.

papers, plastics etc.), and weighed. Although the sampling method may vary based on housing type, in general, ten 100 kg. samples (minimum weight) were collected per day. Blue Box materials and yard waste, if present, were also collected but weighed separately. Total weights of refuse samples were measured for per capita waste generation data. White goods and bulky waste were also analyzed within the scope of the study.

The Residential Study demonstrated a cost effective waste composition and generation rate procedure that uses readily available equipment and that can be implemented by municipal staff.

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EXECUTIVE SUMMARY

The two-fold purpose of the residential portion of the Ontario Waste Composition Study was to:

1. develop a simple, cost effective and statistically reliable method for determining the composition and per capita generation rate of waste from residential sources in Ontario municipalities; and
2. apply the method in several municipalities and obtain current information on the characteristics of residential waste streams.

On the strength of a pre-study literature survey, summarized herein, it became apparent that residential waste generation was a function of the socio-economic and demographic characteristics of a population. Indeed, any assessment of the residential waste generation characteristics of a municipality should take population demographics into consideration.

While the number of socio-economic and demographic parameters that one could incorporate in a study of residential waste generation is very large, time and budget dictated that the parameters in the present study should be restricted to two principal parameters: income level and housing type. Statistics Canada provides census data with respect to these parameters for municipalities across the country and this kind of information was obtained for the three municipalities participating in the waste composition study in Ontario: the Town of Fergus (population: 6,757); the Borough of East York (population: 101,085); and the City of North Bay (population 51,313). The field studies were conducted in the three municipalities during the following periods: July 15 to August 31, 1989; October 24 to December 28, 1989; and February 21 to February 28, 1990 respectively.

Statistics Canada provides socio-economic and demographic information on small geographical sectors of municipalities called Enumeration Areas (EAs) that typically have a residential population of 600-800 persons. Some apartment buildings may have a large enough number of units that they are designated as EAs unto themselves.

In the work reported herein, the EA was the basic population unit whose waste composition and per capita generation rates were studied as representative segments of the entire municipal population. First, all of the EAs in the municipality were classified in a three-by-three, two dimensional matrix of:

Average annual income: high, medium, and low; and

Housing type: single detached dwellings, predominantly multiple dwellings (apts.), and predominantly mixed (detached apts.).

This classification matrix resulted in nine possible combinations of income levels and housing types with each combination termed a "cell". One EA was randomly selected from each cell, unless the cell contained few or no EAs, which was often the case for the low income detached dwelling cell. The residential waste assessments in the Town of Fergus and the Borough of East York were based on data from EAs that were representative of the EA distribution in the income/housing matrix for the respective municipalities. Based on the results of these two municipalities, it was decided to conduct a reduced sampling program in the City of North Bay.

After the Study EAs in the municipality were randomly selected, a curbside refuse sampling plan was designed, based on a procedure that assigned random starting points for refuse collections at street intersections throughout the EA. For each EA, both the number and weight of the refuse samples that had to be collected and sorted in order to obtain the statistical accuracy that we wanted to achieve for the kitchen waste fraction (only) of residential waste was based on the pioneering work of Dr. A. Klee and co-workers. The sample number was nine per EA and the minimum sample weight was 100 kg. To achieve similar levels of statistical accuracy for waste components occurring at lower concentrations in the waste stream (for example, glass and ferrous metals), a greater number of samples, which may be economically impractical, would be required.

It took a crew of four, approximately 5.5 days to collect and sort the bagged refuse and Blue Box materials in a single EA. Records were kept of the number of dwellings from which bagged refuse and Blue Box materials were collected in order to compute estimates of total residential waste generation on a per capita basis, using Statistics Canada data on the average population per dwelling in the EA. Blue Box materials were sorted, weighed and recorded separately in order to estimate the capture rate of certain recyclable items from the residential waste stream.,

Yard wastes were weighed and recorded whenever they were encountered, but this waste stream was not included in the computations of the residential waste composition and the weight was not included in the estimates of per capita generation rates either, for seasonal generation reasons discussed herein.

The moisture content of the combustible fractions of the waste stream was determined by drying. The BTU content of some mixed plastics (laminates), as well as disposable diapers, was determined by bomb calorimetry. Samples of vacuum cleaner bag dust were analyzed for heavy metals.

Special sampling procedures were devised for those apartment buildings where the waste was compacted in containers. Samples of the required weight were removed from the containers for the waste composition analysis. Then the residual contents were collected and weighed, courtesy of special arrangements made with a local waste hauler and transfer station scale house.

The weekly waste streams for seven schools in East York were also collected and the waste composition was determined. Per capita generation rates for the student body and total staff were computed.

A survey was also conducted to assess the yearly tonnages of white goods and other bulky items generated by residential areas in 10 municipalities in Ontario.

The methods developed and used in this study were found to be cost effective and capable of being used by municipal staff. Recommendations are presented to further refine and improve the methods used.

Ontario municipalities are encouraged to use the methods demonstrated in this study to satisfy municipal needs, to generate further data on a consistent province-wide basis and to assist in assessing the effectiveness of new waste management programs and identifying trends in waste composition and generation rates.

Conclusions:

The results of the residential waste study presented herein lead to the following conclusions.

1) Municipalities in Ontario are implementing a number of waste diversion options for residents -- notably, Blue Box and backyard composting -- as the waste management strategies of municipalities continue to change. As the number of waste diversion options increase, the chances of obtaining an accurate baseline of waste generation data decreases. Where there was formerly a single waste stream coming from residences on a predictable and scheduled basis, now there may be two or more curbside waste streams, and possibly another stream directed to a backyard composter. Therefore, there is more potential for error in waste composition studies conducted in municipalities that are aggressively pursuing waste diversion programs (e.g. Fergus and East York) than in those that have yet to implement such programs --- and where there is still a single residential waste stream.

2) Given an understanding of the reality of residential waste stream partitioning noted above, the residential waste assessment procedures for detached dwellings included an estimated allocation for Blue Box materials. Waste assessment of residential populations residing in multi-unit dwellings (apartments) presented additional challenges in data collection. Per capita waste generation rates were obtained for both residential groups; however, a need for improvement in sampling procedures was identified for large apartment buildings (East York) where refuse was compacted.

3) The per capita waste generation rates (excluding yard wastes and bulky items) for the three municipalities appeared to vary with population: Fergus 0.80 kg/capita/day; North Bay 0.93 kg/capita/day; East York 0.99 kg/capita/day. However, municipal population per se is probably only a superficial correlate and not causally related to the waste generation process. For example, the weight (kg) of the newspapers collected in East York, versus Fergus, may partially explain the higher per capita generation rate (kg/person/day) in East York (Table 14). Some of the difference may also be attributed to seasonal factors.

4) The method used in the Study has revealed apparent differences in the per capita waste generation rates within income groups. More waste (excluding yard waste and bulky waste) appears to be generated by residents of detached dwellings than by apartment dwellers (Table 22). However, no easily discernable pattern could be detected in the per capita generation rates between different income groups. More detailed sampling in each municipality would be needed to determine any potential income effects on waste generation characteristics.

5) It is interesting to note that there is very little difference in average per capita generation rates of kitchen waste for Fergus, North Bay and East York. The respective values are: 0.23, 0.24 and 0.25 kg/capita/day (Table 22).

When the kitchen waste fractions were computed as a percent of the total composition of the residential waste stream, Fergus showed a higher percentage than East York and North Bay: Fergus 28.8 % versus, East York 25.5 % and North Bay 26.0 %. Again, larger quantities of other components in the East York and North Bay residential waste streams (e.g. newspapers) may explain the lower percentage (or relative proportion) of kitchen waste in the refuse.

(6) Reliance on "waste composition percent" as the sole means of characterizing waste can be misleading and create more questions than are actually answered. The per capita generation rates of the total waste stream and its components are more important for planners of municipal waste management programs.

7) The study demonstrates a cost effective residential waste assessment method that uses readily available equipment and that can be implemented by municipal staff.

<u>Recommendations:</u>

Municipalities conducting a waste composition study might consider the following recommendations when designing the sampling protocol and implementing the study methodology.

1) For sampling and sorting convenience, municipalities may choose to conduct the waste composition studies in late spring or mid fall when refuse odours are less intense and maggots are less frequently encountered. According to Vesilind & Rimer (ref. 47), the average residential waste composition does not vary by more than ± 10% over three quarters of the year. Therefore, aesthetics of the working conditions can be taken into account without risk of obtaining skewed

data. The inclusion of yard waste in overall residential waste composition percent profiles should be avoided so that baseline composition percentages are not misrepresented.

2) Municipalities may choose to set up independent collection systems to study the seasonal generation of yard waste and leaves. This would require a coordinated effort between garbage collection personnel, private horticultural firms and other agencies generating and collecting these waste streams.

3) In order to avoid the sampling problems that we encountered with the large apartment buildings in East York, where apparent sampling biases were difficult to avoid, arrangements could be made, for example, with 30 units within the building to participate in a refuse study. This would give a more accurate appraisal of the waste composition in these large apartment buildings. As a check, the method described herein for obtaining the per capita generation rate for the entire building could then be compared with the per capita generation rate for the 30 units.

4) Municipalities in Ontario should follow the waste composition procedure in conducting their own waste composition analysis, for reasons of consistent data generation using a cost effective approach. Periodically, municipalities should conduct additional waste composition studies to monitor trends in residential waste management and the effectiveness of waste management programs.

SECTION 1

PREFACE AND BACKGROUND LITERATURE

1.0 PREFACE & BACKGROUND LITERATURE

1.1 Preface

With a view to OUR COMMON FUTURE (ref. 49) and a framework for a sustainable lifestyle, the by-products of industrialized nations must be responsibly managed. The Ontario Ministry of the Environment set two targets for the diversion of solid wastes going to landfill sites in the Province: a 25% diversion by 1992 and a 50% diversion from disposal by the end of the century. The methods that may be used to achieve these goals involve the "3-Rs": Reduce, Reuse and Recycle, and include composting but exclude incineration. Landfill crises are at hand in some Regional and area municipalities in Ontario and many waste disposal sites are close to their capacity. Similarly, in the United States, where 30% of the country's landfill sites will be filled and closed within 5 years, the United States Environmental Protection Agency has initiated an "Agenda for Action" (ref. 46). This program also encourages a maximum effort to divert wastes by prudent implementation of "3R-s" programs.

The development of plans to divert materials from landfill sites requires knowledge of the qualitative and quantitative composition of solid waste streams from residential, commercial and industrial wastesheds. The design of materials recovery facilities and centralized composting facilities that will receive, process and store (short term) components in the waste stream, must be scaled to the per capita waste generation rate of the wasteshed population served by the facilities.

The Ontario Ministry of the Environment contracted Gore & Storrie Limited, in association with Decima Research Limited, to develop quantitative methods that could be used by any municipality in Ontario to assess solid waste generation. The results of the residential portion of the Ontario Waste Composition Study are presented herein.

The residential report is divided into two main parts. The first part reviews the relevant literature (Canadian and non-Canadian) on the following topics: residential waste composition, per capita waste generation rates, some of the methods that have been used in earlier waste composition studies and some of the pit-falls in methods and data handling.

The second part describes the methods used to determine the residential waste compositions and per capita waste generation rates in three municipalities in Ontario: the Town of Fergus, the Borough of East York and the City of North Bay. Also included in the report are data on: solid waste composition and per capita waste generation rates for schools; chemical analyses on vacuum cleaner bag contents; the moisture content of combustible components in the residential waste stream; the heating value (kJ/kg content) of selected mixed plastics and disposable diapers; and a survey of some Ontario data on the generation rates of white goods and bulky items.

1.2 Background Literature

1.2.1 Canadian and Ontario Studies

The Bird & Hale Report (1978)

The acknowledged landmark of waste composition studies in Canada was the work reported by Bird & Hale (cited herein as, BH) in 1978 (ref. 5). Eleven cities were selected with populations in excess of 100,000 from across Canada. The average annual composition of municipal solid waste* entering landfill sites, transfer stations and incinerators, was derived from samples obtained during the spring, summer, winter and fall. In Ontario, Toronto was selected for the study. Twelve visits were made to six sites between October, 1976 and September, 1977, with 2 visits apiece at: Commissioners Street Incinerator, Ingram Incinerator, Dufferin Incinerator, Beare Road Landfill Site, Bermondsey

*municipal solid waste = residential + commercial

Transfer Station and Wellington Incinerator. Sample weights of municipal solid waste ranged up to 400 lbs. (180.7 kg).

The Ontario results of the BH waste composition study, averaged over the year (Table 9 in ref. 5), are shown herein in Tables 1 and 2. The per capita waste generation rate is given in Table 3. It should be pointed out that while we are using the BH data as a "standard" for comparative purposes, the Peter Middleton & Associates report of 1975 (ref. 32) summarized the results of 31 previous studies (United States & Canada), including 4, early 1970's studies from Ontario. Peter Middleton & Associates (ref. 32) noted that their review of waste composition studies was hampered by "six distortion factors": (1) the "solid waste" that was being studied; (2) the geographic location of the study; (3) the season of the year when the study was undertaken; (4) the year of the study; (5) the socio-economic background of the area where the "solid waste" for the study was generated; and (6) moisture transfer that occurred before sampling.

Giving "consideration" to these six factors, Peter Middleton & Associates tabulated "...the following percentage figures...developed for the average yearly composition by weight of residential solid waste in Southern Ontario on an "as generated" basis - 1974:

	(%)	
Paper	35	
Food Wastes	22	
Yard Wastes	15	(ranging from 0 - 20 over 12 months)
Plastic	3	
Rubber and leather	2	
Cloth	2	
Wood	3	
Glass	8	
Metal	8	(ferrous 7, non-ferrous 1)
Other Misc.	2	
	100	

These figures are considered to be accurate to within 20%..."

TABLE 1: WASTE COMPOSITION DATA FOR ONTARIO

COMPONENT	A	B	C	D[1]	D[2]	E	F	G	H	I	J	K	L[12]	M[13]	M[14]
LITERATURE SOURCE OF WASTE COMPOSITION INFORMATION (see footnote 16 below)															
Paper	39.8	44.94	35											39.1	28.2
Kraft		10.75		5.3[4]	7.5[4]	9.0	3.0[4]				2.6				
Newsprint		10.61	10	12.1	12.7		16.3	14.4	15.2	9	16.4	9	5.7		
Fine Paper	6.0	8.07		1.5	1.8	6.0	1.5				1.9				
Other Paper	12.0	15.50		23.3	10.4	12.0	9.8	20.6	10.6	27.0	12.9	31	20.9		
Glass	NW[3]	6.55	8	6.1	7.3	8.0	8.3	5.0	7.0	8.0	6.5	7	15.2	7.7	10.8
Beer containers		0.04													
Returnable softdrink		0.23													
Non-returnable softdrink		1.33													
Liquor and wine		1.53													
Containers-food		1.98													
Containers-other		0.30													
Flat and cullet		1.15													
Ferrous metals	4.4	5.49		5.4	8.7	2.5			2.3	7.0	4.6[6]	6[6]	13.4	3.9	5.6
Beer cans		0.0				4.5		5.2							
Softdrink cans		0.88													
Food cans		2.61													
Other		2.01						0.5							
Non-ferrous Metal		0.89	8[6]	0.7	0.3		2.0[6]	0.7	1.2	1.0				0.6	1.2
Aluminum	0.2	0.85				0.95							3.8		
Other	0.1	0.04											0.2		
Plastics	1.7	5.72	3	9.5	8.4	6	0.9	5.0	3.5	6.0	4.9	5	11.6	6.1	10.8
Container		1.05				1.75									
Sheet film other		4.67				4.0									
Ceramics rubble		1.82									0.7				
Wood (lumber)	1.3	3.36	3	1.5	0.0	4.0	0.7	3.0	1.8	4.0	0.6			1.0	10.8
Food wastes	21.8	22.59	22[7]	17.7[7]	30.4[7]	7.0	40.9[8]	22	24.6	7.0	27.5	30	23.9	27.9[8]	30.1[8]
Textiles/leather/rubber/	2.6	4.11				4.0	1.0[10]	4.0	1.8	4.0	2.3		1.7		
Yard wastes	19.9	3.29	15	7.2	0.0	20.0		15.0	17.0	20.0	4.9	9			
Fines		0.93									4.3		0.8		
Petrolleum chemical mix		0.31													
(other combustables)				2.7	4.1										
(other non-combustables)				3.6											
(miscellaneous)	8.8		2			6.0	0.1[11]	4.6	15.0	6.0	7.5[15]	9		13.6	11.9
Hazardous wastes						1.0			0.6	1.0	0.3				

[1] detached single family
[2] apartments
[3] counted but not weighed
[4] brown paper / corrugated
[5] boxboard only
[6] ferrous / non ferrous
[7] food only
[8] food / yard waste
[9] rubber / leather
[10] textiles only
[11] batteries
[12] Presqueile Park, Ont.
[13] Average of Quebec Municipalities
[14] Average of study in La Salle, P.Q
[15] Sanitary napkins, disposable diapers, pet droppings, ashes, vacuum cleaner bags
[16] Literature sources of the waste composition data for Ontario

- A - Barton (1976) (MSW)
- B - Bird & Hale (1978) (MSW)
- C - Ontario Waste Management Board (1980) (MSW?)
- D - Evans (1985) (residential)
- E - RIS (1987) (?)
- F - Perks (1988) (residential)
- G - Recycling Advisory Committee (1989) (?)
- H - Green Cone Inc. (1989) (?)
- I - OMMRI - II (1990) (?)
- J - City of Guelph (1990) (residential)
- K - SWEAP (1990) (residential)
- L - Flindall (1988) (prov. park)

[16] Literature sources of waste composition data for Québec

- M - GIUROU / GRAIGE (1988) (residential)

TABLE 2: WASTE COMPOSITION DATA FOR THE UNITED STATES & EUROPE

COMPONENT	LITERATURE SOURCE OF WASTE COMPOSITION INFORMATION (see footnote 19 below)								
	A	B[1]	B[2]	C	D	E	F	G	H
Paper	44.94	31.3	43.1 6.5[3]	30.0-60.3		35.6	41.0	22.5	
Kraft paper	10.75				7				
Newsprint	10.61				7				16.41
Fine Paper	8.07								
Other Paper	15.50				20				4.3
Glass	6.55	9.7	7.5	4.5-10.9[4]	7	8.4	8.2	6.9	14.4
Beer containers	0.04								
Returnable softdrink	0.23								
Non-returnable softdrink	1.33								
Liquor and wine	1.53								
Containers-food	1.98								
Containers-other	0.30								
Flat and cullet	1.15								
Ferrous metals	5.49	8.5	4.3			8.9[12]	8.7[12]	3.8[12]	2.8
Beer cans	0.0								
Softdrink cans	0.88		5.2[5]						
Food cans	2.61								
Other	2.01				5[6]				
Non-ferrous Metal	0.89		1.5						0.4
Aluminum	0.85	0.6			1				
Other	0.04			6.7-9.8[7]					
Plastics	5.72	3.4	1.8		9	7.3	6.5	6.0	5.2
Container	1.05								
Sheet film other	4.67			1.3-4.6[8]					
Ceramics rubble	1.82								
Lumber	3.36	3.7	3.5	1.0-3.8					
Food wastes	22.59	17.6	9.5[9]	10.1-22.5[9]	8[9]	8.9	7.9	38.0 1.7[13]	25.7[15]
Textiles/leather/rubber/ wood	4.11	2.6[10] 1.4[11]	1.0[10] 0.7[11]	0.6-2.0[11]	3[11]	9.0	8.0 (8.1)	2.2[14] 2.0[10] 2.8[11]	1.8[11]
Yard wastes	3.29	19.3	14.3	5.2-35.7	31	20.1	17.9		
Fines	0.93			3.0-8.3					22.2
Petrolleum chemical mix	0.31								
(ash/dirt/rock)			1.1	1.0-11.0				3.0	1.8
(miscellaneous)		1.5		0.5-3.0		1.8	1.8 (1.6)	12.0	1.9[16]
(all other)					2				3.0[17] 0.3[18]

[1] from Table 1-2

[2] from Table 4-2

[3] cardboard only

[4] glass / ceramics

[5] tin cans only

[6] other metals

[7] metals only

[8] plastics / rubber

[9] food only

[10] rubber / leather

[11] textiles only

[12] total metals

[13] bones

[14] wood

[15] "organics"

[16] disposable diapers

[17] composite materials

[18] household toxics

[19] American literature sources for waste composition information

A - Bird & Hale (1978) (MSW)

B - Tchobanoglous (1977) (MSW)

C - EMCON Associates (1980) (MSW)

D - Matrix Management Study (1987) (residential)

E - Franklin Associates (1988) (MSW)

F - Kashmanian (1989) (MSW) (numbers in brackets are U.S.EPA: Agenda for Action 1988) (MSW)

G - Blattert (1988) (?)

H - Franke (1987) (residential)

TABLE 3: SUMMARY OF PER CAPITA WASTE GENERATION RATES

Ref.	Location	Lbs.[1]/capita/day	Refuse
5	Canada	2.82	Combined residential and commercial
43	U.S.	4.29	"
43	U.S.	4.05	"
43	U.S.(revised)	3.31	"
27	Seattle	2.3	Residential
30	Ontario	2.2[2]	"
28	U.S.	3.78	Combined residential and commercial
28	NE Michigan	4.32	?
28	Ingham Co, MI	2.3	?
28	Ann Arbor, MI	4.2	?
28	Nottingham, MI	2.12	?
23	U.S. (1990)	3.7	Combined residential
4	Kingston, Ont.	2.09	"
2	Canadian (1989)	4.62	"
	U.S. (1989)	3.59	"

[1] 1 lb. = 0.454 kg.

[2] Reportedly obtained from: Urban Solid Waste Generation Ontario, July 1976, Ont. Waste Management Advisory Board, pg. 1.

While the wide scope of the BH study understandably precluded a greater attention to sample size and sample number, two problems with respect to the BH procedures require some discussion in view of the major objective of the present Study: the development of a method for determining residential waste composition and per capita waste generation rate.

First, BH attempted to convert the weights of the sorted materials from a, so-called, "as received" condition, to a weight which more closely reflected the items in their original, or "as generated" state. While the "as generated" concept is a valid one, it is not possible to compute this value using predetermined factors in conjunction with the equation provided on page 10 of their report (ref. 5). The following discussion will point out some of the complexities that BH were attempting to address.

When moist organic matter comes into contact with dry materials (e.g. plastic, boxboard, or paper) there is a transfer of water from the organic matter to the surface of plastic packaging (=adsorption) or, for example, throughout the entire thickness of a piece of boxboard (=absorption), causing it to swell. Hence the organic matter loses weight, while the other materials gain weight. Under ideal (laboratory) conditions, the weight transfer of the water can be measured. Practically speaking however, the heterogeneous assemblage---and juxtaposition---of wet and dry materials in the average bag of residential refuse poses a much more complex problem than simple moisture transfer between the initially wet and the initially dry components.

Moist organic matter may also be found as a residual layer on surfaces of containers---metal, plastic, glass; or partially absorbed by paper products. The weight of this "tramp" organic matter cannot be "universally predetermined", but must be quantified for every case. The following example further serves to illustrate the complexity of the "as generated" problem.

The moisture content associated with a discarded can of spaghetti sauce, in which a thin layer of sauce is still adsorbed to the inner surface, is a function of the physical-chemical properties of the organic matter in the sauce, as well as the thickness of the sauce coating. In essence, it may be argued that the presence of the organic matter in the sauce increases the apparent amount of water adsorbed to the surface of the can. Put simply, a dirty can will have more moisture associated with it than a clean one. Thus, the weights of materials that we collected in the Study are reported in their "as received" condition; we did not attempt to derive any "as generated" weights.

It is difficult to justify pursuing this level of theoretical detail at the expense of time requirements and financial limitations which control the pursuit of the practical objectives of a waste composition study. Brunner & Ernst (ref. 8) alluded to this point while reporting that tramp organic matter may contribute significantly to the total organic fraction of the waste stream.

The second problem, illustrated by BH's inclusion of yard waste data in the calculation of percent (%) composition (Tables 1 & 2), concerns the misleading impact of quantitatively apportioning a "spurious event" over a time period which exceeds the actual duration of that "event". Again, Brunner & Ernst (ref. 8) may be cited for a relevant example: the mercury (Hg) content from a single battery that was mathematically apportioned over an entire load of refuse as if this were the true "background" level of Hg in all of the constituents of the load. The amount of mercury measured is, however, relative only to the battery and not the entire load.

In Ontario, yard wastes and leaves are not part of the residential waste stream throughout the year. The quantities of these materials in the waste stream not only vary with season but their occurrence in a municipality also varies with population demographics: detached residential dwellings versus apartments; young versus mature trees lining streets, etc. Over and above the false notion conveyed by incorrectly "weighting" seasonal components over the entire year, as in the mercury example above, there are several equally inaccurate, practical consequences.

First, there is an important mathematical result when yard wastes are included in the calculation of percent composition of the more or less "baseline" components of the residential waste stream, e.g., food waste, Blue Box components, etc. When all of the components of the waste stream are normalized to the total ,i.e., the percentage of each component is computed as a proportion of the total, the inclusion of yard wastes as a component causes the other components in the refuse---which are present in the refuse throughout the entire year---to appear to be less abundant than they actually are. Brickner (ref. 7, Table 2) demonstrated the effect of eliminating yard waste from composition calculations. The seasonal waste composition results of Constantine et al. (ref. 11, Table 1) would similarly change if the yard waste component were removed. This computational problem will re-appear below.

Second, the design of a waste management facility will be different, depending on whether the arrival of the waste is spread out over an entire year or delivered in several large loads over a few weeks.

Other Studies

Two reports are briefly reviewed here because they feature either a provocative experimental design or a design that appears to have lead to a problem in data interpretation.

In 1984, the Toronto Recycling Action Committee commissioned an interesting study (ref. 16) to compare the composition of refuse generated on the basis of land use, ie., residential, retail, restaurants and an office tower. The residential sampling strategy was well conceived; residential refuse was collected from two streets in Toronto and per capita generation rates for this wasteshed population could have been readily determined. In addition, the refuse from the commercial establishments was collected at the premises so that both per capita and land use calculations of waste generation could have been made. The report was published in 1985 (ref. 15). The concept of the curbside collection of residential refuse was central feature of the sampling plan developed in the present Ontario Waste Composition Study.

In the spring of 1988, Pollution Probe Foundation studied the waste generation of 68 households in Toronto to determine the quantity of recyclable components (ref. 31). As the sampling program evolved in complexity from the beginning to the end of the study (in step-wise fashion), a problem appears to have been encountered in the presentation of waste composition data. (See Table 4 of the "Hoggs Hollow" report (ref. 31, p. 16)). Newsprint was the only item partitioned from the total household refuse in week two of the study and it was reported as 23.7%. In weeks 3 through 8, when other components, in addition to newsprint, were separated and weighed, the percentage(%) of newsprint dropped to the following values: 17.3, 13.4, 16.9, 13.7, 20.9 and 13.9%. It is highly unlikely that the sudden decrease between weeks 2 and 3 was due to a reduction in newspaper readership or subscriptions. Insufficient quantitative information was provided to clarify and interpret the data presented in the table. A discussion of the presentation of waste composition data in the "percentage" format is given in Section 4.4

As a miscellaneous note, the important topic of "capture rate", ie., the actual quantity of recyclable materials collected via the Blue Box program versus the potential quantity of recyclable materials in the curbside refuse, is presented in Table 5 (p. 17) of the Pollution Probe report. Unfortunately, this table is not referred to in the text and according to the author of the report (pers. commun., G. Perks), no capture rates were determined for any of the households. Intended to serve an illustrative purpose, the table requires textual comment in order to prevent confusion.

Summary of Waste Composition Data For Ontario

Table 1 herein, presents the waste composition data obtained from formal and "informal" literature (post Peter Middleton & Associates review of 1975). It is difficult to judge the completeness of the original data that may have been generated since the BH report. For instance, some Waste Management Master Plans (not cited herein) seem to have applied (and changed, without explanation) the BH data. BH waste composition categories are reported with no changes in this report in Tables 1 and 2 and their results are shown in Column B of Table 1 and Column A of Table 2.

With the exception of columns L and M/M, ie., waste compositions for Presqu'ile Provincial Park and MSW in Quebec, respectively, the data pertain to both MSW and residential waste streams in Ontario, or other "combinations" of information.

On the basis of problems that were already alluded to above---and which will be discussed more completely in Section 4.4---the literature data presented in Table 1 cannot be easily compared. However, it is interesting to note that the values reported for food wastes are generally in the 20% range, with the exception of particularly low values of 7%, in columns E and I, (refs. 39 & 29). RIS (ref. 39) identifies their sources as: "compilation of data from U. S. Environmental Protection Agency, Environment Canada, Waste Sampling Study for the City of Windsor and Waste Composition Literature Reviews performed by State of Rhode Island and Massachusetts."

Residential Plastic Waste

The recent EPIC (Environment and Plastics Institute of Canada) study of post-consumer generation of rigid plastic container waste in Barrhaven, a residential area in Neapean, Ontario, near Ottawa (ref. 44), reported a generation weight of 7 lbs/capita/year (3.19 kg/capita/year). The composition of the plastic waste stream was given as: HDPE + PP, 75%; PET, 12%; and PS + PVC, 13%*.

A survey of the generation rate and composition of plastic film by residents in Peterborough, Ontario, is currently underway (pers. commun., Mr. J. Savage, ESSO Chemical). No data from this study are currently available.

1.2.2 Foreign Studies

1.2.2.1 United States

According to W. J. Rathje (ref. 33), the "disposable society" began in the mid-1800s. The earliest interest in discarded materials may be credited to an archaeologist who excavated the Andover, Massachusetts, town dump in the mid 1920s. In more recent times, knowledge about the kinds of "materials discards" that society generates have been of interest to two quite different groups of professionals: (1) those hoping to gain insight into archaeological interpretation of historical cultures by studying and analyzing modern material cultures; and (2) those hoping to develop the ways and means of reducing the volume of discarded materials through an understanding, in part, of the waste generation patterns of modern society. Oddly enough, while the objectives of these two groups, ie., archaeologists and professional engineers, respectively, are different, the methods employed by each group should have more in common with each other than may be presently acknowledged. Both archaeologists and engineers want to know the composition of the present day waste streams.

The job of conducting waste composition studies for governments has frequently fallen on the shoulders of companies with engineering expertise. These

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*HDPE - high density polyethylene
PP - polypropylene
PET - polyethylene terephthalate
PS - polystyrene
PVC - polyvinyl chloride

companies have been traditionally associated with solid and/or liquid waste management. However, as Rathje noted in 1979, "The behavioral aspect of the legal disposal of solid wastes involves determining the broad socio-economic correlates of household discard behaviour, including variation in solid wastes relative to household demographic composition and social strata, time of year, and general state of the economy. A number of civil engineers and solid waste managers have recently begun to conduct such studies" (ref. 33, pg. 26).

The Peter Middleton & Associates review (ref. 32) cited three residential refuse studies conducted in 1969 and 1970 that concluded that lower income groups throw out a higher percentage of food wastes and wealthier families discard a higher percentage of paper. Cognizant of potential socioeconomic differences in waste generation, a fourth study focused a sampling program on a middle income residential area.

Waste Composition Studies

The number of municipal waste composition studies conducted in the United States is very large. For instance, a list of the studies conducted by SCS Engineers, Long Beach, CA, reportedly fills three typed pages (pers. commun., R. Grier), and currently includes waste compositions investigations for the cities of New York and Los Angeles. The results of studies shown in Table 2 were obtained with relative ease from available literature and is by no means complete. Again, the waste classification categories and first column of data on the left side of the Table are from Table 9 in BH.

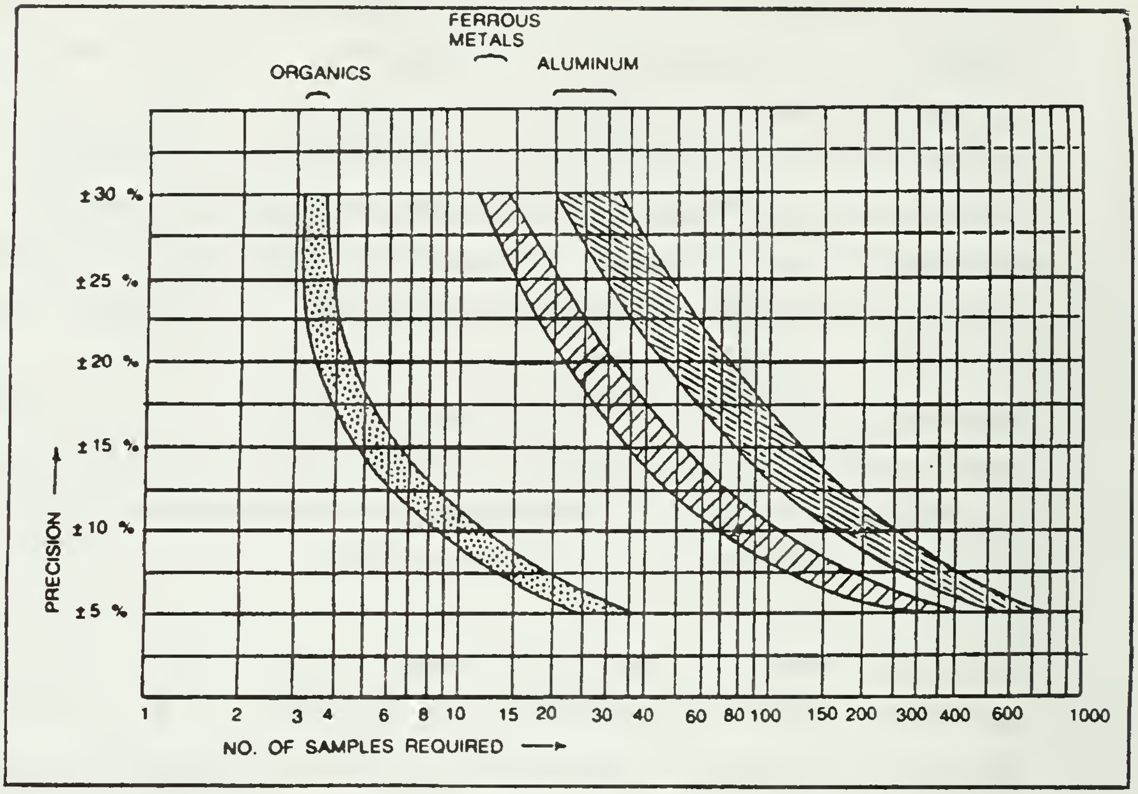
Techniques and Methods

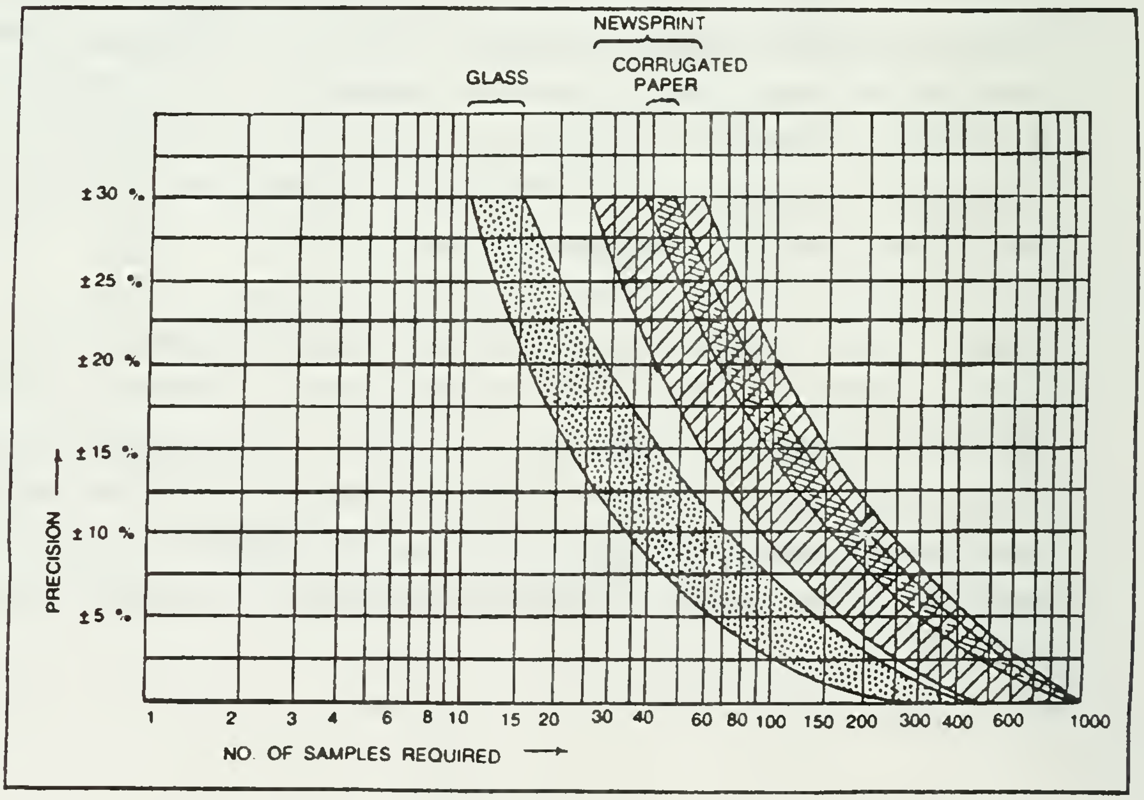
While the American Society for Testing and Materials is frequently cited as the "standard" for many analytical methods, the document in the series, whose title makes it appear appropriate for waste composition studies, i.e., ASTM F 889-82 (ref. 3), is of marginal use because it is expressly designed for use at resource recovery facilities. The most notable individual who has significantly contributed to the "sample-and-sort" methodology is Dr. A. J Klee. Building on the statistical studies of Cochran (ref. 9), Klee & Carruth (ref. 25) reported a method, employing arcsine transformation of raw waste composition data, that enabled them to determine the minimum sample weight required to achieve appropriate levels of statistical confidence with respect to particular components in refuse. The results of their study showed that samples should weigh at least 200 lbs. (90 kg), but need not exceed 300 lbs. (135 kg) (ref. 24). Later, the method was adapted by Trinklein (ref. 45) in the design of a program for the sampling frequency of garbage trucks arriving at an energy-from-waste facility. The 200-300 lbs. (90-135 kg) sample weight range has been confirmed by other investigators (McCamic, ref. 28; also see Lohani & Ko, ref. 26).

How many samples in this weight range must be taken? If one has an approximate idea of the percentage that component 'X' is usually expected in refuse and can assign a precision range that one would like to achieve, with 90% probability, e.g., component 'X' is expected to be 25% of the refuse, with a desired precision (of the estimate) of 20% of the expected value: 25 $\pm$ 20%; then one can determine the number of 200-300 lbs. (90-135 kg) samples which must be taken and sorted. Tables and nomograms may be consulted to obtain the requisite number of samples (see refs. 20, 40, 47 & 48) or the sample number may be calculated according to the equation found in Klee & Carruth (ref. 25) and which is given herein , Section 4.7.2.

Figure 1 shows nomograms for residential waste composition studies.
Sample number is a function of two major factors: component abundance (%), standard deviations of sample data and desired confidence limits. The sample numbers required for satisfactory statistical precision become unmanageably large when dealing with components that are a small fraction of the total refuse or when the desired results are to have a high degree of accuracy and probability. (ref. 28).

FIGURE 1: NOMOGRAMS FOR RESIDENTIAL WASTE COMPOSITION STUDIES SHOWING THE RELATIONSHIP BETWEEN SAMPLE NUMBER AND STATISTICAL PRECISION (WITH 90% CONFIDENCE).





Composition sample requirements, residential sources only (with 90% confidence)

An important contribution to development of a methodology for sampling refuse generated in a wasteshed was made by Rathje and co-workers. Their earliest noteworthy study, "THE MILWAUKEE GARBAGE PROJECT" (ref. 34) clearly demonstrated the relationship between socio-economic stratification of populations and the qualitative and quantitative composition of residential refuse. The concepts embodied in the Rathje methodology are also noted in some engineering sampling protocols, e.g., SCS Engineers (ref. 40), and are contemplated by Woodyard & Klee (ref. 48).

In a literature and protocol review conducted for the State of Massachusetts (ref. 28), considerable emphasis was placed on implementation of a wasteshed sampling program based on socio-economic and demographic characteristics of the wasteshed. As previously noted, some studies have addressed the importance of demographic characterization of waste generation (ref. 34), but few studies have come to light that report results on a demographically sound basis. A very recent study, again by the Rathje group (refs. 35 & 36) was conducted for the City of Phoenix and revealed patterns of refuse disposal along ethnic lines as well as a function of collection time during the week, a point already well known to refuse collectors.

Waste Generation Rates

Waste generation rates may also be computed as part of a materials balance where material inputs must be balanced by outputs. This approach can be applied on a national scale but is not feasible on a small scale because of the difficulty in obtaining accurate input values (see ref. 8). In addition, there are no provisions for sociological "interventions" in this strict flow-sheet approach. The recent Franklin report on waste generation in the United States (ref. 18) is one example of this kind of a study.

The selection of per capita refuse generation rates shown in Table 3 includes rates for residential as well as municipal solid waste. For the United States in 1920, the generation rate was 2.8 lbs.(1.26 kg)/capita/day. A value of 4.03 lbs.(1.82 kg)/capita/day was reported for 1986-87 and excluded industrial wastes and "under-reported" wastes (ref. 1). Several Canadian values are also referenced in Table 3. In a recent "popular" article on solid waste (ref. 37), Rathje mentioned the range of daily per capita generation rates that he is aware of: 2.9(1.31), 3.02(1.36), 4.24(1.92), 4.28(1.93), 5.0(2.26) and...8.0(3.61) lbs.(kg). In his opinion, even a daily rate of 3.0 lbs. per capita may be too high for some parts of the country.

1.2.2.2 Non-North American

While the following sample of studies barely scratches the surface of the world literature, the references indicate the general applicability of the concept that waste generation can be correlated with socioeconomic patterns of human existence. Interesting data were reported by Sridhar et al. (ref. 41) for high, middle and low income families in Ibadan, Nigeria. The average putrescible content (kg/family) was positively correlated with high, medium and low income groups: 2.81, 1.52 and 0.37 kg/family, respectively. Coad (ref. 10) observed a large difference in the waste generation patterns of the wealthy and poor classes of society in Iran. A waste composition profile was recently reported for Minsk, USSR (ref. 6).

SECTION 2

METHOD DEVELOPMENT

2.0 METHOD DEVELOPMENT

2.1 Introduction: Rationale and Overview

It is reasonable to assume that both the quantity and the composition of residential waste generated in municipalities in Ontario has changed since the late 1970's when Bird & Hale conducted their landmark study (ref 5). Changes in packaging, technology, life styles and disposable income are some of the factors that can be expected to have altered the quantity and quality of residential refuse. The purpose of the present work was to develop a simple, cost effective and statistically meaningful method to be used by municipalities to determine the quantity and composition of residential waste, exclusive of leaves and other seasonal yard waste.

The method used in this study is based on the hypothesis that the characteristics of a residential waste stream are related to the socioeconomic lifestyles of people and the demographic characteristics of a municipality. Evidence from studies in the United States and elsewhere supports this hypothesis. The present method was developed by the team of Gore and Storrie Limited and Decima Research Limited.

The three municipalities participating in the method development study were selected in consultation with the Ministry of the Environment and fit into the three population categories that the Ministry required: small (population < 25,000), medium (population > 25,000 and < 100,000) and large (population > 100,000, belonging to Metropolitan Toronto). In deciding the three communities that would be approached to participate in the method development study, consideration was given to the following factors: (1) a municipality within Metro Toronto reflecting the earlier BH report; (2) municipalities outside of the sphere of Metropolitan Toronto; (3) geographic location in Ontario; (4) population and income distribution; and (5) housing type. Relevant information for the three study municipalities is given below, in order of increasing municipal population.

Town of Fergus

The Town of Fergus has a population of 6,757 (1988) and is located about 75 kilometres west of Toronto in Wellington County (Figure 2). Residential areas are generally composed of detached dwellings, occasionally interspersed with duplexes. There are also several neighbourhoods of apartments (3-4 floors; 35-60 units).

Residential refuse was collected weekly from detached dwellings by Plein Disposal; refuse from apartments was collected twice weekly by McLellan Disposal. A Class 1 residential Blue Box program, serviced detached dwellings (McLellan Disposal) but not apartments.

City of North Bay

The City of North Bay has a population of 51,313 (1989) and is located about 335 kilometres north of Toronto in the District of Nipissing (Figure 2). The residential areas are characterized by neighbourhoods of single detached dwellings; detached dwellings; duplexes and other attached dwellings; and neighbourhoods with small apartment buildings (3-4 floors; multiple units).

Residential refuse was collected weekly by Laidlaw Waste Systems Ltd. There was no Blue Box program or drop-off bins for recycling of materials in the City.

Borough of East York

The Borough of East York has a population of approximately 102,000 and is located in the Municipality of Metropolitan Toronto (Figure 2). The residential population is distributed in neighbourhoods of detached dwellings, frequently interspersed with small apartment complexes. There are also areas with numerous, large apartment buildings, each with several hundred units.

FIGURE 2: MAP OF ONTARIO SHOWING LOCATIONS OF THE THREE STUDY MUNICIPALITIES

Residential refuse was collected twice weekly by Borough employees from detached dwellings and apartments with fewer than 30 units. Large apartment buildings also had twice weekly collection service provided by various private contractors. A Class 1 Blue Box program serviced detached dwellings and small apartment buildings but not large apartment buildings. Blue Box collection was also a Borough function.

2.2 General Overview of the Method

2.2.1 Demographic Description of a Municipal Population

2.2.1.1 The Enumeration Area (EA)---General Description

Statistics Canada information about the population of a municipality may be provided for subunits of the population called Enumeration Areas (EAs). The information is derived during census gathering processes. An EA contains approximately 600 people but may frequently range over 800. The geographic area covered by an EA is determined by the type of housing; that is, a larger geographic area is occupied by a population that resides in detached, single dwellings than for a population of apartment dwellers.

Inasmuch as EAs are planned without specific regard for socioeconomic or other demographic factors, the likelihood that discrete socioeconomic sectors of a population are exclusively encompassed within an EA is greater in a large municipality than in a small one.

2.2.1.2 Classification of EAs According to Income

Using the most recent Statistics Canada Census data, each EA in the study community was stratified according to income level. The format for the stratification was:

High Income:	average household income is at least 1/2 standard deviation greater than the mean income for the entire community;
Medium Income:	average household income is no more than 1/2 standard deviation greater than, or less than the mean income for the entire community;
Low Income:	average household income is at least 1/2 standard deviation less than the mean income for the entire community.

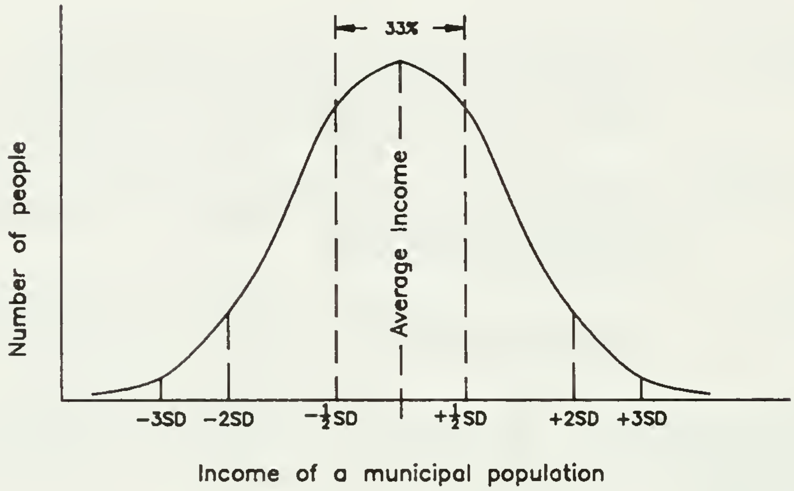
Figure 3 below illustrates the concept of population stratification by income, described above.

2.2.1.3 Classification of EAs According to Housing Type

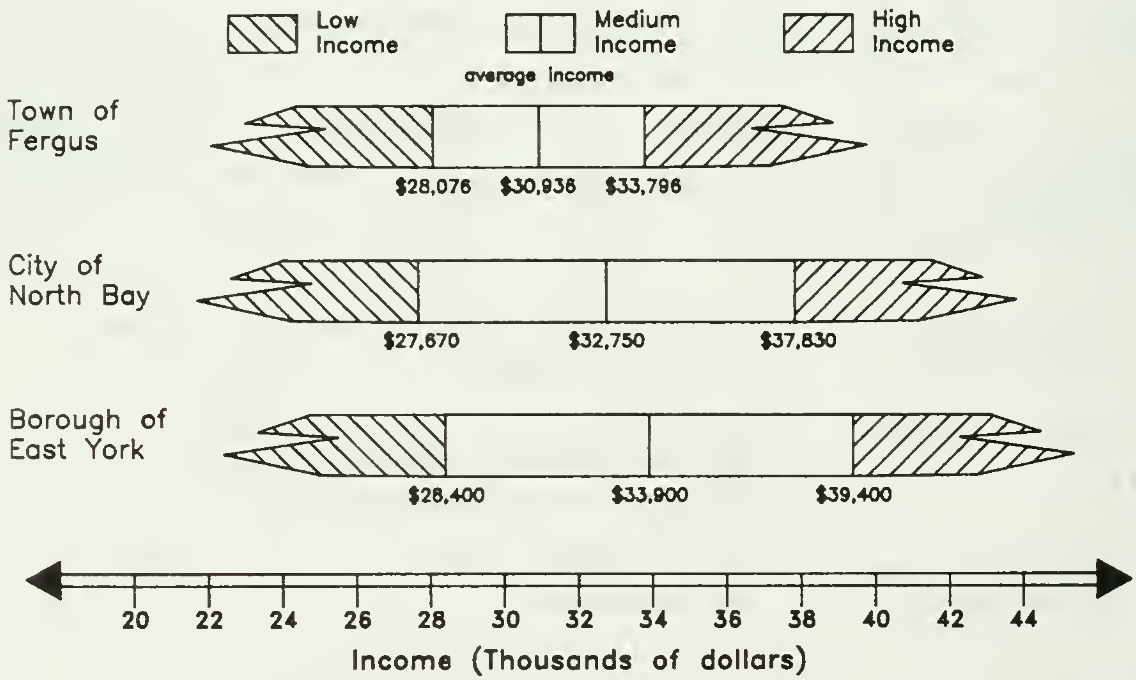
Within each income category, each EA was further classified according to housing type. For each EA, Statistics Canada reports the number of Single Detached residences, Apartments, and Other residences. These numbers, expressed as a percentage of occupied dwellings in the EA are used to identify the predominant housing type.

Primarily Single Detached:	EAs with 60% to 70% of dwellings reported as single detached;
Mixed Dwellings:	EAs with a mixture of single detached, apartment buildings with fewer than 30 units, and "other" dwelling types;
Primarily Multiple Dwellings:	EAs with 60% to 70% of dwellings reported as "apartments".

FIGURE 3: CATEGORIZING A MUNICIPAL POPULATION WITH RESPECT TO INCOME:
- THEORETICAL DISTRIBUTION (3A)
- PRACTICAL APPLICATION (3B)



(3A) Idealized representation of normal income distribution over a municipal population. The middle income range extends between −1/2 SD and +1/2 SD and includes 33% of the population.



(3B) Comparison of the low, medium and high income categories for the three municipalities in the Study.

An exact boundary line between dwelling classifications was not rigorously specified in this Study because of the need for flexibility to consider the distribution of the minor components of the residential mix for a particular EA.

The distribution of types of residences across the whole municipality was examined to ensure that specific cells in the income housing matrix were not grossly out of proportion to the total number of EAs.

Table 4 below shows the housing/income matrix that was used in the present study for classification of the EAs in a municipality.

2.2.1.4 Income/Housing Matrix For the Town of Fergus

Using the most recent census data, the EAs for the Town of Fergus were classified according to the parameters of the income/housing matrix (Table 5). Of the 11 EAs reported by Statistics Canada for Fergus, 9 were placed within the study matrix. Two EAs were not included: a hospital zone and an area of Town that extended outside the Town limits.

Table 5 lists the 6 EAs that were actually sampled in the study. Their location within the Town of Fergus is shown on the map in Figure 4.

2.2.1.5 Income/Housing Matrix For the City of North Bay

Using the most recent census data, the EAs for the City of North Bay were classified according to the parameters of the income/housing matrix (Table 6). Of the 66 EAs reported by Statistics Canada for the City of North Bay, 57 were placed within the study matrix.

Typical of communities in Northern Ontario, the City limits of North Bay encompass a large rural area outside of the built-up central portion of the City. The income/housing matrix only includes those EAs in the urban area of the

TABLE 4: INCOME/HOUSING MATRIX USED FOR CLASSIFYING MUNICIPAL POPULATIONS.

Income Level		Dwelling Type		
		(1) Primarily single Detached Dwellings	(2) Mixed Dwellings	(3) Primarily multiple Dwellings
(A)	High	A1	A2	A3
(B)	Medium	B1	B2	B3
(C)	Low	C1	C2	C3

TABLE 5: CLASSIFICATION OF THE EAs FOR THE TOWN OF FERGUS IN AN INCOME/HOUSING MATRIX. DISTRIBUTION OF EAs IN THE MATRIX (5A) AND EAs SAMPLED IN THE STUDY (5B)

5A: Distribution of EAs in the income / housing matrix.

	(1) Primarily Single Detached	(2) Mixed Dwellings	(3) Primarily Multiple Dwellings
(A) High Income	1	0	0
(B) Medium Income	2	4	1
(C) Low Income	0	0	1

5B: Income / housing matrix cell number and corresponding EAs sampled in the study

Matrix cell	EA Number
A1	258
A2	---
A3	---
B1	262
B2	256,263
B3	257
C1	---
C2	---
C3	260

FIGURE 4: MAP OF THE TOWN OF FERGUS SHOWING TI: LOCATIONS OF THE 6 ENUMERATION AREAS

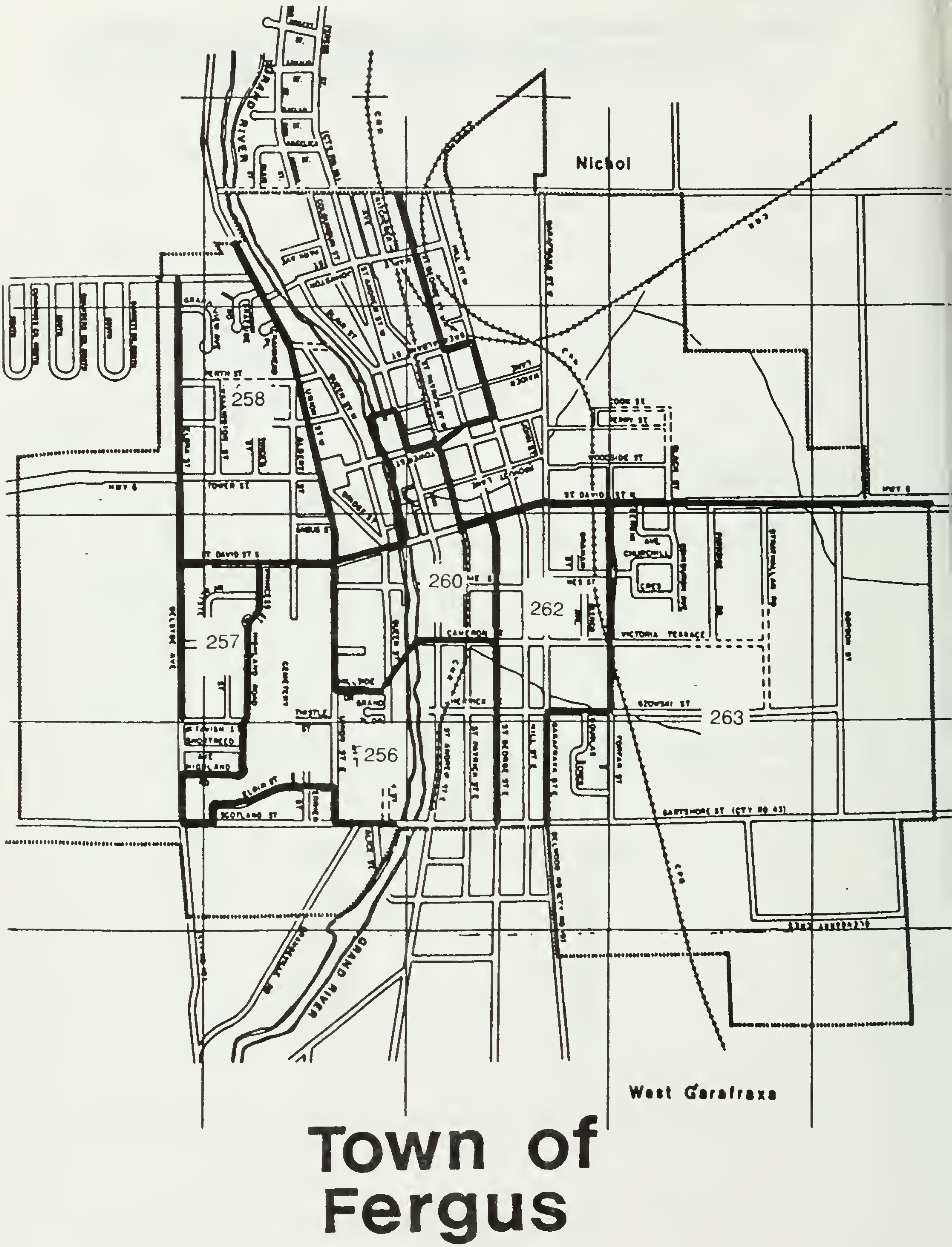


TABLE 6: CLASSIFICATION OF THE EAs FOR THE CITY OF NORTH BAY IN AN INCOME/HOUSING MATRIX. DISTRIBUTION OF EAs IN THE MATRIX (6A) AND EAs SAMPLED IN THE STUDY (6B)

6A: Distribution of EAs in the income / housing matrix.[1]

	(1) Primarily Single Detached	(2) Mixed Dwellings	(3) Primarily Multiple Dwellings
(A) High Income	11 (19%)[2]	2 (4%)	0* (0%)
(B) Medium Income	10 (18%)	15 (26%)	0* (0%)
(C) Low Income	6 (10%)	12 (21%)	1* (2%)

[1] The income / housing matrix accounts for 57 of 66 EAs

[2] EAs in each matrix cell as a percentage (%) of the total 57 EAs

* The asterisks indicate cells that have populations that are too small to sample

6B: Income / housing matrix cell number and corresponding EAs sampled in the study

Matrix cell	EA Number
A1	114
A2	128
A3	---
B1	104*
B2	113*
B3	---
C1	065
C2	111
C3	---

* Cells B1 and B2 : field work is completed

City. 9 EAs were omitted from the matrix because they were either outside the urban area or they lacked necessary information for categorization. For example a hospital zone, parts of the Canadian Forces Base, an Indian Reservation and rural areas were omitted.

The location of the 2 urban EAs that were sampled in the Study are shown on the map of the City of North Bay (Figure 5).

(Note: The City of North Bay was studied after the Town of Fergus and the Borough of East York. Based on the results of the latter municipalities, it was decided to conduct a much reduced sampling program in the City of North Bay. At the same time, it was also decided to involve an employee of the City's engineering department in order to assess the feasibility of implementing the Study methodology by City staff, after a suitable training period. The City employee was very confident that he could continue the study without further assistance from Gore & Storrie Limited).

2.2.1.6 Income/Housing Matrix For the Borough of East York

Using the most recent Statistics Canada census data, the EAs for the Borough of East York were classified according to the parameters of the income/housing matrix (Table 7). Of the 179 EAs that were reported by Statistics Canada, 170 were placed within the study matrix. The remaining 9 were excluded due to insufficient information for categorization. Table 7 gives the 7 EAs that were included in the study and their locations are shown in Figure 6, a map of the Borough of East York.

FIGURE 5:

MAP OF NORTH BAY SHOWING THE LOCATIONS OF THE STUDY ENUMERATION AREAS

TABLE 7: CLASSIFICATION OF THE EAs FOR THE BOROUGH OF EAST YORK IN AN INCOME/HOUSING MATRIX. DISTRIBUTION OF EAs IN THE MATRIX (7A) AND EAs SAMPLED IN THE STUDY (7B)

7A: Distribution of EAs in the income / housing matrix.[1]

	(1) Primarily Single Detached	(2) Mixed Dwellings	(3) Primarily Multiple Dwellings
(A) High Income	13 (8%)[2]	17 (10%)	6 (4%)
(B) Medium Income	22 (13%)	34 (20%)	25 (15%)
(C) Low Income	0 (0%)	8 (5%)	45 (26%)

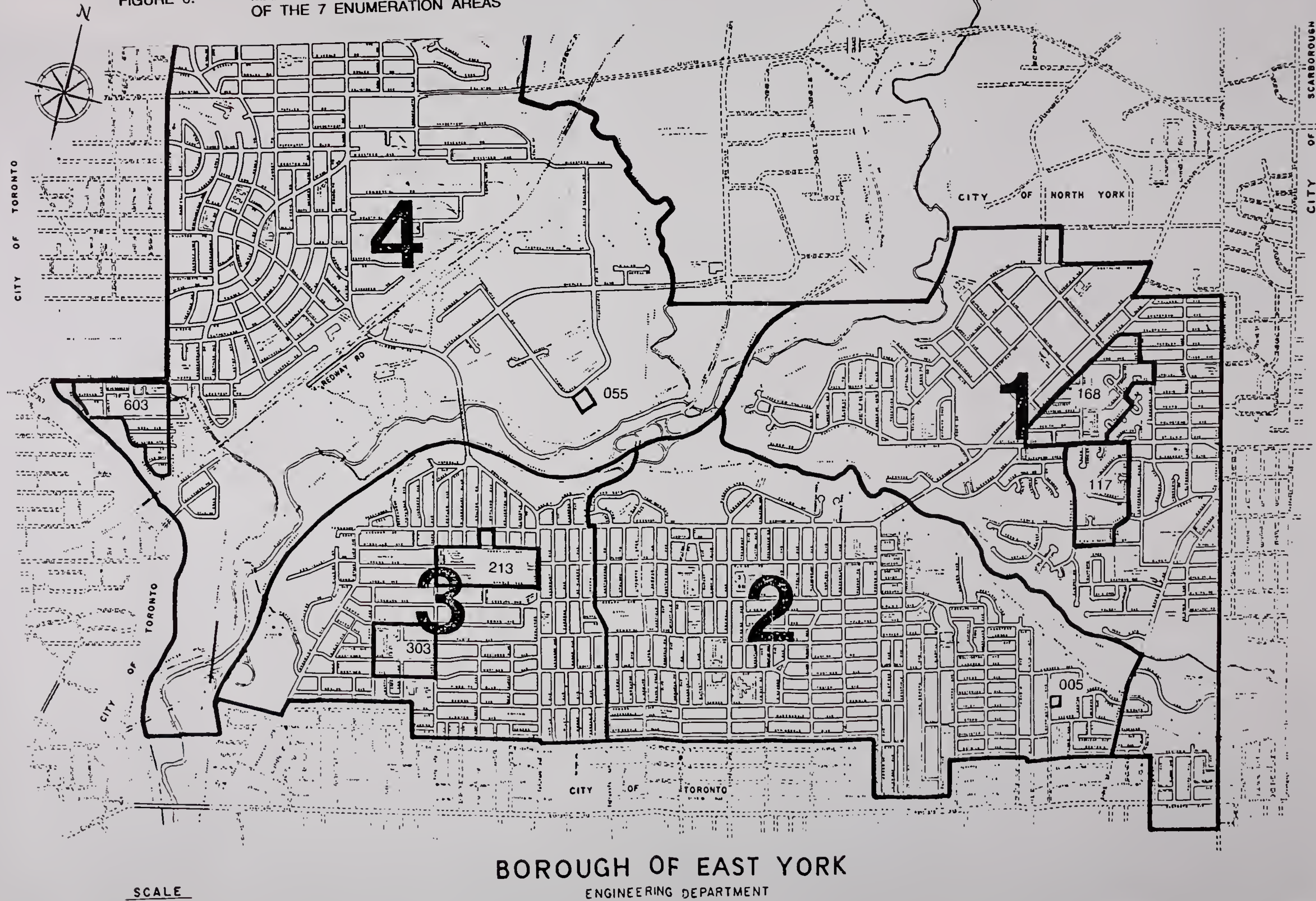
[1] The income / housing matrix accounts for 170 of 179 EAs

[2] EAs in each matrix cell as a percentage (%) of the total 170 EAs

7B: Income / housing matrix cell number and corresponding EAs sampled in the study

Matrix cell	EA Number	EA Name
A1	65-603	603
A2	90-117	117
A3		---
B1	90-168	168
B2	05-213	213
B3	12-054	055
C1		---
C2	05-303	303
C3	90-055	005

FIGURE 6: MAP OF EAST YORK SHOWING THE LOCATIONS OF THE 7 ENUMERATION AREAS



2.2.2 Residential Waste Sampling Plan Based on Municipal Population Demographics

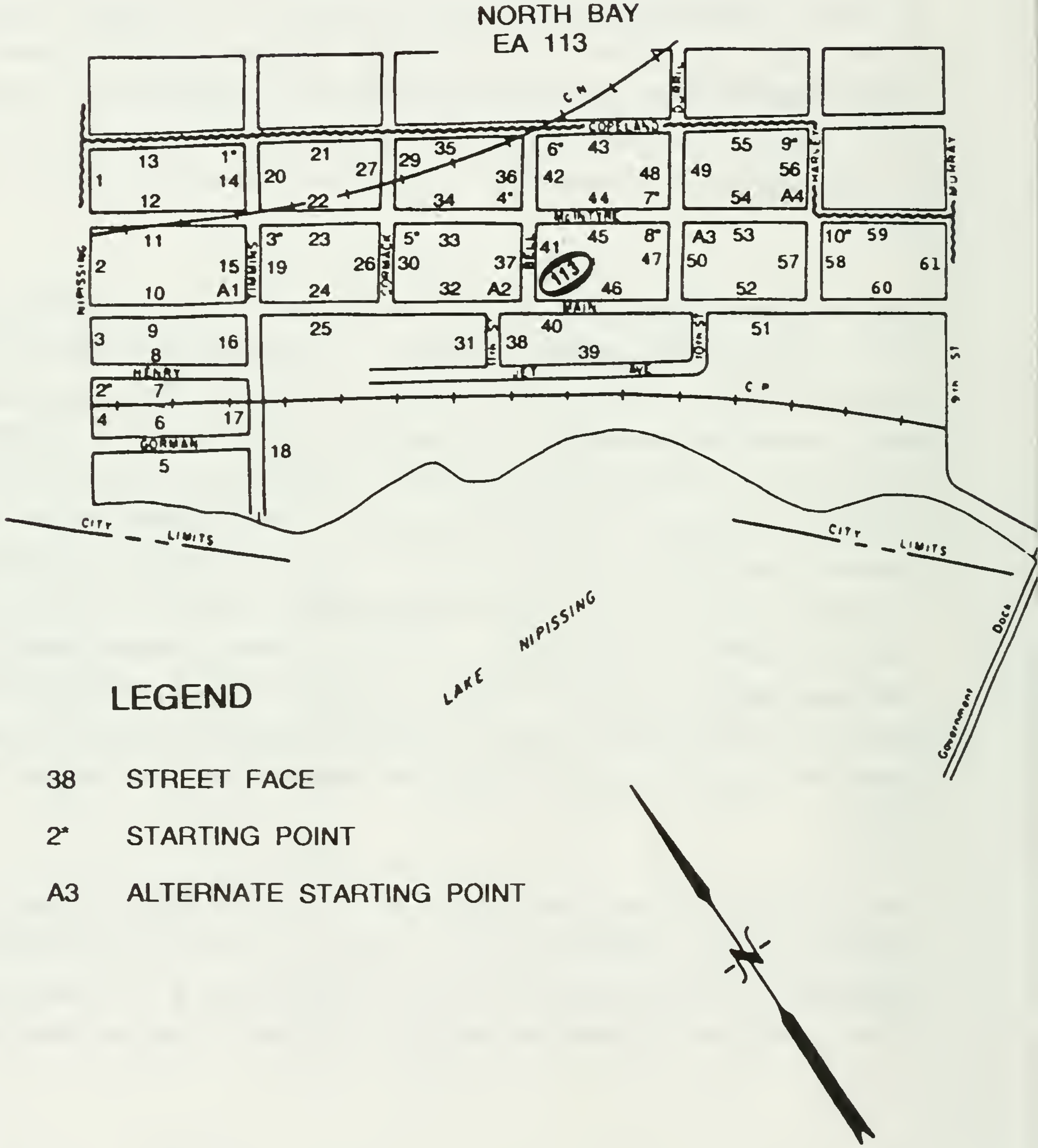
2.2.2.1 Street Numbering and Collection "Starting Points"

The following is a general description of the procedure for setting up a sampling program in each EA. Every street "face" within an EA was given a number. This process proceeded systematically, starting in the upper left corner of the EA map, numbering left to right as street faces were encountered, ending up in the bottom right corner of the EA map. Opposite sides of a street bear different numbers, with eight numbered street faces meeting at an intersection of two streets. The map in Figure 7 shows the numbering systems in a typical EA (for purposes of example, EA 113 from the city of North Bay is shown here).

Next, a random number table was employed to randomly select "starting points" for the curbside waste collection program. For example, if the number 17 was determined randomly, street face number 17 was located. Then, our convention was to select the intersection at the eastern or northern end of the street as a starting point. Certain practical limitations to this procedure were encountered from time to time but were easily overcome. For instance, if the random numbers selected from the table resulted in potential starting points that were too close to each other, i.e., their locations did not permit the collection of a minimum quantity of refuse before encountering another potential starting point, alternative starting points were chosen, as indicated below. In the field, starting points that were too close to each other were frequently "over-run" in order to collect the required weight of refuse at curbside (see also Section 2.2.2.2 below).

Nine starting points, indicated by an * on the map in Figure 7, and 3 or 4 alternate locations (indicated by an A1, A2, etc.) were usually supplied. No preference was implied between the first 9 and the latter 3 or 4 starting points, or the sequence in which the sampling occurred. However, there was a

FIGURE 7: EXAMPLE OF ONE EA SHOWING NUMBERING OF BLOCK FACES AND SAMPLE COLLECTION "STARTING POINTS"



LEGEND

38 STREET FACE

2* STARTING POINT

A3 ALTERNATE STARTING POINT

standardized, CLOCKWISE direction of collection from each starting point that enabled us to drive and collect waste on the right hand side of the street, proceeding clockwise around corners and into and out of cul-de-sacs. Alternative starting points were almost always used, for the reasons noted above.

The sampling of small and large apartment buildings, when they were either part of an EA or constituted an entire EA (by virtue of their size), respectively, will be described below in Section 2.2.3.5.

2.2.2.2 Problems Encountered

As the distribution of dwellings in an EA was not known by the study team from prior experience within any of the municipalities, several minor problems arose as a result of the random and "blind" determination of starting points in EAs. On the one hand, there was complete impartiality in assigning the starting points. On the other hand, some streets were sparsely populated, factories or commercial enterprises were present on others or waste from second floor apartments over commercial premises was co-disposed with commercial waste. The difficulties were readily overcome, on-site, by using the designated alternate starting points. If these latter points were exhausted, additional locations were randomly selected from the remaining potential starting points, i.e., street intersections, in the EA.

2.2.3 Data Acquisition: Collecting and Sorting Residential Refuse

2.2.3.1 Collection Equipment

The following list of equipment includes rented vehicles and purchased equipment:

one - 4.3 m.(14 ft.) cube van (for collection of bagged refuse);
one - pick-up truck (for collection of Blue Box contents);

one - electronic platform scale (150 kg capacity, Accu Weigh Model PAK-150 (electronic, battery operated scale with digital read-out), Exact Weight Scale, Inc., Toronto, Ontario);

six - 1.2 m.(4 ft.) x 1.2 m.(4 ft.) x 1.2 m. (4 ft.) heavy duty corrugated containers ("gaylords"); these containers were used for storing the bagged (non-Blue Box) refuse samples as they were being collected;

four - 1.2 m.(4 ft.) x 1.2 m.(4 ft.) divider frames (2.5 cm. x 5.1 cm. wood furring stock/chicken wire); these were used as horizontal partitions in the back of the cube van for separating the collections of bagged (non-Blue Box) refuse which were stacked on top of each other;

two - 46 cm.(18 in.) x 2.4 m.(8 ft.) divider frames (2.5 cm. x 5.1 cm. wood furring stock/chicken wire); these were used as the two main partitions in the back of the pick-up truck for segregating the collections of Blue Box materials (see Figure 8);

nine - 46 cm.(18 in.) x 41 cm.(16 in.) (approx.) plywood panels; used as partitions in the back of the pick-up truck (see Figure 8);

one - chicken wire "crib": 1.2 m.(4 ft.) x 1.2 m.(4 ft.) x 1.3 cm.(1 2 in.) plywood base; 0.6 m.(2 ft.) high chicken wire and 2.5 cm. (1 in.) x 5.1 cm.(2 in.) furring sides. Nailed to the underside of the crib floor was a square frame which permitted the crib to be centred on the bed of the platform scale (see Figure 9); the crib was used for weighing the refuse as it was being collected from curb-side;

150 - 50.8 cm.(20 in.) x 76.2 cm.(30 in.) x 6 mil polyethylene bags (Oxford Packaging Inc., Mississauga, Ontario); these were used for bagging refuse that was set out loose in garbage cans; the bags were also used for storing refuse samples for moisture and chemical analysis;

40 - 30 litre polyethylene garbage cans; these were used as containers into which sorted refuse was placed (see Figure 10);

one - 2.7 m.(9 ft.) x 3.7 m.(12 ft.) reinforced plastic tarpaulin for covering Blue Box materials in the pick-up truck;

six - elastic straps to secure the tarpaulin in place;

one - broad-mouth aluminum shovel; used for cleaning up spills;

FIGURE 8: PHOTOGRAPH OF PICKUP TRUCK WITH COMPARTMENTS FOR BLUE BOX MATERIALS.

FIGURE 9: PHOTOGRAPH OF CHICKEN WIRE CRIB MOUNTED ON THE PLATFORM SCALE (REAR VIEW OF CUBE VAN)

one - broom; used for cleaning up spills and sweeping out the vehicles;

one - staple gun and 0.95 cm.(3/8 in.) staples for construction and repair of chicken wire dividers and crib;

one - claw hammer; 5.1 cm.(2 in.) common nails: used in the construction of the crib and divider frames.

Special Requirements In Each Municipality For Sample Sorting

a) Town of Fergus

The field study took place between: July 15 and August 31, 1989.
Written approval was received from the City of Guelph that enabled the Study to use the landfill site as its base of operation, with space for sorting the refuse samples, an eating area, washroom facilities and helpful guidance from the municipal staff.

The refuse was sorted, weighed and disposed of at the landfill site. The sorting of bagged refuse took place on the tailgate of the pick-up truck (see Figures 10 & 11), following the sorting and weighing of the Blue Box materials stored in the truck. Several sheets of plywood, resting on the tailgate, extended the working surface to comfortably accommodate four people, surrounded by the garbage cans.

b) City of North Bay

The field study took place between: February 21 - 28 , 1990.
The assistance of one employee of the City Engineering Department was provided to complete the Study team (as noted above). Written approval was received from the City of North Bay that permitted the Study team to use the Work's Yard as their base of operations. Available at that location were: an eating area, washrooms and a telephone.

A large 7.6 m.(25 ft.) x 7.6 m.(25 ft.) carnival tent (see Figure 12) was used as a sorting area at the City's Work's Yard. The tent, supplied by the City of North Bay, provided storage space for the samples and protection for the Study crew from the winter weather. Two, 15,000 BTU propane heaters (see Figure 13) were used to heat the tent. Refuse was sorted inside the tent on a plywood table, mounted on saw horses.

Several combinations of protective clothing were experimented with by the Study crew. In addition to heavy duty rubber gloves and safety glasses, cotton coveralls, a large rubber apron and a hat seemed to provide adequate protection. On very cold days, a nylon parka or shell was worn.

Sorted and weighed samples were disposed of in a 18.3 m.(20 yd.) roll-off bin, rented from a private hauler. When full, the bin was taken to the landfill site for disposal of the waste and an empty bin was left in its place.

c) Borough of East York

The field study took place between: October 24 and December 28 , 1989. Written approval was received from the Municipality of Metropolitan Toronto that enabled the Study to use the Commissioners Street incinerator as its base of operation, with space on the tipping floor for sorting refuse, a heated office and washroom facilities and helpful guidance from municipal staff at both the incinerator and the Bermondsey Transfer Station.

The refuse was sorted, weighed and placed in a 18.3 m.(20 yd) roll-off container, rented by Gore & Storrie Limited for the duration of the study. The sorting of refuse was conducted off the tailgate of the pick-up truck, as described for the Town of Fergus. Arrangements were made with a private hauler to have the container taken to the Bermondsey Transfer Station for disposal when the container was full; an empty container was left in exchange.

FIGURE 10: PHOTOGRAPH SHOWING THE POSITIONING OF THE STUDY TEAM AROUND THE TAILGATE SORTING TABLE

FIGURE 11: PHOTOGRAPH SHOWING THE PLYWOOD TABLE SITTING ON THE PICKUP TRUCK TAILGATE.

FIGURE 12: PHOTOGRAPH SHOWING THE CARNIVAL TENT IN WHICH REFUSE SORTING WAS CONDUCTED.

FIGURE 13: PHOTOGRAPH SHOWING THE PROPANE HEATERS, REFUSE SAMPLES UNDER BLUE TARPAULINS AND ONE CORNER OF THE PLYWOOD SORTING TABLE (LOWER LEFT CORNER OF PHOTOGRAPH) MOUNTED ON SAW HORSES INSIDE THE CARNIVAL TENT.

2.2.3.2 The Field Crew

Four or five people were needed for the waste collection task where a Class 1 Blue Box program was in place (Town of Fergus; Borough of East York): two truck drivers, one collection data recorder and one (or two) people to pick up the bagged refuse and Blue Box materials. Occasionally, a 5 day work-week was not long enough to complete the collection and sorting operations and an additional work day (Saturday) was required.

In North Bay, where there was no Blue Box program in place, a three member crew carried out the refuse collection. It should be noted that the reduced crew number required that they work an extra full day, i.e., Saturdays, to complete the sorting and weighing of waste.

Personal equipment included:

- heavy duty, waterproof (PVC-coated) gloves;
- work clothes or coveralls; apron; hat
- steel toed work boots;
- eye protection;
- tetanus/polio vaccination (optional: diphtheria, Hepatitis A and Hepatitis B);
- traffic safety vest;
- particle masks, worn by crew members concerned with dust and the possibility of disease transmission;
- anti-bacterial soap, used to clean gloves, hands and face before meal breaks and at the end of the day.

2.2.3.3 Documents and Meetings

Two important documents were obtained from the Ministry of the Environment, Waste Management Branch. The first authorized the collection of waste for the Ontario Waste Composition Study; the second was a letter to be given to any individual in the municipality who was interested in learning more about the ongoing residential Study.

Following Ministry of the Environment approval to consider a municipality for inclusion in the Study, a meeting was arranged with the municipality to discuss the aims of the Study and "invite" the municipality to participate. Following the meeting, a formal letter of request was sent to the municipality.

A high level of coordination, to ensure scheduling of refuse collections, required weekly meetings and numerous phone calls between the Study Project Manager, municipal staff and waste haulers. Each week, a map of the EA scheduled for inclusion in the refuse study was delivered to municipal staff and/or the waste haulers. There was only one incident during the entire Study when the "line of communication" failed, but only briefly.

A similar level of coordination was required in order to obtain permission to include small and large apartment buildings in the Study. Usually the details were arranged through phone conversations with apartment owners and building managers and waste haulers, but occasionally written requests for permission were prepared.

In North Bay, a press release was issued by the City to inform its residents about the City's participation in the Ontario Waste Composition Study.

2.2.3.4 Waste Collection Process: Detached Dwellings---General Procedures

The goal of the waste collection process, on any one day, was to obtain 10 (9 as a minimum), 100 kg (minimum weight) samples of residential waste---exclusive of the weight of Blue Box materials and yard waste that were also coincidentally collected if they were placed curbside. This task proceeded as quickly as possible, with a 0700 h start, so that the normal collection of waste and Blue Box items by the municipality was not seriously inconvenienced.

The waste sample collection began at one of the starting points (refer to Figure 9). Waste was collected in front of every dwelling where it was set out, until approximately 100 kg were accumulated in the crib (Figure 12), some variations to this are noted below. An "en route" collection record was kept of the number of dwellings that had waste set out: general waste and/or Blue Boxes. Single and duplex dwellings were also indicated.

The importance of the "en route" collection record and the accuracy of the recording of the number of dwellings that were sampled should be noted. The team member who recorded the trip data did not have time to concentrate on any other aspect of the curb-side collection process.

Loose waste set out in garbage cans was rebagged in clear polyethylene bags. These bags were reused and not included in the analyzed waste sample. The collected waste was placed in the chicken wire crib which was mounted on the platform scale on the floor of the van (see Figure 9). The scale was tared with the empty crib on it, prior to filling the crib with waste. When the minimum required weight of waste had been collected (with an allowance for the estimated inclusions of yard waste co-disposed with household waste), the crib was unloaded and sample was stored in the van.

Corrugated gaylords were used to store six of the waste collections. Two of the remaining collections were piled on top of 1.2 m.(4 ft.) x 1.2 m.(4 ft.) chicken wire dividers placed on top of the collections in the gaylords. The ninth collection of bagged refuse was piled on top of the Blue Box materials, stored in compartments in the pick-up truck (see below), while the tenth collection was kept in the weighing crib.

Yard waste set out at the curb was weighed at the time of sample collection. The weight was recorded and the yard waste was placed back at the curb for municipal waste collection. (Note: the Town of Fergus issued a notice that yard waste should not be set out for collection but this edict appeared to be widely ignored).

Blue Box items were placed in the corresponding sample compartment in the back of the pick-up truck (Figure 8). There was space for 9 collections in the truck; the tenth collection was stored in polyethylene garbage cans in the van.

It took between 2 and 2.5 hours to make 9-10 collections within an EA. Following the last collection, the contents in the pick-up truck were covered with a tarpaulin. Elastic straps secured the crib and contents in the back of the van. The Study team proceeded to the base of operations in the municipality and began sorting the samples.

<u>Special Requirements In Each Municipality For Sample Collection</u>

a) <u>Town of Fergus</u>

Municipal solid waste was collected on Wednesday or Friday, depending on whether the street address was on the North or South side, respectively, of the Grand River. In several cases, EAs were intersected by the River and the sampling programs required waste collections on both days.

b) <u>City of North Bay</u>

Municipal solid waste was collected on Tuesday or Wednesday, depending on the street location in the City. The short time interval between the City's agreement to participate in the Study and the timing of the first curb-side collection precluded a careful coordination of the Study's collection route and the normal collection routes of the City's refuse contractor. Thus the Study crew had to commence sample collection at 0500 h and finish by 0700 h, in order to avoid having the waste picked up by the regular collection service.

c) <u>Borough of East York</u>

The Borough of East York had a twice weekly curb-side collection program: Monday and Thursday or Tuesday and Friday, depending on whether a street was West or East, respectively, of Greenwood Avenue. Therefore, two trips were made to collect waste from the same sample areas, i.e., using the same starting points, in each EA.

Staff in the Borough of East York indicated that about 60% of the weekly volume of refuse was placed at curb-side for the first of the two weekly collections, with about 40% set out for the second collection. This ratio was not universally reliable for all of the EAs in the Borough. With a target of 100 kg (minimum weight) of waste that had to be collected for a sample of adequate size, the following collection protocol was developed and illustrated in the example below.

For a given sample, approximately 60 kg of bagged refuse was collected from approximately 7 houses, on the first collection day. The collection on the second day was initiated at the same "starting point" in the EA and waste was collected from <u>the same number of dwellings</u>. This ensured that an accurate per capita generation rate could be estimated. In theory, the 60/40 relationship would also result in approximately 40 kg of refuse collected on the second occasion, for total of 100 kg of waste for the composition analysis.

The uncertainty of the 60/40, or any other ratio, required that we "overcompensate" with respect to the weight of the first collection in each sample by picking up more than 60 kg (e.g., 70 kg) from approximately 9 dwellings. This "insurance" weight meant that the crew <u>was required</u> to pick up from 9 dwellings on the second collection day. The total sample weight, that is, the sum of two collections, would therefore not likely be less than 100 kg. Of course, the fear was that the weight of refuse collected from the nine dwellings on the second day would put the total considerably over the 100 kg point and require additional hours of sorting.

Waste collection from apartment buildings did not present this kind of a sampling problem (see below).

2.2.3.5 Waste Collection Process: Apartment Buildings

Special Requirements In Each Municipality

a) Town of Fergus

100 kg waste samples were removed from the waste bins at each apartment building for the composition analysis. In some cases, 2 - 100 kg samples were taken. The residual waste that remained after the sample(s) was taken, was removed, weighed and returned to the bin for normal pick-up.

The normal waste collection schedule for apartments was on Monday and Friday. Our collections were made on Fridays, only, and per capita generation rate calculations accounted for the 5 day period of waste accumulation. The number of units in each apartment was determined as well as the occupancy rate.

(Note: the weakness of this procedure, i.e., the omission of collection of refuse generated over the weekend, was rectified later in the Study in the other municipalities. It is possible that the estimated per capita generation rates for this sector of the Fergus population is lower than it might have been, had the calculations included the 3 day part of the week, i.e., the weekend, when people are frequently at home and the refuse generation may be expected to be higher than during the Monday to Friday period.)

b) City of North Bay

In North Bay, waste was sampled from small apartment buildings (fewer than 30 units) only. This waste was placed curb-side at the buildings that were part of the collection route, therefore no particular problems were encountered. The quantity of waste placed at the curb was sufficient to comprise a single sample per building (125.6 kg and 105.3 kg). The number of units occupied in each building was determined later and recorded.

c) Borough of East York

Small Apartment Buildings

The waste from apartment buildings with up to 30 units was collected by the municipality as part of the curb-side residential collection program. Frequently such premises were part of the sampling areas in the Study EAs. The following procedure was applied. On the first collection day, approximately 60 kg was randomly taken from the curb-side pile of bagged waste, weighed and placed in a gaylord. The remaining portion of waste was weighed and replaced at the curb for collection by the Borough's garbage brigade. A similar procedure was followed on the second collection day, except that about 40 kg of waste was randomly collected, with the remainder being weighed and returned to the curb.

A general problem with the small and large apartment buildings was that despite the knowledge of the number of units that were actually occupied, we could not be certain that ALL tenants put out their waste for the collections that we sampled. In our calculation of the per capita waste generation rate we have multiplied the number of units by the Statistics Canada data for average population per dwelling to obtain the estimated number of residents in the apartments. The weight of waste set at the curb (or accumulated in the refuse bins) was divided by the apartment population. Our calculations could underestimate the per capita generation rate if some of the residents did not discard their refuse in a pattern which was coincident with the normal refuse collection pattern. Unless tenants received specific instructions from apartment managers, tenants could be "isolated" from the regularity of garbage collection:...down the garbage shoot...out of sight, out of mind...at least it is not smelling up my unit.

When Blue Box materials, especially grocery bags of newspapers, were placed at the curb in a manner which obviously intended that they would be collected by the Borough's recycling truck, the team placed the materials in the appropriate section of the pick-up truck. Again, as noted above, we did not know how many of the apartment units (number of tenants) contributed to the separate pile of Blue Box materials.

Large Apartment Buildings

Two large apartment buildings were EAs unto themselves: EA 12-055 and EA 90-055. They were treated as individual EAs in that nine, 100 kg samples were collected from each of the two buildings. The following discussion describes the procedures employed at EA 90-055, which serves as the example.

Under normal circumstances, waste collection, by a private hauler, was made twice a week (in both of the EAs). Thus, the Study team applied the "60 40" sampling plan described earlier for the Borough of East York (Section 2.2.3.4). Six bins of waste were set out on each collection day. On day 1, approximately 60 kg of waste were randomly taken from the top of each bin; these collections were the first 6 samples. For the last 3 samples, the bins were paired and resampled so that each sample contained waste from 2 bins.

Prior arrangements were made with the apartment's hauling company to provide an empty front end/overhead packer truck to pick the waste remaining in the 6 bins and deliver it directly to the Bermondsey Transfer Station for weighing and disposal. The weight of the waste was telephoned to the hauler's office from the Transfer Station and the datum was relayed to Gore and Storrie Limited.

A similar sequence of operations was followed on the second collection day, except that the sample weights of waste removed from the bins were approximately 40 kg. The sum of the 18 sample weights and 2 residual weights gave the total weight of refuse generated by the "towering" EA during the week.

2.2.3.6 Special Collections

Yard Waste

Yard waste set out at the curb was weighed and replaced at the curb for the regularly scheduled municipal refuse collection. The weight of yard waste recorded "en route" for each sample was later combined with the yard waste that was co-disposed with household refuse to give a total weight of yard waste for the sample.

While the weight of yard waste is recorded, herein, on the raw data sheets for the waste composition (see Appendices A2, B2 & C2), it may be **NOTED THAT** the calculations of per capita generation rates and waste composition percentages in the present Study do not include the yard waste component. An explanation for this decision in data handling may be found in the Literature Review (see Section 1.2.1).

Leaves

A figure for the reported tonnage of leaves collected from the Borough of East York during the fall, 1989, was obtained from staff at the Commissioners Street Incinerator and confirmed by staff in the Borough Work's Department. The reported weight was 1,115.2 tonnes.

Schools

Special arrangements were made with the Borough of East York Work's Department that enabled the Study team to collect waste from 7 schools: 4 primary, 2 junior high schools and 1 high school. The curb-side sample collection method was the same as that used for small apartment buildings described above in Section 2.2.3.5 (Borough of East York---small apartment buildings).

Christmas

Residential refuse was collected from EA 90-117 (middle income / primarily detached dwellings) on 28 December 1989. Blue Boxes were not set out at the time of this Christmas week collection. The EA had been initially sampled on 28 and 30 November, 1989.

2.2.3.7 Equipment For Waste Sorting

The following equipment and supplies were needed for the waste sorting and composition analysis:

- 1-150 kg capacity platform scale (noted previously);
- 1-5 kg capacity scale (Accurate model 5000 (electronic, battery operated with digital read-out), Exact Weight Scale Inc., Toronto, Ontario);
- 40-polyethylene garbage cans (note above);
- 1-claw hammer;
- 1-slotted screw driver;
- 1-electrician's pliers;
- 4-magnets
- pairing knives for opening plastic bags
- Personal equipment was listed above in Section 2.2.3.2.

2.2.3.8 Personnel

Town of Fergus

Four students from Sheridan College in Mississauga, Ontario, and a graduate of the University of Toronto were the Study crew on this phase of the work. They possessed a background in science or engineering and had a working knowledge of measuring techniques, the care of reasonably delicate equipment and data recording. At the outset of the work they were given instruction, by Dr. Fred Edgcombe, Executive Director, Environment and Plastics Institute of Canada (EPIC) in the kinds of plastics that would likely be encountered during the survey of residential waste.

It was emphasized that the Study was really a "laboratory situation". Thus attention was given to organization, routine, reproducibility, consistency---even the cleanliness of garbage cans, van floor etc. This approach attempted to maximize a scientific attitude and thoughtful responsibility leading to careful work habits that the students learn as part of their analytical training.

Borough of East York

Three members of the Study team departed prior to the time the Borough of East York Study got underway, however one Study team member remained to give important continuity for the work. The three new Study team members were university graduates in science and liberal arts, with practical waste composition experience or with the objectives of the Study serving as a "cause cèlèbre" for their participation.

City of North Bay

The three Study team members included two of the Borough of East York team and one staff member of the City of North Bay Engineering Department. The latter individual was a University graduate with a science background and, at the time, was training to be a Recycling Co-ordinator.

General Attitudes

It took about 2 weeks of sorting waste before the Fergus Study team had "risen above" the physical (distasteful) aspects of the work and saw the larger picture, i.e., the residential waste characteristics of the citizens of Fergus.

In the other two municipalities, the Study team reached a level of proficiency earlier than the Fergus team. It should be noted however, that the working conditions in Guelph, e.g., high temperatures, direct sun, blowing dust, flies, a general maggoty condition of the refuse and very strong odours produced in the heat, were much more "trying" conditions than those experienced by either of the other Study teams.

2.2.3.9 Sorting Routine

Blue Box Materials

Each compartment of the pick-up truck was sequentially unloaded and the Blue Box materials were sorted into the categories noted at the bottom of the data sheets found in Appendices A2, B2 & C2. The separate categories of materials were placed into 114 lit.(30 gal.) polyethylene garbage cans, which had uniform tare weights of 1.8 kg., and the weight of each material was determined. The weights of the Blue Box materials were entered on the appropriate waste sample data sheet. The sample data sheets were identical to those shown in Appendices A2, B2 & C2.

The materials collected in the Blue Box program in the Borough of East York included rigid plastic containers and OCC (Old Corrugated Containers), items that were not part of the recycling program in the Town of Fergus.

The City of North Bay did not have a Blue Box program.

Blue Box materials were separated into the following categories*:

a) Newsprint, including coated paper inserts
b) Liquor/wine bottles
c) Food jars/other bottles
d) Food cans (i) ferrous
(ii) non-ferrous
e) Beer cans (i) ferrous
(ii) non-ferrous
(iii) American
f) Pop cans (i) ferrous
(ii) non-ferrous
g) PET bottles
h) Rigid plastic containers
i) OCC

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*items a-g in the Town of Fergus; items a-i in the Borough of East York

"Bagged" Residential Refuse

The contents of the remainder of the residential waste stream, i.e., the largely bagged refuse, were sorted according to the categories of items listed on the data sheets found in Appendix A2, B2 & C2. Blank data sheets were used to record the weights of the categories of waste. The samples were sorted one at a time by the sorting team.

Each 100+ kg sample was unloaded from the cube van and sorted. The 9-10 samples collected in an EA were sorted over a 3-5 day period. A sorting routine was developed as follows. Garbage cans into which the various components of the waste were sorted, were arranged in an array around each sorter (see Figure 10)---with the following notation of "handedness", in respect to containers for plastics and paper, to permit the sharing of containers between sorters. Directly in front of each sorter (or nearly under the sorting table) were his/her own receptacle for food waste, with containers for polyolefins (polyethylene & polypropylene) and assorted paper tissue on either side of the central food container. Then, progressing backward on the left (or right) hand side was a grouping of containers for other kinds of plastics. On the opposite side, were containers for other categories of paper items. Hence, the "handedness" aspect of container placement permitted the person on the left to sort plastics with the right hand while the person to the right sorted plastics with the left hand. Containers for metals, glass, diapers---categories of materials that could be lobbed some distance to shared containers---were located behind the sorters.

The "handedness routine" was devised to minimize the handling of the same material twice, i.e., transferring an item between hands, and to speed up the sorting efficiency.

Items that were not easily classified, that is, they were composed of several materials that could not be readily separated from each other e.g., light bulbs, costume jewellery, electrical equipment, etc., were weighed separately (or simply counted, as in the case of light bulbs) and recorded on a sheet of "miscellaneous items" for each sample (see Appendices A2, B2 & C2).

Note: The weights of all of the components were summed and the percentage of each component was determined on the basis of this sum and not the weight of the sample determined en route, during curbside collection. As noted above, 3-5 days were required to sort the residential refuse collected from an EA. During this time, the samples lost some weight, presumably via evaporation of water. Under the summer conditions during the Study in the Town of Fergus, moisture loss occurred during the sorting process, as bags of refuse were opened and air exchange promoted evaporation of water, particularly under sunny or windy conditions.

Under the winter conditions during the latter part of the Study in the Borough of East York and for the entirety of the work in the City of North Bay, the garbage was frozen. This created a problem for separating frozen items, particularly food which was frozen to packaging. There was also less evaporation of moisture when the separated items were exposed to the open air.

Table 8 is a copy of the field data sheet used in the study showing the categories into which the household refuse was separated.

Notes On the Categories

Dr. Fred Edgecombe, Executive Director, EPIC (Environment & Plastics Institute of Canada) recommended that we group all polyethylene and polypropylene containers and film plastics together as "polyolefins" (item 5a), rather than trying to distinguish between polyethylene of different densities and crystal linearity. A small amount of SARAN wrap (polyvinylidene chloride) would also have been included in this category.

The PVC category (item 5b) was restricted to rigid containers; the vinyl category was reserved for other materials such as scraps of vinyl siding.

A simple "smoke and drip" test, provided by Dr. Edgecombe, was used to assist in determining the category for a particular plastic item. The test is included as Appendix D but it should not be viewed as a definitive qualitative method when used by itself.

Mixed blended plastics (item 5f) were reserved for plastic packaging around meat products. Coated plastics (item 5g) were for packaging in which the plastic portion was judged to be the greatest percentage by weight, e.g., potato chip bags. The "Tetrapak" boxes were categorized as mostly paper (boxboard) and included in item 1d.

TABLE 8: FIELD DATA SHEET

Town:
Enumeration Area:
Sample :

(1) Paper (a) Newsprint				
(b) Fine Paper / CPO / Ledger				
(c) Magazines / Flyers				
(d) Waxed / Plastic / Mixed				
(e) Boxboard				
(f) Kraft				
(g) Wallpaper				
(h) OCC				
(i) Tissues				
(2) Glass (a) Beer (i) refillable				
(ii) non-refillable				
(b) Liquor & Wine Containers				
(c) Food Containers				
(d) SoftDrink (i) refillable				
(ii) non-refillable				
(e) Other Containers				
(f) Plate				
(g) Other				
(3) Ferrous (a) Soft Drink Containers				
(b) Food Containers				
(c) Beer Cans (i) returnable				
(ii) non-returnable				
(d) Aerosol Cans				
(e) Other				
(4) Non-Ferrous (a) Beer Cans (i) returnable				
(ii) non-returnable				
(iii) American				
(b) Soft Drink Containers				
(c) Other Packaging				
(d) Aluminum				
(e) Other				
(5) Plastics (a) Polyolefins				
(b) PVC				
(c) Polystyrene				
(d) ABS				
(e) PET				
(f) Mixed Blend / Coated				
(g) Nylon				
(h) Vinyl				
(6) Organic (a) Food Waste / Rodent Bedding				
(b) Yard Waste				
(7) Wood				
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos				
(9) Diapers				
(10) Textiles/Leather/Rubber				
(11) Household Hazardous Wastes (a) Paints / Solvents				
(b) Waste Oils				
(c) Pesticides/Herbicides				
(12) Dry Cell Batteries				
(13) Kitty Litter				
(14) Medical Wastes				
(15) BLUE BOX ITEMS (a) Newsprint				
(b) Liquor / Wine Bottles				
(c) Food Jars / Other Bottles				
(d) Food Cans (i) ferrous				
(ii) non-ferrous				
(e) Beer Cans (i) ferrous				
(ii) non-ferrous				
(iii) American				
(f) Pop Cans (i) ferrous				
(ii) non-ferrous				
(g) PET Bottles				
	TOTAL kg		TOTAL kg	

Rodent bedding (item 6a) was routinely encountered in small quantities of urine-soaked cedar shavings and faecal pellets. The material was included in the food waste category because of the putrescible nature of both of the components. Likewise, individual "packages" of canine excreta---presumably contributed by citizens obeying the "poop-and-scoop" statutes---were included in this category. Kitty litter (item 13) was more frequently encountered and because of the inorganic nature of the granular product, save for the associated feline excretory products, the two components were given a single, separate category.

Sanitary napkins were included in the paper category (item 1i).

Medical wastes (item 14) included medicines, insulin bottles and associated used syringes (needles protected and unprotected) and syringes without accompanying evidence of medicinal application.

Aerosol cans were collectively weighed and included in the ferrous section as item 3d. At the time, we felt that one category for ferrous/non-ferrous pressurized containers would be adequate.

2.2.3.10 Moisture Content

After the waste was sorted into the designated categories and weighed, samples of plastics, paper, food waste and disposable diapers were placed in large polyethylene bags and stapled shut. The bags were labelled with the appropriate sample numbered and then taken to the laboratory of the former Ontario Centre for Resource Recovery (now known as the Dufferin Transfer Station), Toronto. The contents of the bags were weighed in tared, aluminum baking pans (purchased in local supermarkets) and placed in the waste drying oven at 203 F(95 C) for 48 h. The samples were removed from the oven, cooled and reweighed to determine the weight loss due to evaporation of water.

A Sartorius top-loading balance (Model # 3802; 6 kg capacity ± 0.1 g) was used for the weight determinations.

2.2.3.11 Inorganic Analyses of Vacuum Cleaner Bag Contents

Bags of vacuum cleaner dust/fibre/hair were frequently encountered in residential waste. As the curbside separation of the residential waste stream is expanding beyond the bulky items presently included in municipal Blue Box programs, it was decided that the chemical composition of the contents of vacuum cleaner bags may be instructive, for example, with respect to the decision to employ a two versus three stream "wet-dry" separation procedure. That is, the heavy metal concentration in the acid-extractable fraction of the vacuum cleaner bag contents could determine whether to exclude these items from the category of waste that will be composted, i.e., due to growing concerns with heavy metal loadings in some kinds of compost prepared from residential waste streams.

While it may be argued that the chemical composition of commercial paints, coatings and inks---or the pigment in the bright yellow HDPE detergent bottles---may be available through Material Safety Data Sheets or on a "need-to-know" request, the inorganic composition of house dust may only be gained through empirical experience, i.e., direct chemical analysis. Furthermore, depending on the geographic location of a municipality, the amount of vehicular traffic occurring within it and local industry, one may hypothesize that there will be differences in the chemical composition of the contents of vacuum cleaner bags.

In the Town of Fergus, vacuum cleaner bags were saved and grouped by EA. One bag was chosen at random from each EA for analysis. Fibrous contents and dust were pulled from the selected bags, placed in acid-washed plastic jars and submitted to X-RAL INC. for a 30 element inorganic analysis by ICP spectroscopy, plus analyses for mercury (Hg) and arsenic (As).

A similar procedure was followed in the Borough of East York except that the pooled sample was made up from the vacuum cleaner bags collected from each EA. No analyses were performed on the bags collected in the City of North Bay.

2.2.3.12 BTU Analyses of Selected Components

The following samples of mixed plastic packaging were obtained from the residential waste stream, washed with detergent, thoroughly rinsed, oven dried (101 C) to a constant weight and submitted for BTU analysis: (1) prepackaged meat containers; (2) prepackaged bacon wrap; (3) plastic ketchup bottle. In addition, a new disposable diaper was similarly oven dried and submitted for BTU analysis.

2.2.4 Data Management

2.2.4.1 General Considerations

As noted in the preceding sections, data were collected at different points during the collection and sorting of residential refuse. Table 9, summarizes the kinds of data that were collected and the intended use of these data.

2.2.4.2 Calculation of Per Capita Generation Rate

Estimation of the Per Capita Generation Rate in an EA

Table 10 serves as an example of how per capita generation rates were computed from the sample data (Appendices A1, B1 & C1) for each EA. The example cited in Table 10 is EA 258 from the Town of Fergus. The weight of waste used for this calculation was made up of either household waste alone or household waste and Blue Box materials, depending on whether or not Blue Box materials were set out. In almost every case the number of houses setting

TABLE 9: SUMMARY OF DATA COLLECTED AND INTENDED USE OF THE RESULTS

Kind of data	Use of data
Weight of refuse samples collected <u>en route</u> in EAs; number of residences setting out bagged refuse and Blue Boxes	Calculation of per capita waste generation rates (apts. in Fergus; those < 30 units in East York)
Weight of components in bagged refuse and Blue Boxes after sorting	Calculation of percent(%) composition Calculation of Blue Box "capture rate" Calculation of moisture content of components in the refuse
Weight of components in bagged refuse collected from schools (East York) and single Christmas week residential collection (East York)	Calculation of per capita waste generation rates Calculation of percent(%) composition
Weight of yard waste collected <u>en route</u> in EAs	(not included as part of the present method development Study)
Chemical analyses	Inorganic analyses of vacuum cleaner bag contents BTU values for selected materials

TABLE 10: SAMPLE CALCULATION OF THE PER CAPITA GENERATION RATE IN AN EA. DATA FROM THE TOWN OF FERGUS, EA # 258

Town: Fergus
EA: 258 / high income; primarily single detached dwellings
Pop: 600
Dwellings: 205
PPD: 2.93

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
31	8	5	115.80	31.11	2.51	0.857	
32	11	5	96.39	26.38	1.63	0.556	
33	6	3	123.52	24.30	3.52	1.201	
34	8	7	96.82	39.50	2.13	0.728	
35	12	8	103.06	45.80	1.64	0.558	
36	9	7	113.69	37.20	2.18	0.745	
37	2	2	42.12	40.36	4.45	1.519	
38	5	5	89.83	15.58	2.79	0.952	
39	7	4	122.68	12.65	2.73	0.932	
40	11	6	141.71	22.39	2.11	0.719	
Sample Ave.	7.9	5.2	104.56	29.53	2.57	0.88	0.094

out Blue Boxes did not equal the number setting out other household refuse. A two-step calculation was required to account for this difference.

Note: A decision had to be made with respect to apportioning the weight of the Blue Box materials collected at curbside. Recycling coordinators from 4 municipalities in Ontario were contacted and asked about the average frequency of Blue Box set-out by residents. Where Blue Box monitoring had been carefully conducted (e.g., East York), a complex picture emerged which reflected demographics of the municipality, thickness of the newspapers, seasonality, etc. Nevertheless, an average set-out frequency of once every two weeks seemed to be a reasonable compromise, given a range of: more than 1 set-out per week to less than 1 set-out every 3 weeks. Thus, we have employed a conservative convention whereby the weight of Blue Box items was divided by two (2) before including these materials in calculations of per capita generation rates or percent composition.

The generation rate of household waste, excluding yard waste, was calculated as follows: The weight of household refuse sampled (column 3) was divided by the number of houses the sample was taken from (column 2). The weight of Blue Box material collected (column 4) was divided by 2, as noted above, and then divided by the number of houses were Blue Box materials had been set out. Next, these two weights were added together and then divided by 7 (days per week) to give a daily weight per dwelling (column 5).

The daily per capita generation rate (column 6) was calculated by dividing the daily weight per dwelling (column 5) by the population per dwelling (PPD) for the given EA.

As an example of the calculation, consider Table 10, Sample Number 31:

1. 115.8 kg (household refuse) divided by 8 (dwellings) = 14.47 kg per dwelling per week; then,

2. 31.1 kg (Blue Box materials) divided by 2 (weeks) = 15.55 kg per week; 15.55 kg Blue Box materials per week divided by 5 (dwellings) = 3.11 kg per dwelling per week; then,

3. [14.47 kg/dwelling plus 3.11 kg/dwelling] divided by 7 (days per week) = 2.51 kg/dwelling/day;

4. 2.51 kg/dwelling/day divided by 2.93 (population per dwelling) = 0.86 kg/capita/day.

The average per capita waste generation rate (kg/capita/day) of all 10 samples was determined after summing all values in Table 10 and dividing by the number of samples.

Thus the per capita waste generation for EA 258 (high income/primarily single detached dwellings) was 0.88 kg ± a Standard Error of 0.09. In other words, the "true" estimate of the average per capita generation rate of the EA lies within the range: 0.79 to 0.97 kg/capita/day.

2.2.4.3 Method to Estimate the "Capture Rate" of the Blue Box Program

The following method was used to estimate the "capture rate" of the Blue Box programs in the Town of Fergus and the Borough of East York. The total weight of Blue Box items in each sample was the sum of: (1) the weight of materials set out in Blue Boxes, divided by 2 as per the conservative convention noted above,; and (2) the weight of the same "potential" Blue Box items that were put out in the bagged refuse, rather than in Blue Boxes. The weight of material set out in the Blue Boxes (1) was divided by the sum of (1) and (2) determined above and then multiplied by 100. This gave the percent which the Blue Box materials represented of the total "municipally recyclable" and potentially collectable categories of materials in the residential waste stream.

2.2.4.4 Per Capita Generation Rate of Waste From Schools

Per capita generation rates were calculated using student population, number of teachers and support staff (administrators, clerical, janitors, etc.). In calculating the per capita generation rate for schools, a 5 day week was used to account for weekend closure of the institutions.

It may also be noted that, as only a single 100 kg (approximately) sample of waste was collected and sorted from each school, an average waste composition was computed by pooling the data from all of the schools. No statistical comparison of waste generation characteristics of the 3 categories of schools may be made.

2.2.5 White Goods and Bulk Item Data Collection Method

Characterization of white goods and bulk item waste generation requires a method that monitors the waste on a yearly basis, and monitors the entire municipality. The put-out rate for worn-out appliances, furniture and other bulk items can be expected to vary over the course of the year. For example, many communities may have a spring/fall clean-up at which time many tonnes of bulk items may be discarded, while for the rest of the year very few bulk items will enter the waste stream. Similarly bulk item put-out by residents will be sporadic and difficult to predict for the municipality being studied.

To determine generation rates of bulk items on a yearly basis, several communities were contacted that have kept accurate yearly records of tonnages of bulk items collected as part of their residential waste collection program. By contacting numerous communities, a broad spectrum of collection practices is represented. As well, a range of potential generation rates can be assessed.

2.2.5.1 Data Collection

Data were collected by telephoning the person responsible for waste collection in each community. This person would typically be the municipal engineer or the recycling co-ordinator. Additional correspondence by telephone or letter was often required to complete the survey and data collection.

Data requested of each community included:

1. tonnages of white goods collected on a weekly/monthly/yearly basis;
2. tonnages of other bulk items collected on a weekly/monthly/yearly basis;
3. description of the collection program for white goods/bulk items to identify data that may be biased or incomplete.

Population data for each community for various years was determined from the Ontario Municipal Directory. These data were used to calculate the per capita generation rate (tonne/capita/year) of white goods and bulk items.

2.2.5.2 Communities Reporting Data

A total of 18 communities was contacted by telephone to inquire about the availability of collection records of white goods and other bulky items. The following 10 communities were able to report collection data:

Town of Ajax
Borough of East York
City of Etobicoke
City of Mississauga
City of North York
City of Oakville
City of Toronto
Town of Whitby
County of Wellington
City of York

SECTION 3

RESULTS

3.0 RESULTS

3.1 Estimation of Per Capita Waste Generation Rates

3.1.1 Town of Fergus

Table 11 shows the per capita generation rates and the quantities of waste (kg/day) generated for the 5 EAs that were part of the sampling program. The following general equation is used:

OVERALL GENERATION RATE (kg/cap/day)

```
Sum of cells          |    waste     |     |    EAs in the cell as     |
  A1-C3 in       =    | generation   |  x  |percentage of total number|
income/housing        |  rate in a   |     |of EAs in the municipality|
   matrix             | matrix cell  |     |   (for Study purposes)    |
```

EAs 255, 259 and 264 were not sampled in the study. The per capita waste generation rates were estimated for these EAs from the rates determined for the EAs that were sampled within the respective income / housing matrix cell (recall Tables 4 & 6). For example, EA 259 is in cell B2. The 0.80 kg per capita generation rate is the average of the two rates obtained from data for EAs 256 and 263 in matrix cell B2.

The average per capita generation rate for the 9 EAs, i.e., 0.804 kg/capita/day, was multiplied by the 1988 population of Fergus (6,757) to get the estimate of the daily rate of residential waste generation for the whole Town (exclusive of yard waste): 5,433 kg/day or 5.43 tonnes/day. The data are shown in Appendix A. (Note that Sample 51 EA 260, is omitted from per capita waste generation rate calculations due to excessive amounts of miscellaneous wastes which indicated that this was a non-representative sample).

We have attempted to check the accuracy of the residential waste generation estimate for the Town of Fergus in the following way.

TABLE 11: RESIDENTIAL WASTE GENERATION DATA INCORPORATED INTO THE INCOME/HOUSING MATRIX TO ESTIMATE THE WEIGHTED PER CAPITA GENERATION RATE (KG/CAPITA/DAY) FOR THE TOWN OF FERGUS.

	(1) Primarily Single Detached	(2) Mixed Dwellings	(3) Primarily Multiple Dwellings
(A) High Income	0.88 (11.1%)	0 (0%)	0 (0%)
(B) Medium Income	0.89 (22.2%)	0.80 (44.4%)	0.60 (11.1%)
(C) Low Income	0 (0%)	0 (0%)	0.78 (11.1%)

Medium Income; Mixed Dwellings (B2): Average of EAs 256 & 263

Weighted per capita generation rate (kg/capita/day) = 0.804

[1] Sample 51 from EA 260 is omitted from the calulation of Generation rate for Low Income; Primarily Multiple Dwellings due to excessive amount of miscellaneous material

- First, residential curbside collection tonnage was estimated from the total tipping charges that Plein Disposal Inc. incurred during the course of our Study in Fergus. It should be noted that this weight included commercial waste from stores located on St. Andrews Street and environs.

  $5,054/6 weeks ÷ $29.70/tonne = 170.2 tonnes/6 weeks
  170.2 tonnes/6 weeks ÷ 42 days/6 weeks = 4.05 tonnes/day

- Second, waste from apartments and "condominiums" in Fergus was collected by McLellan's Disposal Services Limited. According to their records, 100 cu yd of uncompacted waste were picked up weekly form these premises. Using an estimated weight of 250 lbs/cu yd, the following tonnage may be calculated:
  (100 cu yd/wk x 6 wks x 250 lbs/cu yd) ÷ (2.2 lb/kg x 42 days = 1,623 kg/day or 1.6 tonnes/day

- Third, McLellan's Disposal Services Limited also estimated that they picked up 37.7 tonnes of Blue Box items over that 42 day period, or 0.90 tonnes/day.

- Fourth, the total weight of materials (including Blue box and yard waste) collected curbside over that time by the study team was 7.3 tonnes or 0.17 tonnes/day.

The TOTAL of these four separate quantities is 6.72 tonnes/day. This number includes commercial waste, noted above, as well as yard waste. The Study estimate, derived from the per capita generation rate, is 5.43 tonnes/day and does not include yard waste, which is on the order of 20% of the weight of the total waste stream collected by the Study team.

The average population per dwelling in Fergus is 2.63 (Table 11). The average per capita generation rate of 0.804 kg/capita/day (or 1.77 lbs/capita/day) = 5.63 kg/capita/wk (or 12.4 lbs/capita/wk). It should be reiterated that the Fergus data do not include yard wastes.

3.1.2 City of North Bay

Appendix B gives the data obtained for each EA that was sampled. Table 12 reports the per capita generation rate calculated for the study enumeration areas.

The estimated average per capita generation rate of residential waste in North Bay for the medium income brackets is 0.93 kg/capita/day, exclusive of yard waste.

3.1.3 Borough of East York

The income/dwelling matrix in Table 13 accounts for 95% of the EAs in the Borough of East York. Appendix C, herein, gives the data obtained for each EA that was sampled during the course of the study, including the data for the schools and the Christmas collection of refuse in EA 90-117.

Table 13 shows how the per capita generation rates calculated from the sample data are used to estimate the overall generation rate for the Borough of East York.

The estimated average per capita generation rate of residential waste in the Borough of East York was 0.99 kg/capita/day, exclusive of yard waste and leaves.

TABLE 12: RESIDENTIAL WASTE GENERATION DATA INCORPORATED INTO THE INCOME/HOUSING MATRIX TO ESTIMATE THE WEIGHTED PER CAPITA GENERATION RATE (KG/CAPITA/DAY) FOR THE CITY OF NORTH BAY.

	(1) Primarily Single Detached		(2) Mixed Dwellings		(3) Primarily Multiple Dwellings	
(A) High Income	NA	(19.3%)	NA	(3.5%)	0	(0.0%)
(B) Medium Income	0.89	(17.5%)	0.97	(26.3%)	0	(0.0%)
(C) Low Income	NA	(10.5%)	NA	(21.0%)	NA	(1.8%)

Matrix cells A1, A2, C1, C2, C3 were not sampled

Average per capita generation rate of cells B1 and B2, (kg/capita/day) = 0.93

TABLE 13: RESIDENTIAL WASTE GENERATION DATA INCORPORATED INTO THE INCOME/HOUSING MATRIX TO ESTIMATE THE WEIGHTED PER CAPITA GENERATION RATE (KG/CAPITA/DAY) FOR THE BOROUGH OF EAST YORK.

	(1) Primarily Single Detached	(2) Mixed Dwellings	(3) Primarily Multiple Dwellings
(A) High Income	1.29 (7.6%)	0.83 (10.0%)	1.06 (3.5%)
(B) Medium Income	1.17 (12.9%)	1.10 (20.0%)	1.04 (14.7%)
(C) Low Income	0 (0.0%)	1.00 (4.7%)	0.75 (26.5%)

Generation rate for matrix cell A3 is the average of the cells A1 & A2

Weighted per capita generation rate (kg/capita/day) = 0.99

3.2 Composition of Residential Waste Exclusive of Yard Waste

3.2.1 Town of Fergus

Data for the composition of the residential waste stream in the 6 EAs is given in Appendix A1. Table 14 is the estimated average waste composition for the Town determined by weighting the means from each EA using the income housing matrix. Because we are using a series of weighted averages for each waste component, the total composition for a particular municipality will not necessarily sum to a total of 100 percent.

Figure 14 is a bar graph showing the percent food waste data, ± 1 Standard Error (SE). It will be recalled that both sample size (minimum weight = 100 kg) and sample number (9 to 10 per EA) were needed to achieve an accuracy of 90% and a precision of ± 15% for the food waste fraction only. Two sample means are different from each other if their standard errors do not overlap.

3.2.2 City of North Bay

Data for the composition of the residential waste stream in the 2 middle income EAs is given in Appendix B1. Table 14 gives the estimated average waste composition for the City, based on a sample averaging of the available data. The statistically significant food waste data, ± 1 SE, are graphed in Figure 15.

3.2.3 Borough of East York

Data from the composition of the residential waste stream in the 7 EAs is given in Appendix C1. Table 14 is the estimated average waste composition for the Borough, determined by weighting the means from each EA, using the income dwelling matrix.

Figure 16 is a bar graph showing the % food waste data, ± 1 SE.

TOWN OF FERGUS, BOROUGH OF EAST YORK, AND
THE CITY OF NORTH BAY

	Fergus			East York			North Bay	
	Percent Composition: Regular Waste and Blue Box	Percent Composition: Combined Waste Streams	Per Capita Generation (kg/cap/day) Combined Waste Streams	Percent Composition: Regular Waste and Blue Box	Percent Composition: Combined Waste Streams	Per Capita Generation (kg/cap/day) Combined Waste Streams	Percent Composition: Total Waste Stream	Per Capita Generation (kg/cap/day) Total Waste Stream
(1) Paper (a) Newsprint	3.21%	10.26%	0.083	15.11%	18.99%	0.166	10.55%	0.098
(b) Fine Paper / CPO / Ledger	1.87%	1.87%	0.015	1.65%	1.65%	0.016	1.76%	0.016
(c) Magazines / Flyers	4.22%	4.22%	0.034	4.71%	4.71%	0.046	3.14%	0.029
(d) Waxed / Plastic / Mixed	2.06%	2.06%	0.017	2.37%	2.37%	0.023	2.11%	0.020
(e) Boxboard	5.00%	5.00%	0.040	4.03%	4.03%	0.040	4.24%	0.040
(f) Kraft	1.30%	1.30%	0.012	1.30%	1.30%	0.013	1.12%	0.010
(g) Wallpaper	0.42%	0.42%	0.003	0.20%	0.20%	0.002	0.70%	0.007
(h) OCC	3.05%	3.05%	0.025	2.88%	2.95%	0.029	2.81%	0.026
(i) Tissues	3.96%	3.96%	0.032	3.65%	3.83%	0.036	3.62%	0.034
SUBTOTAL (for Category)	27.31%	32.39%	0.260	35.91%	39.86%	0.394	30.01%	0.280
(2) Glass (a) Beer (i) refillable	0.07%	0.07%	0.001	0.10%	0.10%	0.001	0.27%	0.003
(ii) non-refillable	0.05%	0.06%	0.000	0.03%	0.03%	0.000	0.05%	0.001
(b) Liquor & Wine Containers	1.00%	2.00%	0.016	1.40%	1.99%	0.020	1.71%	0.016
(c) Food Containers	3.18%	4.46%	0.036	1.56%	2.13%	0.021	3.61%	0.034
(d) Soft Drink (i) refillable	0.06%	0.06%	0.001	0.10%	0.10%	0.001	0.06%	0.001
(ii) non-refillable	0.25%	0.25%	0.002	0.19%	0.19%	0.002	0.45%	0.004
(e) Other Containers	0.09%	0.09%	0.001	0.07%	0.07%	0.001	0.17%	0.002
(f) Plate	0.03%	0.03%	0.000	0.19%	0.19%	0.002	0.07%	0.001
(g) Other	0.54%	0.54%	0.004	0.82%	0.82%	0.006	0.45%	0.004
SUBTOTAL (for Category)	5.28%	7.58%	0.061	4.45%	5.62%	0.055	6.86%	0.064
(3) Ferrous (a) Soft Drink Containers	0.42%	0.56%	0.005	0.16%	0.19%	0.002	0.77%	0.007
(b) Food Containers	1.63%	2.37%	0.019	1.55%	1.91%	0.019	3.62%	0.034
(c) Beer Cans (i) returnable		0.02%	0.000	0.00%	0.00%	0.000		
(ii) non-returnable				0.00%	0.00%	0.000		
(d) Aerosol Cans	0.37%	0.37%	0.003	0.15%	0.15%	0.001	0.19%	0.002
(e) Other	1.10%	1.10%	0.009	1.53%	1.53%	0.015	1.49%	0.014
SUBTOTAL (for Category)	3.71%	4.44%	0.036	3.39%	3.79%	0.037	6.06%	0.057
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.04%	0.09%	0.001	0.07%	0.08%	0.001	0.25%	0.002
(ii) non-returnable	0.09%	0.09%	0.001	0.00%	0.00%	0.000	0.01%	0.000
(iii) American	0.00%	0.01%	0.000	0.03%	0.04%	0.000	0.06%	0.001
(b) Soft Drink Containers	0.18%	0.41%	0.003	0.25%	0.56%	0.004	0.51%	0.003
(c) Other Packaging	0.00%	0.11%	0.001	0.06%	0.06%	0.001	0.01%	0.000
(d) Aluminum	0.48%	0.48%	0.004	0.31%	0.31%	0.003	0.19%	0.002
(e) Other	0.10%	0.10%	0.001	0.17%	0.17%	0.002	0.11%	0.001
SUBTOTAL (for Category)	0.88%	1.27%	0.010	0.90%	1.02%	0.010	0.95%	0.009
(5) Plastics (a) Polyolefins	6.40%	6.40%	0.051	4.95%	5.04%	0.050	5.04%	0.047
(b) PVC	0.20%	0.20%	0.002	0.06%	0.06%	0.001	0.06%	0.001
(c) Polystyrene	0.66%	0.66%	0.005	0.69%	0.69%	0.007	1.85%	0.013
(d) ABS	0.05%	0.06%	0.000	0.04%	0.04%	0.000	0.06%	0.001
(e) PET	0.09%	0.16%	0.001	0.11%	0.12%	0.001	0.19%	0.002
(f) Mixed Blend Plastic	0.55%	0.55%	0.004	0.30%	0.30%	0.003	0.56%	0.005
(g) Coated Plastic	- N/A -	- N/A -		0.14%	0.14%	0.001	0.16%	0.002
(i) Nylon	0.34%	0.54%	0.003					
(j) Vinyl	0.35%	0.35%	0.005	0.06%	0.06%	0.001	1.06%	0.010
SUBTOTAL (for Category)	8.64%	8.73%	0.070	6.35%	6.45%	0.064	8.52%	0.080
(6) Organic (a) Food Waste / Rodent Bedding	28.76%	28.76%	0.251	23.51%	23.51%	0.252	26.07%	0.243
(b) Yard Waste	************	************		************	************	************	************	************
SUBTOTAL (for Category)	28.76%	28.76%	0.231	23.51%	23.51%	0.252	26.07%	0.245
(7) Wood	1.39%	1.39%	0.011	0.90%	0.90%	0.009	3.69%	0.034
(8) Ceramics / Rubble / Fiberglass /	1.55%	1.55%	0.012	1.77%	1.77%	0.017	2.16%	0.020
Gypsum Board / Asbestos	0.28%	0.28%	0.002					
SUBTOTAL (for Category)	1.83%	1.83%	0.015	1.77%	1.77%	0.017	2.16%	0.020
(9) Drapers	4.55%	4.55%	0.035	2.99%	2.99%	0.030	5.02%	0.047
(10) Textiles/Leather/Rubber	4.18%	4.18%	0.034	4.63%	4.63%	0.046	4.47%	0.042
(11) Household Hazardous (a) Paints / Solvents	0.34%	0.34%	0.003	0.33%	0.33%	0.003	0.92%	0.004
Wastes (b) Waste Oils	0.09%	0.09%	0.001	0.08%	0.08%	0.001	0.00%	0.000
(c) Pesticides/Herbicides	0.01%	0.01%	0.000	0.01%	0.01%	0.000	0.01%	0.000
SUBTOTAL (for Category)	0.44%	0.44%	0.004	0.45%	0.43%	0.004	0.41%	0.004
(12) Dry Cell Batteries	0.07%	0.07%	0.001	0.23%	0.23%	0.002	0.04%	0.000
(13) Kitty Litter	3.26%	3.26%	0.026	1.66%	1.66%	0.016	2.00%	0.019
(14) Medical Wastes	0.07%	0.07%	0.001	0.08%	0.06%	0.001	0.06%	0.001
(15) Miscellaneous	0.60%	0.60%	0.006	1.45%	1.45%	0.014	2.69%	0.027
(16) Ashes	- N/A -	- N/A -	- N/A -	- N/A -	- N/A -	- N/A -	0.77%	0.007
(17) BLUE BOX ITEMS (a) Newsprint	5.06%	- N/A -	- N/A -	5.87%	- N/A -	- N/A -	- N/A -	- N/A -
(b) Liquor / Wine Bottles	1.00%	- N/A -	- N/A -	0.59%	- N/A -	- N/A -	- N/A -	- N/A -
(c) Food Jars / Other Bottles	1.30%	- N/A -	- N/A -	0.58%	- N/A -	- N/A -	- N/A -	- N/A -
(d) Food Cans (i) ferrous	0.55%	- N/A -	- N/A -	0.37%	- N/A -	- N/A -	- N/A -	- N/A -
(ii) non-ferrous	0.11%	- N/A -	- N/A -	0.00%	- N/A -	- N/A -	- N/A -	- N/A -
(e) Beer Cans (i) ferrous	0.02%	- N/A -	- N/A -	0.00%	- N/A -	- N/A -	- N/A -	- N/A -
(ii) non-ferrous	0.04%	- N/A -	- N/A -	0.01%	- N/A -	- N/A -	- N/A -	- N/A -
(iii) American	0.01%	- N/A -	- N/A -	0.00%	- N/A -	- N/A -	- N/A -	- N/A -
(f) Pop Cans (i) ferrous	0.16%	- N/A -	- N/A -	0.04%	- N/A -	- N/A -	- N/A -	- N/A -
(ii) non-ferrous	0.23%	- N/A -	- N/A -	0.11%	- N/A -	- N/A -	- N/A -	- N/A -
(g) PET Bottles	0.09%	- N/A -	- N/A -	0.01%	- N/A -	- N/A -	- N/A -	- N/A -
(h) Plastic Jugs	- N/A -	- N/A -	- N/A -	0.09%	- N/A -	- N/A -	- N/A -	- N/A -
(i) OCC	- N/A -	- N/A -	- N/A -	0.07%	- N/A -	- N/A -	- N/A -	- N/A -
SUBTOTAL (for Category)	8.59%	- N/A -	- N/A -	7.74%	- N/A -	- N/A -	- N/A -	- N/A -

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

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

TABLE 18: CONCENTRATION OF HEAVY METALS (UG/G) IN EXTRACTS PREPRARED FROM THE CONTENTS OF VACUUM CLEANER BAGS RECOVERED FROM RESIDENTIAL WASTE IN EAST YORK

	Enumeration Area						
Metal	603	055	213	303	168	117	005
Alumimum	1100	690	2800	1700	1100	1500	560
Arsenic	3.6	0.8	2.9	2.5	3.8	8.0	3.2
Barium	110	12	66	61	56	41	21
Beryllium	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	<1.0
Boron	33	14	8.5	18	32	9.7	8.8
Cadmium	5.2	2.6	3.3	17	3.8	3.4	2.6
Calcium	18000	11000	15000	9100	32000	18000	7400
Chromium	38	72	33	62	50	120	24
Cobalt	1.8	1.5	3.5	5.8	2.7	2.6	1.9
Copper	57	46	67	43	58	120	27
Iron	2900	1400	4800	1300	3100	3500	1200
Lead	140	14	68	74	120	110	160
Lithium	3.2	<1.0	2.9	2.0	1.4	1.5	2.6
Magnesium	1700	680	2800	1700	1100	1500	580
Manganese	64	24	160	34	90	64	35
Mercury	2.99	0.91	0.98	1.05	5.95	3.15	7.46
Molybdenum	<1.0	<1.0	1.5	1.6	<1.0	<1.0	<1.6
Nickel	10	4.7	18	9.4	16	18	8.6
Phosphorus	1000	600	600	400	400	500	1000
Potassium	2500	2100	3000	1900	2600	1600	2000
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium	55000	5800	6100	8900	3800	3300	28000
Strontium	52	18	39	23	40	29	24
Scandium	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	<10	<10	10	<10	<10	<10	18
Titanium	<20	<20	200	<20	30	40	20
Tungsten	<10	<10	<10	<10	<10	<10	<10
Vanadium	<1.0	2.0	6.6	<1.0	<1.0	1.6	<1.0
Yttrium	<1.0	<1.0	2.1	<1.0	1.0	1.0	<1.0
Zinc	520	230	330	250	310	500	160
Zirconium	<1.0	1.5	3.9	<1.0	1.7	66.0	5.0

TABLE 19: HEATING VALUES (DRY BASIS) FOR MIXED PLASTICS AND DISPOSABLE DIAPERS

Component Analysed	BTU/lb	kJ/kg
Plastic prepacked meat container	15580	36127
Plastic bacon wrap	19100	44289
Plastic ketchup container	22500	52173
Disposable diaper	10150	23536

1 BTU/lb = 2.319 kJ/kg

3.8.3 Borough of East York

The raw data for yard waste are found in Appendix C2.

3.9 Estimation of the "Capture Rate" of the Blue Box Programs

Estimation of the "Capture Rate" of the Blue Box programs in the Town of Fergus and the Borough of East York are Shown in Tables 20 and 21, respectively. Note that the conservative estimate of Blue Box material, as discussed in Section 2.2.4.2, was employed for the amount of material in the Blue Boxes.

3.10 The Effect of Life Style On Residential Waste Characteristics

As we noted in Section 2.1, the method used in the Study was based on the hypothesis that the characteristics of a residential waste stream are related to the socioeconomic life styles of people and the demographic characteristics of a municipality. In Table 22, the per capita generation rates of total residential waste and the quantity of kitchen waste (putrescible matter) for the Town of Fergus and the Borough of East York are compared on the basis of income level and dwelling type. The East York data show that residents in detached dwellings generate more waste than those living in multiple dwellings. The data for the middle income group in the Town of Fergus also suggest this relationship. Other trends in the total waste generation data are less evident.

The generation rates of the kitchen waste (putrescible matter) tended to follow the pattern set by the per capita generation rate of total refuse, but as noted earlier, a potential sampling bias may have underestimated the Borough of East York medium and low income/multiple dwelling kitchen refuse. The uncertainty in the Borough of East York multiple residential waste composition data is not

TABLE 20: AN ESTIMATION OF THE "CAPTURE RATE" OF THE BLUE BOX PROGRAM IN EACH STUDY EA IN THE TOWN OF FERGUS.

EA/Classification	Total wt of recyclables generated in curbside waste (kg)	Weight of recyclables in Blue Boxes (kg)	"Capture Rate" (wt of recyclables) in Blue Boxes as a % of total recyclables generated in curbside waste)
258 / High income primarily single detached	226.2	147.6	65.2
262 / Medium income primarily single detached	214.2	89.3	41.6
263 / Medium income primarily mixed dwelling	183.0	60.2	32.9
256 / Medium income primarily mixed dwelling	248.6	133.2	53.5
257 / Medium income primarily multiple dwelling	289.3	47.5	16.4[1]
260 / Low income primarily multiple dwelling	202.6	68.1	33.6[1]

[1]Apartment buildings do not have Blue Boxes

TABLE 21: AN ESTIMATION OF THE "CAPTURE RATE" OF THE BLUE BOX PROGRAM IN EACH STUDY EA IN THE BOROUGH OF EAST YORK

EA / Classification	Total Wt of recyclables generated in curbside waste (kg)	Wt of recyclables in Blue Boxes (kg)	"Capture Rate" (wt of recyclables in Blue Boxes as a % of total recyclables generated in curbside waste)
603 / High income single detached	375.8	253.0	67.3
117 / High income mixed residential	328.9	171.1	52.0
055 / Medium income high-rise apartment building	322.4	0.0	0.0[1]
168 / Medium income single detached	255.2	143.6	56.3
213 / Medium income mixed residential	349.7	154.8	44.3
303 / Low income mixed residential	245.5	117.9	48.0
005 / Low income high-rise apartments and townhouses	274.0	0.0	0.0[1]
East York Schools	118.6	17.0	14.4

[1] High-rise apartment buildings do not have Blue Box programs

present in the data from the Town of Fergus because the refuse from tenants was bagged but not compacted. The data for the middle income population in the Town of Fergus indicates a convincing trend, suggesting that more food waste is generated by the residents of detached dwellings than those living in multiple dwellings. The potential underestimation of the quantity of the components in the residential refuse from multiple dwellings in the Borough of East York, will exaggerate the difference in kitchen waste generation rates in the detached versus multiple dwelling data.

As the food waste fraction is the only fraction of the residential waste stream where there is some statistical confidence, the per capita generation of food waste by the Town of Fergus and the Borough of East York are compared in the right hand column of Table 22. EA matrix weighting factors were employed to obtain an overall estimate of the per capita generation rate of food waste in the two municipalities. It is interesting to note that the per capita generation rate of kitchen waste in the Town of Fergus, 0.23 kg/cap/day, represented 28.8% of the residential waste stream (see Table 14), while the comparable values for the Borough of East York were: 0.25 kg/cap/day and 25.5%.

3.11 White Goods and Bulk Items: Estimation of Per Capita Generation Rates

Data were collected from 10 communities regarding tonnages of white goods and non-metal bulk items generated. Data for non-metal bulk items collected were available for only 4 of the 10 communities. Generation rates (tonne/capita/year) were based on population data for 1985 and 1988 as reported in the Ontario Municipal Directory.

3.11.1 White Goods Generation Rate

The average generation rate for white goods (metal appliances etc.) is 0.0015 (tonne/capita/year) ± 0.00018 (data in Appendix F).

TABLE 22: EVIDENCE FOR THE EFFECT OF LIFE-STYLE (E.G. HOUSING TYPE) ON RESIDENTIAL WASTE GENERATION

EA	Income/dwelling	Total waste: per capita generation rate (kg/cap/day)	Putrescible per capita generation rate (kg/cap/day)	EA matrix weighting factor (%)		Putrescible content --EA weighted per capita generation rate (kg/cap/day)
	Town of Fergus					
258	high/single detached	0.88	0.24	11.11		0.027
262	medium/single detached	0.89	0.29	22.22		0.065
256,263	medium/mixed	0.80	0.22	44.44		0.096
257	medium/multiple	0.60	0.18	11.11		0.020
260	low/multiple	0.78	0.22	11.11		0.024
					Total	0.232
	Borough of East York					
65-003	high/single detached	1.29	0.28	7.60		0.021
90-117	high/mixed	0.83	0.21	10.00		0.021
90-168	medium/single detached	1.17	0.32	12.90		0.041
05-213	medium/mixed	1.10	0.38	20.00		0.075
12-055	medium/multiple	1.04	0.18	14.70		0.026
05-303	low/mixed	1.00	0.33	4.70		0.016
90-005	low/multiple	0.75	0.19	26.50		0.051
					Total	0.252

3.11.2 Non-Metal Bulk Item Generation Rate

The average generation rate for other bulk items (non-metal) is 0.0172 (tonne/capita/year) $\pm$0.0032 (data in Appendix F).

SECTION 4

DISCUSSION

4.0 DISCUSSION

4.1 General

The methods developed in the present Study are based on the hypothesis that residential waste generation is a function of people's habits and lifestyles. Both economic status and type of housing are two factors that may influence waste generation patterns; cultural background is another. As mentioned in the **Introduction**, this working hypothesis is well supported by the data of W. Rathje and associates and their pioneering studies in the cities of Milwaukee, Wisconsin, and later, in Phoenix, Arizona (refs. 34, 35 & 36).

The scope of the present study precluded an opportunity to profile the residential waste generation characteristics of a single municipality with the depth and detail achieved by Rathje and associates. Nevertheless, the essential elements that we have presented herein are sufficient for any municipality in Ontario to use as guidelines in the development of a detailed residential waste study.

In the following paragraphs we will critically review the methods that we employed so that potential users of the procedures can have the advantage of our experience. In some cases, the need for refinement in sampling procedures will be identified; suggestions will be offered. One of the major problems that we encountered was attributed to municipal recycling programs that served residents of detached dwellings but not apartment buildings, and the sampling problems created by these practices.

4.2 Income / Housing Matrix For the Three Study Municipalities

The EAs from each municipality were placed into the appropriate cells of the income/housing matrix (cf. Table 4) in Sections 2.2.1.2 to 2.2.1.6. The procedure for determining the "absolute" numerical, or dollar, boundaries between the low, medium and high income groups was also described in Section 2.2.1.2 and Figure 3 compares the income boundaries for the three municipalities. The boundary between the low and middle income groups for the three municipalities ranged from $27,670 to $28,400, a narrow spread of about $1,200. However, there was a much greater spread of about $5,700 between the middle and high income boundaries. In other words, a large portion of the high income grouping for the Town of Fergus would be considered part of the middle income grouping for the Borough of East York. Is this an important factor to consider while evaluating the method employed in the present Study? No, it is not. The following points highlight the socio-demographic features of the approach.

1. Each municipal population was objectively assessed with respect to available Statistics Canada data on income and housing.

2. Low, middle and high income brackets are relative to individual municipalities and are based on the mean income which was calculated from Statistics Canada information on the average income within the EAs of the municipality. Other important parameters such as population age, sex, ethnic background, etc. could also be used in designing a residential waste sampling program, given time, budget and manpower to pursue a study at this level of detail.

3. Residential waste generation is a complex social phenomenon which cannot be quantified with the accuracy and precision that is comfortable and familiar to engineering and scientific disciplines. Nevertheless, there are acknowledged "parameters" which have been shown to be correlated with residential waste generation habits (cf. Rathje's studies, refs. 34, 35 & 36, among others). As long as municipalities take these parameters into account when they are evaluating their own, individual

population's waste generation characteristics, the appropriate waste management programs can be planned.

4.3 "Verification" of the Method

Verification of the results of a scientific investigation may be carried out in a number of ways. The investigator may repeat the initial work several times, under the same conditions, in order to determine the reproducibility of the results and the reliability of the method. In order to avoid any personal bias, the work maybe carried out by others, following the procedures initially described by the original investigator. Complications arise when the phenomenon under observation/investigation undergoes periodic fluctuations, or is at least suspected of such oscillations or changes. In this case, choosing the right time to repeat the work may be a critical factor in evaluating both the results and the worthiness of the method. Frequently, alternative procedures may be used to confer confidence or non-confidence on the method under scrutiny.

In the present Study, we have worked to develop a method to characterize and quantify a social phenomenon: residential waste generation. With respect to the amplitude in the annual cycle in waste generation, Figure 1-2 in Vesilind & Reimer (ref. 47) indicates that, for 75% of the year the weekly generation rate will be within ± 10% of the yearly average. The residential data reported by Brickner (ref. 7) supports this notion. The waste composition Studies reported herein were conducted during the summer, fall and winter; and in southwestern and in a more northerly portion of Ontario. From a theoretical point of view, if one wanted to check the accuracy of the waste data and determine the variance of the estimate, the same seasonal "windows" and geographic locations would have to be studied for several years in a row.

A municipality may choose to undertake this yearly monitoring for purposes of tracking progress in waste reduction initiatives. We (the Study) could not

undertake this task ourselves. A yearly monitoring program would have to decide whether, for example, an observed reduction in waste generation was a result of: (1) packaging laws or consumer purchasing practices (2) social changes in the community or (3) the methodology employed.
However, an attempt was made to verify the Study estimates of per capita waste generation for the Town of Fergus by piecing together waste collection estimates from commercial haulers for the same time period (see Section 3.1.1). Allowing for the uncertainties in the information assembled in the latter manner---and making some assumptions about yard waste generation---it seems that the Study method for estimating the per capita waste generation rate, exclusive of yard waste and leaves, yielded an acceptable result.

4.4 Apartment Buildings: Source of Greatest Number of Problems

We have identified some of the problems that may potentially affect the estimation of both the per capita waste generation rate and the percent composition of the waste stream.

Per Capita Waste Generation Rate

Within a similar income grouping in the income housing matrix, the per capita waste generation rates that we determined for residents of apartment buildings were usually lower than those determined for the residents of largely detached dwellings. While we believe that the results underlie real differences in the lifestyles between residents of apartment buildings and detached dwellings [Note: anecdotal evidence of geographers supports this conclusion, although according to Dr. J. Simmons, Geography Department, University of Toronto, (pers. commun.), there is a paucity of documented observations], there is one potential source of error which could lead to a low estimate of the per capita waste generation rate.

We employed the Statistics Canada data for the average population per unit dwellings in the EAs and we have assumed that all of the inhabitants of the apartment units contributed refuse. We did not verify the assumption of 100% refuse "set out" by every apartment unit. In the case of the small apartments in the Town of Fergus and the City of North Bay, we checked the number of units occupied in each building. For the Borough of East York, we know (pers. commun., Dr. J. Simmons) that the vacancy rate of apartments (in Metro Toronto) is exceedingly low and therefore the residential population in the apartments may be accurately reflected by multiplying the number of units by the average population per unit, using Statistics Canada data for the appropriate EA.

In our Study, the weight of refuse generated by the East York apartment buildings, that were EAs unto themselves, was the sum of: 1) - the quantity of refuse removed from the refuse containers for waste composition analyses and 2) - the weight of remaining refuse in the containers. The latter weight was reported by the hauler at the time of weigh-in and disposal of the apartment's refuse at the Bermondsey Transfer Station. It is possible, but unlikely, that significant errors in the weighing resulted in the low per capita generation rates calculated for the two apartment EAs in the Borough of East York.

The most likely source of error was, therefore, the assumption that refuse was contributed from every unit. If this was not true, then we have under estimated the per capita waste generation, (i.e., the total weight of refuse should have been divided by a smaller population of waste-disposing tenants).

The composition and per capita generation rate attributed to apartment buildings may be influenced by two kinds of tenant population dynamics. First, tenant turn-over normally occurs at the end of every month, therefore the amount of waste generated by tenants coming and going will be higher than the normal waste generation rate. Second, the largest number of tenant changes occur at the end of the school year (May-June) and again at the end of August. These are two periods when per capita generation rates in apartment buildings could be expected to exceed the normal yearly average.

Waste Composition: Potential Sampling Biases

The refuse generated in apartment buildings in the Town of Fergus and small apartment buildings (< 30 units) in the Borough of East York and City of North Bay was not compacted. Random samples were unbiasedly taken from accumulations of this household or "unit" refuse. In Section 2.1 we noted the lack of a Blue Box collection for apartment buildings in the Town of Fergus and the set-out of recyclable materials by some of the tenants of the small apartment buildings in the Borough of East York.

In contrast however, the household refuse was compacted in the two "apartment EAs" in the Borough of East York. We think that the combination of refuse compacting and the lack of Blue Box programs for these buildings jointly contributed to a waste sampling bias at these locations. The difficulty in removing "random" samples from the compacted bins may be attributed to: 1) an overwhelming quantity of newsprint, co-mingled with other refuse [because there was no Blue Box (waste management alternative) program in these premises]; 2) wet refuse which was generally bagged in polyethylene supermarket shopping bags. The bags were lodged (compacted with other refuse) in ways which made it difficult to remove them without tearing. When bags were torn, the contents became distributed over the refuse in a bin, making quantitative retrieval of the spilled waste very difficult. We encountered many bags that were already torn, presumably a result of the compacting process.

Thus, the 60 and 40 kg quantities of refuse that were taken for the waste composition analysis were predisposed to have a larger weight of newsprint and a lower quantity of waste contained in small polyethylene bags for a combination of reasons: 1) no alternative disposal for the newsprint was at hand for the tenants; 2) it was easier to remove the newsprint from the compacted refuse; and 3) for detached dwellings, the weight of Blue Box materials was not included as part of refuse weight guideline of 100 kg that we collected at the curb for the waste composition study. The last factor (3) is critical and points out a weakness in the methodology. We recommend the following procedural change in order to get around the sampling bias.

The suggested procedure relates the weight of waste to be sampled with a component in the tenant's household refuse. The component must meet one criterion: it must only be collected by "regular garbage" service, with no options for diversion (i.e., Blue Box).

At the present time, we suggest that the food scrap component of household refuse makes the best "normalization" basis or guideline for this kind of sample collection. We will assume from experience that food waste represents about 27% of the household waste and it always is disposed of in the "regular garbage". For the time being we will also assume that backyard composting is not an option practised extensively by residents in apartment buildings.

We can still apply the 60 / 40 ratio to determine the relative quantities of waste to sample on days one and two, respectively. On day one, we would randomly remove sufficient refuse from the compacted waste so that the sample contained a minimum of 27% x 60, or approximately 16 kg of bagged refuse with food scraps, irrespective of the quantity of newsprint (and all other materials) that were collected during the random sampling.

The same procedure could be used on day two, except that 27% x 40, or 11 kg of bagged refuse with food scraps could have been collected as the guideline for the sample size. In this way, the two samples would have been "normalized" with respect to the general low percentage of newsprint that was found in residential "regular garbage" wherever municipal Blue Box programs were in place. Of course the weight of newsprint (and all other materials) would be recorded as usual, but the distortion of the percent composition results would be minimized. This point is considered further in Section 4.5.

4.5 Percent Composition: A Useful or Confusing Concept?

Is "percent composition" a useful or a confusing concept? The report by Brickner (ref. 7) illustrates the major issue raised by the question, that is: the quantitative "illusion" created by manipulating absolute quantities of per capita generated wastes in relative terms of a percentage of an arbitrarily defined, "total" waste stream. In Table 2 of ref. 7, there are four quantities (total weights) of materials in the waste stream. Brickner shows that while the weight of a component does not change, its "percent" contribution to the total waste stream may be made to change, depending on the **NUMBER** of categories of components in the waste stream. The lesson from this is that waste composition data, presented as "percentage" of the total waste stream are not readily comparable if the same components are not present in the sets of data under comparison. One may attempt to adjust waste composition data by eliminating or combining categories of materials. However, if certain materials are presented in combination at the outset, e.g., a single category for both food & yard wastes, useful manipulations are precluded.

The conversion of finite quantities of a given waste to a percentage basis, subjects the particular material to a mathematical relationship of "interconnectedness" which does not exist in terms of the generation of the waste. The sizing of waste management facilities (e.g., materials recovery facilities for recyclables, centralized or backyard composting facilities, etc.) is based on the best estimates of quantities of certain waste streams that are generated in a municipality. The graphic, frequently pie-shaped depiction of waste composition data (see references cited for some of the data in Tables 1 & 2), is visually appealing but does not convey the important information that planners of waste management facilities need to know. An example of the distortion that can result from using percentage calculations, without providing quantitative, per capita generation rates of the individual components, is illustrated in the handling of yard waste data (see also Tables 1 & 2 in Brickner; ref. 7).

A temporal component must be included as well. Yard waste production and leaf fall are seasonal events in Ontario. In some municipalities, a finite and sometimes large quantity of yard waste can be collected during spring and early summer (in some wet years; and in areas where there is no lawn and garden watering prohibition). Likewise, there is an annual leaf drop and collection in the fall in areas of municipalities where there are mature trees (not in new sub-divisions or on the grounds of many apartment complexes).

Approximately 1,100 tonnes of leaves were collected by the Borough of East York, which works out to an average of 0.01 kg of leaves/cap/day---or 0.02 lbs/person/day. For municipal waste management purposes, the amortization of the tonnage of leaves and yard waste over the entire year, in order to calculate a daily per capita generation rate is very misleading. Leaves and yard waste are not generated by residents on this kind of basis. Likewise, it is equally misleading to record leaves and yard wastes as some annual percentage of an overall waste stream. A hypothetical centralized composting facility that was sized for a daily feed rate of leaves would be grossly undersized. In fact, the entire annual tonnage of leaves may be expected to arrive over a period of approximately 3-4 weeks. The latter arrival rate of leaves will be an important factor in formulating alternative waste management plans for their disposal. A similar argument may be made with respect to the seasonal generation of yard wastes.

In summary, residential waste generation is the result of human activities; the "necessities--and some luxuries--of life". The "residues" that remain after a single day of living can be categorized and quantified. Essential waste management practices---current and planned---require quantitative information about the specific types of residues whose production is properly documented over "real" generation periods, i.e., day, week or month. Percentage composition adds nothing useful to this basic quantitative information; rather, it is a mathematical manipulation of the data that ultimately requires an explanation. Waste composition data presented in a percentage format are only useful when the physical quantity, e.g., per capita generation rate, tonnages etc., of at least one component of the waste stream is also indicated.

4.6 The Blue Box: A Waste Management Option That Presents Problems In Waste Composition Data Handling

The presence of the Blue Box "option" for setting out certain recyclable portions of residentially generated refuse at the curb has presented some significant problems for this study in two areas: 1) the general calculation of per capita generation rates for sectors of municipal populations which have a Blue Box program; 2) the estimation of the efficiency of Blue Box programs to "capture" those recyclables that are part of a municipal program and 3) the general residential waste sampling problems encountered in apartment buildings (discussed above in Section 4.3).

As noted in Section 2.2.4.2, a number of municipal recycling coordinators were interviewed in order to determine a reasonable estimate of the frequency with which residents of detached dwellings put out their Blue Boxes. While many sources of variations in frequency were noted, an overall impression was that a bi-weekly set-out frequency was not unreasonable as an average estimate. Given this assumption, how were the weights of the Blue Box materials to be calculated into the estimated average per capita generation rates and waste composition? We have reasoned that a conservative estimate is preferred and have therefore divided the weights of the Blue Box items by 2. This calculation attempts to account for the randomness of Blue Box set-out by any individual and tries to provide an allowance for an "error factor", necessitated by the small sample of residents. That is, the Study Team typically collected bagged refuse from 7-10 dwellings with Blue Boxes coming from a varied proportion of these dwellings. If our sample population were on the order of 100 or more dwellings, then, given an average bi-weekly set-out frequency, one would anticipate that approximately 50% of the dwellings would have placed there Blue Boxes at the curb each week. Therefore the weekly quantity of Blue Box materials, set out by 50% of the population, would be a reasonable estimate of the weekly generation rate by the entire 100 or more dwellings. In the case of our small samples, we felt it was better to err on the low, or conservative side, and divide the weight by two.

4.7 Random Sampling—When To Exclude Large Objects From the Sample Collection

The statistical concept of "optimum allocation in cluster analysis" is relevant to the practical problem which field crews face in a sampling program like ours. For example, an old oil burner unit was set out at curbside, along with bagged waste. The question arose as to whether to include this item as part of our 100 kg sample or whether to record the weight of this item and treat it separately, like yard waste.

The answer is based on empirical experience with respect to the standard deviation of the expected average weight (or percent composition) of the metal fraction in the residential waste stream. We know from literature reports that metal is a relatively minor component in household garbage; the average weight of metal would also have an associated standard deviation. Discarded oil burners are not a commonly encountered component in residential curbside waste and its weight does not fall within the standard deviation of the average weights of metal that have been historically encountered.

Because we are only collecting 100 kg quantities (approximately) of curbside waste, inclusion of the oil burner weight would have the secondary effect of reducing the relative (proportional) weight of other components that we would collect to achieve the 100 kg total. (NOTE: this is similar to the problem encountered with large quantities of newsprint in the apartment building EAs in the Borough of East York where there are no Blue Box programs and also relates to the discussion of yard wastes.) Calculation of the percent composition for this sample would reveal a skew toward lower than average values for items normally encountered at a higher percent in the residential waste stream.

The optimal allocation for sample weights within clusters (ref. 19) is as follows:

$$\frac{n_1}{N_1 s_1} = \frac{n_2}{N_2 s_2} = \ldots = \frac{n_k}{N_k s_k}$$

Where n_k = sample weight of waste component (cluster)
s_k = expected population standard deviation
N_k = total weight of waste component available for sampling (cluster)

The inclusion of a large oil burner causes the fraction for miscellaneous metal to upset the optimal allocation function. The only solutions to this problem are to increase the sum of $[N_1 \ldots N_k]$ (i.e. total sample weight), or to omit the large item, a priori, from the sample.

4.8 Determining the Number of Samples to Collect

4.8.1 The Original Klee & Carruth (1970) Working Definition of "Organics": Perpetuation of Half the Story Can be Misleading

For the record, it is important to note that certain details in the important work of Klee & Carruth (ref. 25) came to light in the later report of Woodyard & Klee (ref. 48). The latter paper came to our attention after our Study was well underway and shows a graph depicting the range of numbers of 200 - 300 lb.(90-136 kg.) samples that must be analyzed with respect to the relative composition of particular constituents in the waste stream. Graphs of these relationships have appeared in the published literature (ref. 47, Figure 1-6; Figure 1 herein) and in an unpublished manuscript, courtesy of Mr. A. Geswein, U.S.E.P.A. (pers. commun.).

More important is the terminology that was employed by Woodyard and Klee (ref. 48) in the classification of the components in the waste stream. The following five categories were used:

organics	(wet garbage, yard waste, mixed paper, plastic and rubber);
metal	(ferrous, aluminum and/or other nonferrous);
glass	(mixed or colour sorted);
newsprint	
corrugated	

Of interest is the wide variety of items under the category of "organics". While Klee and coworkers were chemically correct in their assignments to this category, the present "conventions" generally separate these items into individual categories (perhaps with the exclusion of wet garbage and yard wastes which are frequently combined; see Table 1, herein). By combining as many materials as they did under the heading of "organics" the relative weight of this fraction of the waste stream was greatly increased, vis-à-vis a conservative definition that restricts "organics" to just kitchen or food wastes. The implications for the original Woodyard & Klee category is that fewer 200 - 300 lb.(90-136 kg.) samples were needed in order to achieve a precision of ± 10%, than presently would be needed for an "organic" category with only food wastes in it, as in our Study. The broader definition of organics used by Klee and coworkers would have application if waste composition information was to be evaluated with respect to the incineration of waste streams.

At the outset of the Study, we were unaware of the Woodyard and Klee paper and <u>assumed</u>--incorrectly--that the term organics, shown on the graphs noted above was restricted to the more conventional usage of present day. Hence, our curb-side sampling plan called for 9 - 10 samples of 90 - 136 kg each in order to give a precision with respect to the organic fraction (by our definition) of ± 10%.

Estimated Percent Composition: Kitchen Waste

The number of samples taken in the study for the purposes of estimating percent composition of household waste was based on the results reported by Klee & Carruth (ref. 25). It is possible, however, to determine the number of samples required to estimate the percent composition of waste within a stated confidence level for the population under study. These calculations are carried out in exactly the same manner as the calculations to estimate the required sample size for the estimation of per capita generation rate (see section 4.8.2 below).

Using the Borough of East York as an example, the following calculation can be made to determine the number of EAs that must be sampled to achieve the desired estimate of the percent composition of kitchen waste. In this case, percent composition will be estimated at a precision of ± 15%, with a 90% probability (confidence level).

The following statistical relationships apply:

$$n = (ts/d)^2$$

where:

- n = number of required samples
- t = t-value at the required confidence level, with appropriate degrees of freedom
- s = estimation of the population standard deviation
- d = precision requirement for the estimate of the population parameter

For example in East York the following calculation can be made:

$\bar{x}$ = 24.0% (% food waste) (unweighted mean)
s = 5.194 (unweighted standard deviation)

alpha = 0.1 (for 90% confidence level)
alpha/2 = 0.05 (two-tail test of confidence)
degrees of freedom = (n-1) = 6
t-value = 1.943

$$n = ((1.943 \times 5.194) / (24.4 \times 0.1))^2$$
$$n = 17.7$$

The t-value at n = 18, (t = 1.740, d.f. = 17), is less than n = 7 (t = 1.943), therefore, a better approximation of the required sample size can be calculated.

By reiteration of the above steps for n = 18, and n = 14, the new approximation of the required sample size is n = 14.7. A final calculation finds:

n = 15
t = 1.761
d.f. = 14

$$n = ((1.761 \times 5.194) / (24.0 \times 0.1))^2$$
$$n = 14.5$$

confirming the approximation.

In the case of the Borough of East York, 8 additional EAs would be required for sampling to achieve the accuracy desired for the food waste component. These EAs could be selected randomly from the list of all possible EAs, or they could be apportioned over all the matrix cells.

In the Town of Fergus, the number of EAs required for sampling to achieve the stated accuracy is only 5 (calculations not shown). This indicates that the number of samples actually taken (6) was more than enough to achieve an estimate at the stated accuracy. No calculations were attempted for the City of North Bay due to the limited nature of the data.

4.8.2 Determining the Appropriate Number of EAs to Sample For the Accuracy of Percentage Waste Generation Rates Required

The following points may be noted about the method:

1. Each EA selected for study was chosen at random by Decima Research, based on Statistics Canada information, as described in Section 2.2.1. In the case of the Borough of East York, if the EA turned out to have too small a population for us to sample, Decima rejected the EA and randomly chose another. If the EA turned out to present sampling problems because the dwellings were mostly located over store-fronts, we reported this to Decima and they randomly chose a replacement. As noted earlier in the report, waste generated in apartment units over stores was co-mingled with waste from the stores. These locations are not easily included in a residential waste sampling program.

2. In the Borough of East York, where there was such a large number of EAs in each income/dwelling matrix cell, it would have been desirable to sample more than one EA per cell---time, manpower and budget permitting. Using the standard deviation of the average per capita generation rates computed for all 7 EAs, we can calculate the number of EAs that we may theoretically wish to sample in the Borough of East York if we wanted to obtain an accuracy of ± 10% with a 90% confidence level for the estimate of the average per capita generation rate.

The following relationships apply:

$$n = (ts/d)^2$$

where:

- n = number of required samples
- t = t-value at required confidence level, with appropriate degrees of freedom
- s = estimate of the population standard deviation
- d = precision requirement for estimate of population parameter

From our sample of 7 EAs, the following results were obtained:

$\bar{x}$ = 1.039 (kg/cap/day)	(unweighted sample mean)
s = 0.188	(unweighted standard deviation)
alpha = 0.1	(for 90% confidence level)
alpha/2 = 0.05	(two-tail test of confidence)
degrees of freedom = (n-1) = 6	
t-value = 1.943	

$$n = ((1.943 \times 0.188) / (1.03 \times 0.1))^2$$
$$n = 12.6$$

The t-value at n = 13 (t = 1.782; d.f. = 12) is much less than at n = 7 (t = 1.943), therefore a better approximation of the required sample size can be calculated.

By reiteration of the above steps for n = 13, the new approximation of the required sample size is n = 11. A final calculation finds:

n = 11
t = 1.812
d.f. = 10

$$n = ((1.812 \times 0.188) / (1.03 \times 0.1))^2$$
$$n = 10.9$$

confirming the approximation.

In the Borough of East York, only 3 additional EAs would be required to achieve the accuracy sought. These EAs could be randomly selected from the list of all possible EAs, or they could be selected from the matrix cells with the largest number of EAs.

In the Town of Fergus, the number of EAs required for sampling to achieve the stated accuracy is 17 (calculations not shown). This large number poses a problem as there are not 17 EAs in Fergus. One suggestion would be to resample EAs at regular intervals until the required number of EAs have been sampled.

No calculations were attempted for North Bay due to the limited nature of the data.

4.9 White Goods: General Comments On Generation Rates Reported

Generation rates for both white goods and non-metal bulk items varies substantially from community to community and from year to year. This can be attributed to a variety of reasons, several of which were identified in our discussions with the community officials. Notable causes for differences are:

1. Type of collection service. Some communities collect white goods and bulk items year round, while other communities have only a spring/fall bulk collection.

2. Commitment to recycling. Communities promoting recycling of white goods for scrap metal (e.g. Toronto) reported increases in tonnages collected as the recycling program became more established.

3. Definition of a "bulky" item requiring special collection. Depending on the municipal waste collection policy, some items that are treated as bulk or special pick-up items in one community may be collected with regular curbside waste in communities that have a "take all" collection policy.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 General

The Study methodology may be used by individual municipalities wishing to assess their own residential waste streams. It may be helpful for a municipality to retain professional expertise to assist in the assessment of the Statistics Canada information on income, dwelling type and any other socio-economic parameters that the municipality has the time and budget to incorporate into their residential waste sampling program. The actual collection and sorting of residential waste can be carried out by municipal employees who have received the proper instruction on waste classification and other field techniques.

5.2 Conclusions

The results of the residential waste study presented herein lead to the following conclusions.

1) Municipalities in Ontario are implementing a number of waste diversion options for residents -- notably, Blue Box and backyard composting -- as the waste management strategies of municipalities continue to change. As the number of waste diversion options increase, the chances of obtaining an accurate baseline of waste generation data decreases. Where there was formerly a single waste stream coming from residences on a predictable and scheduled basis, now there may be two or more curbside waste streams, and possibly a another stream directed to a backyard composter. Therefore, there is more potential for error in waste composition studies conducted in municipalities that are aggressively pursuing waste diversion programs (e.g. Fergus and East York) than in those that have yet to implement such programs --- and where there is still a single residential waste stream.

2) Given an understanding of the reality of residential waste stream partitioning noted above, the residential waste assessment procedures for detached dwellings included an estimated allocation for Blue Box materials. Waste assessment of residential populations residing in multi-unit dwellings (apartments) presented additional challenges in data collection. Per capita waste generation rates were obtained for both residential groups; however, a need for improvement in sampling procedures was identified for large apartment buildings (East York) where refuse was compacted.

3) The per capita waste generation rates (excluding yard wastes and bulky items) for the three municipalities appeared to vary with population: Fergus 0.80 kg/capita/day; North Bay 0.93 kg/capita/day; East York 0.99 kg/capita/day. However, municipal population is probably only a superficial correlate and not causally related to the waste generation process. For example, the weight (kg) of the newspapers collected in East York, versus Fergus, may partially explain the higher per capita generation rate (kg/person/day) in East York (Table 14). Some of the difference may also be attributed to seasonal factors.

4) The method used in the Study has revealed apparent differences in the per capita waste generation rates within income groups. More waste (excluding yard waste and bulky waste) appears to be generated by residents of detached dwellings than by apartment dwellers (Table 22). However, no easily discernable pattern could be detected in the per capita generation rates between different income groups. More detailed sampling in each municipality would be needed to determine any potential income effects on waste generation characteristics.

5) It is interesting to note that there is very little difference in average per capita generation rates of kitchen waste for Fergus, North Bay and East York. The respective values are: 0.23, 0.24 and 0.25 kg/capita/day (Table 22).

   When the kitchen waste fractions were computed as a percent of the total composition of the residential waste stream, Fergus showed a higher percentage than East York and North Bay: Fergus 28.8 % versus, East York 25.5 % and North Bay 26.0 %. Again, larger quantities of other components in the East York and North Bay residential waste streams (e.g. newspapers) may explain the lower percentage (or relative proportion) of kitchen waste in the refuse.

6) Reliance on "waste composition percent" as the sole means of characterizing waste can be misleading and create more questions than are actually answered. The per capita generation rates of the total waste stream and its components are more important for planners of municipal waste management programs.

7) The study demonstrates a cost effective residential waste assessment method that uses readily available equipment and that can be implemented by municipal staff.

5.3 RECOMMENDATIONS

Municipalities conducting waste composition study might consider the following recommendations when designing the sampling protocol and implementing the study methodology.

1) For sampling and sorting convenience, municipalities may choose to conduct the waste composition studies in late spring or mid fall when refuse odours are less intense and maggots are less frequently encountered. According to Vesilind & Rimer (ref. 47), the average residential waste composition does not vary by more than $\pm$ 10% over three quarters of the year. Therefore, aesthetics of the working conditions can be taken into account without risk of obtaining skewed data. The inclusion of yard waste in overall residential waste composition percent profiles should be avoided so that baseline composition

percentages are not misrepresented.

2) Municipalities may choose to set up independent collection systems to study the seasonal generation of yard waste and leaves. This would require a coordinated effort between garbage collection personnel, private horticultural firms and other agencies generating/and collecting these waste streams.

3) In order to avoid the sampling problems that we encountered with the large apartment buildings in East York, where apparent sampling biases were difficult to avoid, arrangements could be made, for example, with 30 units within the building to participate in a refuse study. This would give a more accurate appraisal of the waste composition in these large apartment buildings. As a check, the method described herein for obtaining the per capita generation rate for the entire building could then be compared with the per capita generation rate for the 30 units.

4) Municipalities in Ontario should follow the waste composition procedure in conducting their own waste composition analysis, for reasons of consistent data generation using a cost effective approach. Periodically, municipalities should conduct additional waste composition studies to monitor trends in residential waste management and the effectiveness of waste management programs.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

There were many people who contributed to this research project and they are acknowledged, hopefully without omission.

Town of Fergus:

The Study crew of Bruno D'Addario, Cila Dadd, Jasmine Essue, Don Tooley and Andrea O'Malley were committed to the task of breaking new ground as the Study unfolded, working the bugs out of the Study methods and labouring under environmental conditions and logistical distances that were trying. They performed admirably.

Mr. George Woods, Clerk-Treasurer, Town of Fergus, and Mr. Don Taylor (Wellington Recycling Group) gave their support to our study in the Town of Fergus. Mr. Adolph Plein (Plein Disposal) and Mr. Peter Armer (McLellan Disposal) were patient and went out of their way to accommodate the Study team's presence in the Town of Fergus. Their cooperation was greatly appreciated.

The staff in the Engineering Department, City of Guelph, particularly, Messrs. Dan Hoornweg and John Bull, smoothly arranged for the landfill site to be our base of operations. The staff at the landfill site were ready with assistance and witty rejoinders, making the task a bit lighter.

Mr. Robert Ferguson, Commissioner of Works, Metro Toronto, gave permission to use the laboratory in the former Ontario Centre for Resource Recovery (OCRR) for the moisture analyses. Mr. Brad Guglietti, Waste Management Branch, MOE, arranged for the loan of a Sartorious balance for this work.

Borough of East York:

The transition of the year from fall to winter saw three new faces; the Study team was: Jasmine Essue (from Fergus), Rob Flindall, Gord McLaren and Cria Pettingill. They were steadfast and dedicated to fine tuning the procedures that were initiated by the Fergus crew.

The friendly cooperation of the East York Works Department, in particular: Messrs. Paul Cockburn, Jeff Walker, Elliot Hill, Al Karns and Ms. Kathy Killinger, facilitated the curbside collection of residential and school wastes.

Mr. Robert Ferguson, Commissioner of Works, Metro Toronto, gave us permission to sort the East York refuse on the tipping floor of the Commissioners Street Incinerator and to continue using the OCRR for the moisture analyses.

A & M Disposal and Industrial Disposal provided important refuse collection services in this phase of the Study.

City of North Bay:

Rob Flindall, Gord MacLaren and Dean Wilde (City employee) braved the elements to continue the refuse collecting and sorting in this last phase of the residential Study.

Friendly cooperation was demonstrated by the City of North Bay Engineering Department, in particular, Mr. John Simmonds. The City provided vehicles, the sorting tent and the propane heaters.

In addition to those noted above for the three municipalities, we gratefully acknowledge support and cooperation provided by Messrs. Neal Ahlberg,

REFERENCES

Brendan Killackey and Dan Ionescu, Waste Management Branch, Ministry of the Environment.

The Gore and Storrie team consisted of: Dick Buggeln, Jeff Flewelling, Leslie MacMillan, Rob Flindall, Peter Kurtz, Barb St. Hill, David Fox, Brock Harrington.

The team from Decima Research was Messrs. Ian McKinnon, Russ Wilton, Raj Matuk.

REFERENCES

1. American Public Works Association. 1987. Solid Waste Collection & Disposal: 1987. (Summary Report of North American Practice based on a Survey by the Institute for Solid Wastes of the American Public Works Association). 14 pp.

2. Annon. 1989. "Canada vs the World: we toss more, we save less". Intervenor 14(4): 6. The Newsletter of the Canadian Environmental Law Association.

3. Annual Book of ASTM Standards. 1982. Composition or purity of a solid waste materials stream. ASTM Designation: E 889-82.

4. Barton, T.G. 1976. Refuse analysis for the City of Kingston. Civil Engineering Research Report No. 76-6. Royal Military College of Canada, Kingston, Ontario. iii + 35 pp.

5. Bird & Hale. 1978. Municipal Refuse Statistics for Canadian Communities of over 100,000 (1976-1977). 37 pp. (EPS File No. 4672-1).

6. Blattert, R. E. 1988. "To Russia, with Sludge: Americans see Soviet waste". World Wastes. September pgs. 58-9.

7. Brickner, R.H. 1989. "Refuse quantification in the first person". Waste Age April. pgs. 157-162.

8. Brunner, G. H. & W. R. Ernst. 1986. "Alternative Methods for the Analysis of Municipal Solid Waste". Waste Management & Research 4: 147-60.

9. Cochran, W. G. 1938. "Some Difficulties in the Statistical Analysis of Replicated Experiments". Empire Jour. Exptl. Agr. 6: 157-175. (Not seen by author).

10. Coad, A. 1983. "A case study of waste generation and characteristics in Iran". In: (ed, J.R. Holmes). Practical Waste Management pgs. 503-515.

11. Constantine, L.A., J.D. Murdoch, J.F. Puzio & E.A. Sable. 1989. "Waste Composition, after recycling". Waste Age (April) pgs. 349-351; 382.

12. City of Guelph. 1990. Unpublished report, June 1990.

13. EMCON Associates. 1980. Methane Generation and Recovery from Landfills. Ann Arbor Science, Publishers/The Butterworth Group. Ann Arbor, MI. viii + 139 pp.

14. Flindall, R.S.J. 1989. Analysis of solid waste management at Presqu'ile Provincial Park. Undergraduate thesis, University of Waterloo, Waterloo, Ontario. v + 208 pp.

15. Evans, B. W. 1985. How Garbage Analysis can Reduce Collection Costs. Biocycle. March: 30-33.

16. Evans, B. W. & R. L. Paine. 1984. Composition Analysis of Refuse by Land Use in the Core of the City of Toronto. Prepared for The Toronto Recycling Action Committee. 33 pp + attachments.

17. Franke, B. 1987. Comparing solid waste management options: a case study. Unpublished manuscript. Institute for Energy and Environmental Research. Takoma Park, MD 20912. 15pp + 6 figures.

18. Franklin Associates, Ltd. 1988. Characterization of Municipal Solid Waste in the United States, 1960 to 2000 (update 1988). v + summary + 33 pp.

19. Freund, John E. 1984. Modern Elementary Statistics. 6th Edition. Prentice-Hall, Englewood Cliffs, N.J. xii + 561 pp.

20. Geswein, A. Excerpt from Untitled Document containing "Table 5a1-1. Determination of the Number of Solid Waste Samples required". (Received from Mr. A. Geswein (Solid Waste Branch, EPA) in October, 1988).

21. GIRDUS/GRAIGE. 1988. Le programme de collecte selective a Ville La Salle: composition des dechets, potentiel de resources secondaires et taux de recuperation. L'Universite du Quebec a Montreal. xii + 69 pp.

22. Green Cone Inc. (1989?). Synthesis of studies conducted by Metro Works Department (Toronto), City of Barrie, City of Mississauga, Durham Region and Ontario Ministry of the Environment.

23. Kashmanian, R.M. 1989. Promoting source reduction and recyclability in the market place: A study of consumer and industry response to promotion of source reduced, recycled and recyclable products and packaging. U.S. Environmental Protection Agency contract No. 68-02-4283. 68 pp + appendices.

24. Klee, A. J. 1980. Design & Management for Resource Recovery. Vol. 3. Quantitative Decision-Making. Ann Arbor Science Publishers, Inc./The Butterworth Group, Ann Arbor, MI. xii + 153 pp.

25. Klee, A. J. & D. Carruth. 1970. "Sample Weights in Solid Waste Composition Studies". Jour. Sanitary Engineer. Division; Proc. Amer. Soc. Civil Eng. pgs. 945-54.

26. Lohani, B.N. & S.M. Ko. 1988. "Optimal sampling of domestic solid waste". Journal of Environmental Engineering. 114(6): 1479-1483.

27. Matrix Management Group. 1987. 1986 Washington State Recycling Survey. Washington State Department of Ecology. Solid and Hazardous Waste Program. 37 pp. + appendix.

28. McCamic, F. W. (for Ferrand and Scheinberg Associates). 1985. Waste Composition Studies: Literature Review and Protocol. 68 pp. + notes. Massachusetts Department of Environmental Management. Bureau of Solid Waste Disposal. Publication: #14621-88-50-10-86-C.R.

29. OMMRI 1990. OMMRI - The New Challenge (fold-out brochure).

30. Ontario Waste Management Advisory Board. 1980. Guidelines for Recovering Residential Waste Materials through Source Separation. Ontario Ministry of the Environment. 45 pp.

31. Perks, G. 1988. Waste Less Now. Final Report. Pollution Probe Foundation, Toronto, Ontario. 34 pp.

32. Peter Middleton & Associates Limited 1975. Composition and quantity: a critical evaluation of existing data. A Municipal Solid Waste Management Study by the Pollution Probe Foundation 86 pp.

33. Rathje, W. L. 1979. "Modern Material Culture Studies". In: (M. Schiffer, ed.). Advances in Archaeological Method & Theory. 2: 1-37. Academic Press, New York.

34. Rathje, W.L. & B. Thompson 1981. The Milwaukee Garbage Project. The Solid Waste Council of the Paper Industry.

35. Rathje, W. L., D. C. Wilson & W. W. Hughes. 1988. The Phoenix Recycling Project. A Characterization of Recyclable Materials in Residential Solid Wastes: Initial Results (Executive Summary) 16 pp + appendix.

36. Rathje, W.L., D.C. Wilson, W.W. Hughes and T. Jones, 1989. The Phoenix recyclables report. Characterization of recyclable materials in residential solid wastes. The City of Phoenix, Arizona, Department of Public Works. v + 178 pp.

37. Rathje, W.L. 1989. "Rubbish!" The Atlantic Monthly, December pp 1-10.

38. Recycling Advisory Committee. 1989. Discussion paper. A Recycling Strategy for Ontario. 33 pp + appendix.

39. RIS. 1987. Ontario Recycler's Training Program. Participants Kit. (Figure entitled: Estimated Waste Composition for Ontario Municipalities).

40. SCS Engineers. (Undated). Municipal Solid Waste Survey Protocol. Excerpt (28 pages) from Municipal Solid Waste Survey Protocol, Section 7, U. S. EPA Contract No. 68-03-2486.

41. Sridhar, M. K. C., A. O. Bammeke & M. Ademola Onishakin. 1985. "A Study on the Characteristics of Refuse in Ibadan, Nigeria". Waste Management & Research 3: 191-201.

42. SWEAP. 1990. "Your Guide to SWEAP" (Brochure) 16pp. January. Metropolitan Works Department, Toronto, Ont.

43. Tchobanoglous, G., H. Theisen & R. Eliassen. 1977. Solid Wastes:Engineering Principles and Management Issues. McGraw-Hill Book Company. New York. xv + 621 pp.

44. Trans Ontario Plastics Recovery Inc. 1989. Barrhaven Demonstration Project: Collection of rigid plastics containers in the Blue Box.
ii + 22 pp.

45. Trinklein, B. J. (undated) "An Applied Statistical Approach to Refuse Sampling". (Untitled document, pgs. 365-72; Note: this report from the Mitre Institute, Bedford, Mass., has the following retrieval code in the Washington Library, McLean, VA.: WP 81 W00156).

46. U. S. Environmental Protection Agency. 1988. The Solid Waste Dilemma: An Agenda for Action. Draft Report of the Municipal Solid Waste Task Force. Office of Solid Waste. iii + 69 pp.

47. Vesilind, P.A. & A.E. Rimer. 1981. Unit Operations in Resource Recovery Engineering. Prentice-Hall, Inc., Englewood Cliffs, NJ. x + 452 pp.

48. Woodyard, J.P. & A.J. Klee. 1978. "Solid waste characterization for resource recovery design". In Proceed. Sixth Mineral Waste Symp., U.S. Bureau of Mines/IIT Research Institute. Chicago, Ill. May 2-3, 1978. pg 272-279.

49. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press, Oxford & New York. xv + 400 pp. (Brundtland Commission).

50. Personal communication. Dr. Fred Edgecombe. Environment and Plastics Institute of Canada (EPIC). 1262 Don Mills Rd. ,suite 104 ,Dons Mills Ontario (M3B 2W7).

APPENDIX A

TOWN OF FERGUS

APPENDIX A1

CALCULATION OF PER CAPITA WASTE GENERATION RATES FOR STUDY EAs

Town: Fergus
EA: 256 medium income: primarily mixed dwellings
Pop: 755
Dwellings: 300
PPD: 2.52

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
21	8	5	118.28	39.03	2.67	1.059	
22	7	1	103.84	0.80	2.18	0.864	
23	10	6	98.25	17.27	1.61	0.639	
24	11	8	100.78	78.63	2.01	0.798	
25	8	5	103.12	15.30	2.06	0.817	
26	8	4	89.22	8.90	1.75	0.695	
27	8	4	82.43	17.67	1.79	0.709	
28	11	6	104.20	28.40	1.69	0.671	
29	10	8	74.14	36.20	1.38	0.549	
30	6	5	101.34	24.10	2.76	1.094	
Sample Avg.	8.7	5.2	97.56	26.63	1.99	0.79	0.056

Town: Fergus
EA: 258 high income: primarily single detached
Pop: 600
Dwellings: 205
PPD: 2.93

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
31	8	5	115.80	31.11	2.51	0.857	
32	11	5	96.39	26.38	1.63	0.556	
33	6	3	123.52	24.30	3.52	1.201	
34	8	7	96.82	39.50	2.13	0.728	
35	12	8	103.06	45.80	1.64	0.558	
36	9	7	113.69	37.20	2.18	0.745	
37	2	2	42.12	40.36	4.45	1.519	
38	5	5	89.83	15.58	2.79	0.952	
39	7	4	122.68	12.65	2.73	0.932	
40	11	6	141.71	22.39	2.11	0.719	
Sample Avg.	7.9	5.2	104.56	29.53	2.57	0.88	0.094

Town: Fergus
EA: 257 medium income: primarily multiple dwellings
Pop: 685
Detached: 50
Other: 240
PPD: 2.36

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
41	9	4	102.36	10.32	1.81	0.767	
42	9	8	102.58	44.60	2.03	0.859	
43	9	10	100.48	40.10	1.88	0.797	
46	36	0	177.00	0.00	0.98	0.417	
47	36	0	133.00	0.00	0.74	0.313	
50	36	0	240.60	0.00	1.34	0.566	
44/45	36	0	261.80	0.00	1.45	0.616	
48/49	36	0	204.00	0.00	1.13	0.480	
Detached Avg.	9.0	7.3	101.8	31.7	1.9		
Other Avg.	36.0	0	203.28	0.00	1.13	0.60	0.069

Detached Samples 41-43
Other Dwellings: Samples 44-50

***Total weight of waste found in apartment dumpsters used in column 4**
***5 day collection period for apartments in Samples 44-50**
***No Blue Box collection for apartments in Fergus**

Town: Fergus
EA: 260 low income: primarily multiple dwellings
Pop: 600
Detached: 70
Other: 195
PPD: 2.26

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
51	2	2	120.14	7.63	8.85	3.918	
52	7	4	101.35	7.12	2.20	0.971	
53	10	3	89.34	28.09	1.95	0.861	
54	8	6	85.08	22.80	1.79	0.792	
55	11	11	95.29	36.30	1.47	0.652	
56	7	5	94.41	34.20	2.42	1.069	
57/58	64	0	249.42	0.00	0.78	0.345	
Detached Avg.	7.5	5.2	97.60	22.69	3.11		
Other Avg.	64	0	249.42	0.00	0.78	1.23	0.500

Detached Samples 51-56
Other Dwellings: Samples 57-58

***5 day collection period for apartments in Samples 44-50**
***No Blue Box collection for apartments in Fergus**

APPENDIX A2

WASTE COMPOSITION DATA

Town: Fergus
EA: 263 medium income: primarily mixed dwellings
Pop: 995
Dwellings: 320
PPD: 2.98

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
1	7	6	83.69	23.78	1.99	0.668	
2	4	3	94.14	17.94	3.79	1.272	
3	9	5	100.63	21.80	1.91	0.640	
4	7	5	98.03	14.70	2.21	0.742	
5	10	2	65.90	7.63	1.21	0.407	
6	6	3	100.31	14.50	2.73	0.917	
7	8	2	98.46	7.42	2.02	0.679	
8	6	2	121.29	5.79	3.09	1.038	
9	6	3	100.80	6.83	2.56	0.860	
Sample Avg.	7	3.4	95.92	13.38	2.39	0.80	0.084

*Sample 5 contained a large amount of yard waste mixed with household waste.

Town: Fergus
EA: 262 medium income: primarily single detached
Pop: 815
Dwellings: 300
PPD: 2.72

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
10	8	2	94.38	8.20	1.98	0.727	
11	5	2	133.53	6.50	4.05	1.488	
12	8	2	104.53	8.36	2.16	0.796	
13	7	7	121.30	34.50	2.83	1.040	
14	7	2	82.14	9.56	2.02	0.742	
15	11	7	104.26	48.60	1.85	0.680	
16	8	3	107.01	7.60	2.09	0.769	
17	9	6	97.87	22.30	1.82	0.669	
18	8	5	99.05	25.20	2.13	0.783	
19	5	2	106.38	7.70	3.31	1.219	
Sample Avg.	7.6	3.8	105.05	17.85	2.42	0.89	0.086

TABLE 16: MOISTURE CONTENT OF SOME COMBUSTIBLE MATERIALS IN EAST YORK AND FERGUS RESIDENTIAL WASTE

	% Moisture															
	PAPER								PLASTIC							
Sample Number	News-print	Fine Paper	Maga-zines (Fliers)	Mixed Paper	Box Board	Kraft	OCC	Tissues	Poly-olefin	Poly-styrene	Mixed Blend	Coated	Food Waste	Wood	Diapers	Textiles
East York																
118	24.6	22.5	11.4	21.2	25.2	17.9	11.0	44.3	19.6	20.2	18.6	11.1	75.5	9.9		
125	21.2		17.1	27.6	31.4	28.6	13.1	39.1	15.4	12.6	33.2	3.9	66.3		71.3	15.6
134	34.6	20.4	16.3	19.8	25.9	38.1	15.6	46.0	18.6	19.4	34.7	6.2	68.0		71.4	41.3
	15.0	19.0	13.0	18.6	30.1	14.3	10.1	43.5	20.2	5.9	31.9	10.1	62.6			11.1
149	8.8	15.0	6.8	11.7	17.9	25.3	10.0	32.3	31.4	7.1	23.1	13.2	66.2		52.6	18.4
	7.9	9.3	5.5	18.6	16.3	23.3	9.4	40.6	13.8	9.5	32.5	1.5	51.4		61.7	12.1
159	24.2	12.4	8.3	13.0	21.4	15.6	11.5	41.6	8.8	8.1	29.3		55.4		44.4	20.2
Fergus																
55		28.4	18.0		24.3	25.3		41.5	27.0	18.1	27.5		71.9			
						21.5			21.4				61.7			
													71.7			
58		15.0	14.3		19.9	23.3		33.4	34.9	1.9	14.3		66.0		63.7	
			19.8		17.1			49.7	27.4				66.0			
			12.9						16.3				68.9			
Average	19.5	17.8	13.0	18.6	23.0	23.3	11.5	41.2	23.2	11.4	27.2	7.7	65.5	9.9	60.8	19.8

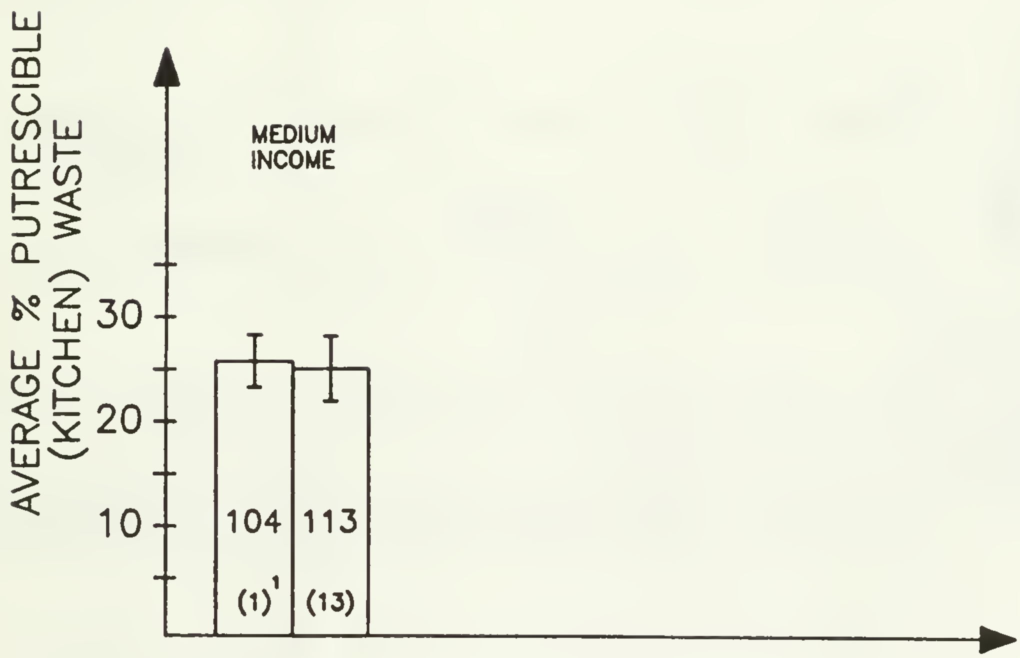
TABLE 15: SUMMARY OF WASTE GENERATION CHARACTERISTICS OF 7 SCHOOLS IN THE BOROUGH OF EAST YORK

School Category	School Name	Number of Students and staff	Weekly weight (kg)	Per capita Generation (kg/cap/day)[1]	% Composition Putrescible	% Composition Total paper
Primary[2]						
1	Diefenbaker	230	198.87	0.173	30.95	51.6
3	Selwyn	224	152.93	0.136	35.35	52.5
5	George Webster	393	201.15	0.102	36.46	41.2
6	Crescent Town	351	147.83	0.084	33.05	51.2
Junior High School						
2	Cosburn	414	338.61	0.164	44.21	44.0
4	George Brown	339	361.12	0.213	30.91	51.1
Senior High School						
7	Leaside	1180	954.20	0.162	19.64	64.8

1 5 day week

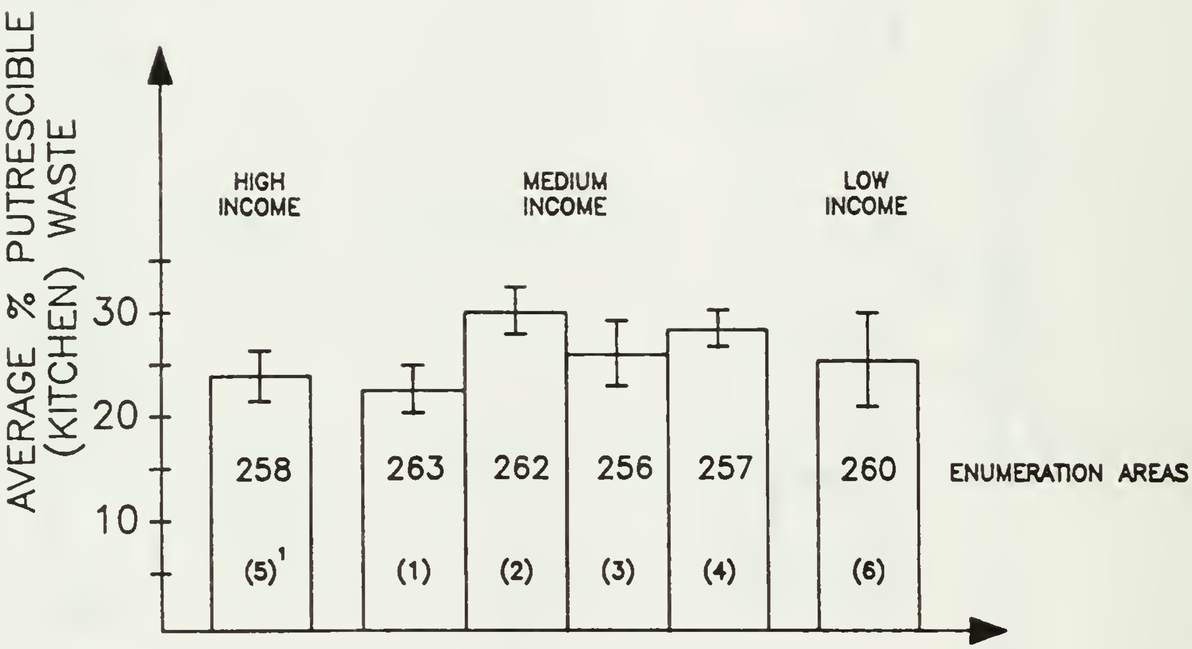
2 numbers refer to columns of data in Appendix C

FIGURE 15: BAR GRAPH COMPARING THE PERCENTAGE FOOD WASTE GENERATED IN THE EAS IN THE CITY OF NORTH BAY.



1 — Consecutive weeks in study

FIGURE 14: BAR GRAPH COMPARING THE PERCENTAGE FOOD WASTE GENERATED IN THE EAS IN THE TOWN OF FERGUS.



1 – Consecutive weeks in study

3.3 Christmas Collection

The residential refuse from a middle income/detached dwelling from the Borough of East York (EA 90-117) was sampled during Christmas week. The data are shown in Appendix C. As Blue Boxes were not set out on the day of the Christmas collection, the quantities of these materials, generated along with the other refuse, are not known. On a per capita basis the amount of food wastes and boxboard was greater during this period than during the period of, 28-30 November, when the EA was sampled as part of the Borough of East York baseline study. When Blue Box materials are removed from the percent waste composition calculations of the November data for the same EA, the Standard Errors for the November and Christmas food waste data come close to overlapping but in fact, do not.

3.4 Schools in East York: Per Capita Generation Rates and Waste Composition

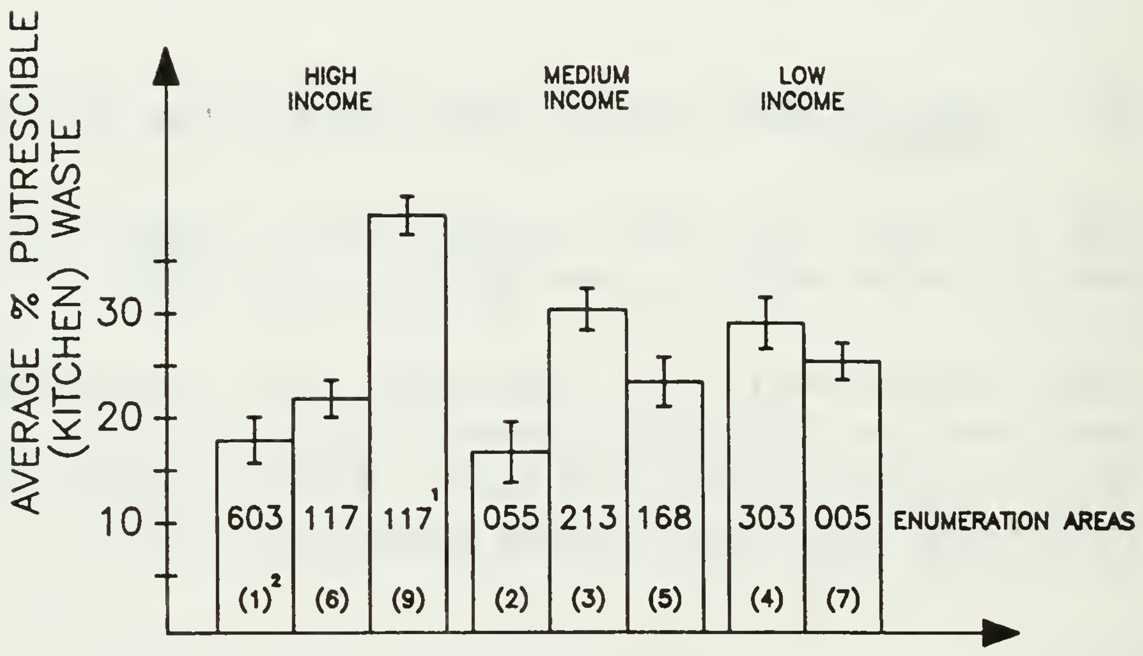
Table 15 compares the per capita generation rates of 4 primary schools, 2 junior high schools and a single senior high school in East York.

Waste composition data are given in Appendix C2. Table 15 shows that food waste ranges from 19.6% to 44.2%, with an average of 32.9%. Waste paper (total of all categories) was the greatest fraction of the waste stream and ranged from 41.2% to 64.8% of total waste, with an average of 51%.

3.5 Moisture Content

Table 16 shows the moisture content of combustible materials in the residential waste from both the Borough of East York and the Town of Fergus.

FIGURE 16: BAR GRAPH COMPARING THE PERCENTAGE FOOD WASTE GENERATED IN THE EAS IN THE BOROUGH OF EAST YORK.



1 — Christmas Collection

2 — Consecutive weeks in study

TABLE 17: CONCENTRATION OF HEAVY METALS (UG/G) IN EXTRACTS PREPARED FROM THE CONTENTS OF VACUUM CLEANER BAGS RECOVERED FROM RESIDENTIAL WASTE IN FERGUS

	Sample Number					
Metal	2	26	28	31	33	55
Alumimum	15500	3390	15900	6480	12100	12200
Arsenic	1.9	5.2	5.7	6.4	1.7	11.4
Barium	250	44	260	170	120	260
Beryllium	1	<1	2	<1	<1	1
Boron	11	24	23	9	7	5
Cadmium	460	2	39	3	<2	2
Calcium	30400	8770	42400	23500	39700	24800
Chromium	66	24	110	43	27	41
Cobalt	9	4	10	5	4	3
Copper	77	28	160	53	59	99
Iron	9200	1900	9600	4400	6100	8200
Lead	160	<10	120	56	49	120
Lithium	3	<1	7	<1	<1	1
Magnesium	10600	2400	18200	7900	15700	8700
Manganese	200	71	310	130	210	200
Mercury	0.588	0.339	1.69	0.913	0.434	2.28
Molybdenum	3	<1	3	3	<1	3
Nickel	54	11	56	32	17	29
Phosphorus	2100	420	1300	600	640	1100
Potassium	8690	2120	8970	4620	5930	4720
Silver	4	2	7	5	3	6
Sodium	2090	4650	1220	29400	1260	42800
Strontium	120	29	130	59	85	130
Scandium	<10	<10	<10	<10	<10	<10
Tin	50	30	50	30	30	20
Titanium	2100	460	3300	710	1100	990
Tungsten	<10	30	26	15	20	30
Vanadium	14	4	10	4	9	22
Yttrium	5	1	6	2	5	5
Zinc	570	240	530	280	330	310
Zirconium	77	24	160	58	52	51

3.6 Metal Analyses On Vacuum Cleaner Bag Contents: Town of Fergus and Borough of East York

Tables 17 and 18 gives the metal analyses conducted on the contents of vacuum cleaner bags recovered from residential waste in the Town of Fergus and the Borough of East York.

3.7 BTU Values for Mixed Plastics and Disposable Diapers

Table 19 gives BTU values for 3 kinds of mixed plastic packaging: rigid and flexible wrap as well as a new (unused) disposable diaper. These data supplement the BTU information from Vesilind & Rimer (ref. 47) and Edgecombe (pers. commun.) presented in Appendix E of this report.

3.8 Yard Wastes

3.8.1 Town of Fergus

Yard waste was always collected when it was placed out with the other waste. It was weighed as a separate component of the waste stream. The raw data for yard waste are found in Appendix A2. As noted above, yard waste was not supposed to be placed at the curb for municipal collection in the Town of Fergus.

3.8.2 City of North Bay

The North Bay waste analysis was conducted during the month of February, so very little yard waste was expected to be found. However, several bags of yard waste, weighing 23.5 kg, were found in sample 203 for EA 104. No other samples contained yard waste.

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: FERGUS
Enumeration Area: 256 medium income; primarily mixed dwellings
n = 10

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	10 kg	10 % wt	MEAN AND STANDARD ERROR ON A WEIGHT BASIS: MEAN (kg)	SE (kg)	MEAN AND STANDARD ERROR ON A PERCENT BASIS: MEAN (%)	SE (%)
(1) Paper (a) Newsprint	3.900	2.42%	7.000	7.58%	1.000	1.51%	7.600	3.43%	7.100	8.44%	2.900	2.67%	8.300	9.17%	3.900	4.75%	3.000	2.98%	1.500	1.13%	4.85	0.65	4.33%	0.86%
(b) Fine Paper / CPO / Ledger	1.000	0.73%	1.800	1.55%	1.300	1.22%	1.900	1.08%	0.900	0.63%	1.900	2.02%	1.000	1.77%	0.900	0.76%	1.200	1.31%	3.000	2.63%	1.48	0.20	1.38%	0.20%
(c) Magazines / Flyers	36.600	26.08%	3.700	3.50%	2.900	2.26%			8.200	7.64%	4.854	3.10%	3.300	3.65%	3.500	4.75%	6.000	7.33%	51.100	45.09%	12.17	3.37	10.56%	4.46%
(d) Waxed / Plastic / Mixed	1.600	1.17%	1.800	1.75%	2.610	2.46%	0.000	0.43%	2.200	2.00%	1.800	1.92%	1.900	1.35%	1.200	1.02%	1.000	1.78%	1.800	1.41%	1.64	0.17	1.54%	0.18%
(e) Boxboard	4.000	2.93%	4.700	4.57%	4.550	4.30%	6.200	3.85%	5.700	5.17%	3.300	3.67%	7.000	7.74%	2.300	1.95%	4.100	4.47%	2.700	2.58%	4.98	0.57	4.52%	0.56%
(f) Kraft	2.900	2.05%	0.900	0.78%	1.400	1.33%	4.900	3.07%	1.000	0.91%	0.300	0.86%	1.100	1.22%	3.200	2.78%	1.200	1.31%	0.400	0.35%	1.71	0.40	1.47%	0.38%
(g) Wallpaper																	0.100	0.11%	0.800	0.65%	0.09	0.08	0.08%	0.06%
(h) OCC	6.900	2.04%	11.700	11.37%	0.600	0.57%	1.900	1.08%	2.010	1.85%	3.900	3.86%	3.000	3.32%	3.500	2.67%	1.000	1.76%	2.800	2.39%	3.53	1.00	3.54%	1.00%
(i) Tissues	2.000	2.12%	2.700	2.63%	6.260	3.90%	7.000	3.43%	4.400	3.30%	4.900	3.12%	4.900	4.86%	1.900	1.61%	7.100	7.74%	1.900	1.34%	4.55	0.56	4.06%	0.67%
(2) Glass (a) Beer (i) refillable									0.252	0.23%											0.00	0.00	0.02%	0.03%
(ii) non-refillable																								
(b) Liquor & Wine Containers	1.500	1.10%	0.266	0.26%	0.423	0.40%			1.700	1.54%			0.000	0.68%							0.45	0.20	0.40%	0.17%
(c) Food Containers	2.900	1.76%	12.000	11.66%	2.900	2.35%	2.200	1.57%	1.700	1.34%	1.900	2.02%	1.300	1.44%	8.200	2.29%	1.800	1.56%	0.300	0.71%	2.86	1.00	2.79%	1.06%
(d) SoftDrink (i) refillable	2.500	1.85%																			0.25	0.25	0.18%	0.18%
(ii) non-refillable			3.600	3.50%	3.000	2.43%															0.84	0.45	0.61%	0.41%
(e) Other Containers							0.112	0.08%	0.216	0.20%											0.00	0.00	0.02%	0.02%
(f) Plate																								
(g) Other	0.020	0.01%	0.771	0.75%			0.088	0.08%	0.063	0.06%	0.476	0.31%	0.075	0.08%							0.15	0.08	0.13%	0.09%
(3) Ferrous (a) Soft Drink Containers	0.088	0.07%	0.600	0.58%	0.001	0.00%	0.031	0.02%	0.200	0.18%	0.900	0.42%	0.100	0.11%	0.400	0.34%	0.600	0.65%	0.060	0.05%	0.25	0.07	0.33%	0.07%
(b) Food Containers	3.300	2.63%	1.600	1.55%	1.800	1.70%	2.100	1.50%	3.900	3.08%	1.300	1.30%	1.700	1.88%	1.100	0.63%	1.200	1.31%	0.900	0.33%	1.79	0.30	1.61%	0.24%
(c) Beer Cans (i) returnable																								
(ii) non-returnable																								
(d) Aerosol Cans	0.900	0.68%	0.188	0.18%	0.043	0.61%	0.903	0.22%	0.438	0.40%	0.200	0.21%			0.248	0.21%	0.400	0.64%			0.55	0.00	0.39%	0.07%
(e) Other	0.600	0.44%	1.900	1.85%	0.603	0.57%					1.580	1.69%	1.900	2.10%	2.900	2.12%	0.900	0.87%			0.99	0.29	0.90%	0.29%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.100	0.08%			0.220	0.21%	0.018	0.01%	0.300	0.27%											0.00	0.03	0.06%	0.02%
(ii) non-returnable			0.100	0.10%									0.017	0.02%							0.01	0.01	0.01%	0.01%
(iii) American																								
(b) Soft Drink Containers	0.047	0.03%	0.900	0.59%	0.100	0.06%	0.100	0.07%	0.093	0.09%	0.044	0.08%	0.015	0.02%	0.200	0.17%	0.300	0.33%	0.200	0.18%	0.15	0.04	0.14%	0.04%
(c) Other Packaging																								
(d) Aluminum	2.000	1.47%	0.230	0.22%	0.200	0.16%	0.800	0.18%	0.800	0.73%	0.900	0.93%	1.100	1.22%	0.900	0.54%	0.900	0.33%	0.100	0.09%	0.55	0.19	0.49%	0.15%
(e) Other	0.047	0.03%									0.036	0.02%	0.900	0.44%			0.000	0.01%			0.03	0.04	0.08%	0.04%
(5) Plastics (a) Polyolefins	3.900	2.86%	8.000	7.77%	6.564	6.10%	7.611	3.55%	6.300	5.08%	7.900	7.79%	8.900	9.79%	4.414	3.75%	7.863	6.59%	4.500	3.97%	6.95	0.52	6.53%	0.68%
(b) PVC	0.060	0.04%	0.089	0.09%			0.086	0.06%	0.150	0.14%	0.043	0.04%	0.001	0.07%	0.100	0.09%	0.400	0.44%			0.10	0.04	0.09%	0.04%
(c) Polystyrene	0.700	0.51%	0.000	0.58%	0.006	0.57%	0.200	0.50%	0.500	0.43%	1.100	1.17%	1.400	1.55%	0.900	0.99%	0.800	0.85%	0.900	0.35%	0.80	0.10	0.86%	0.12%
(d) ABS																								
(e) PET							0.058	0.04%	0.204	0.18%	0.067	0.07%	0.062	0.07%							0.04	0.00	0.04%	0.02%
(f) Mixed Blend / Coated	0.900	0.57%	0.436	0.43%	1.980	1.38%	0.900	0.56%	0.300	0.27%	0.000	0.84%	1.200	1.33%	0.200	0.17%	0.000	0.65%	0.912	0.80%	0.67	0.13	0.64%	0.16%
(g) Nylon	0.019	0.01%	0.366	0.36%	0.700	0.03%	0.043	0.03%	0.275	0.25%	0.060	0.06%	0.018	0.01%	0.141	0.12%	0.046	0.08%	0.600	0.53%	0.23	0.08	0.21%	0.07%
(h) Vinyl			0.118	0.11%			0.138	0.10%			0.263	0.29%			0.015	0.01%	0.005	0.01%	0.400	0.35%	0.09	0.04	0.09%	0.04%
(6) Organic (a) Food Waste / Rodent Bedding	29.000	21.29%	21.700	21.08%	50.100	47.10%	41.200	29.42%	31.500	29.58%	34.100	30.41%	22.900	25.20%	50.700	43.02%	29.300	31.50%	12.300	10.85%	32.23	3.89	29.43%	3.47%
(b) Yard Waste	4.900	*******	8.900	*******	17.100	*******	3.100	*******	27.900	*******	12.900	*******	18.400	*******	18.900	*******	40.100	*******	8.900	*******	13.64	3.83	*******	*******
(7) Wood	0.089	0.06%	1.500	1.46%	0.371	0.35%	0.600	0.43%	7.000	6.33%	0.448	0.48%	3.400	3.76%	0.903	0.77%	0.400	0.44%	0.298	0.26%	1.46	0.69	1.37%	0.60%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	1.724	1.26%	1.736	1.09%	1.240	1.17%	0.334	0.24%	5.070	4.86%	0.825	0.88%	1.356	1.50%	0.352	0.30%			0.500	0.44%	1.31	0.46	1.21%	0.43%
(9) Diapers	3.900	2.56%	5.200	3.08%	0.900	0.85%	3.100	3.54%	4.900	4.43%	1.300	1.35%	0.600	0.66%	9.900	7.98%			0.000	0.58%	3.19	0.96	2.74%	0.81%
(10) Textiles/Leather/Rubber	1.000	0.73%	4.670	4.24%	2.550	2.40%	3.381	3.71%	4.820	4.37%	1.690	1.60%	3.783	4.18%	1.312	1.11%	1.618	1.76%	2.000	1.70%	2.86	0.51	2.64%	0.43%
(11) Household Hazardous Wastes (a) Paints / Solvents			0.991	0.67%							4.300	4.50%	0.088	0.10%					3.310	2.93%	0.84	0.56	0.83%	0.51%
(b) Waste Oils																								
(c) Pesticides/Herbicides																								
(12) Dry Cell Batteries			0.048	0.08%	0.016	0.03%			0.129	0.12%	0.023	0.03%			0.632	0.53%					0.09	0.05	0.09%	0.08%
(13) Kitty Litter	3.000	3.06%					2.900	1.89%			3.300	3.53%			3.200	2.72%					1.41	0.61	1.19%	0.50%
(14) Medical Wastes																								
(15) Miscellaneous	1.900	0.95%	1.315	1.20%	0.781	0.64%	0.099	0.06%	0.550	0.50%	0.003	0.01%	0.781	0.86%	0.000	0.76%	0.491	0.54%	0.080	0.08%	0.61	0.15	0.56%	0.14%
(16) BLUE BOX ITEMS (a) Newsprint	12.900	9.01%	0.133	0.12%	6.700	6.31%	17.900	18.99%	4.900	4.43%	1.850	2.06%	3.900	4.30%	6.850	3.00%	12.400	14.80%	9.100	8.02%	7.55	1.70	6.70%	1.40%
(b) Liquor / Wine Bottles	2.850	2.09%			0.650	0.61%	3.600	2.57%					1.300	2.18%	3.150	2.87%	2.000	2.16%	0.900	0.75%	1.61	0.44	1.30%	0.38%
(c) Food Jars / Other Bottles	2.350	1.67%					6.700	4.78%	1.060	0.85%	1.890	1.35%	1.700	1.88%	2.080	1.74%	1.900	1.47%	0.750	0.66%	1.76	0.61	1.48%	0.43%
(d) Food Cans (i) ferrous	0.900	0.59%	0.341	0.33%	0.750	0.71%	2.900	1.57%	0.900	0.83%	0.900	0.93%	0.650	0.72%	0.750	0.64%	0.900	0.98%	0.900	0.29%	0.85	0.17	0.78%	0.12%
(ii) non-ferrous							6.700	4.78%													0.67	0.67	0.48%	0.48%
(e) Beer Cans (i) ferrous																								
(ii) non-ferrous	0.010	0.01%																			0.00	0.00	0.00%	0.00%
(iii) American																								
(f) Pop Cans (i) ferrous	0.580	0.40%			0.250	0.24%	2.530	1.88%			0.100	0.11%	0.100	0.11%	1.100	0.96%	0.900	0.93%	0.900	0.64%	0.53	0.23	0.43%	0.16%
(ii) non-ferrous	0.100	0.07%	0.007	0.01%	0.250	0.34%	0.900	0.36%	0.300	0.40%	0.016	0.06%	0.100	0.11%	0.100	0.09%	0.300	0.33%	0.990	0.90%	0.22	0.06	0.30%	0.09%
(g) PET Bottles	0.357	0.36%			0.034	0.03%	0.084	0.08%	0.300	0.27%	0.155	0.14%	0.334	0.99%	0.100	0.09%			0.100	0.09%	0.16	0.06	0.12%	0.06%
	136.49	100.00%	108.69	100.00%	106.16	100.00%	140.06	100.00%	110.53	100.00%	85.96	100.00%	90.49	100.00%	117.44	100.00%	91.75	98.43%	113.38	100.00%	110.96		98.85%	
*** TOTAL BLUE BOX COMPONENTS DIVIDED BY 6 *** (see 8.8.4 Data Management)	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

EA 256 medium income; primarily mixed dwellings

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	vacuum bag	1.300
		1.3
2	vacuum (parts)	1.315
		1.315
3	heating element	0.407
	vacuum bag	0.344
	light bulb (1)	********
		0.751
4	straw hat	0.098
	light bulb (2)	*******
	biodegradable bags (2)	********
		0.098
5	plastic toy	0.330
	light bulbs (2)	*******
	biodegradable bags (4)	********
		0.33
6	light bulbs (2)	*******
	Instabond lepage	0.006
		0.006
7	soapstone sculpture	0.161
	vacuum bag	0.600
	light bulb (1)	********
		0.761
8	vacuum bag	0.900
		0.9
9	winter gage	0.091
	vacuum bag	0.400
		0.491
10	light bulb (1)	0.080
		0.08

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: FERGUS
Enumeration Area: 257 medium income; primarily multiple dwellings
n = : 10

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	10 kg	10 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	10.800	10.06%	6.200	4.97%	2.800	2.32%	9.800	10.81%	12.400	11.57%	10.300	16.01%	17.600	15.63%	11.800	11.29%	30.000	25.19%	17.300	16.69%	13.15	2.11	12.99%	2.07%
(b) Fine Paper / CPO / Ledger	0.800	0.74%	2.300	2.01%	1.300	1.24%	1.600	1.76%	1.300	1.60%	0.000	0.06%	0.000	0.00%	1.100	1.10%	1.400	1.32%	4.100	3.90%	1.65	0.32	1.55%	0.30%
(c) Magazines / Flyers	0.600	0.56%	2.900	2.33%	8.100	6.72%	5.100	5.63%	1.000	0.08%	4.400	4.32%	3.300	3.11%	4.200	4.20%	7.300	6.60%	1.300	1.44%	3.65	0.79	3.00%	0.73%
(d) Waxed / Plastic / Mixed	2.200	2.14%	2.700	2.17%	3.000	2.49%	2.300	2.83%	1.200	1.19%	1.300	1.19%	1.300	1.35%	1.700	1.70%	1.300	1.25%	0.300	0.29%	1.74	0.31	1.51%	0.22%
(e) Boxboard	6.000	5.58%	10.200	8.19%	5.000	4.19%	8.300	8.95%	5.000	4.67%	3.300	3.21%	3.600	3.20%	3.700	3.70%	4.200	3.97%	2.200	2.11%	5.30	0.83	4.27%	0.56%
(f) Kraft	1.700	1.58%	1.000	0.80%	1.200	1.00%	0.000	0.99%	0.900	0.84%	1.000	0.98%	3.300	2.04%	0.700	0.70%	0.500	0.47%	1.700	1.63%	1.19	0.17	1.10%	0.19%
(g) Wallpaper																								
(h) OCC	3.900	3.63%	1.100	0.88%	2.400	1.00%	5.500	6.07%	11.200	10.34%	1.300	1.26%	3.800	3.24%	0.900	0.90%	3.400	3.07%	4.000	3.84%	3.87	1.00	3.66%	0.96%
(i) Tissues	6.900	5.63%	5.100	4.09%	6.300	5.25%	2.000	5.20%	3.000	2.80%	4.000	4.52%	3.300	3.11%	4.100	4.10%	2.000	1.89%	2.700	2.59%	3.81	0.40	3.51%	0.31%
(2) Glass (a) Beer (i) refillable	0.500	0.47%									0.000	0.06%					0.300	0.25%			0.17	0.10	0.15%	0.09%
(ii) non-refillable															0.300	0.30%					0.03	0.05	0.03%	0.06%
(b) Liquor & Wine Containers	4.075	3.78%	0.100	0.08%	2.700	2.26%			1.000	0.93%	4.000	3.30%	3.400	3.06%			5.400	5.91%	2.600	2.06%	3.13	0.55	1.90%	0.50%
(c) Food Containers	5.000	4.65%	0.700	0.56%	3.800	3.15%	4.300	4.76%	1.700	1.09%	0.100	8.01%			5.000	5.00%	4.600	4.58%	8.100	7.77%	3.60	0.77	3.70%	0.75%
(d) SoftDrink (i) refillable									0.400	0.37%					0.400	0.40%					0.08	0.00	0.08%	0.05%
(ii) non-refillable																								
(e) Other Containers			0.200	0.16%	0.300	0.25%							3.100	4.32%							0.36	0.51	0.49%	0.40%
(f) Plate					0.333	0.26%									0.023	0.02%					0.04	0.08	0.03%	0.02%
(g) Other							0.477	0.33%													0.03	0.03	0.03%	0.05%
(3) Ferrous (a) Soft Drink Containers	0.800	0.74%	0.400	0.32%	2.800	2.32%	0.400	0.44%	0.600	0.47%	0.600	0.50%	0.800	0.71%	0.300	0.30%	0.300	0.25%	1.000	0.08%	0.81	0.23	0.78%	0.19%
(b) Food Containers	1.900	1.77%	1.400	1.12%	1.000	0.83%	2.100	2.32%	1.700	1.30%	4.400	4.32%	2.300	2.06%	4.000	4.00%	1.300	1.25%	2.700	2.50%	2.28	0.36	2.19%	0.51%
(c) Beer Cans (i) returnable																								
(ii) non-returnable																								
(d) Aerosol Cans					0.104	0.14%	0.098	0.10%	0.184	0.17%	0.300	0.20%	0.222	0.20%	0.008	0.03%			0.038	0.08%	0.09	0.03	0.09%	0.03%
(e) Other	0.800	0.74%	2.000	2.25%	0.156	0.16%	0.573	0.63%	0.900	0.84%			0.100	0.09%	0.400	0.40%	3.400	3.21%			0.80	0.39	0.80%	0.34%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.300	0.19%					0.009	0.07%	0.100	0.09%	0.300	0.30%	0.100	0.08%	0.017	0.08%					0.07	0.03	0.06%	0.02%
(ii) non-returnable	0.500	0.47%	0.001	0.00%	0.300	0.17%					0.800	0.78%	0.100	0.08%	0.100	0.10%					0.19	0.08	0.17%	0.08%
(iii) American																	0.048	0.04%	0.600	0.38%	0.08	0.04	0.04%	0.04%
(b) Soft Drink Containers	0.100	0.08%	0.100	0.08%	3.300	2.76%	0.100	0.11%	0.100	0.09%	0.400	0.25%	0.000	0.33%	0.400	0.40%	0.300	0.25%	1.500	1.44%	0.84	0.33	0.60%	0.27%
(c) Other Packaging																								
(d) Aluminum	0.600	0.76%	0.400	0.32%	0.200	0.36%	0.300	0.33%	0.300	0.26%	0.100	0.10%	0.800	0.19%	0.400	0.60%	0.100	0.08%	0.300	0.29%	0.36	0.08	0.36%	0.07%
(e) Other	0.008	0.09%	1.000	1.26%	0.100	0.08%	0.008	0.02%			0.009	0.00%	0.200	0.19%			0.180	0.17%			0.22	0.15	0.19%	0.13%
(5) Plastics (a) Polyolefins	5.400	5.02%	7.000	6.24%	7.018	5.82%	5.530	6.10%	4.400	4.11%	6.600	6.48%	9.300	8.17%	7.215	7.21%	4.081	3.84%	4.600	4.32%	6.27	0.39	5.90%	0.44%
(b) PVC	0.217	0.20%	0.300	0.25%	0.200	0.17%	0.330	0.37%	0.031	0.03%	0.108	0.10%	0.030	0.02%	0.170	0.17%	0.698	0.65%	0.103	0.10%	0.23	0.06	0.21%	0.06%
(c) Polystyrene	1.300	1.12%	1.000	0.80%	0.500	0.95%	0.300	0.35%	0.200	0.09%	0.300	0.09%	0.554	0.49%	0.522	0.53%	0.300	0.28%	0.500	0.48%	0.58	0.10	0.52%	0.09%
(d) ABS							0.084	0.04%									0.145	0.14%			0.00	0.01	0.02%	0.01%
(e) PET	0.131	0.12%					0.136	0.15%	0.233	0.22%			0.300	0.27%	0.200	0.20%	0.060	0.06%	0.300	0.10%	0.15	0.03	0.19%	0.03%
(f) Mixed Blend / Coated	0.900	0.84%	0.700	0.56%	0.600	0.50%	0.800	0.48%	0.400	0.51%	0.700	0.09%	0.600	0.53%	0.800	0.80%	0.000	0.57%	1.300	1.15%	0.75	0.07	0.09%	0.07%
(g) Nylon	0.191	0.17%	0.300	0.24%	0.009	0.03%	0.229	0.25%	0.108	0.10%	0.007	0.07%	0.008	0.01%	0.109	0.10%	0.226	0.21%	2.200	2.11%	0.34	0.21	0.32%	0.20%
(h) Vinyl	0.088	0.04%	0.084	0.05%	0.003	0.00%	1.200	1.32%	0.200	0.19%	0.000	0.01%			0.300	0.30%	0.165	0.16%	0.086	0.08%	0.35	0.12	0.25%	0.19%
(6) Organic (a) Food Waste / Rodent Bedding	37.100	34.51%	40.100	32.17%	38.100	31.42%	23.100	25.48%	26.700	26.78%	30.700	30.10%	46.100	40.98%	30.400	30.24%	22.700	21.44%	25.100	24.07%	32.51	2.48	30.03%	1.61%
(b) Yard Waste		*******		*******	0.700	*******		*******		*******		*******	1.400	*******		*******		*******	0.900	*******	1.19	0.08	*******	******
(7) Wood	0.700	0.05%	0.144	0.12%	0.384	0.32%	1.000	1.10%	0.009	0.00%	0.009	0.00%	0.700	0.63%	1.200	1.20%	0.004	0.00%	0.910	0.87%	0.51	0.14	0.40%	0.13%
(8) Ceramics / Rubble / Fiberglass /	0.700	0.65%	3.003	2.46%					3.800	3.55%	0.500	0.50%	0.700	0.63%	0.300	0.30%			4.300	4.32%	1.30	0.34	1.27%	0.95%
Gypsum Board / Asbestos																			0.000	0.00%	0.09	0.00	0.00%	0.00%
(9) Diapers	4.800	4.46%	4.000	3.20%			10.800	11.09%	8.000	8.02%	3.000	3.54%	0.600	0.96%	0.300	0.30%	4.700	4.44%	10.000	10.17%	5.47	1.17	3.51%	1.21%
(10) Textiles/Leather/Rubber	1.100	1.02%	3.800	2.22%	1.891	1.00%	4.100	4.53%	0.125	5.71%	2.000	2.33%	0.634	0.90%	3.858	3.85%	7.750	7.32%	1.157	1.09%	3.30	0.73	3.03%	0.71%
(11) Household Hazardous (a) Paints / Solvents Wastes			0.000	0.40%	0.204	0.17%															0.06	0.06	0.07%	0.06%
(b) Waste Oils																								
(c) Pesticides/Herbicides																								
(12) Dry Cell Batteries			0.080	0.07%	0.075	0.06%	0.130	0.14%	0.023	0.09%	0.018	0.00%	0.800	0.71%			0.210	0.20%	0.118	0.11%	0.13	0.08	0.19%	0.07%
(13) Kitty Litter	4.200	3.91%	0.700	0.56%	5.100	4.23%			11.000	10.26%					3.800	3.82%	4.300	4.25%	1.300	1.25%	3.27	1.13	3.04%	1.05%
(14) Medical Wastes					0.165	0.14%			0.003	0.00%	0.013	0.01%	0.314	0.26%					0.128	0.12%	0.00	0.03	0.08%	0.08%
(15) Miscellaneous			0.229	0.19%	0.018	0.01%	0.070	0.09%	0.003	0.00%	1.700	1.57%	0.961	0.95%	0.341	0.24%			0.335	0.30%	0.30	0.16	0.29%	0.15%
(16) BLUE BOX ITEMS (a) Newsprint	2.600	2.42%	12.800	9.78%	8.550	7.10%															3.34	1.39	1.90%	1.19%
(b) Liquor / Wine Bottles	0.400	0.42%	2.250	1.81%	8.600	4.80%															0.84	0.85	0.71%	0.30%
(c) Food Jars / Other Bottles			3.130	2.23%	3.800	3.19%															0.70	0.47	0.57%	0.58%
(d) Food Cans (i) ferrous	1.000	0.98%	1.550	1.84%	1.130	0.95%															0.27	0.19	0.91%	0.16%
(ii) non-ferrous																								
(e) Beer Cans (i) ferrous			3.900	1.76%																	0.33	0.33	0.19%	0.19%
(ii) non-ferrous	0.008	0.01%																			0.00	0.00	0.02%	0.02%
(iii) American	0.900	0.47%	0.400	0.36%																	0.10	0.08	0.08%	0.06%
(f) Pop Cans (i) ferrous	0.250	0.25%	0.400	0.29%	0.300	0.25%															0.10	0.08	0.08%	0.04%
(ii) non-ferrous	0.250	0.25%	0.000	0.08%	0.200	0.17%															0.03	0.03	0.04%	0.06%
(g) PET Bottles	0.100	0.08%	0.000	0.04%	0.100	0.08%															0.03	0.01	0.02%	0.01%
	107.36	100.02%	124.65	100.00%	120.51	100.02%	90.66	100.00%	107.18	100.02%	101.91	100.00%	112.64	100.00%	100.07	100.00%	106.97	100.00%	104.26	100.00%	107.30	3.12	100.02%	0.02%
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

*** TOTAL BLUE BOX COMPONENTS DIVIDED BY 2 ***
(see 2.2.4 Data Management)

EA: 257 medium income; primarily multiple dwellings

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1		
2	sponge	0.200
	lightbulbs	0.029
		0.229
3	lightbulb	0.018
4	lightbulbs	0.070
		0.07
5	lightbulbs	0.003
		0.003
6	fanbelts	0.300
	fluorescent lighter holder	0.400
	cigarette rolling machine	1.100
		1.7
7	wood knife	0.594
	fly sticks	0.367
		0.961
8	softball	0.314
	electrical tape	0.027
		0.341
9	spark plug wire	
10	glue stick	0.024
	insulated bag	0.081
	lightbulbs	0.101
	sea shells	0.130
		0.335

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: FERGUS
Enumeration Area: 254 high income: primarily single detached
n = 10

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	10 kg	10 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
																					MEAN AND STANDARD ERROR ON A WEIGHT BASIS		MEAN AND STANDARD ERROR ON A PERCENT BASIS	
(1) Paper (a) Newsprint	5.000	3.83%	4.000	4.46%	4.300	3.37%	1.200	1.03%	3.100	4.55%	3.900	2.83%	0.300	0.57%	0.300	0.31%	3.000	1.90%	4.300	3.00%	3.36	0.62	2.38%	0.49%
(b) Fine Paper / CPO / Ledger	1.200	0.82%	1.300	1.37%	2.000	1.30%	1.400	1.39%	3.000	2.36%	20.600	13.38%	0.000	1.71%	2.700	2.78%	1.600	1.48%	19.100	12.73%	5.45	2.41	4.18%	1.69%
(c) Magazines / Flyers	3.800	2.91%	1.400	1.28%	1.300	1.17%	8.700	7.47%	6.800	3.60%	3.900	4.46%			2.600	2.67%	3.080	2.40%	6.300	4.90%	4.01	0.89	3.23%	0.12%
(d) Waxed / Plastic / Mixed	2.300	1.76%	1.900	1.74%	1.600	1.20%	1.100	0.94%	2.600	2.22%	2.100	1.99%	0.600	1.14%	22.000	22.03%	2.400	1.86%	2.600	1.73%	5.92	2.00	5.08%	2.11%
(e) Boxboard	7.300	3.74%	0.700	9.13%	8.400	7.03%	3.700	4.49%	4.000	4.18%	5.700	4.31%	0.800	1.32%	3.300	3.39%	7.300	5.59%	5.300	3.55%	5.04	0.75	4.62%	0.51%
(f) Kraft	1.600	1.32%	1.400	1.28%	1.800	1.63%	4.200	3.61%	1.000	0.85%	1.000	0.76%	0.300	0.57%	1.600	1.55%	1.600	1.24%	1.000	0.67%	1.53	0.35	1.39%	0.29%
(g) Wallpaper	1.300	0.36%	0.800	0.73%																	0.21	0.14	0.17%	0.12%
(h) OCC	2.500	1.99%	1.600	1.46%	1.800	1.35%	2.500	2.17%	3.600	3.07%	4.300	3.23%	4.300	8.15%	9.700	9.81%	3.300	2.49%	3.000	2.00%	3.06	0.30	2.97%	0.68%
(i) Tissues	6.800	5.20%	4.900	3.64%	9.100	6.69%	2.000	1.72%	3.900	3.33%	5.300	4.01%	0.600	1.14%	3.900	3.99%	6.700	5.21%	6.600	4.35%	4.87	0.49	3.81%	0.32%
(2) Glass (a) Beer (i) refillable																	1.200	0.93%			0.15	0.12	0.12%	0.09%
(ii) non-refillable							0.300	0.26%					0.300	0.58%			0.600	0.47%	3.600	1.73%	0.46	0.26	0.35%	0.17%
(b) Liquor & Wine Containers	0.300	0.23%			0.900	0.67%					0.600	0.50%	0.400	0.76%	0.600	0.41%	3.300	2.73%	9.100	3.07%	1.34	0.81	1.48%	0.43%
(c) Food Containers	8.100	4.87%	1.300	1.37%	0.800	0.60%	2.200	1.89%													0.07	0.07	0.06%	0.06%
(d) SoftDrink (i) refillable									0.700	0.60%														
(ii) non-refillable																					0.15	0.10	0.11%	0.07%
(e) Other Containers	0.000	0.00%			0.074	0.06%					0.300	0.38%									0.07	0.07	0.06%	0.06%
(f) Plate							0.700	0.60%							0.028	0.03%					0.01	0.01	0.01%	0.01%
(g) Other									0.055	0.03%					0.056	0.04%								
(3) Ferrous (a) Soft Drink Containers	0.800	0.61%			0.200	0.13%	0.100	0.09%	0.100	0.09%	0.100	0.08%			0.080	0.08%	0.300	0.23%	0.400	0.27%	0.36	0.06	0.13%	0.06%
(b) Food Containers	1.000	1.45%	2.400	2.19%	1.200	0.90%	0.800	0.69%	0.800	0.51%	0.800	0.61%	0.300	0.56%	0.300	0.31%	1.300	1.01%	3.800	2.55%	1.35	0.35	1.06%	0.34%
(c) Beer Cans (i) returnable																								
(ii) non-returnable																								
(d) Aerosol Cans	0.400	0.31%	2.019	1.64%	0.300	0.37%	0.100	0.09%					0.347	0.47%			1.000	0.78%	0.074	0.03%	0.43	0.20	0.39%	0.18%
(e) Other	0.100	0.08%	4.515	4.15%	2.665	1.99%	8.000	7.04%	4.456	3.78%	0.474	0.36%	0.018	0.03%	0.023	0.03%	2.493	1.94%	3.300	2.55%	2.71	0.89	2.23%	0.77%
(4) Non-Ferrous (a) Beer Cans (i) returnable																	0.018	0.01%	0.200	0.15%	0.00	0.00	0.01%	0.01%
(ii) non-returnable	0.200	0.15%							0.200	0.17%									0.100	0.07%	0.06	0.06	0.04%	0.06%
(iii) American																								
(b) Soft Drink Containers	0.100	0.09%	0.100	0.09%	0.018	0.01%	0.100	0.09%	0.200	0.17%			0.100	0.10%			0.300	0.23%	0.200	0.13%	0.11	0.03	0.10%	0.03%
(c) Other Packaging											0.300	0.13%	0.018	0.03%							0.00	0.09	0.02%	0.06%
(d) Aluminum	0.900	0.69%	0.200	0.18%	0.400	0.30%	0.100	0.09%	0.300	0.43%			0.100	0.10%	0.300	0.21%	0.300	0.39%	0.200	0.13%	0.31	0.06	0.25%	0.06%
(e) Other							0.129	0.11%	0.700	0.60%							0.400	0.31%			0.12	0.06	0.10%	0.06%
(5) Plastics (a) Polyolefins	9.000	7.37%	7.300	6.67%	10.700	7.03%	6.880	8.00%	6.368	5.47%	0.088	9.84%	1.800	3.41%	4.700	4.64%	9.300	7.17%	9.200	6.30%	7.48	0.84	0.17%	0.47%
(b) PVC	0.738	0.56%	0.400	0.37%	0.100	0.17%	0.300	0.45%	0.288	0.34%	0.451	0.34%			0.360	0.27%			0.326	0.32%	0.31	0.07	0.36%	0.08%
(c) Polystyrene	1.100	0.84%	0.600	0.55%	0.600	0.45%	0.400	0.34%	0.300	0.45%	0.600	0.43%	0.100	0.10%	0.200	0.21%	0.900	0.79%	0.400	0.27%	0.54	0.09	0.44%	0.07%
(d) ABS	0.011	0.01%	2.186	2.00%							0.122	0.09%			0.916	0.04%					0.33	0.23	0.30%	0.21%
(e) PET							0.200	0.17%	0.065	0.03%			0.018	0.03%					0.200	0.17%	0.00	0.05	0.04%	0.05%
(f) Mixed Blend / Coated	0.700	0.54%	1.069	1.00%	0.700	0.53%	0.650	0.56%	1.250	1.03%	0.600	0.45%	0.100	0.19%			1.089	0.83%	0.800	0.60%	0.96	0.13	0.56%	0.11%
(g) Nylon	0.215	0.16%	3.100	2.83%	0.104	0.08%	1.400	1.30%	0.100	0.08%	0.084	0.06%	0.011	0.08%	0.100	0.10%	0.898	0.70%	3.200	2.13%	0.92	0.46	0.74%	0.32%
(h) Vinyl	0.500	0.38%	0.130	0.11%	0.012	0.01%	1.000	0.86%	1.000	0.85%	0.800	0.58%	0.092	0.17%			1.280	0.99%	0.106	0.07%	0.50	0.10	0.41%	0.10%
(6) Organic (a) Food Waste / Rodent Bedding	40.400	30.91%	32.400	29.67%	48.600	36.19%	19.000	19.31%	30.100	25.66%	35.600	27.06%	0.300	12.32%	32.100	33.06%	40.800	31.79%	45.400	30.24%	33.09	3.98	27.91%	2.37%
(b) Yard Waste	8.000	*******	15.200	*******	4.300	*******	5.900	*******	21.000	*******	22.800	*******	15.600	*******	9.300	*******	70.800	*******	73.100	*******	24.00	8.22	*******	******
(7) Wood	1.300	0.99%	2.100	1.92%	0.281	0.21%	1.400	1.20%	3.700	3.13%	0.125	0.09%	0.010	0.09%	0.065	0.07%	0.181	0.15%	0.500	0.34%	0.96	0.35	0.81%	0.33%
(8) Ceramics / Rubble / Fiberglass /	2.300	1.69%			1.381	1.10%					0.444	0.34%							0.625	0.47%	0.49	0.25	0.36%	0.19%
Gypsum Board / Asbestos			1.600	1.39%	2.800	2.00%	1.753	1.50%													0.00	0.22	0.49%	0.36%
(9) Diapers	6.400	5.49%	4.300	3.93%	4.300	3.37%	3.100	2.66%	7.000	6.74%	5.400	4.08%	0.300	0.38%					11.300	7.00%	4.35	1.24	3.38%	0.89%
(10) Textiles/Leather/Rubber	2.918	2.23%	2.753	2.53%	3.522	2.03%	19.900	17.08%	2.175	1.85%	1.600	1.21%	4.202	7.87%	0.945	0.97%	21.977	17.08%	0.871	0.38%	8.00	2.30	5.41%	2.03%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.400	0.31%											0.900	1.71%			0.686	0.55%			0.30	0.11	0.23%	0.17%
(b) Waste Oils															7.800	8.08%					0.78	0.78	0.89%	0.89%
(c) Pesticides/Herbicides																								
(12) Dry Cell Batteries	0.020	0.03%	0.118	0.11%	0.397	0.32%	0.159	0.14%			0.094	0.07%			0.014	0.01%	0.064	0.03%	0.300	0.80%	0.11	0.04	0.08%	0.03%
(13) Kitty Litter	1.600	1.26%	3.000	2.74%	9.000	5.96%			2.100	1.79%	7.000	5.20%			1.300	1.34%					2.32	0.93	1.95%	0.70%
(14) Medical Wastes					0.017	0.01%			0.018	0.03%							5.436	2.06%	0.017	0.01%	0.35	0.34	0.27%	0.27%
(15) Miscellaneous	0.644	0.49%	0.198	0.18%	1.958	1.45%	0.070	0.06%	0.456	0.39%	0.080	0.07%	9.557	18.17%	0.555	0.57%	0.300	0.23%	2.700	1.89%		1.07		1.09%
(16) BLUE BOX ITEMS (a) Newsprint	9.000	6.89%	9.400	7.68%	4.100	3.07%	15.100	12.36%	15.500	13.04%	7.600	5.73%	12.850	24.36%	3.350	3.43%	3.850	2.76%	7.350	4.60%	8.98	1.42	9.36%	2.17%
(b) Liquor / Wine Bottles	1.800	1.43%	2.800	2.96%	2.250	1.58%	2.360	2.00%	1.200	1.02%	5.300	5.35%	3.450	8.84%	0.650	0.67%	0.880	0.98%	1.880	1.23%	2.27	0.42	2.20%	0.37%
(c) Food Jars / Other Bottles	3.100	2.37%	1.000	0.91%	1.500	1.13%	0.800	0.69%	3.550	3.03%	3.700	2.80%	3.600	9.82%	2.500	2.37%	1.250	0.97%	0.300	0.33%	2.18	0.40	2.14%	0.80%
(d) Food Cans (i) ferrous	1.300	0.99%	0.700	0.54%	0.450	0.34%	0.500	0.45%	2.400	2.05%	1.500	1.17%	0.250	0.47%	1.060	1.08%	0.300	0.18%	1.450	0.97%	0.98	0.22	0.95%	0.17%
(ii) non-ferrous																								
(e) Beer Cans (i) ferrous																								
(ii) non-ferrous	0.042	0.05%					0.100	0.09%			0.100	0.08%			0.200	0.21%			0.010	0.01%	0.06	0.00	0.04%	0.06%
(iii) American	0.060	0.04%							0.050	0.04%											0.01	0.01	0.01%	0.01%
(f) Pop Cans (i) ferrous	0.061	0.05%	0.150	0.14%	0.500	0.37%	0.650	0.56%	0.900	0.17%	0.330	0.26%			0.150	0.13%	0.300	0.16%	0.022	0.01%	0.33	0.07	0.19%	0.02%
(ii) non-ferrous	0.000	0.04%	0.100	0.09%	0.080	0.04%	0.250	0.21%	0.100	0.09%	0.150	0.11%			0.066	0.05%	0.800	0.18%	0.016	0.01%	0.09	0.03	0.09%	0.02%
(g) PET Bottles	0.000	0.04%	0.668	0.03%	3.300	2.47%			0.100	0.08%			0.060	0.06%			0.078	0.06%			0.98	0.33	0.27%	0.24%
	130.70	100.00%	108.96	100.00%	135.75	100.00%	116.30	100.00%	117.20	100.00%	132.30	100.00%	52.75	100.00%	97.30	100.00%	129.70	98.67%	150.11	100.00%	118.90		99.99%	
*** TOTAL BLUE BOX COMPONENTS DIVIDED BY 3 *** (see 3.2.4 Data Management)	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

EA: 254 high income: primarily single detached

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	wheelbearing grease tube	0.186
	vacuum bag	0.100
	lightbulb	0.059
	biodegradable bags	0.300
		0.644
2	sponge	0.052
	vacuum bags	********
	lightbulbs	0.144
		0.196
3	lightbulbs	0.158
	vacuum bags	1.7
	biodegradable bags	0.1
		1.958
4	ant traps	0.058
	twine	0.012
		0.07
5	bucket of stucco	4.300
	lightbulbs	0.080
		4.38
6	lightbulb	0.086
		0.086
7	playpen	9.500
	lightbulbs	0.057
		9.557
8	vacuum bag	0.500
	golfball	0.046
	sponge	0.606
		0.555
9	arborite	0.088
	lightbulbs	0.312
		0.3
10	dried food packages	[illegible]
	furnace filter	0.800
	cable hose	0.395
	brake shoes	1.600
	rope w steel treads	0.007
	scotch tape rolls	0.080
		[illegible]

Town: FERGUS
Enumeration Area: 260 low income; primarily multiple dwellings
n = : 8

MEAN AND STANDARD ERROR ON A WEIGHT BASIS / MEAN AND STANDARD ERROR ON A PERCENT BASIS

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	2.400	2.31%	7.700	7.33%	2.000	1.97%	9.900	0.73%	2.400	2.17%	3.400	3.06%	11.800	11.07%	29.300	20.99%	5.58	3.24	7.33%	2.53%
(b) Fine Paper / CPO / Ledger	1.000	0.96%	1.800	1.75%	1.400	1.38%	0.900	0.88%	2.700	2.44%	0.200	4.69%	1.300	1.04%	0.700	0.30%	1.68	0.52	1.73%	0.47%
(c) Magazines / Flyers	1.000	1.63%	1.900	1.81%	1.000	1.87%	7.300	7.18%	2.800	2.17%	8.600	7.05%	1.700	1.83%	4.542	3.23%	3.81	0.99	3.46%	0.01%
(d) Waxed / Plastic / Mixed	1.700	1.04%	2.000	1.91%	2.300	2.39%	2.300	2.39%	1.000	1.72%	1.800	1.71%	1.300	1.43%	2.100	1.50%	1.08	0.10	1.80%	0.11%
(e) Boxboard	3.600	3.06%	4.200	4.01%	3.300	3.21%	4.600	4.72%	0.400	3.79%	3.000	4.31%	4.100	3.91%	3.800	4.16%	4.03	0.32	4.40%	0.25%
(f) Kraft	0.800	0.77%	1.400	1.34%	0.300	0.29%	0.800	0.79%	0.000	0.81%	0.800	0.72%	0.200	0.19%	0.700	0.50%	0.74	0.13	0.68%	0.13%
(g) Wallpaper											6.900	0.22%					0.86	0.86	0.78%	0.78%
(h) OCC	0.800	0.77%	0.611	0.58%	0.000	0.88%	3.300	3.24%	4.700	4.23%	4.100	3.79%	12.100	11.53%	7.100	5.09%	4.39	1.38	3.76%	1.27%
(i) Tissues	2.300	2.21%	3.600	3.43%	2.300	2.46%	2.300	2.26%	4.100	3.71%	3.300	2.97%	2.500	2.39%	3.400	2.44%	3.00	0.24	2.73%	0.20%
(2) Glass (a) Beer (i) refillable	0.500	0.48%													1.000	0.72%	0.19	0.15	0.17%	0.10%
(ii) non-refillable																				
(b) Liquor & Wine Containers									0.300	0.43%	0.331	0.21%	1.700	1.83%	8.700	6.23%	1.39	1.08	1.08%	0.76%
(c) Food Containers	2.300	2.45%	4.900	4.67%	3.800	3.73%	2.400	2.36%	3.000	2.73%	1.000	0.05%	4.400	4.20%	15.600	0.74%	4.40	1.36	3.79%	0.04%
(d) SoftDrink (i) refillable																				
(ii) non-refillable																				
(e) Other Containers					0.600	0.59%					0.042	0.04%	0.230	0.22%			0.11	0.06	0.11%	0.07%
(f) Plate							0.341	0.34%							0.094	0.07%	0.03	0.04	0.03%	0.04%
(g) Other					0.135	0.13%			0.670	0.61%	0.320	0.29%	0.149	0.14%	0.500	0.36%	0.22	0.09	0.19%	0.06%
(3) Ferrous (a) Soft Drink Containers	0.048	0.05%	0.400	0.38%			0.300	0.29%	0.100	0.09%	0.031	0.03%	0.700	0.67%	0.500	0.36%	0.26	0.09	0.25%	0.09%
(b) Food Containers	1.000	1.34%	1.700	1.63%	0.700	0.09%	0.800	0.79%	1.600	1.43%	1.100	0.09%	2.300	2.20%	1.700	1.22%	1.44	0.19	1.31%	0.18%
(c) Beer Cans (i) returnable																				
(ii) non-returnable																				
(d) Aerosol Cans			0.400	0.38%	0.300	0.21%	0.117	0.13%	0.300	0.43%	0.300	0.27%	0.700	0.67%	0.100	0.07%	0.29	0.06	0.27%	0.09%
(e) Other	0.800	0.77%	0.300	0.18%	0.022	0.03%	1.454	1.43%	1.800	1.63%	1.160	1.07%	3.700	3.53%	5.905	4.23%	1.68	0.70	1.61%	0.34%
(4) Non-Ferrous (a) Beer Cans (i) returnable													0.100	0.10%	0.500	0.14%	0.04	0.03	0.05%	0.03%
(ii) non-returnable	0.100	0.10%					0.300	0.29%					0.700	0.67%	0.200	0.16%	0.16	0.09	0.13%	0.08%
(iii) American																				
(b) Soft Drink Containers			0.034	0.03%	0.100	0.10%	0.047	0.05%	0.400	0.36%	0.079	0.07%	0.300	0.29%	0.063	0.05%	0.12	0.03	0.12%	0.03%
(c) Other Packaging																				
(d) Aluminum	0.341	0.32%	0.300	0.29%	0.300	0.40%	0.100	0.10%	0.800	0.73%	0.400	0.36%	0.400	0.38%	0.200	0.14%	0.41	0.06	0.39%	0.07%
(e) Other	0.010	0.01%					0.020	0.02%	0.000	0.01%	0.000	0.05%			0.010	0.01%	0.01	0.01	0.01%	0.01%
(5) Plastics (a) Polyolefins	4.600	4.42%	6.554	6.25%	6.800	6.76%	3.400	3.51%	0.805	0.85%	4.629	4.17%	3.912	3.65%	5.500	3.85%	5.13	0.45	5.60%	0.33%
(b) PVC	0.037	0.04%	0.133	0.13%	0.300	0.29%	0.206	0.20%	0.200	0.18%	0.298	0.27%	0.100	0.10%	0.509	0.36%	0.21	0.03	0.19%	0.04%
(c) Polystyrene	1.000	0.96%	0.800	0.76%	0.400	0.39%	0.400	0.39%	0.500	0.45%	1.000	0.05%	1.200	1.17%	0.700	0.50%	0.73	0.11	0.65%	0.10%
(d) ABS			0.300	0.10%					0.080	0.06%			0.300	0.13%			0.08	0.03	0.06%	0.03%
(e) PET	0.135	0.13%					0.300	0.20%			0.048	0.04%	0.200	0.16%	0.500	0.36%	0.14	0.06	0.11%	0.05%
(f) Mixed Blend / Coated	0.500	0.48%	0.500	0.46%	0.400	0.39%	0.300	0.40%	0.600	0.54%	0.500	0.27%	0.400	0.38%	0.400	0.29%	0.45	0.05	0.43%	0.04%
(g) Nylon	1.600	1.63%	0.073	0.07%	0.011	0.01%	0.036	0.04%	0.251	0.21%	0.300	0.27%	2.600	2.48%	0.500	0.36%	0.71	0.33	0.66%	0.34%
(h) Vinyl	1.000	0.96%					0.700	0.07%	0.146	0.13%	0.042	0.04%	0.153	0.13%	0.300	0.21%	0.20	0.15	0.27%	0.13%
(6) Organic (a) Food Waste / Rodent Bedding	24.700	23.76%	34.500	31.80%	38.400	37.73%	36.700	36.07%	34.400	31.14%	20.800	18.75%	12.600	18.05%	18.106	13.69%	38.13	4.74	36.12%	4.82%
(b) Yard Waste	0.100	*******	13.500	*******	3.300	*******	1.000	*******	9.100	*******	12.400	*******		*******	0.300	*******	4.60	2.00	*******	*******
(7) Wood	0.300	0.29%	0.700	0.67%	0.076	0.07%	0.080	0.08%	0.700	0.63%	3.000	3.23%	12.401	11.84%	12.310	8.83%	3.79	1.00	3.22%	1.83%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	12.622	12.14%	1.200	1.14%	0.025	0.03%	0.775	0.76%	0.500	0.45%	1.245	1.12%	0.346	0.33%	1.700	1.22%	2.33	1.48	2.17%	1.43%
(9) Diapers	0.200	0.19%	0.300	0.29%	3.300	3.21%	4.400	4.33%	0.082	0.07%	0.300	0.27%	7.000	7.34%	3.300	2.29%	2.71	1.03	2.53%	1.01%
(10) Textiles/Leather/Rubber	3.900	3.59%	0.400	0.38%	0.000	0.88%	3.400	3.34%	0.592	0.54%	13.729	12.37%	8.700	8.81%	4.048	3.33%	4.77	1.64	4.34%	1.50%
(11) Household Hazardous (a) Paints / Solvents									0.880	0.79%	2.080	1.83%	0.112	0.11%			0.32	0.26	0.34%	0.23%
Wastes (b) Waste Oils																				
(c) Pesticides/Herbicides	0.273	0.39%							0.000	0.03%	0.244	0.22%					0.07	0.04	0.06%	0.04%
(12) Dry Cell Batteries			0.068	0.06%	0.040	0.00%	0.020	0.03%	0.237	0.21%	0.599	0.54%			0.112	0.08%	0.14	0.07	0.12%	0.06%
(13) Kitty Litter	6.300	0.06%	5.200	4.96%	10.000	10.61%			7.400	6.70%							3.71	1.51	3.34%	1.43%
(14) Medical Wastes							0.013	0.01%	1.013	0.03%			0.932	0.89%			0.33	0.16	0.23%	0.13%
(15) Miscellaneous	19.985	19.22%	0.067	0.06%	1.608	1.58%	0.009	0.04%	2.268	2.05%	0.368	0.31%	0.400	0.38%	0.705	0.51%	3.36	2.41	3.12%	2.87%
(16) BLUE BOX ITEMS (a) Newsprint	2.000	1.97%			8.400	8.24%	8.430	8.31%	9.400	8.51%	13.500	12.17%					6.35	1.83	5.09%	1.78%
(b) Liquor / Wine Bottles	0.265	0.25%			0.150	0.17%	1.400	1.38%	2.750	2.49%	0.900	0.81%					0.68	0.35	0.63%	0.33%
(c) Food Jars / Other Bottles	0.800	0.77%	2.000	1.91%	8.430	2.41%	0.800	0.09%	3.750	3.39%	1.330	1.23%					1.37	0.46	1.26%	0.45%
(d) Food Cans (i) ferrous	0.600	0.58%	0.330	0.33%	1.150	1.13%	0.400	0.39%	1.400	1.27%	0.330	0.30%					0.34	0.17	0.33%	0.18%
(ii) non-ferrous																				
(e) Beer Cans (i) ferrous																				
(ii) non-ferrous			0.059	0.06%	0.400	0.39%			0.000	0.00%							0.06	0.03	0.06%	0.03%
(iii) American																				
(f) Pop Cans (i) ferrous	0.000	0.00%	0.650	0.62%	0.300	0.29%	0.250	0.25%	0.700	0.63%	0.600	0.54%					0.34	0.11	0.32%	0.10%
(ii) non-ferrous	0.030	0.03%	0.250	0.24%	0.018	0.02%	0.300	0.29%	0.060	0.05%	0.100	0.09%					0.10	0.04	0.09%	0.04%
(g) PET Bottles			0.000	0.00%					0.000	0.00%	0.100	0.09%					0.03	0.01	0.03%	0.01%
TOTAL kg	103.87	100.00%	104.92	100.00%	101.73	100.00%	101.73	100.00%	110.47	100.00%	110.94	100.05%	104.74	100.00%	139.57	100.00%	109.73		100.00%	

*** TOTAL BLUE BOX COMPONENTS DIVIDED BY 8 ***
(see 3.3.4 Data Management)

Town: FERGUS
EA 260 low income; primarily multiple dwellings

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	playpen	8.800
	stroller	2.400
	training wheels	0.600
	paint covered plastics	7.800
	hairdryer	0.300
	tennis racket	0.400
	lightbulbs	0.085
		19.985
2	sponges	0.001
	shells	0.066
		0.067
3	scale (bathroom)	1.600
	latex prophylactics	0.008
		1.608
4	lightbulb	0.004
	hemp rope	0.005
		0.009
5	vacuum cleaner bags	1.300
	coffee maker	0.400
	lightbulbs	0.149
	flood light cable	0.108
	caulking tube	0.319
		2.268
6	lightbulbs	0.085
	clay	0.429
	rope	0.022
	sponge	0.024
		0.368
7	vibrating foot bath	1.600
	lightbulbs	0.071
	aspirator	0.020
	ant trap	0.020
	hair dryer	0.492
		2.803
8	wall hanging	0.608
	candle	0.800
	shell bracelet	0.008
		0.706

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: FERGUS
Enumeration Area: 262 medium income: primarily single detached
n = 10

SAMPLE #	1		2		3		4		5		6		7		8		9		10		MEAN AND STANDARD ERROR ON A WEIGHT BASIS		MEAN AND STANDARD ERROR ON A PERCENT BASIS	
	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	2.400	2.44%	4.600	3.53%	0.000	0.57%			1.900	1.75%	0.213	0.13%	8.900	7.48%	2.900	2.30%	1.900	0.06%	1.600	1.25%	2.93	0.93	2.09%	0.73%
(b) Fine Paper / CPO / Ledger	1.100	1.12%	0.400	0.29%	1.900	1.25%	0.600	0.44%	1.200	1.41%	0.800	0.61%	3.000	2.06%	1.400	1.29%	0.600	0.73%	0.700	0.64%	1.13	0.23	1.04%	0.23%
(c) Magazines / Flyers	1.900	1.22%	1.600	1.32%	4.900	4.25%	2.600	1.01%	2.900	2.03%	0.800	0.61%	0.600	0.55%	0.200	0.18%	0.200	0.12%	1.800	1.06%	1.53	0.42	1.48%	0.41%
(d) WS&S / Plastic / Mixed	2.900	2.25%	1.300	1.56%	1.000	1.31%	1.700	1.25%	2.400	2.61%	2.000	1.98%	2.000	2.30%	1.900	1.79%	4.000	3.59%	2.300	2.12%	2.52	0.22	2.09%	0.33%
(e) Boxboard	5.600	5.99%	4.600	3.37%	5.106	4.61%	6.900	4.56%	3.400	6.55%	5.600	4.41%	1.000	0.89%	8.900	7.53%	6.000	5.91%	6.100	5.61%	5.31	0.00	4.96%	0.59%
(f) Kraft	0.800	0.81%	1.000	0.73%	1.900	1.25%	5.000	2.67%	1.000	1.17%	1.000	1.64%	1.000	0.89%	1.000	1.47%	1.000	0.00%	0.900	0.25%	1.34	0.31	1.18%	0.33%
(g) Wallpaper			0.900	0.66%													1.000	0.30%			0.19	0.19	0.16%	0.11%
(h) OCC	4.000	4.06%	4.900	5.50%	2.600	2.64%	3.800	4.12%	1.900	1.41%	1.300	0.08%	5.000	4.45%	2.000	1.84%	0.800	0.79%	2.600	2.39%	3.03	0.34	2.67%	0.42%
(i) Tissues	3.400	3.43%	4.900	2.50%	4.900	5.06%	4.800	3.16%	3.900	3.67%	5.300	4.05%	5.600	5.19%	7.100	6.59%	8.106	7.25%	4.600	4.43%	4.00	0.50	4.53%	0.44%
(2) Glass (a) Beer (i) refillable																								
(ii) non-refillable																								
(b) Liquor & Wine Containers	6.100	5.19%	0.700	0.51%	2.700	1.98%	0.337	0.25%			0.310	0.24%	3.200	2.85%	1.106	1.01%			0.057	0.64%	1.33	0.52	1.26%	0.52%
(c) Food Containers	4.300	4.98%	10.000	7.35%	3.600	3.40%	1.600	1.03%	1.900	2.29%	3.000	1.52%	2.000	1.77%	4.100	3.72%	7.900	6.34%	3.106	2.85%	4.09	0.87	3.54%	0.82%
(d) SoftDrink (i) refillable			0.794	0.54%																	0.07	0.07	0.05%	0.05%
(ii) non-refillable											1.900	0.91%			5.000	2.73%					0.42	0.31	0.37%	0.73%
(e) Other Containers																								
(f) Plate			0.000	0.54%																	0.06	0.06	0.04%	0.04%
(g) Other			0.900	0.97%	6.209	5.30%					0.400	0.32%	3.400	4.73%					2.600	3.50%	1.63	0.79	1.48%	0.73%
(3) Ferrous (a) Soft Drink Containers	2.600	2.54%	1.100	0.81%	0.960	0.10%	1.900	0.96%	0.960	0.83%			0.900	0.27%	0.045	0.04%	0.000	0.34%	1.100	1.01%	0.76	0.27	0.09%	0.27%
(b) Food Containers	1.106	1.12%	11.700	8.57%	1.600	1.70%	1.200	0.88%	1.400	1.64%	5.200	3.93%	2.900	2.21%	2.200	2.00%	0.400	0.36%	5.600	5.50%	5.19	1.06	2.00%	0.73%
(c) Beer Cans (i) returnable																								
(ii) non-returnable																								
(d) Aerosol Cans	0.100	0.10%	4.200	2.08%					0.220	0.26%			0.700	0.65%	0.356	0.35%	0.300	0.43%			0.61	0.41	0.48%	0.30%
(e) Other	1.319	1.34%	4.600	3.52%			0.159	0.12%			0.700	0.38%			0.175	0.16%	0.006	0.05%	0.182	0.17%	0.74	0.47	0.59%	0.33%
(4) Non-Ferrous (a) Beer Cans (i) returnable							0.071	0.05%			0.106	0.08%			0.039	0.04%	0.700	0.63%			0.05	0.07	0.09%	0.08%
(ii) non-returnable	0.800	0.61%											0.039	0.05%					0.200	0.18%	0.10	0.08	0.19%	0.08%
(iii) American																								
(b) Soft Drink Containers											0.600	0.61%									0.08	0.09	0.06%	0.06%
(c) Other Packaging																								
(d) Aluminum	0.900	0.90%	0.700	0.51%	0.400	0.38%	0.300	0.32%	0.600	1.05%	0.900	0.33%	0.600	0.35%	0.400	0.27%	0.300	0.43%	0.400	0.37%	0.50	0.06	0.46%	0.07%
(e) Other	0.153	0.15%	2.600	2.05%	0.144	0.14%															0.31	0.20	0.23%	0.30%
(5) Plastics (a) Polyolefins	5.800	5.69%	12.000	9.40%	7.200	6.79%	7.000	5.61%	7.300	9.14%	8.106	6.91%	6.900	5.76%	9.600	9.01%	8.900	7.45%	7.600	7.16%	6.91	0.63	7.54%	0.43%
(b) PVC	0.072	0.07%	1.300	0.85%	1.283	1.21%	0.162	0.12%	0.118	0.14%	0.900	0.35%	0.300	0.11%	0.062	0.06%					0.34	0.13	0.29%	0.13%
(c) Polystyrene	1.000	1.00%	1.400	1.05%	0.000	0.57%	0.700	0.91%	0.400	0.47%	0.600	0.61%	1.000	0.89%	0.600	0.74%	1.000	0.05%	0.700	0.64%	0.64	0.09	0.76%	0.07%
(d) ABS											0.304	0.23%			0.125	0.11%					0.04	0.06	0.03%	0.03%
(e) PET			0.900	0.13%					0.100	0.33%			0.061	0.05%	0.900	0.66%			0.064	0.06%	0.10	0.06	0.03%	0.03%
(f) Mixed Blend / Coated	0.500	0.51%	0.200	0.13%	0.600	0.57%	0.500	0.37%	0.900	0.33%	0.900	0.25%	0.200	0.11%	0.050	0.05%	0.600	0.81%	1.300	1.20%	0.66	0.12	0.44%	0.11%
(g) Nylon	0.014	0.01%			0.014	0.01%	0.900	0.37%	0.000	0.01%	0.106	0.08%	0.106	0.08%	0.100	0.08%	0.106	0.09%	0.106	0.09%	0.10	0.06	0.08%	0.03%
(h) Vinyl	1.600	1.55%	1.900	0.95%			1.204	0.80%					7.100	6.29%							1.00	0.09	0.94%	0.63%
(6) Organic (a) Food Waste / Rodent Bedding	27.300	27.73%	32.000	23.43%	28.400	26.73%	56.700	41.71%	35.000	43.25%	47.960	35.95%	21.600	19.15%	35.600	35.08%	42.500	37.99%	45.600	45.12%	37.06	3.33	32.06%	2.61%
(b) Yard Waste	7.900	*******	30.600	*******	2.900	*******	22.450	*******	19.800	*******	9.700	*******	17.900	*******	2.000	*******	0.400	*******		*******	11.31	3.37	*******	*******
(7) Wood	0.800	0.81%	2.000	2.12%	1.346	1.37%	0.455	0.33%	0.500	0.50%	0.463	0.33%	0.300	0.27%	0.017	0.02%	0.200	0.18%	0.165	0.17%	0.71	0.27	0.61%	0.21%
(8) Ceramics / Rubble / Fiberglass /	0.210	0.22%	5.300	4.03%	3.842	3.62%	0.193	0.18%	0.106	0.12%			5.987	5.31%	0.061	0.06%					1.30	0.79	1.33%	0.65%
Gypsum Board / Asbestos			5.300	4.00%	1.400	1.62%															0.60	0.50	0.54%	0.41%
(9) Diapers	11.700	11.68%	2.300	1.85%	7.000	7.17%	11.300	8.31%	8.100	0.49%	2.900	2.20%	10.000	9.55%			4.800	4.32%			3.05	1.93	5.65%	1.97%
(10) Textiles/Leather/Rubber	5.300	5.25%	3.400	2.49%	3.106	4.81%	6.000	4.41%	0.471	0.55%	1.415	1.07%	5.600	5.37%	3.013	2.77%	0.990	0.27%	2.600	2.59%	2.65	0.58	2.94%	0.49%
(11) Household Hazardous (a) Paints / Solvents	0.400	0.41%	0.000	0.08%	0.683	0.64%	0.339	0.30%			0.183	0.14%									0.27	0.11	0.22%	0.09%
Wastes (b) Waste Oils																								
(c) Pesticides/Herbicides							0.261	0.21%													0.06	0.06	0.03%	0.03%
(12) Dry Cell Batteries					0.084	0.08%			0.030	0.04%	0.064	0.05%			0.063	0.03%	0.016	0.01%	0.016	0.07%	0.05	0.01	0.03%	0.01%
(13) Kitty Litter	4.600	4.67%			3.100	4.61%			0.900	1.03%	10.600	2.20%	8.900	7.53%	0.300	0.46%	7.800	0.83%	15.700	12.61%	5.09	1.50	5.40%	1.50%
(14) Medical Wastes															0.300	0.95%					0.05	0.05	0.03%	0.03%
(15) Miscellaneous			0.300	0.25%	2.700	2.58%	2.600	1.91%	1.600	1.88%	3.410	2.56%	2.730	2.42%	0.133	0.12%			1.544	1.42%	1.30	0.42	1.31%	0.33%
(16) BLUE BOX ITEMS (a) Newsprint	3.500	3.55%	3.700	1.99%	0.400	0.40%	8.100	6.99%	2.400	2.61%	16.106	15.73%	1.650	1.54%	4.650	4.25%	8.200	7.54%	1.650	1.33%	5.26	1.66	4.40%	1.34%
(b) Liquor / Wine Bottles					1.100	1.04%	1.250	0.93%	1.250	1.47%	0.550	0.40%	0.800	0.55%	2.350	2.16%	2.250	2.00%	1.900	1.30%	1.06	0.34	0.96%	0.24%
(c) Food Jars / Other Bottles	0.300	0.30%			1.800	1.51%	4.600	3.08%	0.300	0.59%	3.350	2.54%	0.900	0.55%	3.000	2.75%	0.350	0.31%	0.900	0.26%	1.40	0.49	1.17%	0.38%
(d) Food Cans (i) ferrous	0.800	0.30%	0.000	0.04%	0.250	0.24%	2.150	1.48%	0.450	0.53%	1.300	0.91%	0.860	0.75%	0.500	0.46%	0.250	0.67%	0.150	0.14%	0.68	0.50	0.53%	0.15%
(ii) non-ferrous																								
(e) Beer Cans (i) ferrous																								
(ii) non-ferrous					0.060	0.06%	0.100	0.07%			0.300	0.73%	0.106	0.08%	0.100	0.09%	0.050	0.04%	0.150	0.14%	0.08	0.03	0.07%	0.02%
(iii) American																								
(f) Pop Cans (i) ferrous																								
(ii) non-ferrous			0.300	0.37%	0.700	0.66%	0.550	0.38%	0.130	0.18%	0.650	0.49%	0.900	0.19%	0.550	0.31%	0.600	0.61%	0.350	0.29%	0.65	0.09	0.37%	0.08%
(g) PET Bottles	0.100	0.10%			0.026	0.03%	0.100	0.07%	0.001	0.00%	0.135	0.11%					0.100	0.09%	0.050	0.05%	0.08	0.05	0.03%	0.01%
	98.88	100.00%	136.66	100.00%	100.00	100.00%	135.95	100.00%	85.82	100.00%	131.63	100.00%	112.83	100.00%	108.75	100.00%	111.63	99.49%	108.66	100.00%	113.58		99.99%	
*** TOTAL BLUE BOX COMPONENTS DIVIDED BY 8 *** (see Methods & Materials)	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	light bulbs (2)	********
2	transformer	0.200
	light bulbs (3)	0.100
	biodegradable bags (6)	********
		0.2
3	misc scrap from sample	2.700
	light bulbs (2)	********
	biodegradable bags (2)	********
		2.7
4	fertilizer	2.600
	light bulb (1)	********
		2.6
5	roll electrical tape	********
	vacuum bag	1.600
		1.6
6	hair dryer	0.341
	light bulbs (3)	********
		0.341
7	electrical wire	0.273
		0.273
8	transformer	0.183
	rechargeable welder	********
		0.133
9	light bulb (1)	********
10	glass tube	********
	pool cleaner head	1.544
	rubberballs	********
		1.544

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: FERGUS
Enumeration Area: 263 medium income; primarily mixed dwellings
n = 9

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	6.900	7.22%	3.400	3.33%	0.800	0.72%	0.800	0.76%	4.300	0.17%	0.100	8.46%	8.100	7.93%	3.700	2.03%	15.700	15.08%	3.67	1.37	3.84%	1.51%
(b) Fine Paper / CPO / Ledger	3.000	3.77%	0.800	0.78%	3.600	3.20%	3.300	3.13%	1.300	1.86%	4.800	4.46%	0.000	0.94%	0.300	0.24%	0.600	0.58%	2.34	0.99	2.29%	0.63%
(c) Magazines / Flyers	3.300	3.06%	0.012	0.01%	4.800	4.59%			0.100	0.14%	6.700	6.09%							1.91	1.00	1.81%	0.98%
(d) Waxed / Plastic / Mixed	2.400	2.31%	1.300	1.26%	3.000	3.30%	1.800	1.71%	2.400	3.44%	2.400	2.23%	2.300	2.25%	0.800	0.54%	2.300	2.21%	2.18	0.20	2.10%	0.31%
(e) Boxboard	4.200	4.39%	1.300	1.65%	12.700	11.39%	7.700	7.35%	3.900	8.46%	4.800	4.86%	3.700	3.34%	6.800	5.48%	3.600	3.57%	6.12	1.01	6.01%	0.94%
(f) Kraft	2.300	2.41%	0.600	0.58%	6.000	5.38%	4.300	4.08%	1.200	1.72%	1.700	1.58%	4.200	4.11%	1.800	1.45%	1.900	1.83%	2.67	0.50	2.57%	0.53%
(g) Wallpaper			3.300	3.39%	0.100	0.09%													0.80	0.39	0.39%	0.58%
(h) OCC	2.000	2.72%	10.400	10.09%	0.441	0.40%	0.441	0.42%	0.800	1.13%	1.000	1.77%	3.800	3.72%	3.700	2.98%			2.66	1.08	2.58%	1.03%
(i) Tissues	3.000	3.37%	1.700	1.65%	7.600	6.09%	4.000	4.96%	8.400	12.05%	2.400	2.23%	3.000	3.53%	2.000	2.09%	2.000	2.49%	4.14	0.80	4.33%	1.10%
(2) Glass (a) Beer (i) refillable							1.200	1.14%			0.264	0.25%							0.16	0.13	0.15%	0.13%
(ii) non-refillable									0.964	1.38%									0.11	0.11	0.13%	0.15%
(b) Liquor & Wine Containers	1.300	1.26%					4.000	4.63%					2.200	2.13%			2.300	2.21%	1.18	0.57	1.14%	0.54%
(c) Food Containers	6.100	6.48%	0.542	0.53%	2.300	2.00%	2.000	2.75%	2.240	3.21%	1.700	1.58%	3.600	3.29%	4.400	3.94%	4.700	4.51%	3.30	0.77	3.35%	0.79%
(d) SoftDrink (i) refillable																	0.400	0.38%	0.04	0.04	0.04%	0.04%
(ii) non-refillable											1.400	1.30%							0.16	0.16	0.14%	0.14%
(e) Other Containers																						
(f) Plate											0.023	0.03%							0.00	0.00	0.03%	0.03%
(g) Other			1.100	1.07%			2.000	2.75%			0.045	0.04%					2.300	2.21%	0.77	0.39	0.67%	0.36%
(3) Ferrous (a) Soft Drink Containers	0.300	0.31%	1.300	1.26%	0.300	0.27%	0.300	0.47%	0.200	0.20%	0.500	0.46%			0.400	0.33%			0.39	0.13	0.39%	0.13%
(b) Food Containers	1.600	1.67%	1.000	0.97%	1.200	1.08%	3.000	2.94%	1.200	1.72%	1.200	1.15%	2.200	2.13%	1.800	1.45%	2.500	2.40%	1.74	0.23	1.71%	0.22%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans	2.000	2.09%	0.150	0.15%	0.300	0.27%	1.000	0.95%	0.300	0.22%					0.200	0.16%	0.300	0.29%	0.49	0.21	0.31%	0.30%
(e) Other	0.450	0.47%	3.104	3.01%	0.400	0.36%	2.000	1.90%			1.700	1.58%			1.700	1.37%	1.100	1.06%	1.18	0.35	1.08%	0.35%
(4) Non-Ferrous (a) Beer Cans (i) returnable											0.060	0.05%							0.01	0.01	0.01%	0.01%
(ii) non-returnable					0.700	0.63%	0.200	0.19%	0.018	0.03%							0.100	0.10%	0.11	0.08	0.10%	0.07%
(iii) American																						
(b) Soft Drink Containers													1.200	1.06%					0.19	0.19	0.19%	0.16%
(c) Other Packaging																						
(d) Aluminum	0.100	0.10%	0.100	0.10%	0.400	0.36%	0.600	0.57%	0.700	1.00%	1.000	0.93%			0.100	0.08%	2.500	2.40%	0.61	0.36	0.63%	0.26%
(e) Other			0.268	0.26%							0.100	0.09%							0.04	0.03	0.04%	0.03%
(5) Plastics (a) Polyolefins	6.600	6.91%	5.950	5.77%	7.200	6.46%	8.000	7.90%	7.200	10.53%	6.600	5.86%	5.100	4.89%	5.700	4.90%	8.800	3.94%	6.18	0.46	6.19%	0.57%
(b) PVC									0.200	0.30%	0.500	0.46%					1.100	1.06%	0.20	0.13	0.20%	0.12%
(c) Polystyrene	0.600	0.63%	2.400	2.65%	0.800	0.72%	0.300	0.28%	0.600	0.86%	0.600	0.56%	0.700	0.64%	0.700	0.56%			0.74	0.22	0.74%	0.22%
(d) ABS			0.080	0.08%									0.090	0.09%					0.03	0.01	0.03%	0.01%
(e) PET	0.131	0.14%			0.065	0.06%	0.062	0.06%	0.100	0.14%	0.068	0.06%	0.137	0.13%	0.600	0.48%			0.13	0.06	0.12%	0.05%
(f) Mixed Blend / Coated	0.400	0.42%	0.400	0.29%	0.800	0.72%	0.700	0.66%	0.600	0.86%	0.300	0.28%	0.107	0.10%	0.165	0.13%	1.466	1.41%	0.53	0.14	0.53%	0.14%
(g) Nylon	1.000	1.05%	0.195	0.19%	0.100	0.09%	1.000	0.95%			0.500	0.46%	0.083	0.08%	0.400	0.32%	0.103	0.10%	0.37	0.13	0.36%	0.18%
(h) Vinyl					0.517	0.46%							0.360	0.35%					0.10	0.07	0.09%	0.06%
(6) Organic (a) Food Waste / Rodent Bedding	21.200	22.11%	14.400	13.97%	20.100	18.03%	31.400	29.75%	24.000	35.39%	23.200	21.57%	25.600	25.26%	40.600	32.86%	22.400	21.49%	24.86	2.51	24.49%	2.55%
(b) Yard Waste	20.500	*******	0.350	*******	5.100	*******	3.000	*******	35.300	*******	2.600	*******	7.800	*******	2.100	*******	8.300	*******	8.90	3.53	*******	*******
(7) Wood	0.866	0.91%	4.200	4.07%	2.500	2.24%	0.155	0.15%	0.009	0.01%	2.100	1.95%			10.600	8.37%	0.600	0.58%	2.31	1.11	2.05%	0.91%
(8) Ceramics / Rubble / Fiberglass /			19.230	18.65%							4.400	4.09%							2.63	2.13	2.59%	2.07%
Gypsum Board / Asbestos	0.174	0.18%	1.800	1.75%	0.709	0.64%							0.700	0.69%	0.397	0.24%	0.600	0.58%	0.48	0.19	0.45%	0.18%
(9) Diapers	0.144	0.15%	9.800	9.51%	7.000	6.28%	10.800	10.05%					11.300	11.00%	13.700	11.05%	3.000	3.74%	6.39	1.80	5.74%	1.62%
(10) Textiles/Leather/Rubber	9.557	10.00%	5.000	4.85%	0.370	0.33%	0.994	0.94%	2.250	3.26%	10.000	9.48%	7.300	7.05%	15.100	12.16%	17.000	17.18%	7.80	2.06	7.23%	1.84%
(11) Household Hazardous (a) Paints / Solvents					1.451	1.33%													0.16	0.16	0.14%	0.14%
Wastes (b) Waste Oils																						
(c) Pesticides/Herbicides									0.080	0.11%									0.01	0.01	0.01%	0.01%
(12) Dry Cell Batteries	0.166	0.17%									0.064	0.06%					0.003	0.03%	0.06	0.03	0.05%	0.09%
(13) Kitty Litter					10.600	9.58%	2.600	2.47%			8.300	7.73%	7.100	6.93%	5.100	4.11%	4.200	4.05%	4.29	1.35	3.98%	1.21%
(14) Medical Wastes	0.008	0.00%	0.051	0.05%															0.01	0.01	0.01%	0.01%
(15) Miscellaneous			0.041	0.04%	0.086	0.08%	0.076	0.07%											0.03	0.01	0.03%	0.01%
(16) BLUE BOX ITEMS (a) Newsprint	9.150	9.57%	3.000	3.10%	8.800	7.89%	3.500	3.38%	3.150	4.53%	3.500	3.29%	2.300	2.26%	2.450	1.97%	0.550	0.53%	4.07	0.98	4.03%	0.87%
(b) Liquor / Wine Bottles			1.750	1.70%	0.700	0.63%	0.850	0.81%			1.300	1.21%							0.51	0.23	0.44%	0.21%
(c) Food Jars / Other Bottles	1.400	1.46%	3.100	3.01%	0.500	0.45%	1.200	1.14%	0.250	0.36%	1.600	1.67%	0.800	0.79%	0.194	0.16%	1.600	1.65%	1.24	0.31	1.21%	0.33%
(d) Food Cans (i) ferrous	0.600	0.63%	0.650	0.64%			1.100	1.04%			0.350	0.33%	0.525	0.53%	0.090	0.07%	0.300	0.29%	0.36	0.11	0.35%	0.11%
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous	0.060	0.06%			0.300	0.27%	0.250	0.24%									0.100	0.19%	0.08	0.04	0.07%	0.06%
(iii) American																						
(f) Pop Cans (i) ferrous																						
(ii) non-ferrous	0.530	0.56%	0.400	0.39%	0.400	0.36%	0.490	0.47%	0.250	0.36%	0.300	0.28%	0.196	0.19%	0.165	0.13%	0.500	0.48%	0.38	0.06	0.37%	0.06%
(g) PET Bottles	0.136	0.14%	0.070	0.07%					0.165	0.24%			0.090	0.09%			0.060	0.06%	0.06	0.02	0.07%	0.03%
	95.87	100.05%	103.11	99.99%	111.53	99.29%	100.45	99.93%	69.72	100.07%	107.54	100.07%	103.17	100.07%	124.18	100.07%	104.05	100.05%	106.81		99.96%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

*** TOTAL BLUE BOX COMPONENTS DIVIDED BY n ***
(see Methods & Materials)

MEAN AND STANDARD ERROR ON A WEIGHT BASIS

MEAN AND STANDARD ERROR ON A PERCENT BASIS

Town: FERGUS
EA: 263 medium income; primarily mixed dwellings

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	2 pool chlorine bottles	*******
2	vacuum bag	0.041
		0.041
3	light bulb	0.086
		0.086
4	misc. scraps	0.004
	fuse	0.029
	light bulbs	0.049
		0.079
5		
6	lepage cement container	*******
7		
8		
9		

APPENDIX B

CITY OF NORTH BAY

APPENDIX B1

CALCULATION OF PER CAPITA WASTE GENERATION RATES FOR STUDY EAs

Town: North Bay
EA: 104 medium income: primarily single detached dwellings
Pop: 1160
Detached: 300
Other: 75
PPD: 3.09

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
201	4	0	117.81	0	4.21	1.36	
202	7	0	114.94	0	2.35	0.76	
203	4	0	104.06	0	3.72	1.20	
204	7	0	141.28	0	2.88	0.93	
205	4	0	98.32	0	3.51	1.14	
206	7	0	127.98	0	2.61	0.85	
207	6	0	111.42	0	2.65	0.86	
208	11	0	116.69	0	1.52	0.49	
209	11	0	106.12	0	1.38	0.45	
Sample Avg.	6.8	0.0	115.40	0.00	2.76	0.89	0.103

Town: North Bay
EA: 113 medium income: primarily mixed dwellings
Pop: 860
Detached: 195
Apartments: 35
Other: 125
PPD: 2.42

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
211	7	0	101.80	0	2.08	0.86	
213	8	0	97.70	0	1.74	0.72	
214	8	0	138.96	0	2.48	1.03	
216	6	0	119.08	0	2.84	1.17	
217	9	0	99.84	0	1.58	0.65	
218	7	0	129.76	0	2.65	1.09	
219	8	0	94.87	0	1.69	0.70	
212	8	0	126.05	0	2.25	0.93	
215	4	0	105.49	0	3.77	1.56	
Detached Avg.	7.6	0.0	111.7	0.0	2.15		
Other Avg.	6.0	0.0	115.8	0.0	3.01	0.97	0.095

Detached Samples 211,213,214,216-219
Other Dwellings Samples 212,215
*Samples 212,215 used total weight of waste found at the apartment

APPENDIX B2

WASTE COMPOSITION DATA

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: North Bay
Enumeration Area: 104 medium income; primarily single detached dwellings
Sample Number: 201 - 209
Collection Date: February 21, 1990

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt
(1) Paper (a) Newsprint	10.200	9.09%	9.000	7.84%	12.800	12.30%	6.100	4.46%	7.800	7.96%
(b) Fine Paper / CPO / Ledger	0.900	0.76%	1.500	1.31%	0.400	0.38%	0.900	0.66%	0.600	0.61%
(c) Magazines / Flyers	1.294	1.10%	1.600	1.39%	2.106	2.03%	3.300	2.41%	2.000	2.04%
(d) Waxed / Plastic / Mixed	1.700	1.44%	3.200	2.78%	1.300	1.25%	1.900	1.39%	2.200	2.25%
(e) Boxboard	4.300	3.65%	5.100	4.44%	2.800	2.69%	7.400	5.40%	4.300	4.39%
(f) Kraft	0.700	0.59%	2.000	1.74%	0.400	0.38%	1.200	0.88%	1.700	1.73%
(g) Wallpaper					0.700	0.67%				
(h) OCC			2.300	2.00%	2.200	2.11%	3.700	2.94%	0.700	0.71%
(i) Tissues	2.500	2.13%	5.200	4.53%	2.100	2.02%	4.200	3.43%	4.100	4.18%
(2) Glass (a) Beer (i) refillable	3.600	3.06%								
(ii) non-refillable										
(b) Liquor & Wine Containers			1.900	1.66%			2.900	2.12%	1.449	1.48%
(c) Food Containers	8.100	6.88%	5.100	4.44%	2.800	2.69%	5.636	4.12%	3.690	3.77%
(d) SoftDrink (i) refillable									0.900	0.92%
(ii) non-refillable	0.700	0.59%	0.694	0.60%	0.201	0.19%			1.910	1.94%
(e) Other Containers					0.356	0.34%	0.291	0.21%	0.060	0.07%
(f) Plate									0.499	0.51%
(g) Other	0.913	0.78%	0.449	0.39%			0.355	0.28%	0.142	0.14%
(3) Ferrous (a) Soft Drink Containers	0.092	0.08%	1.200	1.05%	0.031	0.03%	2.000	1.46%	0.600	0.61%
(b) Food Containers	3.800	3.23%	7.100	6.18%	2.000	1.93%	4.800	3.51%	4.200	4.29%
(c) Beer Cans (i) returnable										
(ii) non-returnable										
(d) Aerosol Cans					0.256	0.25%	0.116	0.09%	0.386	0.39%
(e) Other	0.221	0.19%	2.337	2.03%	1.557	1.50%	7.227	5.29%	0.559	0.57%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.400	0.34%	0.400	0.35%			0.700	0.51%		
(ii) non-returnable	0.300	0.25%								
(iii) American							0.016	0.01%		
(b) Soft Drink Containers	0.300	0.25%	0.200	0.17%	0.121	0.13%	0.400	0.29%	0.700	0.71%
(c) Other Packaging	0.016	0.01%							0.011	0.01%
(d) Aluminum	0.200	0.17%	0.200	0.17%	0.200	0.19%	0.200	0.15%	0.100	0.10%
(e) Other			0.563	0.49%			0.279	0.20%		
(5) Plastics (a) Polyolefins	4.900	4.16%	7.200	6.27%	3.600	3.46%	8.300	6.06%	3.600	3.71%
(b) PVC							0.031	0.02%	0.050	0.05%
(c) Polystyrene	1.000	0.85%	1.600	1.39%	1.000	0.96%	6.300	4.75%	0.600	0.61%
(d) ABS										
(e) PET	0.375	0.32%	0.900	0.78%	0.269	0.26%			0.057	0.06%
(f) Mixed Blend/ Layered Plastic	0.700	0.59%	0.700	0.61%	0.400	0.38%	0.700	0.51%	0.700	0.71%
(g) Coated Plastic	0.200	0.17%	0.300	0.26%	0.100	0.10%	0.100	0.07%	0.100	0.10%
(h) Nylon										
(i) Vinyl	0.221	0.19%	0.069	0.06%	0.644	0.30%	3.072	2.24%	0.398	0.41%
(6) Organic (a) Food Waste / Rodent Bedding	19.300	16.39%	36.200	31.53%	17.400	16.72%	26.800	19.35%	30.800	31.43%
(b) Yard Waste		*******		*******	23.500	*******		*******		*******
(7) Wood	1.800	1.53%	0.150	0.14%	36.000	34.60%	2.800	2.04%	0.144	0.15%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	36.100	30.65%	0.477	0.42%	0.116	0.11%	0.475	0.35%	0.391	0.30%
(9) Diapers	4.400	3.74%	10.700	9.32%	0.208	0.20%	7.600	5.35%	14.100	14.39%
(10) Textiles/Leather/Rubber	6.800	5.77%	2.500	2.18%	1.200	1.15%	14.710	10.74%	7.000	7.14%
(11) Household Hazardous Wastes (a) Paints / Solvents			3.800	3.31%						
(b) Waste Oils	0.103	0.09%								
(c) Pesticides/Herbicides										
(12) Dry Cell Batteries							0.182	0.13%		
(13) Kitty Litter	1.200	1.02%			2.400	2.31%	4.000	2.93%		
(14) Medical Waste			0.064	0.06%						
(15) Miscellaneous	0.030	0.03%	0.700	0.61%			4.627	3.38%	0.334	0.34%
(16) Ashes							3.700	2.70%		
TOTAL kg	117.78	100.00%	114.80	100.00%	104.06	100.00%	126.94	100.00%	97.99	100.00%

SAMPLE #:	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN AND STANDARD ERROR ON A WEIGHT BASIS: MEAN (kg)	SE (kg)	MEAN AND STANDARD ERROR ON A PERCENT BASIS: MEAN (%)	SE (%)
(1) Paper (a) Newsprint	13.800	11.07%	11.400	10.23%	16.300	16.13%	21.200	20.13%	12.33	1.62	11.09%	1.57%
(b) Fine Paper / CPO / Ledger	1.100	0.84%	1.100	0.99%	1.300	1.15%	0.900	0.83%	0.97	0.11	0.84%	0.09%
(c) Magazines / Flyers	3.200	2.57%	5.100	4.58%	2.700	2.39%	3.300	3.13%	2.73	0.39	2.80%	0.34%
(d) Waxed / Plastic / Mixed	3.600	2.89%	2.000	1.80%	3.750	3.32%	2.200	2.09%	2.43	0.39	2.15%	0.25%
(e) Boxboard	5.500	4.41%	4.600	4.13%	5.000	4.43%	4.600	4.37%	4.91	0.42	4.27%	0.25%
(f) Kraft	1.800	1.44%	1.200	1.08%	1.000	0.89%	0.700	0.66%	1.21	0.17	1.07%	0.16%
(g) Wallpaper									0.08	0.08	0.07%	0.07%
(h) OCC	5.700	4.57%	9.200	8.26%	2.400	2.13%	1.400	1.33%	3.01	0.94	2.61%	0.82%
(i) Tissues	5.900	4.73%	1.700	1.57%	4.800	4.25%	3.200	3.03%	4.09	0.48	3.59%	0.41%
(2) Glass (a) Beer (i) refillable			1.600	1.44%					0.96	0.60	0.50%	0.38%
(ii) non-refillable												
(b) Liquor & Wine Containers	2.500	2.01%	0.952	0.85%					1.06	0.39	0.99%	0.31%
(c) Food Containers	3.500	2.81%	2.600	2.33%	5.400	4.78%	5.200	4.94%	4.67	0.34	4.08%	0.47%
(d) SoftDrink (i) refillable									0.10	0.10	0.10%	0.10%
(ii) non-refillable	0.233	0.19%			0.683	0.60%			0.42	0.15	0.39%	0.13%
(e) Other Containers	0.012	0.01%	0.691	0.62%					0.16	0.08	0.14%	0.07%
(f) Plate									0.06	0.06	0.06%	0.06%
(g) Other	0.761	0.63%	0.411	0.37%	0.381	0.34%			0.38	0.11	0.33%	0.09%
(3) Ferrous (a) Soft Drink Containers	1.600	1.28%	0.039	0.03%	0.800	0.71%	1.200	1.14%	0.84	0.24	0.71%	0.15%
(b) Food Containers	3.800	3.05%	6.800	6.10%	6.500	5.76%	4.200	3.99%	4.80	0.38	4.22%	0.30%
(c) Beer Cans (i) returnable												
(ii) non-returnable												
(d) Aerosol Cans	0.200	0.16%	0.196	0.18%	0.357	0.32%	0.225	0.21%	0.19	0.06	0.18%	0.04%
(e) Other	0.090	0.90%			1.403	1.24%	0.648	0.62%	1.60	0.74	1.31%	0.34%
(4) Non-Ferrous (a) Beer Cans (i) returnable			0.149	0.13%					0.18	0.09	0.13%	0.07%
(ii) non-returnable									0.03	0.03	0.03%	0.03%
(iii) American	1.200	0.96%							0.14	0.13	0.11%	0.11%
(b) Soft Drink Containers	0.500	0.40%	0.095	0.09%	0.500	0.44%	1.200	1.14%	0.45	0.11	0.40%	0.11%
(c) Other Packaging	0.003	0.00%			0.012	0.01%			0.00	0.00	0.00%	0.00%
(d) Aluminum	0.400	0.32%	0.300	0.27%	0.200	0.18%	0.200	0.19%	0.22	0.06	0.19%	0.02%
(e) Other					0.067	0.06%	0.074	0.07%	0.11	0.06	0.09%	0.05%
(5) Plastics (a) Polyolefins	6.473	5.19%	0.000	3.92%	7.200	6.38%	7.000	6.65%	6.53	0.68	5.57%	0.37%
(b) PVC	0.128	0.10%			0.153	0.13%	0.339	0.29%	0.06	0.05	0.06%	0.03%
(c) Polystyrene	2.491	2.00%	0.600	0.54%	0.000	0.33%	0.800	0.76%	1.69	0.64	1.38%	0.43%
(d) ABS												
(e) PET	0.400	0.32%	0.188	0.17%	0.131	0.12%	0.064	0.06%	0.19	0.04	0.16%	0.04%
(f) Mixed Blend/ Layered Plastic	0.050	0.04%	0.700	0.63%	1.000	0.89%	0.500	0.47%	0.69	0.06	0.60%	0.05%
(g) Coated Plastic	0.200	0.16%	0.200	0.19%	0.150	0.13%	0.200	0.19%	0.17	0.03	0.15%	0.03%
(h) Nylon												
(i) Vinyl			0.013	0.01%					1.40	0.99	1.27%	0.04%
(6) Organic (a) Food Waste / Rodent Bedding	34.100	27.35%	36.000	32.31%	36.700	32.50%	33.000	31.33%	30.00	2.45	26.55%	2.33%
(b) Yard Waste		*******		*******		*******		*******	2.61	2.61	*******	*******
(7) Wood	0.491	0.39%	0.060	0.05%	0.044	0.04%	0.259	0.25%	4.64	3.96	4.25%	3.79%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.103	0.08%	0.179	0.16%	0.785	0.70%			4.29	3.99	3.64%	3.38%
(9) Diapers	13.500	10.83%	13.000	11.67%			0.199	0.19%	7.08	2.01	6.21%	1.85%
(10) Textiles/Leather/Rubber	1.900	1.52%	2.239	2.01%			7.800	7.41%	4.51	1.80	4.21%	1.32%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.756	0.61%	0.094	0.08%					0.51	0.42	0.44%	0.37%
(b) Waste Oils									0.01	0.01	0.01%	0.01%
(c) Pesticides/Herbicides												
(12) Dry Cell Batteries	0.349	0.28%							0.06	0.04	0.03%	0.03%
(13) Kitty Litter	3.600	2.89%	0.075	0.07%					1.25	0.55	1.02%	0.44%
(14) Medical Waste			0.107	0.10%	0.517	0.46%	0.121	0.11%	0.07	0.04	0.06%	0.06%
(15) Miscellaneous	3.329	2.67%	0.756	0.68%	3.924	3.59%	0.389	0.37%	1.55	0.61	1.27%	0.48%
(16) Ashes					6.000	5.31%	1.900	1.80%	1.39	0.75	1.09%	0.62%
TOTAL kg	124.69	100.00%	111.41	100.00%	112.91	100.00%	105.32	100.00%	115.98		99.75%	

EA: 104 medium income; primarily single detached dwellings

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	light bulbs - 2	*********
	electrical wire	0.030
		0.030
2	light bulbs - 2	*********
	vaccum bag dust	0.700
		0.700
3	light bulbs - 1	*********
4	sewing machine (metal)	3.700
	electric motor	0.200
	vaccum bag dust	0.600
	electrical wire	0.033
	scissors (plastic/metal)	0.061
	electrical fuses	0.033
	light bulbs - 8	*********
		4.627
5	light bulbs - 3	*********
	vaccum bag dust	0.334
		0.334
6	vaccum bag dust	3.000
	paint brush (wood/hair)	0.049
	golf balls	0.099
	electrical fuses	0.034
	copper pennies	0.130
	majic markers	0.013
		3.329
7	"Comet","Ajax" cleaners	0.393
	vaccum bag dust	0.019
	light switches (ABS & metal)	0.350
	light bulbs - 4	
		0.756
8	vacuum bag dust	0.260
	electronic components	0.329
	record player	3.800
	light bulbs - 2	*********
		3.924
9	light bulbs - 3	*********
	vacuum bag dust	0.219
	clock (plastic)	0.100
	electrical wire	0.070
		0.389

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: North Bay
Enumeration Area: 115 medium income; primarily mixed dwellings
Sample Number: 211 - 219
Collection Date: February 27, 1990

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN AND STANDARD ERROR ON A WEIGHT BASIS: MEAN (kg)	SE (kg)	MEAN AND STANDARD ERROR ON A PERCENT BASIS: MEAN (%)	SE (%)
(1) Paper (a) Newsprint	17.900	17.48%	24.000	19.12%	8.000	9.29%	4.300	4.11%	13.900	13.90%	7.700	6.47%	6.900	6.91%	6.900	5.33%	3.700	8.13%	10.87	2.25	10.05%	1.91%
(b) Fine Paper / CPO / Ledger	0.900	0.88%	19.000	15.14%	1.100	1.19%	0.900	0.82%	1.300	1.28%	1.400	1.18%	1.400	1.40%	1.300	1.16%	0.800	0.87%	3.16	1.98	2.87%	1.58%
(c) Magazines / Flyers	3.200	3.14%	10.000	8.08%	2.000	2.61%	0.700	0.64%	8.500	8.36%	5.900	3.46%	1.900	1.90%	5.000	3.86%	1.000	2.05%	4.36	1.07	3.86%	0.64%
(d) Waxed / Plastic / Mixed	1.900	1.87%	3.000	2.32%	2.491	2.02%	0.800	0.73%	2.000	1.96%	2.200	1.83%	2.000	2.00%	2.000	1.54%	2.000	2.91%	2.21	0.22	2.08%	0.23%
(e) Boxboard	3.300	3.24%	4.900	3.00%	2.600	2.81%	2.000	1.83%	4.100	4.03%	4.800	4.03%	3.900	3.91%	8.100	6.26%	3.300	3.04%	4.57	0.60	4.20%	0.51%
(f) Kraft	0.800	0.79%	1.500	1.20%	0.500	0.54%	0.600	0.55%	1.000	0.98%	2.000	1.68%	1.300	1.30%	2.300	1.82%	1.300	1.40%	1.30	0.23	1.17%	0.17%
(g) Wallpaper	2.700	2.65%	0.013	0.01%													8.000	8.29%	1.19	0.96	1.33%	1.04%
(h) OCC	1.800	1.77%	2.300	1.83%	4.300	4.66%	5.300	4.84%	1.300	1.28%	1.100	0.90%	7.100	7.11%	2.000	1.54%	2.700	2.90%	3.12	0.69	3.01%	0.71%
(i) Tissues	4.300	4.43%	3.400	2.71%	4.300	4.64%	1.500	1.37%	3.000	3.88%	4.400	3.69%	4.200	4.21%	3.600	2.78%	4.900	5.18%	3.84	0.33	3.63%	0.38%
(2) Glass (a) Beer (i) refillable															0.310	0.24%			0.03	0.03	0.03%	0.03%
(ii) non-refillable					0.900	0.97%													0.10	0.10	0.11%	0.11%
(b) Liquor & Wine Containers	1.900	1.87%	3.400	2.71%	0.800	0.86%	0.500	0.46%	8.700	8.53%	0.900	0.30%	2.400	2.40%	6.300	4.87%	0.030	0.03%	2.78	0.97	2.52%	0.89%
(c) Food Containers	1.900	1.87%	4.400	3.51%	3.000	3.98%	2.000	1.83%	2.000	1.35%	7.300	6.30%	3.400	3.41%	4.400	3.40%	1.900	2.05%	3.46	0.63	3.13%	0.48%
(d) Soft Drink (i) refillable			0.200	0.16%															0.02	0.02	0.02%	0.02%
(ii) non-refillable	1.300	1.28%	0.700	0.56%							0.600	0.50%	0.700	0.70%	0.235	0.18%	1.200	1.30%	0.53	0.17	0.50%	0.17%
(e) Other Containers			0.063	0.05%	0.459	0.50%					0.400	0.34%	0.759	0.76%	0.151	0.12%			0.20	0.09	0.20%	0.09%
(f) Plate					0.200	0.22%	0.181	0.17%									0.308	0.36%	0.08	0.04	0.08%	0.03%
(g) Other			1.187	0.95%	0.277	0.30%	0.225	0.21%	0.256	0.25%			1.000	1.00%	1.300	1.00%	1.400	1.51%	0.62	0.19	0.58%	0.18%
(3) Ferrous (a) Soft Drink Containers	1.900	1.87%	0.300	0.24%	0.900	0.97%			0.400	0.39%	1.200	1.01%	1.300	1.30%	2.000	1.54%	0.200	0.22%	0.91	0.25	0.84%	0.22%
(b) Food Containers	2.100	2.06%	4.100	3.27%	1.900	2.05%	1.700	1.55%	4.300	4.22%	3.000	2.52%	4.300	4.31%	4.100	3.17%	3.700	3.00%	3.24	0.35	3.02%	0.34%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans	0.366	0.36%	0.200	0.16%	0.200	0.22%	0.173	0.16%	0.091	0.09%	0.133	0.11%	0.194	0.19%	0.289	0.22%	0.097	0.10%	0.23	0.05	0.21%	0.04%
(e) Other	0.030	0.03%	0.500	0.40%	2.200	2.37%	5.089	4.65%	0.058	0.06%	0.168	0.14%	0.300	0.30%	6.797	5.25%	0.094	0.10%	1.65	1.09	1.57%	0.82%
(4) Non-Ferrous (a) Beer Cans (i) returnable	1.400	1.38%			0.900	0.97%							0.400	0.40%	0.286	0.22%	0.200	0.22%	0.35	0.16	0.33%	0.17%
(ii) non-returnable																						
(iii) American									0.041	0.04%			0.086	0.09%	0.041	0.03%			0.02	0.01	0.02%	0.01%
(b) Soft Drink Containers			0.500	0.40%	0.300	0.32%	0.106	0.10%	0.030	0.03%	0.131	0.11%	0.200	0.20%	0.300	0.22%	0.500	0.54%	0.23	0.06	0.21%	0.06%
(c) Other Packaging					0.007	0.01%			0.001	0.00%	0.019	0.01%	0.040	0.04%			0.037	0.04%	0.02	0.01	0.02%	0.01%
(d) Aluminum	0.111	0.11%	0.300	0.24%	0.300	0.32%	0.077	0.07%	0.200	0.20%	0.200	0.17%	0.077	0.08%	0.179	0.14%	0.300	0.32%	0.19	0.03	0.18%	0.03%
(e) Other					0.334	0.36%	0.312	0.29%	0.220	0.22%					0.400	0.33%			0.13	0.06	0.14%	0.06%
(5) Plastics (a) Polyolefins	4.300	4.22%	4.300	3.42%	5.700	6.15%	1.780	1.63%	5.800	5.70%	4.800	4.03%	5.500	5.51%	7.300	5.64%	4.255	4.59%	4.89	0.35	4.82%	0.47%
(b) PVC	0.265	0.26%			0.211	0.23%	0.184	0.17%	0.156	0.15%			0.046	0.05%			0.169	0.18%	0.11	0.03	0.11%	0.03%
(c) Polystyrene	0.660	0.64%	1.400	1.12%	2.062	2.22%	1.400	1.28%	1.281	1.26%	1.310	1.10%	1.100	1.10%	1.900	1.47%	1.374	1.48%	1.41	0.12	1.32%	0.13%
(d) ABS							0.900	0.82%			0.159	0.13%			0.008	0.03%	0.046	0.05%	0.13	0.10	0.11%	0.08%
(e) PET	0.250	0.25%	0.800	0.64%	0.063	0.07%					0.009	0.03%	0.133	0.13%			0.800	0.86%	0.23	0.11	0.22%	0.11%
(f) Mixed Blend/ Layered Plastic	0.700	0.69%	0.500	0.40%	0.200	0.22%	0.400	0.37%	0.700	0.69%	0.700	0.59%	0.700	0.70%	0.700	0.54%	0.700	0.79%	0.59	0.06	0.53%	0.08%
(g) Coated Plastic	0.082	0.08%	0.200	0.16%	0.100	0.11%	0.001	0.00%	0.215	0.21%	0.400	0.34%	0.200	0.20%	0.900	0.70%	0.200	0.22%	0.19	0.04	0.17%	0.03%
(h) Nylon																						
(i) Vinyl	0.200	0.20%			2.000	2.16%	5.400	4.93%											0.86	0.61	0.84%	0.56%
(6) Organic (a) Food Waste / Rodent Bedding	37.400	36.74%	24.200	19.26%	21.590	23.29%	7.400	6.76%	34.200	33.63%	33.200	29.56%	33.000	33.65%	36.800	29.42%	17.700	18.11%	27.57	3.46	25.60%	3.16%
(b) Yard Waste		*******		*******		*******		*******		*******		*******		*******		*******		*******			*******	******
(7) Wood	4.100	4.03%	0.500	0.40%	1.200	1.29%	18.919	17.29%	0.043	0.04%	0.008	0.01%	2.000	2.00%	2.800	2.16%	0.045	0.05%	3.29	2.01	3.02%	1.84%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.824	0.81%	0.200	0.16%	0.375	0.41%			0.858	0.84%			0.300	0.30%	4.700	3.63%			0.81	0.50	0.68%	0.38%
(9) Diapers							1.700	1.55%			24.900	20.91%	4.100	4.11%	2.300	1.83%	3.300	3.84%	4.30	2.66	3.63%	2.25%
(10) Textiles/Leather/Rubber	1.200	1.18%	4.200	3.33%	8.000	8.71%	14.700	13.43%	0.448	0.44%	2.300	1.93%	4.300	4.91%	8.424	6.51%	1.800	1.79%	5.13	1.57	4.73%	1.66%
(11) Household Hazardous (a) Paints / Solvents Wastes			0.500	0.40%					0.094	0.09%			0.800	0.80%	2.373	1.83%			0.42	0.26	0.33%	0.21%
(b) Waste Oils																						
(c) Pesticides/Herbicides					0.155	0.17%													0.02	0.02	0.02%	0.02%
(12) Dry Cell Batteries			0.036	0.03%	0.018	0.02%	0.008	0.01%	0.016	0.02%	0.176	0.14%	0.083	0.08%					0.04	0.02	0.03%	0.02%
(13) Kitty Litter	3.400	3.34%			4.700	5.07%			4.100	4.02%	4.700	3.93%					9.000	10.37%	2.88	1.10	2.97%	1.18%
(14) Medical Wastes					0.164	0.18%	0.177	0.16%	0.040	0.04%	0.196	0.16%					0.029	0.03%	0.07	0.03	0.06%	0.03%
(15) Miscellaneous			0.532	0.43%	3.366	3.79%	29.822	27.27%	3.765	3.68%			0.452	0.47%	0.718	0.56%	2.253	2.43%	4.77	3.19	4.51%	2.93%
(16) Ashes																	3.900	4.10%	0.43	0.43	0.46%	0.46%
	101.86	100.00%	125.59	100.00%	92.68	100.00%	109.46	100.00%	101.84	100.00%	119.06	100.00%	99.94	100.00%	129.48	100.00%	92.83	100.00%	108.05		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

MISCELLANEOUS ITEMS

NOTE: *** - NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	light bulbs - 2	*********
2	vaccum bag dust	0.200
	electronic circuits	0.300
	magic markers	0.032
	light bulbs - 4	*********
		0.532
3	light bulbs - 7	*********
	electric food blender	2.800
	humidifier (plastic/metal)	1.200
	3-ring binder	0.312
	vaccum bag dust	0.254
	picture frame (metal/glass)	0.800
		5.366
4	books	24.300
	3-ring binders	2.400
	food thermos	0.300
	brass plumbing	2.800
	electrical fuse	0.022
	light bulbs - 3	*********
		29.822
5	light bulbs - 8	*********
	vaccum bag dust	0.019
	clock (plastic)	0.425
	electrical fuse	0.021
	photo albums	3.300
		3.765
6		
7	light bulbs - 9	*********
	charcoal filter	0.452
		0.452
8	light bulbs - 8	*********
	vaccum bag dust	0.718
		0.718
9	light bulbs - 4	*********
	plant brush (wood/hair)	0.153
	electric hot plate	0.400
	vaccum bag dust	1.700
		2.253

APPENDIX C

BOROUGH OF EAST YORK

APPENDIX C1

CALCULATION OF PER CAPITA WASTE GENERATION RATES FOR STUDY EAs

Town: East York
EA: 05-213 medium income: primarily mixed dwellings
Pop: 975
Detached: 150
Other: 210
PPD: 2.71

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
121	10	4	146.01	94.12	3.77	1.390	
122	7	7	111.43	52.30	2.81	1.036	
123	5	0	124.00	0.00	3.54	1.307	
124	7	4	116.36	38.50	3.06	1.130	
125	7	5	119.88	37.00	2.98	1.098	
126	8	6	137.83	39.70	2.93	1.083	
127	5	3	92.57	31.20	3.39	1.250	
129	11	0	160.48	0.00	2.08	0.769	
128	10	10	146.40	16.80	2.24	0.827	
Detached Avg.	7.5	3.6	126.07	36.60	3.07		
Other Avg.	10	10	148.40	16.80	2.24	1.10	0.069

Detached: Samples 121-127, 129
Other Dwellings: Samples 128

***Sample 128 assumed all units in Apartment building contributed to the Blue Box weight recorded.**

Town: East York
EA: 05-303 low income: primarily mixed dwellings
Pop: 675
Dwellings: 235
PPD: 2.87

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
131	6	3	95.94	11.37	2.56	0.890	
132	7	2	116.84	18.36	3.04	1.059	
133	6	5	118.27	43.47	3.44	1.198	
134	7	3	84.81	8.00	1.92	0.669	
135	missing data						
136	6	4	108.70	33.39	3.18	1.110	
137	7	3	98.18	33.48	2.80	0.976	
138	6	3	117.35	13.93	3.13	1.089	
139	missing data						
Sample Avg.	6.4	3.3	105.73	23.14	2.87	1.00	0.066

Town: East York
EA: 65-603 high income: primarily single detached
Pop: 600
Dwellings: 340
PPD: 2.50

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
101	8	7	118.60	85.62	2.99	1.197	
102	7	6	135.56	69.96	3.60	1.440	
103	7	4	110.42	42.96	3.02	1.208	
104	7	6	127.81	49.11	3.19	1.277	
105	8	7	163.99	67.20	3.61	1.446	
106	6	5	122.95	53.95	3.70	1.479	
107	6	6	95.32	48.34	2.85	1.138	
108	5	2	108.15	12.04	3.52	1.408	
109	9	8	113.53	76.85	2.57	1.027	
Sample Avg.	7.0	5.7	122.37	56.23	3.23	1.29	0.053

Town: East York
EA: 12-055 medium income: primarily multiple dwellings
Pop: 735
Dwellings: 474
PPD: 1.55

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
111-119	474	0	5338.90	0.00	1.61	1.04	NA

Town: East York
EA: 90-168 medium income: primarily single detached
Pop: 935
Dwellings: 375
PPD: 2.49

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
141	7	5	93.93	45.30	2.56	1.03	
142	6	2	81.23	28.45	2.95	1.18	
143	6	2	109.00	7.90	2.88	1.16	
144	4	3	91.57	16.87	3.67	1.47	
145	4	4	60.04	41.23	2.88	1.16	
146	6	4	117.52	19.69	3.15	1.26	
147	11	8	112.78	67.52	2.07	0.83	
148	4	2	81.26	22.06	3.69	1.48	
149	9	5	113.13	38.07	2.34	0.94	
Sample Avg.	6.3	3.9	95.61	31.91	2.91	1.17	0.073

Town: East York
EA: 90-117 high income: mixed dwellings
Pop: 805
Detached: 175
Other: 150
PPD: 2.48

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
151	8	5	106.18	29.23	2.31	0.93	
152	4	2	84.31	9.99	3.37	1.36	
153	11	7	115.60	49.70	2.01	0.81	
154	8	4	94.23	43.89	2.47	0.99	
155	9	6	128.66	40.42	2.52	1.02	
156	13	7	97.79	52.40	1.61	0.65	
157	12	8	106.80	66.66	1.87	0.75	
158	16	16	102.13	49.99	1.14	0.46	
159	13	0	104.05	0.00	1.14	0.46	
Detached Avg.	8.8	5.2	104.46	37.60	2.38		
Other Avg.	14.0	12.0	104.47	58.32	1.50	0.83	0.096

Detached Samples 151-157
Other Dwellings Samples 158, 159

*Samples 158, 159 used total weight of waste found at the apartment
*Sample 158 assumed all units in Apartment building contributed to the Blue Box weight recorded.

Town: East York
EA: 90-055 low income: primarily multiple dwellings
Pop: 453
Dwellings: 259
PPD: 1.75

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
161-169	259	0	2364.60	0.00	1.30	0.75	

Town: East York - Christmas Collection
EA: 90-117 high income: mixed dwellings
Pop: 805
Detached: 175
Other: 150
PPD: 2.48

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Collected Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
181	9	0	114.30	0	2.12	0.853	
182	8	0	116.90	0	2.44	0.982	
183	7	0	93.10	0	2.22	0.894	
184	9	0	123.60	0	2.29	0.923	
185	10	0	103.30	0	1.72	0.694	
186	11	0	135.20	0	2.05	0.826	
187	6	0	91.70	0	2.55	1.027	
188	16	0	206.60	0	2.15	0.868	
189	13	0	245.00	0	3.14	1.267	
Detached Avg.	8.6	0.0	111.16	0.00	2.20		
Other Avg.	14.5	0.0	225.80	0.00	2.65	0.93	0.053

Detached Samples 181-187
Other Dwellings Samples 188,189

*Collected weights do not match sample weights of sorted refuse because field crew did not have scale with them during collection. Samples were reweighed at sorting site, and excess materials (+ 100 kg) were discarded.

*Samples 158, 159 used total weight of waste found at the apartment
*Number of days between collection days was six (6) weeks due to the City rescheduling collections over the Christmas Holiday.
*No Blue Box collection over Christmas Holiday

Town: East York
EA: Schools

Sample number	School Category	Daily weight (kg)	Students and Staff	Waste /person /day (kg)
1	Primary	39.77	230	0.173
2	Jr. High	67.72	414	0.164
3	Primary	30.59	224	0.136
4	Jr. High	72.22	339	0.213
5	Primary	40.23	393	0.102
6	Primary	29.57	351	0.084
7	Sr. High	190.84	1180	0.162

APPENDIX C2

WASTE COMPOSITION DATA

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area: 06 - 213 medium income; primarily mixed dwellings
n = 121 - 129
Collection Date: Tuesday November 7
Thursday November 9

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	15.100	7.82%	5.000	3.88%	13.600	11.38%	9.000	6.04%	14.300	10.53%	4.700	2.98%	5.300	4.91%	16.900	15.11%	5.700	3.62%	10.29	1.59	7.62%	1.34%
(b) Fine Paper / CPO / Ledger	1.600	0.83%	2.400	1.75%	1.100	0.94%	2.500	1.85%	1.000	1.58%	2.200	1.40%	2.400	2.22%	2.200	1.97%	1.700	1.10%	2.00	0.15	1.49%	0.18%
(c) Magazines / Flyers	4.700	2.47%	18.759	13.68%	8.700	3.70%	1.300	1.11%	4.400	3.18%	5.400	3.47%	3.800	3.52%	7.900	7.06%	5.300	3.42%	6.30	1.65	4.94%	1.32%
(d) Waxed / Plastic / Mixed	3.600	1.86%	3.600	2.77%	2.600	2.21%	2.900	2.14%	3.200	2.32%	8.100	5.19%	1.400	1.30%	1.700	1.52%	6.400	4.17%	3.74	0.79	2.60%	0.42%
(e) Boxboard	4.200	2.18%	4.600	3.53%	8.000	7.32%	6.300	4.63%	3.500	3.08%	3.211	2.04%	4.300	4.17%	4.600	4.20%	7.600	4.91%	5.43	0.58	4.10%	0.33%
(f) Kraft	4.900	2.34%	0.705	0.51%	1.000	0.83%	1.700	1.25%	1.300	0.94%	0.400	0.31%	1.300	1.21%	1.000	0.89%	1.100	0.71%	1.50	0.44	1.02%	0.21%
(g) Wallpaper																	0.700	0.43%	0.08	0.08	0.05%	0.05%
(h) OCC	2.600	1.35%	0.807	0.64%	0.992	0.33%	3.200	2.36%	1.033	0.73%	4.100	2.02%	8.600	7.97%	1.600	1.51%	7.600	5.04%	3.36	0.90	2.57%	0.62%
(i) Tissues	5.600	3.00%	5.300	3.87%	4.100	3.49%	7.000	3.17%	5.600	4.02%	11.000	6.98%	3.300	3.36%	3.600	3.22%	6.900	4.20%	5.06	0.77	4.32%	0.43%
(2) Glass (a) Beer (i) refillable											0.894	0.93%			0.297	0.26%			0.06	0.05	0.06%	0.04%
(ii) non-refillable																						
(b) Liquor & Wine Containers	2.300	1.20%			1.100	0.84%	13.000	9.29%							3.300	3.17%	1.301	0.84%	2.59	1.39	1.72%	1.04%
(c) Food Containers	2.155	1.12%	1.752	1.38%	3.000	2.58%	2.273	1.68%	2.766	2.02%	1.418	0.90%	0.964	0.90%	1.700	1.32%	2.048	1.62%	2.07	0.22	1.38%	0.12%
(d) Soft Drink (i) refillable	0.351	0.17%	0.386	0.29%					2.064	1.48%									0.31	0.22	0.27%	0.16%
(ii) non-refillable	2.200	1.14%			0.400	0.38%	0.478	0.53%			0.798	0.50%			0.683	0.79%	0.209	0.14%	0.56	0.39	0.37%	0.13%
(e) Other Containers	0.182	0.09%					0.266	0.20%					0.106	0.10%	0.240	0.21%	0.255	0.16%	0.12	0.04	0.09%	0.03%
(f) Plate																	2.500	1.61%	0.28	0.28	0.18%	0.18%
(g) Other	0.445	0.32%	0.836	0.46%	0.854	0.71%	0.361	0.27%	1.403	1.02%	1.398	0.88%	0.157	0.11%			2.308	1.49%	0.65	0.25	0.38%	0.10%
(3) Ferrous (a) Soft Drink Containers			0.032	0.03%	0.000	0.05%	0.200	0.15%	0.727	0.53%	0.900	0.57%			0.160	0.15%	0.000	0.04%	0.24	0.11	0.16%	0.07%
(b) Food Containers	2.300	1.29%	1.200	0.88%	0.862	0.72%	1.900	1.60%	1.000	1.36%	1.105	0.70%	0.800	0.74%	2.600	2.30%	5.000	1.04%	1.78	0.28	1.26%	0.21%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans					0.464	0.40%	0.224	0.17%	0.214	0.15%	0.008	0.02%			0.111	0.10%			0.18	0.05	0.09%	0.04%
(e) Other	2.307	1.12%	0.033	0.02%	0.657	0.36%	0.351	0.24%			0.751	0.50%	6.178	5.68%	0.007	0.01%	0.600	0.53%	1.23	0.86	0.07%	0.00%
(4) Non-Ferrous (a) Beer Cans (i) returnable					0.173	0.15%	0.091	0.02%	0.250	0.18%					0.400	0.36%	0.017	0.01%	0.10	0.06	0.08%	0.04%
(ii) non-returnable							0.116	0.09%											0.01	0.01	0.01%	0.01%
(iii) American	0.083	0.04%			0.043	0.04%	0.200	0.15%											0.04	0.03	0.02%	0.02%
(b) Soft Drink Containers	0.200	0.10%	0.130	0.11%	0.217	0.18%	0.200	0.15%	0.014	0.01%	0.900	0.57%			0.868	0.78%	0.154	0.09%	0.30	0.11	0.22%	0.09%
(c) Other Packaging									0.086	0.06%					0.094	0.08%			0.01	0.01	0.01%	0.01%
(d) Aluminum	0.700	0.36%	0.158	0.12%	0.600	0.51%	0.540	0.40%	0.559	0.40%	3.084	1.94%	0.047	0.04%	0.168	0.13%	0.409	0.36%	0.69	0.31	0.46%	0.19%
(e) Other					0.570	0.49%											0.396	0.26%	0.11	0.07	0.08%	0.06%
(5) Plastics (a) Polyolefins	6.600	3.53%	5.200	3.79%	6.300	5.36%	6.300	4.05%	7.759	5.83%	8.829	6.11%	3.400	3.44%	6.200	5.54%	6.389	3.38%	6.88	0.36	4.61%	0.34%
(b) PVC					0.065	0.05%			0.053	0.05%	0.040	0.02%	0.008	0.05%	0.176	0.16%	0.152	0.10%	0.06	0.02	0.03%	0.02%
(c) Polystyrene	0.996	0.46%	0.508	0.37%	0.736	0.63%	0.934	0.69%	0.710	0.51%	0.800	0.51%	0.889	0.83%	1.649	1.47%	1.500	0.97%	0.98	0.12	0.72%	0.11%
(d) ABS	0.053	0.03%			0.043	0.04%											0.083	0.05%	0.02	0.01	0.01%	0.01%
(e) PET	0.127	0.07%			0.062	0.05%			0.208	0.15%	0.249	0.15%			0.437	0.39%	0.146	0.09%	0.14	0.05	0.10%	0.04%
(f) Mixed Blend Plastic	0.400	0.21%	0.400	0.29%	0.600	0.51%	0.500	0.37%	0.700	0.51%	1.000	0.63%	0.400	0.37%	0.800	0.72%	0.600	0.38%	0.63	0.06	0.47%	0.06%
(g) Coated Plastic	0.100	0.05%	0.118	0.09%	0.120	0.10%	0.220	0.16%	0.214	0.15%	0.400	0.25%	0.111	0.10%	0.200	0.18%	0.816	0.59%	0.27	0.06	0.19%	0.05%
(h) Nylon																						
(i) Vinyl																						
(6) Organic (a) Food Waste / Rodent Bedding	33.578	27.22%	41.910	30.36%	45.829	39.03%	45.400	33.51%	57.327	41.90%	61.300	38.88%	45.100	41.80%	30.300	27.27%	45.000	28.98%	47.06	3.09	34.23%	2.04%
(b) Yard Waste	45.600	******	18.500	******	1.700	******	10.100	******		******	8.400	******	13.000	******		******	10.400	******	11.79	4.71	******	******
(7) Wood	0.095	0.05%	0.438	0.32%	0.298	0.25%	0.128	0.09%	0.090	0.07%	1.020	0.62%	1.409	1.60%	0.139	0.12%	8.469	5.47%	1.34	0.90	0.82%	0.58%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	3.941	1.89%	0.190	0.14%	0.514	0.44%	0.100	0.07%									2.106	1.36%	0.73	0.45	0.45%	0.23%
(9) Diapers	12.500	6.37%	10.400	7.58%	2.600	2.21%	5.300	3.91%	2.800	2.03%	8.674	5.50%	0.200	0.18%	5.000	4.47%	6.700	4.52%	6.00	1.31	4.07%	0.77%
(10) Textiles/Leather/Rubber	2.985	1.40%	4.748	3.46%	5.153	4.39%	3.004	2.22%	1.066	0.77%	4.379	2.79%	0.706	0.63%	2.292	2.02%	10.600	6.62%	3.65	0.98	2.19%	0.66%
(11) Household Hazardous Wastes (a) Paints / Solvents			0.574	0.42%									0.473	0.44%	1.144	1.02%			0.24	0.14	0.21%	0.12%
(b) Waste Oils																	3.600	2.32%	0.40	0.40	0.26%	0.26%
(c) Pesticides/Herbicides																						
(12) Dry Cell Batteries	0.637	0.33%	0.045	0.03%					0.066	0.05%	0.061	0.04%	0.024	0.02%	0.163	0.17%	0.000	0.01%	0.12	0.07	0.07%	0.04%
(13) Kitty Litter	9.500	4.89%	0.390	0.29%	1.200	1.02%									2.371	2.12%	7.600	4.91%	2.34	1.21	1.47%	0.66%
(14) Medical Wastes	0.079	0.04%	0.090	0.07%	0.008	0.01%	0.043	0.03%	0.058	0.04%	0.307	0.19%	0.012	0.01%	0.098	0.09%	0.061	0.08%	0.06	0.03	0.06%	0.02%
(15) Miscellaneous			0.447	0.33%	6.320	5.05%	0.111	0.08%	0.200	0.14%			0.288	0.27%	1.380	1.15%			0.96	0.70	0.63%	0.60%
(16) BLUE BOX ITEMS (a) Newsprint	34.400	17.96%	21.360	15.57%			15.450	11.40%	12.900	9.37%	15.600	9.89%	12.600	11.96%	8.200	7.53%			13.63	3.54	9.38%	2.04%
(b) Liquor / Wine Bottles	2.400	1.24%	2.750	2.01%			1.300	0.96%			0.390	0.16%	0.200	0.19%					0.77	0.37	0.51%	0.24%
(c) Food Jars / Other Bottles	3.700	1.92%	0.700	0.51%			1.250	0.92%	1.600	1.16%	2.000	1.27%	0.300	0.32%					1.10	0.43	0.70%	0.23%
(d) Food Cans (i) ferrous	3.600	1.87%					0.550	0.41%	3.150	2.28%	1.000	0.67%	1.000	0.90%					1.06	0.48	0.68%	0.29%
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous									0.100	0.07%									0.01	0.01	0.01%	0.01%
(iii) American																						
(f) Pop Cans (i) ferrous	0.080	0.04%	0.430	0.33%			0.080	0.04%	0.100	0.07%	0.080	0.05%							0.06	0.05	0.05%	0.04%
(ii) non-ferrous	1.600	0.83%	0.500	0.39%			0.600	0.19%	0.050	0.04%	0.200	0.13%	1.000	0.87%					0.88	0.19	0.39%	0.18%
(g) PET Bottles	0.080	0.08%																	0.00	0.00	0.00%	0.02%
(h) Plastic Jugs	1.100	0.57%	0.600	0.44%			0.630	0.52%	0.180	0.11%	0.700	0.64%	0.100	0.09%					0.84	0.16	0.63%	0.08%
(i) OCC									0.100	0.07%					0.900	0.18%			0.08		0.03%	
TOTAL kg	193.07	100.00%	137.15	100.00%	117.88	100.02%	130.30	100.02%	136.16	100.00%	157.88	100.00%	107.98	100.00%	111.98	100.02%	154.80	100.02%	136.88		100.02%	

*** WEIGHT OF BLUE BOX ITEMS DIVIDED BY 6 ***
(see Methods & Materials)

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	light bulbs (6)	**********
2	copper tube	0.045
	cosmetics various containers	0.403
	light bulbs (2)	**********
		0.447
3	electrical wire	0.332
	drum kit (wood metal)	8.105
	calculator	0.004
	light bulb (1)	**********
		8.326
4	plastic metal toy	0.111
		0.111
5	tube of silicon	0.900
	light bulbs (3)	**********
		0.900
6	light bulbs (4)	**********
7	electrical fuse box (ABS)	0.268
	paint tubes	0.030
	light bulbs (5)	**********
		0.298
8	electrical fuses glass	0.043
	vacuum bag	1.217
	light bulbs (9)	**********
		1.383
9	light bulbs (5)	**********

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area: 00 - 300 low income, primarily mixed dwellings
n = : 131 - 199
Collection Dates: Tuesday November 14
Thursday November 16

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	Weight basis MEAN (kg)	Weight basis SE (kg)	Percent basis MEAN (%)	Percent basis SE (%)
(1) Paper (a) Newsprint	4.900	4.54%	11.900	9.00%	14.700	10.30%	3.900	5.28%	1.000	1.54%	8.900	7.05%	3.100	2.70%	8.400	6.30%	1.800	2.20%	6.31	1.56	3.37%	1.04%
(b) Fine Paper / CPO / Ledger	5.300	5.25%	6.200	5.03%	3.100	2.21%	0.900	1.05%	0.900	1.47%	2.400	1.05%	2.100	1.82%	1.000	1.29%	0.300	0.38%	2.35	0.84	2.27%	0.57%
(c) Magazines / Flyers	3.400	3.38%	8.000	6.47%	10.300	7.30%	2.900	3.38%	1.300	2.40%	1.000	0.80%	3.100	2.70%	3.000	2.43%	1.800	2.39%	3.90	1.07	3.44%	0.71%
(d) Waxed / Plastic / Mixed	2.300	2.17%	1.580	1.26%	4.100	2.85%	2.100	2.48%	0.800	1.31%	2.400	1.05%	2.600	2.26%	2.247	1.82%	1.000	1.27%	2.12	0.83	1.94%	0.18%
(e) Boxboard	4.600	4.34%	6.200	5.07%	6.500	4.64%	4.000	5.74%	2.900	4.75%	5.100	4.09%	4.300	3.74%	3.100	2.51%	2.300	2.05%	4.43	0.46	4.22%	0.54%
(f) Kraft	1.600	1.54%	1.600	1.29%	3.100	1.30%	1.100	1.29%	0.300	0.82%	1.000	1.28%	1.400	1.22%	1.700	1.38%	0.700	0.39%	1.37	0.17	1.25%	0.08%
(g) Wallpaper																						
(h) OCC	12.600	12.64%	3.100	2.51%	2.700	1.93%	1.000	1.87%	0.800	1.31%	1.168	0.94%	3.400	2.90%	11.300	9.08%	0.213	0.27%	4.11	1.34	3.72%	1.41%
(i) Tissues	4.800	4.74%	5.100	4.13%	4.900	3.14%	6.000	8.00%	2.000	3.27%	7.100	5.80%	4.900	4.26%	4.200	3.40%	2.300	2.05%	4.83	0.34	4.40%	0.35%
(2) Glass (a) Beer (i) refillable																						
(ii) non-refillable																						
(b) Liquor & Wine Containers	1.300	1.10%	1.300	1.05%	0.833	0.59%	0.060	0.07%			2.187	1.75%			0.491	0.60%			0.67	0.30	0.58%	0.21%
(c) Food Containers	0.930	0.77%	0.600	0.49%	1.103	0.79%	0.980	1.15%	1.000	2.62%	2.693	3.18%	1.571	1.18%	1.414	1.14%	0.772	0.98%	1.27	0.21	1.27%	0.25%
(d) Soft Drink (i) refillable																						
(ii) non-refillable					0.468	0.55%													0.00	0.05	0.04%	0.04%
(e) Other Containers					0.056	0.05%									0.568	0.35%	0.759	0.90%	0.13	0.09	0.13%	0.11%
(f) Plate											0.099	0.05%							0.01	0.01	0.01%	0.01%
(g) Other	0.400	0.40%	0.604	0.49%	0.841	0.61%			0.413	0.84%							0.360	0.35%	0.29	0.10	0.28%	0.09%
(3) Ferrous (a) Soft Drink Containers	0.755	0.75%	0.095	0.08%	0.600	0.42%	0.160	0.19%			0.091	0.07%			0.081	0.03%	0.083	0.08%	0.20	0.08	0.18%	0.08%
(b) Food Containers	0.700	0.69%	0.900	0.73%	0.966	0.09%	1.100	1.29%	0.300	0.40%	2.400	1.03%	1.300	1.31%	3.400	1.94%	0.928	1.18%	1.24	0.24	1.14%	0.18%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans	0.228	0.33%	0.121	0.10%			0.095	0.11%	0.150	0.22%	0.437	0.33%			0.041	0.03%			0.12	0.00	0.11%	0.04%
(e) Other	0.300	0.29%	0.057	0.05%	1.897	0.83%			0.075	0.12%	0.093	0.07%	0.512	0.42%	0.558	0.47%	0.213	0.27%	0.40	0.15	0.32%	0.11%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.043	0.04%																	0.00	0.00	0.00%	0.00%
(ii) non-returnable																						
(iii) American					0.057	0.04%											0.013	0.00%	0.01	0.01	0.01%	0.00%
(b) Soft Drink Containers	0.080	0.03%	0.000	0.45%			0.163	0.19%	0.200	0.38%	0.600	0.64%	0.084	0.07%	0.300	0.16%	0.117	0.13%	0.24	0.09	0.25%	0.07%
(c) Other Packaging																						
(d) Aluminum	0.160	0.16%	0.240	0.19%	0.700	0.50%	0.128	0.19%	0.100	0.16%	0.600	0.39%	0.200	0.17%	0.500	0.04%	0.083	0.11%	0.26	0.08	0.22%	0.04%
(e) Other					0.100	0.07%							0.007	0.02%	1.000	0.85%			0.13	0.11	0.10%	0.09%
(5) Plastics (a) Polyolefins	3.929	3.79%	3.746	4.03%	8.000	5.71%	4.590	5.33%	3.307	5.31%	6.400	5.13%	6.300	5.48%	6.500	5.10%	3.400	4.82%	5.53	0.50	5.35%	0.15%
(b) PVC			0.225	0.18%	0.130	0.09%			0.233	0.38%	0.078	0.06%	0.001	0.02%			0.001	0.06%	0.09	0.00	0.09%	0.04%
(c) Polystyrene	0.200	0.20%	0.600	0.49%	0.550	0.38%	0.200	0.25%	0.300	0.49%	0.400	0.82%	0.900	0.78%	0.724	0.50%	0.330	0.49%	0.45	0.08	0.42%	0.08%
(d) ABS			0.270	0.22%													0.269	0.34%	0.00	0.04	0.06%	0.04%
(e) PET			0.108	0.09%							0.144	0.12%			0.280	0.23%			0.00	0.00	0.03%	0.03%
(f) Mixed Blend Plastic	0.300	0.28%	0.400	0.32%	0.400	0.25%	0.300	0.35%	0.100	0.16%	0.200	0.16%	0.300	0.48%	0.400	0.32%	0.800	0.95%	0.32	0.00	0.50%	0.04%
(g) Coated Plastic	0.119	0.19%	0.120	0.10%	0.125	0.08%	0.001	0.07%	0.010	0.00%	0.207	0.17%	0.011	0.01%	0.078	0.00%	0.100	0.19%	0.09	0.00	0.08%	0.03%
(h) Nylon																						
(i) Vinyl													0.093	0.08%					0.01	0.01	0.01%	0.01%
(6) Organic (a) Food Waste / Rodent Bedding	39.200	38.70%	45.700	36.97%	33.700	23.50%	33.300	39.03%	15.300	25.00%	50.700	40.62%	43.000	37.64%	35.000	28.82%	19.700	25.04%	35.36	3.87	33.03%	2.27%
(b) Yard Waste	3.000	*******		*******		*******	13.700	*******		*******	7.300	*******	2.000	*******		*******		*******	2.89	1.98	*******	*******
(7) Wood	1.300	1.29%	0.684	0.54%	0.867	0.95%	0.007	0.01%	0.040	0.08%	0.412	0.35%	2.900	1.91%	8.200	6.67%			1.48	0.87	1.29%	0.71%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos					0.946	0.66%					0.709	0.57%			7.571	6.15%	0.589	0.40%	1.07	0.82	0.87%	0.66%
(9) Diapers	0.200	0.50%	3.000	3.42%	5.000	3.71%	7.700	9.03%	1.400	2.29%	0.700	0.50%	12.400	10.70%	2.000	1.78%	3.000	6.36%	4.20	1.31	4.13%	1.26%
(10) Textiles/Leather/Rubber	3.100	3.06%	2.900	2.35%	10.155	7.25%	1.105	1.29%	0.600	0.98%	8.600	6.29%	3.900	2.90%	3.095	2.50%	0.864	1.10%	3.76	1.13	3.13%	0.79%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.125	0.12%	4.700	5.20%	0.072	0.05%													0.34	0.32	0.44%	0.42%
(b) Waste Oils							3.500	4.10%	0.952	1.56%									0.50	0.39	0.63%	0.47%
(c) Pesticides/Herbicides																						
(12) Dry Cell Batteries	0.209	0.21%	0.022	0.02%	0.010	0.01%									0.084	0.07%			0.04	0.00	0.03%	0.02%
(13) Kitty Litter					1.253	0.97%	0.629	0.73%	11.900	19.48%					9.600	7.61%			2.59	1.33	3.20%	2.19%
(14) Medical Wastes	0.035	0.03%	0.087	0.05%	0.019	0.01%	0.094	0.11%	0.275	0.48%	0.257	0.21%	0.325	0.28%	0.375	0.32%	0.332	0.42%	0.19	0.04	0.20%	0.00%
(15) Miscellaneous	0.330	0.33%	2.407	1.95%			3.471	4.07%	0.099	0.16%	0.588	0.47%			0.750	0.38%	10.776	13.70%	2.04	1.18	2.84%	1.44%
(16) BLUE BOX ITEMS (a) Newsprint	2.150	2.10%	3.650	4.37%	14.750	10.54%	6.300	2.70%	13.080	21.37%	11.550	8.25%	3.900	3.18%	4.150	3.30%	16.600	21.10%	8.84	1.80	8.34%	3.47%
(b) Liquor / Wine Bottles	0.300	0.49%			2.600	1.86%					2.750	2.20%	2.300	2.18%	0.450	0.30%	4.490	3.80%	1.47	0.34	1.42%	0.62%
(c) Food Jars / Other Bottles	1.460	1.43%	2.900	2.35%	2.468	1.76%	0.500	1.11%			1.642	1.32%	2.900	2.57%	1.200	0.97%	0.930	1.91%	1.61	0.30	1.41%	0.29%
(d) Food Cans (i) ferrous	0.650	0.64%	0.400	0.35%	1.460	1.04%	0.250	0.68%			0.250	0.20%	0.800	0.70%	0.800	0.62%	0.500	0.64%	0.57	0.14	0.66%	0.11%
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous															0.015	0.01%			0.00	0.00	0.00%	0.00%
(ii) non-ferrous											0.097	0.08%							0.01	0.01	0.01%	0.01%
(iii) American																	0.087	0.05%	0.00	0.00	0.01%	0.01%
(f) Pop Cans (i) ferrous	0.300	0.30%	0.081	0.08%	0.300	0.14%	0.200	0.23%			0.058	0.05%	0.180	0.15%					0.09	0.00	0.09%	0.03%
(ii) non-ferrous	0.047	0.00%	0.013	0.01%	0.130	0.11%	0.100	0.18%			0.130	0.18%	0.100	0.09%			0.300	0.35%	0.08	0.00	0.08%	0.03%
(g) PET Bottles	0.098	0.04%											0.041	0.04%			0.130	0.19%	0.00	0.00	0.03%	0.02%
(h) Plastic Jugs	0.650	0.64%	0.180	0.15%	0.119	0.08%	0.200	0.82%			0.200	0.16%	0.650	0.57%	0.330	0.28%	0.700	0.89%	0.34	0.09	0.62%	0.10%
(i) OCC									0.211	0.54%			0.148	0.13%			0.052	0.07%	0.00		0.08%	
	101.30	100.00%	123.61	100.00%	140.00	100.00%	85.34	100.00%	61.07	100.00%	124.82	100.00%	114.96	100.00%	123.59	100.00%	78.67	100.00%	100.90		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

*** WEIGHT OF BLUE BOX ITEMS DIVIDED BY 9 ***
(see Methods & Materials)

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	car wax	0.130
	vaccum dust	0.188
	light bulb (1)	*********
		0.332
2	calculator	0.099
	vaccum bag dust	1.847
	walkman radio	0.333
	electrical switch	0.075
	light bulbs (3)	0.056
		2.407
3	light bulbs (9)	*********
4	lamp (metal)	3.000
	motor oil filter	0.471
	light bulbs (2)	*********
		3.471
5	steel and plastic brush	0.099
		0.099
6	video cassettes	0.536
	car bumper (metal plastic)	0.052
	light bulbs (4)	*********
		0.588
7	light bulb (6)	*********
8	stove elements	0.596
	electrical fuse glass	0.094
		0.750
9	cardboard/plastic spool	0.176
	wood frame windows	10.600
	light bulb (1)	*********
		10.776

Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area: 83 - 100 high income, primarily single detached
n = : 101 - 109
Collection Dates: Tuesday October 24
Thursday October 30

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN AND STANDARD ERROR ON A WEIGHT BASIS: MEAN (kg)	SE (kg)	MEAN AND STANDARD ERROR ON A PERCENT BASIS: MEAN (%)	SE (%)
(1) Paper (a) Newsprint	3.500	3.43%	3.900	2.39%	1.600	1.37%	5.200	3.52%	14.300	7.53%	0.400	0.27%	0.400	5.43%	8.300	7.39%	12.600	8.04%	6.49	1.54	4.97%	0.90%
(b) Fine Paper / CPO / Ledger	2.800	1.74%	25.900	14.24%	3.300	4.04%	2.700	1.83%	2.200	1.69%	2.100	1.44%	1.200	1.02%	4.200	3.74%	3.900	2.49%	5.48	2.84	3.58%	1.09%
(c) Magazines / Flyers	7.500	4.07%	10.500	6.26%	9.900	7.55%	18.100	12.24%	17.900	9.47%	5.500	3.77%	8.400	7.12%	8.900	7.00%	19.100	12.15%	11.76	1.72	7.91%	0.09%
(d) Waxed / Plastic / Mixed	3.600	2.21%	3.400	2.08%	5.100	3.89%	8.700	5.88%	4.100	2.16%	2.900	1.78%	2.300	2.17%	5.700	3.29%	3.900	2.30%	4.14	0.62	2.86%	0.44%
(e) Boxboard	4.200	2.62%	6.300	3.73%	5.100	3.89%	3.300	3.56%	12.700	6.68%	7.734	3.51%	3.100	2.87%	3.300	4.73%	3.100	3.25%	6.09	0.86	4.00%	0.44%
(f) Kraft	2.400	1.49%	1.600	0.96%	1.200	0.03%	1.900	1.06%	2.400	1.26%	1.100	0.73%	1.900	0.35%	1.900	0.80%	1.200	0.77%	1.50	0.19	1.00%	0.08%
(g) Wallpaper																						
(h) OCC	3.100	1.03%	3.300	2.00%	4.300	3.28%	1.900	1.29%	3.300	2.79%	2.300	1.56%	6.179	2.87%	1.400	1.25%	1.900	1.22%	3.01	0.42	2.03%	0.26%
(i) Tissues	3.900	2.43%	3.700	2.21%	3.900	2.73%	8.300	3.73%	11.300	3.95%	3.300	3.77%	2.900	2.46%	3.400	4.61%	6.200	3.00%	3.87	0.91	3.79%	0.46%
(2) Glass (a) Beer (i) refillable			3.900	2.39%															0.43	0.43	0.26%	0.20%
(ii) non-refillable																						
(b) Liquor & Wine Containers			2.400	1.43%	1.079	0.83%			1.700	0.00%							0.700	0.45%	0.03	0.30	0.49%	0.18%
(c) Food Containers	2.679	1.67%	0.390	0.23%	0.647	0.49%	1.260	0.86%	0.908	0.53%	0.226	0.10%	1.139	0.87%	2.097	2.40%	0.900	0.27%	1.21	0.30	0.61%	0.24%
(d) Soft Drink (i) refillable															1.300	1.94%			0.17	0.17	0.17%	0.17%
(ii) non-refillable			0.637	0.38%	1.037	0.79%					0.179	0.12%							0.21	0.15	0.14%	0.09%
(e) Other Containers									0.980	0.04%	0.057	0.04%							0.01	0.01	0.01%	0.01%
(f) Plate															0.139	0.12%			0.02	0.02	0.01%	0.01%
(g) Other	0.012	0.01%	0.557	0.33%	0.084	0.06%	0.304	0.21%	0.261	0.19%	4.914	3.12%	0.280	0.24%	0.004	0.00%			0.50	0.50	0.47%	0.34%
(3) Ferrous (a) Soft Drink Containers	0.083	0.04%	0.118	0.07%	0.082	0.06%	0.155	0.10%	0.031	0.02%					0.057	0.06%	0.662	0.42%	0.15	0.07	0.08%	0.04%
(b) Food Containers	1.200	0.73%	0.700	0.42%	1.411	1.08%	0.900	0.61%	1.515	0.80%	2.200	1.51%	0.387	0.38%	0.661	0.59%	0.900	0.27%	1.12	0.17	0.75%	0.11%
(c) Beer Cans (i) returnable			0.300	0.30%			0.017	0.01%											0.08	0.08	0.09%	0.08%
(ii) non-returnable																						
(d) Aerosol Cans	0.067	0.04%	0.427	0.25%	0.152	0.10%	0.577	0.23%	0.162	0.10%	0.169	0.14%	0.194	0.10%	0.309	0.03%	0.142	0.06%	0.23	0.04	0.16%	0.06%
(e) Other	0.173	0.11%	1.083	0.65%	0.169	0.12%	0.235	0.16%			14.543	9.96%	0.010	0.01%	4.615	4.57%	2.700	1.72%	2.65	1.59	1.90%	1.19%
(4) Non-Ferrous (a) Beer Cans (i) returnable			0.143	0.09%													0.074	0.05%	0.09	0.03	0.01%	0.01%
(ii) non-returnable																						
(iii) American																						
(b) Soft Drink Containers	0.081	0.05%	0.151	0.09%	0.066	0.07%	0.111	0.08%	0.260	0.14%	0.114	0.08%	0.032	0.03%	0.061	0.05%	0.166	0.19%	0.12	0.02	0.08%	0.01%
(c) Other Packaging											0.800	0.14%							0.08	0.09	0.03%	0.09%
(d) Aluminum	0.398	0.24%	0.140	0.08%	0.165	0.13%	0.227	0.15%	0.519	0.27%	2.189	1.50%	0.199	0.17%	0.157	0.14%	0.214	0.14%	0.47	0.22	0.51%	0.15%
(e) Other	0.015	0.01%	0.186	0.11%					1.161	0.63%									0.15	0.13	0.08%	0.01%
(5) Plastics (a) Polyolefins	7.690	4.79%	8.900	4.77%	5.406	4.12%	7.424	3.02%	8.900	4.74%	7.990	5.46%	4.100	3.98%	0.081	5.41%	13.900	8.27%	7.73	0.83	5.19%	0.50%
(b) PVC					0.969	0.05%			0.059	0.03%	0.070	0.05%							0.02	0.01	0.01%	0.01%
(c) Polystyrene	0.900	0.57%	0.900	0.54%	1.909	1.47%	0.627	0.42%	0.900	0.47%	0.776	0.55%	0.700	0.59%	0.000	0.00%	2.000	1.36%	1.04	0.16	0.72%	0.13%
(d) ABS											0.645	0.44%			0.139	0.12%			0.09	0.07	0.07%	0.05%
(e) PET	0.139	0.08%									0.095	0.07%							0.03	0.02	0.03%	0.01%
(f) Mixed Blend Plastic	0.200	0.12%	0.200	0.12%	0.340	0.26%	2.200	1.49%	0.900	0.33%	0.800	0.55%	0.539	0.46%	0.400	0.36%	1.600	1.00%	0.76	0.23	0.53%	0.13%
(g) Coated Plastic	0.200	0.12%	0.246	0.12%	1.300	1.14%	0.446	0.30%	0.747	0.39%	0.114	0.08%	0.800	0.03%	0.100	0.09%	0.200	0.13%	0.40	0.15	0.27%	0.12%
(h) Nylon																						
(i) Vinyl	0.108	0.12%			0.019	0.01%	1.159	0.79%			3.400	2.33%	0.042	0.04%					0.54	0.38	0.37%	0.26%
(6) Organic (a) Food Waste / Rodent Bedding	32.900	20.40%	34.900	14.84%	20.514	20.22%	35.900	24.27%	55.300	29.23%	27.100	18.00%	17.482	14.83%	37.930	35.08%	26.190	16.91%	31.36	3.65	21.43%	2.17%
(b) Yard Waste	18.900	*******	65.300	*******	70.300	*******	16.900	*******	11.300	*******	73.900	*******	34.900	*******	43.100	*******	22.300	*******	40.18	8.25	*******	
(7) Wood	4.367	2.72%	0.737	0.44%	0.009	0.01%	1.073	0.73%	0.430	0.22%	4.906	3.36%	0.062	0.05%	0.553	0.49%	0.110	0.07%	1.36	0.65	0.00%	0.42%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.337	0.21%	14.704	4.76%	0.031	0.73%	0.830	0.57%	0.316	0.17%	1.636	1.19%			1.191	1.06%			2.10	1.39	1.36%	0.95%
(9) Diapers	6.300	3.29%	0.300	0.90%	4.800	3.96%	10.300	6.93%	4.900	2.49%	10.400	7.11%	0.400	0.34%			6.800	4.64%	5.10	1.39	3.53%	0.08%
(10) Textiles/Leather/Rubber	16.900	10.37%	3.363	2.00%	14.300	10.61%	3.320	2.38%	3.400	1.80%	6.973	4.79%	0.999	0.56%	3.693	3.29%	1.062	0.09%	5.09	1.03	4.11%	1.32%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.016	0.01%	0.178	0.11%			0.140	0.10%			0.150	0.09%	1.956	1.66%	0.799	0.71%			0.36	0.22	0.30%	0.19%
(b) Waste Oils					0.010	0.01%													0.00	0.00	0.00%	0.00%
(c) Pesticides/Herbicides			0.477	0.29%					0.084	0.05%	0.930	0.01%			1.300	1.94%			0.23	0.17	0.19%	0.13%
(12) Dry Cell Batteries	0.906	0.23%	0.006	0.05%	0.222	0.17%			0.010	0.01%	0.045	0.06%	0.090	0.08%			0.630	0.40%	0.16	0.07	0.10%	0.00%
(13) Kitty Litter	5.362	3.36%	7.550	4.51%	2.600	1.98%	3.219	2.17%	0.348	0.18%	1.398	1.05%	0.490	0.42%	2.400	2.19%			2.73	0.89	1.83%	0.54%
(14) Medical Wastes	0.430	0.27%	0.111	0.07%			0.272	0.19%	0.321	0.17%	0.105	0.07%	0.062	0.05%	0.900	0.05%	0.067	0.04%	0.16	0.03	0.10%	0.05%
(15) Miscellaneous	0.857	0.53%	2.749	1.64%	10.250	7.82%	0.911	0.62%	1.980	1.05%	0.335	0.16%	35.749	35.32%	1.539	1.64%	5.582	3.65%	6.76	3.79	3.27%	3.67%
(16) BLUE BOX ITEMS (a) Newsprint	28.800	17.94%	25.150	14.98%	16.800	12.61%	13.530	9.16%	24.930	13.09%	19.850	13.87%	19.400	16.69%	3.800	3.01%	25.830	16.41%	20.11	2.71	13.31%	1.36%
(b) Liquor / Wine Bottles	6.500	3.99%	1.800	1.19%	0.990	0.76%	6.800	4.12%	4.400	2.32%	2.650	1.86%	2.250	1.61%	1.530	1.36%	3.400	2.19%	3.52	0.68	2.31%	0.30%
(c) Food Jars / Other Bottles	3.363	2.46%	5.600	3.27%	2.150	1.64%	2.300	1.56%	1.900	0.84%	6.830	1.68%	1.447	1.23%	0.497	0.44%	1.579	1.01%	2.40	0.49	1.56%	0.29%
(d) Food Cans (i) ferrous	1.050	0.65%	1.900	1.16%	1.150	0.88%	1.150	0.78%	1.700	0.80%	1.900	0.84%	1.900	0.85%	0.930	0.51%	1.400	0.80%	1.16	0.15	0.78%	0.08%
(ii) non-ferrous									0.008	0.00%									0.00	0.00	0.00%	0.05%
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous	0.044	0.03%					0.010	0.01%	0.064	0.02%	0.060	0.00%							0.01	0.01	0.01%	0.00%
(iii) American	0.083	0.04%	0.006	0.00%	0.150	0.11%			0.010	0.01%							0.030	0.03%	0.03	0.00	0.03%	0.01%
(f) Pop Cans (i) ferrous	0.016	0.01%			0.150	0.11%			0.350	0.18%							0.330	0.41%	0.13	0.08	0.08%	0.03%
(ii) non-ferrous	0.100	0.06%	0.300	0.18%	0.100	0.08%	0.010	0.01%	0.330	0.18%	0.930	0.17%	0.950	0.04%	0.900	0.03%	0.900	0.57%	0.03	0.06	0.12%	0.03%
(g) PET Bottles	0.123	0.06%			0.960	0.08%	0.053	0.02%					0.072	0.02%			0.330	0.22%	0.08	0.04	0.08%	0.06%
(h) Plastic Jugs	0.081	0.04%	0.050	0.12%			0.380	0.37%	0.150	0.08%	0.088	0.07%					0.500	0.36%	0.18	0.07	0.11%	0.08%
(i) OCC							0.650	0.37%	0.150	0.08%	0.750	0.51%					0.750	0.48%	0.94		0.16%	
	160.65	100.00%	167.79	100.00%	131.12	100.00%	147.89	100.00%	189.80	100.00%	145.73	100.00%	117.80	100.00%	112.38	100.00%	156.71	100.00%	147.77		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

*** WEIGHT OF BLUE BOX ITEMS DIVIDED BY 2 ***
(see 2.2.4 Data Management)

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	light bulbs (6)	**********
	electrical fuses glass (2)	**********
	brass frame	0.312
	saniflush cleaner	0.085
	air freshener solid	0.162
	magic marker pen	0.052
	make-up and case	0.046
		0.857
2	light bulbs (6)	**********
	telephone books	1.9
	vaccum bags	0.267
	photo-degradable bags	0.164
	floor wax in HDPE container	0.415
		2.749
3	light bulbs (3)	**********
	telephone book	10.237
	electrical wire	0.013
		10.250
4	electrical wire	0.117
	magic marker pens	0.103
	vaccum dust	0.689
	light bulb (1)	**********
		0.911
5	light bulbs (4)	**********
	rocks	0.087
	umbrella (material unknown	0.330
	plastic and metal glasses	0.001
	vaccum bag	1.109
	saniflush cleaner	0.430
		1.980
6	light bulbs (10)	**********
	typewriter cartridge	0.077
	electrical wire	0.135
	electrical fuse glass	0.023
		0.235
7	electric motor and parts	31.275
	electrical fuses glass	0.074
	telephone books	4.4
	light bulbs (4)	**********
		35.749
8	light bulbs (9)	**********
	photographic equipment	0.498
	electrical wire	0.204
	brass	0.088
	electric motor	0.389
	can of glue (Lepages)	0.217
		1.396
9	asphalt piece	2.103
	electrical motor	3.800
	electric shaver	0.498
	electrical switches	0.019
	light bulbs (5)	**********
		3.888

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area: 90 – 117 high income; mixed dwellings
n = ; 151 – 159
Collection Dates: Tuesday November 28
Thursday November 30

SAMPLE #	1		2		3		4		5		6		7		8		9		MEAN AND STANDARD ERROR ON A WEIGHT BASIS		MEAN AND STANDARD ERROR ON A PERCENT BASIS	
	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	6.200	5.25%	11.300	15.08%	4.300	3.18%	5.400	4.65%	4.300	2.89%	1.000	1.00%	6.000	4.77%	0.000	7.83%	15.000	15.45%	7.34	1.46	6.53%	1.58%
(b) Fine Paper / CPO / Ledger	1.200	1.02%	0.700	0.80%	2.400	1.78%	2.600	2.24%	2.400	1.84%	1.700	1.43%	1.600	1.30%	1.600	1.27%	0.600	0.77%	1.75	0.25	1.39%	0.17%
(c) Magazines / Flyers	9.000	6.39%	3.400	5.87%	6.100	5.99%	6.200	5.34%	22.600	15.10%	6.600	5.73%	7.000	5.71%	7.000	6.01%	3.300	3.18%	8.42	1.91	6.60%	1.18%
(d) Waxed / Plastic / Mixed	2.270	1.92%	5.000	4.10%	5.000	2.00%	4.225	5.04%	2.000	1.06%	2.000	2.37%	1.900	1.57%	4.008	5.22%	2.555	2.46%	3.10	0.27	2.93%	0.29%
(e) Boxboard	5.000	5.39%	3.400	3.87%	7.700	3.70%	7.400	6.37%	5.000	3.00%	5.000	4.97%	6.900	4.99%	4.100	3.24%	10.500	9.93%	6.16	0.73	5.14%	0.70%
(f) Kraft	1.500	1.27%	0.552	0.61%	1.000	1.41%	2.200	1.89%	1.700	1.14%	2.100	1.77%	1.700	1.23%	7.200	5.70%	1.300	1.45%	2.26	0.04	1.85%	0.39%
(g) Wallpaper																	1.000	1.34%	0.18	0.18	0.17%	0.17%
(h) OCC	5.400	2.88%	1.228	1.40%	5.373	3.09%	1.300	1.29%	5.300	2.33%	1.900	1.00%	15.000	11.40%	0.584	0.46%	1.759	1.09%	8.90	1.54	3.02%	1.11%
(i) Tissues	5.300	4.06%	4.000	4.55%	4.800	3.55%	6.300	5.42%	4.000	2.69%	6.200	5.22%	6.300	5.00%	9.400	2.09%	4.400	4.54%	5.21	0.51	4.84%	0.39%
(2) Glass (a) Beer (i) refillable									0.791	0.53%									0.00	0.00	0.06%	0.06%
(ii) non-refillable																	0.470	0.43%	0.09	0.05	0.06%	0.05%
(b) Liquor & Wine Containers	0.156	0.13%	5.300	5.98%	0.952	0.70%			0.750	0.49%	0.854	0.72%	0.607	0.44%	6.300	4.98%	2.033	2.86%	1.79	0.09	1.39%	0.62%
(c) Food Containers	0.603	0.08%	0.621	0.71%	1.522	1.15%	0.359	0.31%	3.441	2.31%	1.000	0.85%	1.018	0.74%	0.785	0.92%	0.400	6.17%	1.77	0.65	1.50%	0.61%
(d) Soft Drink (i) refillable																						
(ii) non-refillable			0.900	1.02%					0.093	0.47%	0.473	0.40%					0.241	0.23%	0.26	0.12	0.26%	0.12%
(e) Other Containers	0.061	0.06%																	0.01	0.01	0.01%	0.01%
(f) Plate			0.750	0.84%															0.08	0.08	0.09%	0.00%
(g) Other	0.768	0.65%	1.200	1.37%	0.202	0.15%	1.154	0.99%	1.106	0.74%			0.251	0.19%	0.500	0.40%	0.409	0.30%	0.62	0.15	0.54%	0.15%
(3) Ferrous (a) Soft Drink Containers					0.022	0.02%	0.156	0.13%	0.000	0.54%	0.053	0.05%	0.180	0.15%	0.031	0.02%	0.800	0.77%	0.23	0.11	0.10%	0.09%
(b) Food Containers	1.300	1.10%	0.751	0.85%	1.600	1.18%	1.200	1.03%	1.300	0.87%	1.000	1.00%	1.300	0.84%	1.700	1.34%	2.400	2.31%	1.49	0.16	1.33%	0.16%
(c) Beer Cans (i) returnable																						
(ii) non-returnable					0.212	0.16%													0.00	0.00	0.09%	0.09%
(d) Aerosol Cans	0.338	0.29%	0.300	0.57%	0.186	0.14%	0.577	0.50%	0.231	0.16%	0.353	0.30%	0.264	0.10%	0.263	0.21%	0.163	0.16%	0.32	0.00	0.28%	0.05%
(e) Other	1.353	1.15%	1.218	1.56%	0.400	0.30%	0.334	0.28%	1.148	0.77%	5.000	3.29%	0.974	0.70%			0.978	0.04%	1.14	0.34	0.08%	0.33%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.019	0.02%			0.025	0.02%			0.008	0.05%	0.400	0.34%	0.018	0.01%			0.154	0.18%	0.08	0.04	0.07%	0.04%
(ii) non-returnable																						
(iii) American									0.097	0.02%					0.300	0.34%	0.099	0.19%	0.05	0.05	0.04%	0.03%
(b) Soft Drink Containers	0.278	0.24%	0.300	0.29%	0.093	0.07%	0.070	0.06%	0.145	0.10%	0.048	0.04%	0.256	0.10%	0.800	0.93%	0.200	0.19%	0.23	0.08	0.19%	0.00%
(c) Other Packaging																						
(d) Aluminum	0.300	0.42%	0.079	0.09%	0.700	0.53%	0.382	0.30%	0.514	0.21%	0.300	0.25%	0.400	0.29%	0.400	0.30%	0.548	0.53%	0.42	0.06	0.30%	0.06%
(e) Other	0.262	0.22%					0.000	0.03%					0.023	0.09%					0.04	0.05	0.05%	0.02%
(5) Plastics (a) Polyolefins	7.781	6.00%	5.000	0.71%	7.100	5.23%	0.600	5.65%	7.000	4.70%	7.400	6.23%	0.700	4.84%	6.100	4.83%	5.000	5.40%	6.71	0.24	5.00%	0.26%
(b) PVC	0.085	0.07%	0.052	0.07%	0.098	0.07%	0.181	0.16%	0.700	0.47%	0.060	0.03%	0.038	0.03%	0.161	0.14%			0.16	0.07	0.12%	0.05%
(c) Polystyrene	1.100	0.06%	0.400	0.46%	0.036	0.71%	1.002	0.86%	1.100	0.74%	2.000	2.19%	0.600	0.40%	0.877	0.09%	0.700	0.67%	1.04	0.21	0.83%	0.18%
(d) ABS	1.950	1.18%																	0.13	0.15	0.15%	0.18%
(e) PET	0.171	0.14%	0.134	0.15%	0.195	0.19%			0.400	0.27%	0.094	0.05%	0.128	0.09%	0.088	0.55%	0.300	0.29%	0.25	0.07	0.16%	0.06%
(f) Mixed Blend Plastic	0.400	0.34%	0.091	0.10%	0.400	0.30%	0.400	0.89%	0.200	0.13%	0.321	0.19%	0.500	0.36%	0.400	0.32%	0.257	0.28%	0.37	0.07	0.30%	0.06%
(g) Coated Plastic	0.110	0.09%	0.107	0.13%	0.208	0.15%	0.200	0.17%	0.034	0.04%	0.118	0.10%	0.123	0.09%	0.132	0.10%	0.100	0.10%	0.15	0.09	0.11%	0.01%
(h) Nylon																						
(i) Vinyl																						
(6) Organic (a) Food Waste / Rodent Bedding	39.700	33.84%	14.600	16.81%	35.400	26.10%	35.800	30.02%	36.600	24.60%	23.000	19.88%	33.000	23.08%	27.400	21.57%	51.000	29.69%	31.11	2.06	25.47%	1.83%
(b) Yard Waste		*******	8.200	*******		*******		*******		*******		*******		*******	10.400	*******		*******	2.07	1.34	*******	******
(7) Wood	0.253	0.30%	1.818	2.07%	5.000	5.70%	1.488	1.28%	0.891	0.00%	5.416	2.86%	0.408	0.39%	0.401	0.32%	0.079	0.08%	1.54	0.55	1.28%	0.44%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	6.061	5.08%	0.307	0.32%	5.083	2.29%	0.253	0.83%			1.400	1.16%			0.098	0.08%			1.32	0.68	1.00%	0.36%
(9) Diapers			0.400	0.95%	1.000	0.74%	5.700	3.18%	5.300	3.70%			0.200	0.14%	7.400	5.65%	1.300	1.16%	2.16	0.91	1.69%	0.69%
(10) Textiles/Leather/Rubber	2.516	2.15%	16.666	21.20%	7.552	3.39%	3.000	2.58%	10.250	6.69%	7.000	6.40%	2.225	1.81%	7.541	5.73%	5.810	3.67%	5.99	1.74	6.21%	1.99%
(11) Household Hazardous Wastes (a) Paints / Solvents	1.268	1.07%	0.000	1.09%					0.398	0.19%							0.030	0.03%	0.34	0.18	0.26%	0.15%
(b) Waste Oils																						
(c) Pesticides/Herbicides																						
(12) Dry Cell Batteries	0.044	0.04%	0.044	0.05%			0.018	0.01%	0.237	0.16%	0.395	0.33%	0.049	0.04%	0.045	0.04%			0.09	0.04	0.07%	0.04%
(13) Kitty Litter									6.400	4.57%	1.700	1.43%					2.200	2.12%	1.10	0.78	0.00%	0.33%
(14) Medical Wastes					0.094	0.05%	0.008	0.01%	0.087	0.06%	0.080	0.07%	0.021	0.09%	0.814	0.17%			0.05	0.08	0.04%	0.08%
(15) Miscellaneous	2.771	2.35%	1.400	1.39%	5.250	3.88%			0.098	0.06%	5.647	4.44%	1.600	1.30%	0.708	0.86%	0.338	0.32%	1.90	0.09	1.61%	0.55%
(16) BLUE BOX ITEMS (a) Newsprint	10.750	9.11%	4.300	4.87%	19.250	12.00%	17.700	15.24%	16.600	11.16%	30.700	17.44%	26.750	19.34%	19.000	15.78%			14.78	2.86	11.86%	2.08%
(b) Liquor / Wine Bottles	1.400	1.19%			5.400	4.14%	0.750	0.65%	1.000	0.67%	5.060	2.57%	2.108	1.39%	3.100	1.66%			1.78	0.54	1.38%	0.44%
(c) Food Jars / Other Bottles	0.700	0.58%	0.094	0.11%	1.460	1.07%	1.750	1.51%	0.300	0.34%	1.250	1.05%	2.300	1.81%	2.750	2.18%			1.32	0.33	0.84%	0.26%
(d) Food Cans (i) ferrous	0.000	0.76%	0.350	0.85%	1.800	0.89%	0.600	0.73%	1.100	0.74%	0.600	0.51%	1.330	0.88%	0.146	0.11%			0.74	0.15	0.59%	0.11%
(ii) non-ferrous	0.008	0.01%					0.007	0.01%											0.00	0.00	0.00%	0.00%
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous							0.017	0.01%					0.018	0.01%					0.00	0.00	0.00%	0.00%
(iii) American	0.010	0.01%			0.020	0.01%	0.094	0.08%	0.011	0.01%			0.100	0.07%					0.06	0.01	0.01%	0.01%
(f) Pop Cans (i) ferrous	0.013	0.01%			0.130	0.11%	0.100	0.08%			0.300	0.25%	0.015	0.01%	0.038	0.03%			0.07	0.06	0.06%	0.09%
(ii) non-ferrous	0.460	0.39%	0.060	0.06%	0.150	0.11%	0.300	0.47%	0.250	0.17%	0.100	0.09%	0.250	0.18%	0.017	0.01%			0.06	0.06	0.18%	0.05%
(g) PET Bottles	0.094	0.06%					0.034	0.09%											0.01	0.00	0.01%	0.00%
(h) Plastic Jugs	0.300	0.30%			0.088	0.08%	0.130	0.13%	0.750	0.50%	0.400	0.17%	0.250	0.18%					0.18	0.06	0.14%	0.08%
(i) OCC																						
	118.08	100.00%	87.86	100.00%	135.80	100.00%	116.17	100.00%	144.78	100.00%	116.78	100.00%	138.56	100.00%	126.48	100.00%	100.71	100.00%	121.47		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

*** WEIGHT OF BLUE BOX ITEMS DIVIDED BY 2 ***
(see 5.2.4 Data Management)

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	hair dryer metal/plastic	0.844
	electrical fuses glass?	0.378
	radio	1.310
	electrical wire	0.239
	light bulbs (7)	*********
		2.771
2	electrical wire	1.400
	light bulbs (2)	*********
		1.400
3	vaccum bag dust	0.843
	car headlamp	0.511
	electrical fuse glass	0.022
	flood lamp bulb	0.752
	wrist watch	0.022
	decoration plastic/wire	3.100
		5.250
4	light bulb (1)	*********
5	shotgun shells	0.098
	light bulbs (5)	*********
		0.098
6	telephone book	1.898
	plastic metal cap	0.185
	fuse box metal ABS?	3.300
	telephone parts	0.088
	light bulbs (14)	*********
		5.267
7	telephone book	1.600
	light bulb (1)	*********
		1.600
8	electrical fuse glass	0.022
	vaccum bag dust	0.684
	light bulbs (12)	*********
		0.706
9	video tape cassette	0.132
	vaccum bag dust	0.206
	light bulbs (5)	*********
		0.338

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area, 90 - 055 low income; primarily multiple dwellings
n = : 111 - 119
Collection Dates: Tuesday October 30
Thursday November 2

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN AND STANDARD ERROR ON A WEIGHT BASIS: MEAN (kg)	SE (kg)	MEAN AND STANDARD ERROR ON A PERCENT BASIS: MEAN (%)	SE (%)
(1) Paper (a) Newsprint	25.400	26.63%	32.300	34.90%	37.000	29.63%	12.700	11.82%	25.000	24.35%	41.700	41.38%	29.300	30.64%	26.700	29.66%	27.300	27.02%	28.06	2.72	29.63%	2.35%
(b) Fine Paper / CPO / Ledger	3.000	3.10%	2.900	3.18%	4.300	4.67%	0.000	0.36%	0.400	0.38%	1.000	1.39%	1.600	1.67%	1.155	1.26%	1.300	1.21%	1.72	0.40	1.64%	0.44%
(c) Magazines / Flyers	6.000	6.29%	3.300	2.71%	6.300	6.37%	1.800	1.67%	3.700	3.52%	2.800	2.79%	3.400	3.56%	5.500	6.11%	4.300	4.25%	4.04	0.55	4.21%	0.61%
(d) Waxed / Plastic / Mixed	3.410	3.57%	3.300	3.58%	0.600	0.64%	0.300	0.47%	0.300	0.17%	1.900	1.89%	1.600	1.87%	1.600	1.79%	1.600	1.32%	1.06	0.58	1.79%	0.41%
(e) Boxboard	3.100	3.25%	2.300	2.38%	3.600	3.86%	1.800	1.67%	1.148	1.02%	5.300	5.36%	2.500	2.61%	2.300	2.44%	1.400	1.42%	2.58	0.43	2.67%	0.44%
(f) Kraft	0.300	0.32%	1.500	1.63%	1.400	1.30%	0.700	0.65%	4.000	3.80%	0.400	0.40%	1.477	1.54%	0.300	0.36%	0.900	0.91%	1.26	0.37	1.29%	0.35%
(g) Wallpaper	0.019	0.02%											0.698	0.73%	7.600	8.44%	0.100	0.10%	0.94	0.54	1.02%	0.93%
(h) OCC	0.700	0.73%	7.000	7.58%	2.500	2.68%	17.400	16.19%	7.900	7.51%	1.300	1.29%	5.900	6.17%	2.700	3.00%	1.300	1.32%	5.21	1.76	5.10%	1.84%
(i) Tissues	2.600	2.73%	1.300	2.06%	5.500	3.75%	1.000	0.02%	0.300	0.10%	3.400	3.37%	1.900	1.37%	3.500	3.89%	3.700	3.74%	2.37	0.42	2.47%	0.45%
(2) Glass (a) Beer (i) refillable			0.258	0.28%															0.06	0.06	0.02%	0.02%
(ii) non-refillable			0.638	0.69%															0.07	0.07	0.08%	0.08%
(b) Liquor & Wine Containers			0.121	0.13%	0.330	0.33%	0.222	0.21%	2.900	2.10%	0.773	0.77%							0.41	0.24	0.39%	0.23%
(c) Food Containers	2.267	2.41%	0.218	0.24%	1.077	1.13%	0.367	0.37%	1.884	1.29%	0.792	0.79%	0.738	0.77%	0.735	0.84%			0.91	0.25	0.53%	0.26%
(d) Soft Drink (i) refillable	1.600	1.68%			0.214	0.23%			0.484	0.46%									0.28	0.20	0.30%	0.21%
(ii) non-refillable											0.214	0.21%							0.03	0.03	0.02%	0.02%
(e) Other Containers													0.010	0.01%					0.00	0.00	0.00%	0.00%
(f) Plate			5.000	5.42%															0.56	0.56	0.00%	0.00%
(g) Other			0.125	0.14%			0.578	0.54%			1.330	1.32%	2.547	2.71%	0.518	0.58%	12.401	12.63%	2.05	1.54	2.06%	1.56%
(3) Ferrous (a) Soft Drink Containers	0.061	0.02%	0.033	0.04%	0.298	0.33%	0.070	0.07%			0.330	0.33%	0.123	0.13%	0.053	0.07%	0.062	0.06%	0.11	0.04	0.12%	0.04%
(b) Food Containers	1.200	1.38%	0.700	0.76%	1.100	1.18%	0.300	0.47%	0.500	0.39%	2.700	2.88%	1.310	1.37%	0.500	0.33%	0.412	0.62%	0.05	0.25	0.97%	0.26%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans	0.495	0.53%	0.112	0.12%	0.578	0.41%					0.175	0.17%	0.076	0.07%	0.406	0.53%	0.298	0.29%	0.22	0.07	0.23%	0.07%
(e) Other			5.300	5.04%	0.833	0.88%	17.026	15.58%	2.490	2.37%	5.421	5.40%	0.846	0.88%	1.958	2.18%	2.016	2.04%	3.83	1.83	3.73%	1.70%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.019	0.02%	0.250	0.27%	0.006	0.10%					0.071	0.07%	0.038	0.04%					0.06	0.03	0.06%	0.02%
(ii) non-returnable																						
(iii) American	0.018	0.02%	0.034	0.04%	0.165	0.18%							0.040	0.04%	0.053	0.06%	0.053	0.09%	0.04	0.02	0.04%	0.02%
(b) Soft Drink Containers	0.275	0.29%	0.200	0.33%	0.191	0.20%	0.100	0.09%	0.000	0.00%	0.300	0.30%	0.065	0.07%	0.200	0.22%	0.330	0.36%	0.19	0.04	0.20%	0.04%
(c) Other Packaging																						
(d) Aluminum	0.129	0.14%	0.207	0.22%	0.351	0.38%	0.156	0.13%			0.107	0.11%	0.148	0.13%	0.423	0.47%	0.415	0.42%	0.22	0.05	0.23%	0.06%
(e) Other	0.258	0.27%			0.044	0.05%	1.221	1.14%			0.080	0.02%			0.583	0.65%	0.383	0.39%	0.30	0.14	0.30%	0.14%
(5) Plastics (a) Polyolefins	3.934	4.12%	3.800	4.12%	4.700	3.04%	3.900	2.70%	2.168	2.06%	4.820	4.79%	4.100	4.29%	3.600	4.02%	4.000	4.04%	3.78	0.28	3.91%	0.53%
(b) PVC	0.147	0.15%							0.061	0.06%	0.241	0.24%	0.098	0.10%	0.029	0.02%	0.098	0.02%	0.07	0.03	0.07%	0.02%
(c) Polystyrene	0.598	0.63%	1.148	1.24%	0.400	0.43%	0.271	0.25%	0.545	0.52%	0.294	0.29%	0.809	0.85%	0.384	0.43%	0.447	0.45%	0.58	0.10	0.58%	0.11%
(d) ABS																						
(e) PET	0.047	0.05%	0.129	0.14%	0.096	0.42%					0.123	0.12%	0.209	0.22%	0.513	0.33%	0.315	0.32%	0.17	0.06	0.18%	0.02%
(f) Mixed Blend Plastic	0.117	0.12%	0.100	0.11%	0.250	0.27%	0.083	0.08%	0.000	0.02%	0.468	0.46%	0.150	0.13%	0.100	0.11%	0.100	0.10%	0.15	0.06	0.16%	0.02%
(g) Coated Plastic	0.006	0.06%	0.000	0.02%	0.106	0.11%	0.006	0.02%			0.128	0.13%	0.029	0.02%	0.100	0.11%	0.110	0.11%	0.06	0.09	0.07%	0.02%
(h) Nylon																						
(i) Vinyl	0.146	0.13%	0.104	0.11%	0.088	0.09%			0.416	0.40%	0.374	0.37%	0.427	0.45%					0.17	0.06	0.17%	0.06%
(6) Organic (a) Food Waste / Rodent Bedding	35.200	36.00%	10.652	11.56%	18.000	10.29%	4.800	4.47%	10.400	15.02%	16.000	16.47%	13.300	14.12%	10.706	18.33%	17.000	18.10%	16.64	3.72	17.25%	2.89%
(b) Yard Waste		*******		*******		*******		*******		*******		*******		*******		*******		*******			*******	******
(7) Wood	0.500	0.53%	0.739	0.80%	0.008	0.02%	5.800	3.40%	0.020	0.00%			2.814	2.94%	3.106	3.65%	0.008	0.01%	1.42	0.64	1.44%	0.06%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.072	0.08%	1.831	1.98%	0.718	0.77%			19.000	18.07%	0.104	0.10%	4.484	3.11%	0.478	0.53%	0.478	0.48%	3.06	2.06	3.01%	1.98%
(9) Diapers	0.700	0.79%			0.500	0.54%							0.100	0.10%	0.636	0.70%	0.500	0.51%	0.27	0.10	0.29%	0.11%
(10) Textiles/Leather/Rubber	2.736	2.87%	6.061	6.39%	2.061	3.21%	28.858	26.83%	8.248	7.85%	1.164	1.15%	9.726	10.17%	5.553	5.02%	12.312	12.65%	8.58	2.83	8.47%	2.62%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.512	0.54%	0.806	0.86%	0.838	0.08%	2.700	2.51%			1.071	1.06%			1.309	1.58%	2.700	2.73%	1.06	0.34	1.10%	0.34%
(b) Waste Oils																	0.300	0.30%	0.03	0.03	0.02%	0.02%
(c) Pesticides/Herbicides																						
(12) Dry Cell Batteries					0.063	0.07%									0.018	0.02%	0.016	0.02%	0.01	0.01	0.01%	0.01%
(13) Kitty Litter											1.380	1.37%	3.168	3.51%	0.631	0.70%	0.631	0.64%	0.70	0.37	0.72%	0.38%
(14) Medical Wastes	0.166	0.17%	0.204	0.22%	0.325	0.35%	0.012	0.01%							0.299	0.33%			0.11	0.06	0.12%	0.02%
(15) Miscellaneous	0.415	0.43%	0.250	0.29%	0.779	0.83%	4.463	4.13%	7.696	7.33%	4.211	4.18%	1.593	1.67%			0.244	0.25%	2.18	0.89	2.12%	0.85%
(16) BLUE BOX ITEMS (a) Newsprint																						
(b) Liquor / Wine Bottles																						
(c) Food Jars / Other Bottles																						
(d) Food Cans (i) ferrous																						
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous																						
(iii) American																						
(f) Pop Cans (i) ferrous																						
(ii) non-ferrous																						
(g) PET Bottles																						
(h) Plastic Jugs																						
(i) OCC																						
	95.46	100.00%	92.25	100.00%	93.63	100.00%	107.49	100.00%	105.15	100.00%	100.79	100.00%	95.61	100.00%	90.01	100.00%	96.91	100.00%	97.66		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

EA. 90-055 low income, primarily multiple dwellings

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	electrical switch	0.034
	vaccum bag	0.364
	mascara make-up	0.015
	light bulbs (2)	**********
		0.413
2	spark plugs (automobile)	0.215
	electrical fuse glass?	0.018
	light bulbs (2)	**********
		0.250
3	vaccum bag	0.779
	light bulb (1)	**********
		0.779
4	water pump metal/plastic	3.300
	water faucets plastic metal	0.263
	electrical wire	0.424
	oil filter (automobile)	0.338
	electrical fuses glass	0.067
	copper pipe	0.071
		4.463
5	books	3.510
	telephone books	3.900
	umbrella	0.269
	electrical fuses glass?	0.017
		7.696
6	electrical wire	4.100
	deodorant stick	0.111
		4.211
7	boat wax in metal can	0.118
	fluorescent light bulbs	0.275
	wood/fiberglass slo	1.200
	light bulbs (9)	**********
		1.593
8	light bulbs (3)	**********
9	propane gas tank	0.512
	electric fuse glass	0.063
	light bulbs (8)	**********
		0.244

Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area: 00 - 168 medium income; primarily single detached
n = 141 - 149
Collection Dates: Tuesday November 21
Thursday November 23

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
																			MEAN AND STANDARD ERROR ON A WEIGHT BASIS		MEAN AND STANDARD ERROR ON A PERCENT BASIS	
(1) Paper (a) Newsprint	11.100	9.62%	4.600	4.80%	5.100	4.74%	0.500	0.50%	7.400	8.19%	2.000	2.38%	2.300	1.50%	7.300	7.97%	2.600	1.96%	5.87	1.03	5.75%	1.12%
(b) Fine Paper / CPO / Ledger	0.900	0.78%	0.900	0.94%	1.000	1.76%	0.800	0.80%	0.700	0.87%	6.200	5.06%	2.000	1.28%	2.100	2.29%	2.500	1.91%	2.00	0.57	1.76%	0.42%
(c) Magazines / Flyers	4.700	4.07%	5.300	5.53%	8.400	7.80%	2.500	2.50%	3.400	4.33%	12.100	9.91%	3.300	3.50%	6.800	7.42%	7.000	5.34%	6.16	0.96	5.80%	0.79%
(d) Waxed / Plastic / Mixed	1.900	1.65%	1.500	1.56%	3.106	2.89%	0.900	0.90%	1.600	1.98%	3.003	2.42%	2.600	1.80%	1.400	1.53%	3.000	2.07%	2.21	0.33	1.97%	0.35%
(e) Boxboard	4.500	3.90%	4.100	4.28%	5.400	5.01%	3.000	3.00%	3.200	3.97%	4.500	3.69%	6.200	4.29%	3.700	4.04%	4.600	3.06%	4.38	0.34	3.08%	0.18%
(f) Kraft	1.400	1.21%	1.400	1.46%	5.300	4.92%	5.300	5.30%	0.545	0.94%	1.400	1.15%	2.100	1.45%	1.600	1.75%	2.300	1.66%	2.14	0.47	1.90%	0.44%
(g) Wallpaper																						
(h) OCC	3.500	3.03%	0.456	0.48%	2.400	2.33%	0.391	0.39%	0.300	0.62%	3.700	4.67%	4.300	2.97%	0.700	0.76%	1.400	1.07%	2.17	0.04	1.82%	0.49%
(i) Tissues	3.700	3.21%	5.000	5.22%	6.100	5.66%	2.600	2.60%	5.000	6.21%	3.700	3.00%	6.000	4.14%	3.800	4.15%	5.500	4.18%	4.63	0.30	4.29%	0.40%
(2) Glass (a) Beer (i) refillable	0.522	0.45%									0.369	0.47%					0.285	0.22%	0.15	0.08	0.19%	0.07%
(ii) non-refillable																						
(b) Liquor & Wine Containers	0.274	0.24%	4.400	4.50%	0.890	0.83%					1.400	1.12%			1.076	1.17%	1.400	1.07%	1.05	0.46	1.01%	0.48%
(c) Food Containers	0.418	0.36%	4.241	4.42%							1.100	0.90%	1.418	0.98%	2.608	2.85%	4.849	3.60%	1.63	0.62	1.47%	0.58%
(d) Soft Drink (i) refillable																						
(ii) non-refillable																						
(e) Other Containers					0.019	0.02%					0.364	0.41%			0.214	0.93%	0.130	0.09%	0.10	0.09	0.08%	0.05%
(f) Plate							0.139	0.15%	0.426	0.33%	0.700	0.62%					1.364	1.04%	0.30	0.16	0.26%	0.12%
(g) Other					0.075	0.07%							0.104	0.07%	0.008	0.04%	0.319	0.29%	0.06	0.00	0.06%	0.03%
(3) Ferrous (a) Soft Drink Containers					0.153	0.14%					0.063	0.05%			0.060	0.09%	0.125	0.10%	0.03	0.02	0.04%	0.03%
(b) Food Containers	0.785	0.68%	1.900	1.98%	0.909	0.84%	0.300	0.30%	0.190	0.25%	1.300	1.00%	1.000	1.11%	1.400	1.53%	2.700	2.06%	1.24	0.26	1.19%	0.22%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans			0.103	0.11%									0.514	0.35%			0.119	0.09%	0.08	0.06	0.06%	0.04%
(e) Other					7.833	7.20%	0.046	0.05%	1.602	1.99%	0.251	0.21%	0.339	0.23%	0.127	0.14%	0.065	0.07%	1.14	0.86	1.11%	0.80%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.035	0.03%					0.130	0.13%							0.300	0.33%			0.06	0.06	0.06%	0.06%
(ii) non-returnable																						
(iii) American															0.044	0.05%			0.00	0.00	0.01%	0.01%
(b) Soft Drink Containers			0.253	0.24%	0.075	0.07%	0.105	0.10%	0.094	0.12%	0.067	0.06%	0.141	0.10%	0.600	0.06%	0.046	0.04%	0.13	0.08	0.12%	0.07%
(c) Other Packaging																						
(d) Aluminum	0.177	0.15%	0.314	0.33%	0.097	0.09%	0.181	0.18%	0.250	0.26%	0.602	0.57%	0.506	0.35%	0.200	0.22%	0.400	0.31%	0.35	0.08	0.27%	0.05%
(e) Other	0.040	0.04%			0.077	0.07%					0.207	0.17%							0.04	0.00	0.03%	0.03%
(5) Plastics (a) Polyolefins	5.300	4.59%	5.100	5.32%	5.100	4.74%	1.000	1.90%	3.300	4.10%	8.885	7.26%	7.100	4.93%	4.373	4.77%	7.000	5.84%	5.34	0.70	4.77%	0.47%
(b) PVC			0.024	0.03%	0.177	0.16%							0.174	0.12%	0.078	0.09%			0.05	0.03	0.06%	0.02%
(c) Polystyrene	0.752	0.65%	0.300	0.31%	1.880	1.75%	0.143	0.14%	0.610	0.76%	1.300	0.98%	2.357	1.63%	0.700	0.76%	1.700	1.30%	1.07	0.25	0.93%	0.18%
(d) ABS																						
(e) PET	0.068	0.06%															0.072	0.05%	0.09	0.01	0.01%	0.01%
(f) Mixed Blend Plastic	0.200	0.17%	0.168	0.17%	0.400	0.37%	0.294	0.29%	0.143	0.18%	0.300	0.35%	0.300	0.21%	0.229	0.35%	0.000	0.80%	0.28	0.04	0.35%	0.03%
(g) Coated Plastic	0.035	0.03%	0.106	0.16%	0.200	0.19%	0.043	0.04%	0.112	0.14%	0.084	0.03%	0.160	0.19%	0.110	0.12%	0.300	0.23%	0.13	0.06	0.12%	0.02%
(h) Nylon																						
(i) Vinyl																						
(6) Organic (a) Food Waste / Rodent Bedding	33.400	28.95%	28.200	29.42%	30.940	28.74%	8.300	8.30%	22.800	28.30%	28.390	28.12%	45.000	31.70%	34.900	28.11%	28.300	30.12%	30.25	3.55	27.42%	2.75%
(b) Yard Waste		*******	1.300	*******		*******		*******	2.106	*******		*******	26.300	*******		*******	2.100	*******	3.33	2.85	*******	******
(7) Wood	0.515	0.45%	7.630	7.97%	2.568	2.33%	0.038	0.04%	0.011	0.01%	0.245	0.30%	1.800	1.39%			0.536	0.41%	1.46	0.83	1.41%	0.86%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	4.000	3.47%	0.000	0.01%	0.358	0.32%	46.951	46.95%	0.097	0.12%	3.542	2.80%			1.800	1.97%	0.360	0.27%	6.37	5.10	6.24%	5.11%
(9) Diapers			0.300	0.21%	4.400	4.00%	4.200	4.70%	3.900	4.10%	7.000	8.47%	8.100	5.59%	1.775	1.94%	4.000	3.51%	3.96	0.96	3.80%	0.75%
(10) Textiles/Leather/Rubber	8.800	7.37%	4.900	4.98%	4.100	3.81%	1.300	1.90%	4.471	5.55%	1.129	0.92%	1.600	1.11%	2.100	2.29%	1.300	0.99%	3.26	0.79	3.12%	0.78%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.171	0.15%	0.259	0.33%	0.755	0.70%					0.551	0.45%					0.135	0.10%	0.21	0.09	0.18%	0.08%
(b) Waste Oils																						
(c) Pesticides/Herbicides																						
(12) Dry Cell Batteries			0.412	0.43%							0.214	0.16%	0.086	0.06%					0.08	0.05	0.07%	0.05%
(13) Kitty Litter	4.200	3.64%			2.660	2.47%	2.000	2.00%			13.100	10.73%	7.400	5.11%			13.000	9.91%	4.77	1.78	3.83%	1.35%
(14) Medical Wastes	0.400	0.30%									0.336	0.28%	0.473	0.33%			0.329	0.25%	0.17	0.07	0.15%	0.05%
(15) Miscellaneous	1.204	1.04%	0.057	0.06%	2.145	1.99%	0.883	0.38%	0.208	0.26%	0.171	0.14%	0.293	0.16%	0.197	0.22%	1.067	0.80%	0.64	0.22	0.61%	0.20%
(16) BLUE BOX ITEMS (a) Newsprint	18.756	16.35%	13.530	14.14%	1.300	1.98%	5.300	5.30%	15.400	18.18%	7.800	6.51%	26.630	18.41%	5.600	0.12%	14.450	11.02%	18.13	2.69	10.96%	2.13%
(b) Liquor / Wine Bottles					1.550	1.44%	0.400	0.40%	0.000	1.12%			2.850	1.83%	1.800	1.97%	0.750	0.57%	0.89	0.31	0.81%	0.27%
(c) Food Jars / Other Bottles	1.600	1.39%	0.250	0.36%	0.300	0.46%	1.710	1.71%	3.200	3.97%	1.000	0.83%	1.750	1.21%	0.235	0.25%	1.000	0.78%	1.35	0.31	1.29%	0.58%
(d) Food Cans (i) ferrous	1.800	1.56%	0.400	0.42%	0.400	0.37%	0.300	0.30%	0.600	0.74%	0.550	0.45%	1.900	1.31%	0.300	0.33%	0.800	0.61%	0.78	0.19	0.68%	0.13%
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous											0.060	0.04%							0.01	0.01	0.00%	0.00%
(ii) non-ferrous							0.900	0.90%					0.010	0.01%					0.03	0.03	0.03%	0.03%
(iii) American													0.083	0.04%			0.076	0.03%	0.01	0.01	0.01%	0.01%
(f) Pop Cans (i) ferrous	0.150	0.13%							0.015	0.02%	0.250	0.20%	0.200	0.14%			0.250	0.19%	0.10	0.04	0.08%	0.03%
(ii) non-ferrous	0.400	0.35%					0.136	0.15%	0.800	0.37%	0.008	0.01%	0.250	0.17%	0.300	0.33%	0.550	0.42%	0.29	0.09	0.20%	0.08%
(g) PET Bottles											0.008	0.06%	0.035	0.02%			0.087	0.05%	0.06	0.01	0.01%	0.01%
(h) Plastic Jugs	0.135	0.15%	0.097	0.09%			0.078	0.08%	0.150	0.15%			0.300	0.21%	0.043	0.06%	0.100	0.08%	0.09	0.06	0.08%	0.03%
(i) OCC															2.750	3.00%	1.000	0.78%	0.48		0.42%	
	115.96	100.00%	95.95	100.00%	107.70	100.00%	100.01	100.00%	86.58	100.00%	122.10	100.00%	144.75	100.00%	91.58	100.00%	131.15	100.00%	109.90		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

*** WEIGHT OF BLUE BOX ITEMS DIVIDED BY 3 ***
(see 2.2.4 Data Management)

Town: EAST YORK
EA 00 - 168 medium income; primarily single detached

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	electrical switch	0.042
	calculator	0.019
	road salt	1.146
		1.204
2	hair dye	0.057
	light bulbs (2)	***********
		0.057
3	electric hair dryer	0.327
	vaccum bag dust	1.818
	light bulbs (2)	***********
		2.145
4	vaccum dust	0.883
		0.883
5	plastic/metal nuts and bolts	0.061
	camera flashbulb	0.147
	light bulbs (2)	***********
		0.208
6	thermometer (plastic)	0.079
	windshield wiper (rubber)	0.092
	light bulbs (10)	***********
		0.171
7	florescent light bulb	0.200
	vaccum dust	0.093
	light bulbs (4)	***********
		0.293
8	magic markers (plastic)	0.197
	light bulbs (2)	***********
		0.197
9	florescent light bulbs	0.613
	vaccum bag dust	0.454
	light bulb (1)	***********
		1.067

Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK - Christmas Collection
Enumeration Area: 90 - 117 high income; mixed dwellings
n = 161 - 169
Collection Date - Thursday December 26

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN AND STANDARD ERROR ON A WEIGHT BASIS: MEAN (kg)	SE (kg)	MEAN AND STANDARD ERROR ON A PERCENT BASIS: MEAN (%)	SE (%)
(1) Paper (a) Newsprint	2.300	2.37%	2.000	2.21%	5.700	4.10%	2.800	3.04%	7.800	8.45%	2.000	2.10%	4.300	3.96%	2.300	2.55%	8.300	8.29%	3.89	0.89	4.58%	0.81%
(b) Fine Paper / CPO / Ledger	0.800	0.89%	1.900	2.10%	1.200	1.33%	1.000	1.09%	1.000	1.11%	1.200	1.32%	1.500	1.64%	0.700	0.73%	1.000	1.00%	1.14	0.12	1.26%	0.14%
(c) Magazines / Flyers	2.800	3.01%	1.800	1.00%	1.000	1.11%	1.000	1.73%			2.400	2.63%	1.000	1.09%	2.100	2.33%	2.000	2.84%	2.46	0.38	1.96%	0.33%
(d) Waxed / Plastic / Mixed	5.800	6.24%	5.000	5.55%	3.584	3.97%	6.767	7.34%	6.800	7.34%	8.300	6.30%	8.377	9.17%	4.400	4.88%	5.100	5.39%	ERR	ERR	6.00%	0.63%
(e) Boxboard	8.000	8.61%	11.000	12.10%	8.700	9.64%	6.000	6.67%	9.100	10.10%	11.000	12.71%	8.000	8.79%	8.000	8.86%	10.700	11.69%	7.06	1.09	10.26%	0.52%
(f) Kraft	1.900	2.04%	2.100	2.32%	0.900	1.00%	1.300	1.32%	1.400	1.55%	1.300	1.64%	1.000	1.75%	1.100	1.33%	0.800	0.87%	ERR	ERR	1.55%	0.16%
(g) Wallpaper																	5.100	5.57%	0.89	0.36	0.62%	0.45%
(h) OCC	6.700	7.21%	2.300	2.43%	3.100	3.45%	8.400	6.54%	6.900	7.66%	4.300	4.71%	2.800	2.85%	0.900	1.00%	1.300	1.45%	3.62	0.79	4.18%	0.85%
(i) Tissues	7.700	8.29%	5.800	6.41%	6.200	6.87%	5.700	6.10%	2.800	3.11%	6.100	6.69%	6.300	7.12%	5.600	6.21%	3.400	5.73%	5.33	0.51	6.06%	0.55%
(2) Glass (a) Beer (i) refillable	0.273	0.29%									0.243	0.27%							0.03	0.04	0.06%	0.04%
(ii) non-refillable			0.239	0.26%											0.913	1.01%			0.13	0.10	0.14%	0.11%
(b) Liquor & Wine Containers			0.341	0.38%	1.017	1.13%			1.900	2.11%	2.100	2.30%			5.300	5.87%	2.800	3.06%	1.36	0.59	1.63%	0.65%
(c) Food Containers	0.400	0.43%	1.596	1.76%	1.932	2.14%	0.837	0.00%	0.500	0.55%	0.800	0.88%	1.400	1.33%	3.400	3.77%	3.200	3.50%	1.58	0.37	1.73%	0.41%
(d) Soft Drink (i) refillable																						
(ii) non-refillable							0.450	0.49%	0.900	1.00%	0.251	0.28%					0.440	0.40%	0.25	0.11	0.22%	0.12%
(e) Other Containers					1.665	1.84%	0.168	0.18%									0.193	0.21%	0.22	0.10	0.25%	0.20%
(f) Plate			0.022	0.02%															0.00	0.00	0.00%	0.00%
(g) Other	0.691	0.74%	0.718	0.79%			0.175	0.10%			0.500	0.55%	0.339	0.37%	0.175	0.19%	0.112	0.12%	0.36	0.09	0.33%	0.10%
(3) Ferrous (a) Soft Drink Containers	0.117	0.13%	0.001	0.07%	0.132	0.15%	0.030	0.03%	0.000	0.09%	0.000	0.06%	0.092	0.10%	0.200	0.22%	0.800	0.87%	0.25	0.09	0.26%	0.10%
(b) Food Containers	1.000	1.08%	2.200	2.45%	1.100	1.22%	0.600	0.67%	0.900	1.00%	0.255	0.28%	1.200	1.42%	2.000	2.22%	2.500	2.73%	1.34	0.25	1.47%	0.27%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans					0.407	0.45%	0.347	0.43%	0.175	0.19%	0.103	0.13%	0.093	0.10%	0.777	0.86%	0.290	0.32%	0.25	0.08	0.27%	0.09%
(e) Other	0.089	0.10%	0.433	0.48%	0.054	0.04%	0.007	0.07%	0.057	0.06%	0.369	0.33%	0.312	0.34%			0.088	0.10%	0.16	0.05	0.18%	0.05%
(4) Non-Ferrous (a) Beer Cans (i) returnable			0.017	0.02%			0.051	0.03%	0.100	0.11%							3.300	3.50%	0.57	0.30	0.41%	0.39%
(ii) non-returnable																						
(iii) American			0.017	0.02%							0.300	0.33%			0.200	0.22%			0.03	0.03	0.06%	0.03%
(b) Soft Drink Containers	0.100	0.11%	0.102	0.11%	0.700	0.78%	0.603	0.04%			0.090	0.10%	0.088	0.07%	0.600	0.67%	1.000	1.09%	0.30	0.12	0.33%	0.13%
(c) Other Packaging													0.028	0.03%			0.054	0.06%	0.01	0.01	0.01%	0.01%
(d) Aluminum	0.400	0.45%	0.500	0.55%	0.800	0.88%	0.700	0.76%	0.300	0.33%	0.300	0.33%	1.000	1.09%	0.400	0.44%	0.300	0.33%	0.34	0.07	0.38%	0.08%
(e) Other													0.222	0.24%					0.00	0.00	0.02%	0.02%
(5) Plastics (a) Polyolefins	7.800	8.39%	6.400	7.06%	6.800	7.51%	7.200	7.80%	7.000	7.77%	8.000	8.43%	6.400	7.01%	7.200	7.98%	3.394	3.71%	6.73	0.56	7.39%	0.32%
(b) PVC			0.008	0.01%	0.058	0.06%	0.053	0.00%					0.100	0.11%	0.200	0.22%			0.00	0.00	0.00%	0.00%
(c) Polystyrene	0.700	0.75%	0.600	0.66%	0.700	0.78%	0.900	0.98%	0.800	0.89%	0.800	0.88%	0.000	0.04%	0.600	0.67%	1.000	1.09%	0.74	0.06	0.83%	0.07%
(d) ABS																						
(e) PET			0.127	0.14%							0.057	0.06%			0.273	0.30%	0.189	0.21%	0.07	0.03	0.08%	0.04%
(f) Mixed Blend Plastic	0.300	0.34%	0.100	0.11%	0.300	0.33%	0.600	0.65%	0.300	0.33%	0.400	0.44%	0.300	0.33%	0.800	0.33%	0.100	0.11%	0.32	0.00	0.35%	0.08%
(g) Coated Plastic	0.027	0.03%	0.073	0.08%	0.100	0.11%	0.100	0.11%	0.100	0.11%	0.024	0.03%	0.012	0.01%	0.139	0.33%	0.100	0.11%	0.08	0.00	0.09%	0.00%
(h) Nylon																						
(i) Vinyl																						
(6) Organic (a) Food Waste / Rodent Bedding	38.400	41.39%	38.900	43.01%	40.100	44.45%	38.300	41.59%	28.600	31.75%	34.700	38.03%	41.191	45.10%	39.200	43.45%	27.300	30.03%	36.32	1.07	39.63%	1.63%
(b) Yard Waste		*******		*******		*******		*******		*******		*******		*******		*******		*******			*******	*******
(7) Wood	1.604	1.73%	0.108	0.12%			0.019	0.03%	0.013	0.00%	0.124	0.14%	0.450	0.50%	0.173	0.19%	0.341	0.37%	0.33	0.17	0.34%	0.18%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	1.307	1.41%	1.040	1.15%	0.126	0.14%			0.535	0.59%	0.560	0.61%			0.194	0.22%	0.255	0.28%	0.44	0.15	0.46%	0.17%
(9) Diapers			0.290	0.33%	0.600	0.66%	3.400	3.00%									0.800	0.88%	0.34	0.37	0.39%	0.40%
(10) Textiles/Leather/Rubber	1.600	1.73%	4.409	4.38%	5.800	6.20%	3.900	4.23%	3.000	3.32%	3.600	3.09%	0.500	0.55%	1.200	1.33%	2.400	2.62%	2.08	0.53	3.27%	0.61%
(11) Household Hazardous (a) Paints / Solvents																						
Wastes (b) Waste Oils																						
(c) Pesticides/Herbicides							0.010	0.01%											0.00	0.00	0.00%	0.00%
(12) Dry Cell Batteries							0.188	0.18%	0.080	0.09%	0.080	0.07%	0.092	0.10%			0.031	0.03%	0.04	0.08	0.04%	0.06%
(13) Kitty Litter							0.425	0.44%	0.700	0.77%	0.796	0.87%	2.400	2.63%			1.339	1.63%	1.25	0.67	1.36%	0.74%
(14) Medical Wastes			0.011	0.01%	0.071	0.08%	0.019	0.02%	0.091	0.10%	0.193	0.31%	0.050	0.05%	0.258	0.28%			0.08	0.03	0.08%	0.09%
(15) Miscellaneous	2.008	2.16%	0.304	0.34%	0.063	0.07%	0.066	0.06%	2.466	2.74%					0.336	0.39%	2.392	2.61%	0.81	0.88	0.33%	0.40%
(16) BLUE BOX ITEMS (a) Newsprint																						
(b) Liquor / Wine Bottles																						
(c) Food Jars / Other Bottles																						
(d) Food Cans (i) ferrous																						
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous																						
(iii) American																						
(f) Pop Cans (i) ferrous																						
(ii) non-ferrous																						
(g) PET Bottles																						
(h) Plastic Jugs																						
(i) OCC																						
	92.80	100.00%	90.64	100.00%	90.27	100.00%	92.38	100.00%	90.13	100.00%	91.34	100.00%	91.83	100.00%	90.83	100.00%	91.31	100.00%	91.15		100.00%	
	TOTAL kg		TOTAL kg *		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

* note some weight apparently lost due to moisture loss

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	TV converter	2.009
		2.008
3	metal keys	0.112
	shoe polish in ferrous tin	0.057
	vaccum cleaner bag dust	0.183
	light bulbs (4)	**********
		0.304
3	cosmetics	0.063
	light bulb (1)	**********
		0.063
4	electrical fuses glass	0.058
	light bulb (1)	**********
		0.058
5	telephone book	1.034
	electrical switch plastic metal	0.625
	electric kettle	0.807
	light bulb (2)	**********
		2.466
6	light bulb (1)	**********
7	light bulbs (2)	**********
8	thermos	0.336
	light bulb (1)	**********
		0.336
9	vaccum bag dust	1.879
	brass ornament	0.014
	electrical wire	0.499
	light bulbs (2)	**********
		2.392

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Enumeration Area: 183 Barrington Ave
n = : 151 - 159
04la

SAMPLE #	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt	7 kg	7 % wt	8 kg	8 % wt	9 kg	9 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
																			MEAN AND STANDARD ERROR ON A WEIGHT BASIS		MEAN AND STANDARD ERROR ON A PERCENT BASIS	
(1) Paper (a) Newsprint	22.600	24.04%	24.300	25.85%	14.500	14.26%	17.700	18.04%	17.700	17.79%	13.600	14.80%	15.900	17.10%	14.500	16.14%	23.600	30.87%	16.80	1.74	18.82%	1.86%
(b) Fine Paper / CPO / Ledger	0.400	0.43%	0.800	0.85%	0.400	0.39%	3.500	3.57%	0.200	0.20%	1.600	1.74%	1.400	1.51%	1.500	1.02%	0.700	0.74%	1.21	0.33	1.29%	0.34%
(c) Magazines / Flyers	3.700	4.01%	4.000	4.25%	3.000	3.34%	1.100	1.12%	3.500	3.52%	2.600	2.83%	2.000	2.13%	4.800	5.42%	2.100	2.89%	3.47	0.49	3.67%	0.54%
(d) Waxed / Plastic / Mixed	1.500	1.57%	1.900	2.01%	1.400	1.38%	8.169	8.85%	3.544	3.56%	2.300	2.50%	2.400	2.57%	1.848	2.06%	2.645	2.90%	2.77	0.72	3.00%	0.79%
(e) Boxboard	4.900	5.17%	3.200	3.57%	3.331	3.21%	2.100	2.14%	4.500	4.52%	3.500	3.66%	4.600	4.96%	3.200	3.57%	4.700	4.99%	4.60	0.85	4.86%	0.57%
(f) Kraft	0.800	0.90%	1.100	1.18%	1.400	1.37%	1.100	1.12%	0.700	0.70%	1.000	1.09%	1.300	1.40%	1.700	1.90%	1.600	1.70%	1.20	0.12	1.39%	0.12%
(g) Wallpaper					0.200	0.20%			0.600	0.60%					0.059	0.06%			0.10	0.07	0.10%	0.07%
(h) OCC	1.500	1.56%	1.100	1.18%	3.800	3.70%	7.000	7.13%	3.400	3.45%	0.268	0.29%	1.300	1.40%	0.800	0.90%	1.600	1.70%	2.73	0.89	2.81%	0.84%
(i) Tissues	1.800	1.90%	2.800	2.98%	3.800	3.74%	1.600	1.63%	3.400	3.45%	3.100	3.35%	3.100	3.30%	3.700	4.16%	3.800	4.05%	3.85	0.42	3.64%	0.46%
(2) Glass (a) Beer (i) refillable									1.300	1.31%									0.17	0.17	0.17%	0.17%
(ii) non-refillable							0.367	0.37%											0.07	0.07	0.07%	0.07%
(b) Liquor & Wine Containers	1.800	1.90%	1.762	1.89%	0.103	0.10%	0.634	0.65%	3.500	3.52%	1.357	1.48%	0.359	0.39%	2.800	3.18%	2.604	2.76%	2.35	0.57	2.44%	0.60%
(c) Food Containers	0.406	0.43%	2.700	2.89%	1.911	1.88%			3.829	3.85%	4.500	4.89%	2.311	2.49%	4.538	5.12%	0.720	0.76%	3.30	0.57	2.96%	0.65%
(d) Soft Drinks (i) refillable																						
(ii) non-refillable	0.256	0.27%	0.219	0.23%	1.214	1.19%	0.419	0.43%	0.130	0.13%							0.473	0.50%	0.30	0.13	0.31%	0.12%
(e) Other Containers									0.461	0.46%	0.130	0.14%					0.358	0.38%	0.11	0.06	0.11%	0.06%
(f) Plate							0.406	0.42%			0.196	0.22%							0.07	0.05	0.07%	0.05%
(g) Other	1.074	1.13%	0.293	0.31%	2.020	1.99%			0.509	0.51%	1.676	1.82%	3.000	2.19%	0.048	0.05%	1.900	2.04%	1.04	0.30	1.09%	0.31%
(3) Ferrous (a) Soft Drink Containers	0.093	0.10%	0.130	0.14%	0.094	0.09%	0.441	0.45%	0.175	0.18%	0.468	0.51%	0.100	0.11%	0.230	0.26%	0.400	0.42%	0.24	0.06	0.26%	0.05%
(b) Food Containers	3.300	3.69%	4.800	5.12%	2.300	2.26%	0.747	0.76%	1.100	1.11%	3.700	4.04%	3.138	3.36%	5.300	5.90%	1.900	2.02%	2.71	0.51	2.90%	0.38%
(c) Beer Cans (i) returnable																						
(ii) non-returnable																						
(d) Aerosol Cans	0.271	0.29%							0.135	0.13%	0.353	0.38%	0.059	0.06%	0.304	0.34%	0.125	0.13%	0.14	0.05	0.13%	0.05%
(e) Other	0.360	0.38%	0.961	1.02%	1.712	1.68%	6.153	6.27%	3.009	3.02%	0.111	0.12%	0.105	0.11%			0.400	0.42%	1.44	0.67	1.40%	0.66%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.185	0.20%			0.320	0.31%	0.017	0.02%	0.008	0.01%	0.064	0.07%	0.126	0.13%	0.084	0.09%	0.200	0.21%	0.11	0.03	0.13%	0.04%
(ii) non-returnable																						
(iii) American	0.017	0.02%	0.095	0.10%			0.200	0.20%					0.089	0.10%	0.196	0.22%	0.100	0.11%	0.07	0.02	0.07%	0.03%
(b) Soft Drink Containers	0.953	1.00%	0.800	0.85%	0.269	0.26%	0.167	0.17%	0.300	0.30%	0.431	0.47%	0.232	0.25%	0.150	0.17%	0.320	0.34%	0.44	0.10	0.46%	0.11%
(c) Other Packaging	1.690	1.79%																	0.19	0.19	0.20%	0.20%
(d) Aluminum	0.296	0.31%	0.403	0.43%	0.221	0.22%	0.166	0.17%	0.400	0.40%	0.308	0.34%	0.426	0.46%	0.200	0.22%	0.213	0.23%	0.30	0.04	0.32%	0.04%
(e) Other	0.074	0.08%	0.510	0.54%	1.700	1.67%	0.544	0.55%			0.100	0.11%			0.028	0.03%			0.33	0.19	0.33%	0.18%
(5) Plastics (a) Polyolefins	3.900	4.11%	7.600	8.12%	8.400	8.26%	5.301	5.40%	3.017	3.04%	8.400	9.14%	3.100	3.30%	5.760	6.41%	6.000	6.37%	5.72	0.58	6.05%	0.56%
(b) PVC	0.211	0.22%							0.153	0.15%			0.121	0.13%	0.049	0.05%	0.130	0.13%	0.07	0.03	0.08%	0.03%
(c) Polystyrene	0.300	0.32%	0.300	0.32%	1.400	1.38%	0.800	0.82%	0.636	0.64%	0.633	0.69%	0.600	0.65%	0.800	0.90%	0.600	0.64%	0.65	0.10	0.69%	0.10%
(d) ABS					0.555	0.55%	0.050	0.05%	0.019	0.02%									0.07	0.06	0.07%	0.05%
(e) PET	0.153	0.16%	0.147	0.16%	0.199	0.20%	0.068	0.07%	0.185	0.19%	0.065	0.07%	0.125	0.13%	0.080	0.09%	0.191	0.20%	0.15	0.03	0.16%	0.02%
(f) Mixed Blend Plastic	0.300	0.33%	0.400	0.43%	0.146	0.14%	0.255	0.26%	0.200	0.20%	0.167	0.18%	0.220	0.24%	0.126	0.14%	0.277	0.29%	0.23	0.04	0.26%	0.04%
(g) Coated Plastic	0.200	0.21%	0.112	0.12%	0.098	0.10%	0.038	0.04%	0.100	0.10%	0.200	0.22%	0.100	0.11%	0.138	0.17%	0.220	0.23%	0.14	0.03	0.14%	0.02%
(h) Nylon																						
(i) Vinyl									0.115	0.11%									0.01	0.01	0.01%	0.01%
(6) Organic (a) Food Waste / Rodent Bedding	18.998	20.03%	23.000	23.56%	23.875	23.46%	30.100	30.66%	24.424	24.54%	33.600	33.35%	29.500	31.52%	23.500	26.32%	24.000	25.44%	24.31	1.30	25.90%	1.76%
(b) Yard Waste	3.800	*******		*******		*******		*******		*******		*******		*******		*******		*******	0.40	0.40	*******	******
(7) Wood			0.073	0.08%	0.800	0.79%	0.204	0.21%	0.400	0.40%	0.342	0.37%			0.155	0.17%	0.164	0.17%	0.24	0.08	0.24%	0.08%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	3.566	3.79%			0.217	0.21%	1.092	1.11%	0.588	0.59%					0.233	0.26%	0.293	0.31%	0.94	0.98	0.97%	0.46%
(9) Diapers	13.300	14.03%	3.600	3.79%							3.100	3.35%	3.300	3.61%	3.400	3.64%	1.772	1.88%	3.80	1.41	4.08%	1.50%
(10) Textiles/Leather/Rubber	2.662	2.81%	1.584	1.70%	3.142	3.09%	15.901	16.20%	3.200	3.22%	1.534	1.67%	2.155	2.33%	6.600	7.45%	3.400	3.61%	4.91	1.90	5.12%	1.52%
(11) Household Hazardous Wastes (a) Paints / Solvents					1.187	1.18%													0.13	0.13	0.13%	0.13%
(b) Waste Oils																						
(c) Pesticides/Herbicides																						
(12) Dry Cell Batteries	0.141	0.15%	0.161	0.17%					0.013	0.01%	0.043	0.05%	3.800	4.06%			0.023	0.02%	0.47	0.42	0.49%	0.44%
(13) Kitty Litter							3.900	3.96%	7.407	7.44%			1.622	1.73%	0.125	0.14%			1.45	0.84	1.46%	0.89%
(14) Medical Wastes	0.229	0.24%					0.019	0.02%	0.086	0.09%			0.085	0.09%	0.008	0.01%	0.058	0.06%	0.05	0.03	0.05%	0.03%
(15) Miscellaneous	0.418	0.44%	1.058	1.13%	3.199	3.15%	0.023	0.02%	0.058	0.06%					0.163	0.18%	0.493	0.52%	0.62	0.36	0.63%	0.35%
(16) BLUE BOX ITEMS (a) Newsprint																						
(b) Liquor / Wine Bottles																						
(c) Food Jars / Other Bottles																						
(d) Food Cans (i) ferrous																						
(ii) non-ferrous																						
(e) Beer Cans (i) ferrous																						
(ii) non-ferrous																						
(iii) American																						
(f) Pop Cans (i) ferrous																						
(ii) non-ferrous																						
(g) PET Bottles																						
(h) Plastic Jugs																						
(i) OCC																						
	93.98	100.00%	93.99	100.00%	101.64	100.00%	98.19	100.00%	99.59	100.00%	91.90	100.00%	93.53	100.00%	89.81	100.00%	94.19	100.00%	94.98		100.00%	
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

E.A. 183 Barrington Ave

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	vaccum bag dust	0.419
		0.419
2	ajax cleaning powder	0.236
	vaccum bag dust	0.791
	electrical wire	0.081
	light bulb (1)	**********
		1.058
3	vaccum bag dust	0.307
	electrical wire	0.000
	record player	4.800
	light bulbs (2)	**********
		3.199
4	lectrical fuse glass	0.003
	lightbulb (1)	**********
		0.003
5	electrical wire	0.059
	light bulb (1)	**********
		0.058
6		
7		
8	clock (plastic?)	0.163
		0.163
9	vaccum bag	0.430
	plastic metal valve	0.063
		0.493

Waste Composition Study

GORE & STORRIE LIMITED

Town: EAST YORK
Sampling Area: East York schools
n = : 171 – 179
Collection Dates: December 12, December 14, December 19

School Classification

SAMPLE #:	1 Primary kg	1 % wt	2 Jr. High kg	2 % wt	3 Primary kg	3 % wt	4 Jr. High kg	4 % wt	5 Primary kg	5 % wt	6 Primary kg	6 % wt	7 High School kg	7 % wt	MEAN (kg)	SE (kg)	MEAN (%)	SE (%)
(1) Paper (a) Newsprint	5.800	5.86%	2.000	2.09%	6.500	6.39%	7.300	7.16%	7.100	6.90%	13.100	12.71%	6.700	6.96%	6.66	1.59	6.41%	62.46%
(b) Fine Paper / CPO / Ledger	10.500	10.40%	11.700	12.20%	0.600	7.68%	6.500	6.39%	6.700	6.46%	12.700	10.09%	13.000	12.35%	10.50	0.84	10.33%	29.90%
(c) Magazines / Flyers	1.800	1.82%	1.300	1.25%	0.500	0.96%	6.000	6.83%	0.800	0.78%	2.200	1.85%	12.300	11.80%	3.87	1.61	3.42%	72.92%
(d) Waxed / Plastic / Mixed	4.331	4.37%	6.600	6.86%	6.601	7.09%	6.119	6.00%	7.666	7.46%	7.537	6.44%	3.600	3.30%	6.36	0.43	6.50%	14.00%
(e) Boxboard	5.600	5.00%	4.200	4.36%	4.200	5.00%	2.800	2.73%	2.300	2.24%	3.400	2.86%	5.400	5.12%	3.90	0.47	4.00%	17.37%
(f) Kraft	12.000	12.12%	6.800	7.09%	0.700	11.58%	5.400	5.30%	6.700	6.54%	9.700	8.16%	2.500	2.18%	7.31	1.33	7.37%	65.73%
(g) Wallpaper																		
(h) OCC	2.600	2.90%	4.200	4.38%	2.400	2.97%	5.400	5.30%	2.400	2.34%	0.731	0.61%	16.500	17.36%	5.19	2.30	5.11%	00.09%
(i) Tissues	11.500	11.61%	5.500	5.76%	6.600	10.51%	6.600	6.48%	5.700	5.50%	11.700	6.65%	4.300	4.08%	7.73	1.13	7.80%	42.80%
(2) Glass (a) Beer (i) refillable											0.292	0.25%			0.04	0.04	0.04%	1.66%
(ii) non-refillable							0.007	0.80%					0.622	0.66%	0.18	0.11	0.17%	4.35%
(b) Liquor & Wine Containers					0.153	0.12%			0.348	0.34%					0.07	0.00	0.07%	2.00%
(c) Food Containers	0.400	0.44%	0.783	0.82%	0.700	0.84%	1.000	0.98%	0.900	0.88%	0.152	0.12%	0.156	0.15%	0.59	0.15	0.60%	5.09%
(d) Soft Drink (i) refillable																		
(ii) non-refillable			0.413	0.43%	0.634	0.76%	0.261	0.26%	0.908	0.89%	0.335	0.28%	0.107	0.12%	0.39	0.11	0.39%	4.22%
(e) Other Containers																		
(f) Plate																		
(g) Other	0.829	0.29%											0.330	0.52%	0.10	0.06	0.09%	2.47%
(3) Ferrous (a) Soft Drink Containers	0.150	0.15%	0.400	0.42%	0.200	0.24%	0.331	0.32%	0.260	0.32%	0.051	0.04%	0.300	0.28%	0.25	0.00	0.22%	1.80%
(b) Food Containers	0.500	0.30%	0.078	0.08%	0.560	0.40%	0.099	0.10%	1.099	1.07%			1.600	1.52%	0.53	0.23	0.53%	6.08%
(c) Beer Cans (i) returnable																		
(ii) non-returnable																		
(d) Aerosol Cans							0.139	0.12%							0.02	0.02	0.00%	0.70%
(e) Other	0.965	0.99%	0.340	0.35%	0.091	0.04%	0.390	0.38%	3.107	2.08%	0.214	0.18%			0.81	0.86	0.80%	11.23%
(4) Non-Ferrous (a) Beer Cans (i) returnable													0.400	0.38%	0.06	0.06	0.06%	2.31%
(ii) non-returnable																		
(iii) American			0.037	0.04%											0.01	0.01	0.01%	0.21%
(b) Soft Drink Containers	0.549	0.35%	1.100	1.12%	0.242	0.29%	0.800	0.78%	0.500	0.29%	0.090	0.08%	0.300	0.46%	0.51	0.13	0.59%	5.16%
(c) Other Packaging			0.164	0.17%					0.200	0.30%	0.087	0.08%	0.044	0.06%	0.07	0.06	0.07%	1.26%
(d) Aluminum	0.600	0.61%	0.500	0.51%	0.326	0.38%	0.410	0.40%	0.230	0.22%	0.257	0.22%	1.345	1.47%	0.52	0.18	0.32%	7.00%
(e) Other							0.045	0.04%							0.01	0.01	0.01%	0.23%
(5) Plastics (a) Polyolefins	6.100	6.16%	5.300	5.73%	5.518	0.39%	6.800	6.67%	5.200	5.07%	7.000	5.89%	4.216	4.00%	5.78	0.30	5.73%	12.32%
(b) PVC																		
(c) Polystyrene	6.180	2.21%	1.700	1.77%	1.258	1.50%	2.500	2.50%	1.476	1.44%	0.321	0.27%	2.712	2.57%	1.71	0.50	1.72%	11.33%
(d) ABS																		
(e) PET							0.063	0.00%							0.01	0.01	0.07%	0.50%
(f) Mixed Blend Plastic	0.340	0.04%			0.045	0.00%			0.024	0.09%	0.061	0.05%	0.047	0.04%	0.11	0.09	0.11%	3.32%
(g) Coated Plastic	0.014	0.01%	0.100	0.10%	0.113	0.13%	0.234	0.23%	0.200	0.20%	0.235	0.20%	0.013	0.01%	0.13	0.04	0.12%	1.42%
(h) Nylon																		
(i) Vinyl											0.024	0.02%			0.00	0.00	0.00%	0.14%
(6) Organic (a) Food Waste / Rodent Bedding	31.000	31.31%	42.400	44.21%	29.600	33.95%	31.500	30.91%	37.500	36.39%	40.393	34.00%	36.700	18.64%	33.30	3.61	33.14%	******
(b) Yard Waste		*******		*******		*******		*******		*******		*******		*******				
(7) Wood	1.884	1.90%	0.178	0.10%	0.094	0.11%	0.971	0.95%	0.000	0.00%	2.114	1.78%	1.800	1.71%	1.01	0.30	0.90%	13.65%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos																		
(9) Diapers	0.800	0.81%			0.100	0.12%	1.300	1.95%					0.400	0.38%	0.43	0.26	0.43%	10.47%
(10) Textiles/Leather/Rubber	0.179	0.18%	0.215	0.22%	0.368	0.44%	1.765	1.73%	1.457	1.43%	0.861	0.36%	0.160	0.17%	0.70	0.24	0.68%	9.42%
(11) Household Hazardous (a) Paints / Solvents Wastes (b) Waste Oil (c) Pesticides/Herbicides																		
(12) Dry Cell Batteries											0.031	0.03%	0.022	0.02%	0.01	0.00	0.01%	0.16%
(13) Kitty Litter																		
(14) Medical Wastes											0.001	0.00%			0.00	0.00	0.00%	0.12%
(15) Miscellaneous					0.083	0.10%			6.094	3.90%			1.500	1.23%	0.78	0.53	0.79%	23.32%
(16) BLUE BOX ITEMS (a) Newsprint									6.150	2.10%					0.31	0.31	0.30%	15.42%
(b) Liquor / Wine Bottles									0.150	0.15%					0.00	0.08	0.00%	0.87%
(c) Food Jars / Other Bottles	0.600	0.61%							0.750	0.73%	1.700	1.42%			0.44	0.04	0.40%	6.77%
(d) Food Cans (i) ferrous	0.560	0.33%							0.100	0.10%	0.100	0.08%			0.08	0.00	0.08%	1.09%
(ii) non-ferrous											0.000	0.00%			0.00	0.00	0.00%	0.08%
(e) Beer Cans (i) ferrous																		
(ii) non-ferrous																		
(iii) American																		
(f) Pop Cans (i) ferrous	0.100	0.10%							0.200	0.20%	0.600	0.50%			0.13	0.08	0.11%	3.37%
(ii) non-ferrous	0.100	0.10%							0.500	0.49%	0.900	0.76%			0.31	0.13	0.12%	6.37%
(g) PET Bottles											0.062	0.05%			0.01	0.01	0.01%	0.66%
(h) Plastic Jugs									0.100	0.10%	0.000	0.04%			0.06	0.01	0.06%	0.50%
(i) OCC																		
TOTAL kg	99.06	100.00%	95.91	100.00%	83.71	100.00%	101.36	100.00%	102.90	100.00%	118.81	100.00%	100.40	100.00%	101.04		100.00%	

Note: the MEAN (kg) and SE (kg) columns are headed "MEAN AND STANDARD ERROR ON A WEIGHT BASIS"; the MEAN (%) and SE (%) columns are headed "MEAN AND STANDARD ERROR ON A PERCENT BASIS".

*** WEIGHT OF BLUE BOX ITEMS DIVIDED BY 8 ***
(see 8.2.4 Data Management)

Town: EAST YORK

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1		
2		
3	electrical wire	0.083
		0.083
4		
5	binders, boxboard, plastic, metal	5.200
	electric heater	1.094
		6.094
6		
7	electrical wire	1.500
		1.500
8		
9		

APPENDIX D

FLAME TEST AID TO IDENTIFICATION OF PLASTICS

Identifying Rigid Plastic Containers

Plastics Group, The Dow Chemical Company
2040 W.H. Dow Center, Midland, MI 48674

January 1989

This table can be used to identify the plastic used in rigid plastic containers. With only a glass of water, knife and match, anybody can determine the plastic with a very high degree of accuracy.

For example, if you put a piece of the "unknown" plastic in a glass of water and it sank, you would know the plastic was polyvinyl chloride or polystyrene (unless the container was a soft drink or miniature liquor bottle). If the plastic sank and didn't burn, then you could be assured that the bottle was produced from polyvinyl chloride.

Multi-layer, multi-component containers cannot be accurately identified by this system. However, these containers are a small percentage of the total market.

Referring to the list of "Typical Packaging Containers" on the reverse side of this page makes it even easier to identify plastics.

	Type of Plastic					
	HDPE	PET	PVC	P/P	LDPE	P/S
Weight % of bottles produced (1986) in U.S.A.	62%	24%	7%	3%	1%	Nil
Float/sinks in water	F	S	S	F	F	S
Can be transparent	NO	YES	YES	YES	NO	YES
Burns with matches[1]	YES (White Smoke, Drips)	YES (Drips)	NO	YES (White Smoke, Drips)	YES (White Smoke, Drips)	YES (Black particles, No Drips)
Rigidity	Semi-Rigid	Rigid, Tough	Semi-Rigid	Semi-Rigid	Flexible	Brittle to Semi-Rigid
Bottle surface	Rough	Usually Glossy	Very Glossy	Usually Low Gloss	Low Gloss	Glossy

[1] Use caution when striking the match and attempting to ignite the piece of plastic. Keep the glass of water handy to quickly extinguish the burning piece of plastic. Remember that burning plastic may drip. The hot droplets will burn flesh and can mar surfaces.

Recycle Plastics

APPENDIX E

PUBLISHED BTU DATA

Ultimate Analysis of Typical Municipal Refuse Components

(ref. 47)

Refuse component	C (%)	H_2 (%)	O_2 (%)	N_2 (%)	S (%)	*Inerts**	*Btu/lb*	*Percent moisture*	*Percent as delivered*
Newspapers	49.14	6.10	43.03	0.05	0.16	1.43	7.974	3.97	10.33
						1.33	8.480		
	48.34	6.13	42.30	0.14	0.11	2.96	8.266		
Brown paper	44.90	6.08	47.84	0	0.11	1.01	7.256	3.83	6.13
						1.07	7.706		
Magazine paper	32.91	4.95	38.55	0.07	0.09	23.47	5.354	4.11	7.48
Corrugated boxes	43.73	5.70	44.93	0.09	0.21	5.06	7.043	5.20	23.68
						5.34	7.429		
Plastic coated paper	45.30	6.17	45.50	0.18	0.08	3.64	7.341	4.71	0.84
						2.776	7.703		
Waxed milk cartons	59.18	9.25	30.13	0.12	0.10	1.17	11.327	3.45	0.84
						1.22	11.733		
Paper food cartons	44.74	6.10	41.92	0.15	0.16	6.50	7.258	6.11	2.27
						6.93	7.730		
Junk mail	37.87	5.41	42.74	0.17	0.09	13.09	6.088	6.56	3.03
Tissue paper	43.9	6.1	49.0			0.93	6.999	7.00	2.18
Cardboard	43.52	6.08	44.33	0.18	0.14	5.57	7.841		
Miscellaneous paper	44.00	6.13	41.63	0.43	0.12	7.65	7.793		
Vegetable and food wastes	49.06	6.62	37.55	1.68	0.20	1.06	1.795	78.29	2.52
Citrus rinds, seeds	47.96	5.68	41.67	1.11	0.12	0.74	1.707	78.70	1.68
Meat scraps, cooked	59.59	9.47	24.65	1.02	0.19	5.11	7.623	38.74	2.52
Fried fats	73.14	11.54	14.82	0.43	0.07	0.	16.466	0.	2.53
Garbage	41.72	5.75	27.62	2.79	0.25	21.87	7.246		
Leather	42.01	5.32	22.83	5.98	1.00	21.16	7.243	7.46	0.42
Rubber composition, heel, sole catch	53.22	7.09	7.76	0.50	1.34	29.74	10.899	1.13	0.42
Plastics									
Average	78.0	9.0	13.0				13.910		0.84
High	90.0	10.0					19.303		
Low	53.8	7.0	37.2				9.580		
Polyethylene	85.6	14.4					19.950		
Vinyl	47.1	5.9	18.6 (chlorine = 28.4%)				8.830		
Plastic film	67.21	9.72	15.82	0.46	0.07	6.72	13.846		
Mixed, from municipal refuse, contaminated with food waste									
Other plastics, rubber, leather	47.70	6.04	24.06	1.93	0.33	19.72	9.049		
Paints, oils	32.1	13.1	34.8			0.	12.780		0.84
Vacuum cleaner	35.69	4.73	20.38	6.26	1.15	30.34	6.386	3.47	0.84
Evergreen trimmings	48.51	6.54	40.44	1.71	0.19	0.81	2.708	69.00	1.68
Flower, garden plants	46.65	6.61	40.18	1.21	0.26	2.34	3.697	53.94	1.68
Lawn grass, green	46.18	5.96	36.43	4.46	0.42	1.62	2.058	75.24	1.68
Ripe tree leaves	52.15	6.11	30.34	6.99	0.16	3.82	7.984	9.97	2.52
Softwood, pine	53.33	6.08	40.90	0.25	0.10	0.12	9.150		
Hardwood, oak	49.49	6.63	43.39	0.25	0.10	0.15	8.682		
Wood	49.00	6.0	42.00			2.28	6.840	24.00	2.52
	48.30	5.97	42.44	0.29	0.11	2.89	8.236		
Grass and dirt	36.20	4.75	26.61	2.10	0.26	30.08	6.284		
Rags	43.9	6.1	49.0			0.93	6.999	7.00	0.84
Textiles	46.19	6.41	41.85	2.18	0.20	2.17	8.034		
Dirt						100.00			1.68
Glass bottles	0.52	0.07	0.36	0.03		99.02	84		
Btu in labels, coatings, and remains of contents									
Glass, ash, ceramics						100.000			8.50
Glass, stones, ceramics			(same as above, glass bottles)						
Metal cans	4.54	0.63	4.28	0.05	0.01	90.49	742		
Btu in labels, coatings, remains of contents									
Metals						100.00	2.660		7.53

**Inerts—ash, glass, metal, stone, ceramics. Source: Compiled in Ref. 15.*

RELATIVE ENERGY VALUES FOR COMBUSTIBLES
(Btu per Pound)

(ref. 50)

Material	Value
Residual fuel oil	20,900
Plastics	
Polyethylene	19,900
Polypropylene	19,850
Polystyrene	17,800
Polyurethane	11,000
Coal	11,500
Rubber	10,900
Newspaper	8,000
Leather	7,200
Corrugated boxes (paper)	7,000
Textiles	6,900
Wood	6,700
Average for MSW	4,650
Yard waste	3,000
Food waste	2,600

APPENDIX F

WHITE GOODS AND BULK ITEMS GENERATION RATE DATA

Town: Oakville

Population (1985)[1] : 83,214
Population (1988) : 98,404

Year	White Goods (tonne)	Generation Rate (t/capita/year)
1984	115	0.0014
1985	100	0.0012
1986	106	0.0013
1987	185	0.0019
1988	258	0.0026
1989	256	0.0026

[1] all population data taken from the Ontario Municipal Directory

Town: Etobicoke

Population (1985): 298,490
Population (1988): 293,433

Year	White Goods (tonnes)	Generation Rate (t/capita/year)
1986	325	0.0011
1987	331	0.0011
1988	335	0.0011
1989	391	0.0013

Town: Toronto

Population (1988): 597,126

Year	White Goods (tonne)	Generation Rate (t/capita/year)
May - December		
1987	223.0	0.0006
1988	324.6	0.0005
1989	1088.7	0.0018

Town: City of York

Population (1988): 131,537

Year	White Goods (tonnes)	Generaton Rate (t/capita/year)
1989	260	0.0020

Town: Ajax

Population (1988): 45,046

Year	White Goods (tonnes)	Generation Rate (t/capita/year)
1989	65	0.0014

Town: North York

Population (1988): 544,560

Year	White Goods[1] (tonnes)	Generation Rate (t/capita/year)
1988	330[1]	NA
1989	1100	0.0020

[1] Only part of the city provided with separate white goods collection

Town: East York

Population (1988): 96,497

Year	White Goods (tonnes)	Generation Rate (t/capita/year)
1989	150	0.0016

Town: Mississauga

Population (1988): 385,156

Year	White Goods (tonnes)	Generation Rate (t/capita/year)
1989	150.9	0.0004

Town: Whitby

Population (1988): 49,948

Year	White Goods (tonnes)	Generation Rate (t/capita/year)
1989	175	0.0035

County: Wellington

Population (1988): 62,992

Year	White Goods Generated
1989	480 cu.yd./year (approximately)

Town: Toronto

Population (1985)[1] : 606,247
Population (1988) : 597,126

Year	Other Bulk Items (tonnes)	Generation Rate (t/capita/year)
1984	17597.7	0.029
1985	17534.8	0.029
1986	18882.6	0.031
1987	18887.4	0.032
1988	15078.2	0.025

[1] All population data taken from the Ontario Municipal Directory

Town: Etobicoke

Population (1985): 298,490
Population (1988): 293,433

Year	Other Bulk Items (tonne)	Generation Rate (t/capita/year)
1986	1517	0.005
1987	1300	0.004
1988	1283	0.004
1989	1261	0.004

Town: Oakville
Population (1988): 98,404

Year	Other Bulk Items (tonnes)	Generation Rate (t/capita/year)
1989	1172	0.012

Town: Whitby
Population (1988): 49,948

Year	Other Bulk Items (tonnes)	Generation Rate (t/capita/year)
1989	705	0.014

APPENDIX G

GLOSSARY OF TERMS

GLOSSARY OF TERMS

ABS---acryl butyl styrene; a dense plastic found in, e.g., computer housings, telephone casings, pipe;

absorb---(in the sense used in the present report) the uptake or penetration of water or other solvent into the interstices of a chemical matrix, i.e., not unlike the uptake of water by a dry sponge;

accuracy---in a statistical sense, the term gives an indication of the closeness of the results, estimates, etc. to the "true" value.

adsorb---the adherence of water or solvent to the surface of an object, without penetration into the "interior", ie., a `film' of moisture;

BTU---British Thermal Unit; the amount of heat required to raise the temperature of 1 pound of water 1 Fahrenheit degree ; in this case, the "potential energy" or the amount of heat that would be released from the material if it were to be burned (usually rated calories per unit weight of material - SI units: kiloJoules per kilogram);

commercial wastes---discarded materials generated by commercial businesses as a result of normal activities in the workplace;

ferrous---a metal object containing elemental iron, giving a `positive' or attractive response to a magnet;

MSW---municipal solid waste, usually defined as the sum of residential and commercial solid wastes, and excluding industrial wastes;

non-ferrous---a metal object which does not give a `positive' or attractive response to a magnet, e.g., copper, brass, lead, aluminum, etc.

OCC---old corrugated containers; variously called, old corrugated cardboard;

PET---polyethylene terephthalate; the plastic used to manufacture the common 2 litre pop bottles;

polyolefin---in the sense used here, a grouping of chemically related plastics whose chemical building blocks are either ethylene or propylene;

precision---in a statistical sense, the term gives an indication of the <u>repeatability</u> of a series of observations, estimates, etc. The Standard Error is one kind of estimate of the precision or repeatability or "tightness" of the grouping of the observations (= data);

putrescible---a material which is biodegradable; usually a term reserved for animal or vegetable matter;

PVC---polyvinyl chloride; a plastic containing chlorine; well known as siding, plastic window sashes and frames, pipe and a few rigid containers;

residential waste---discarded materials generated by individuals in the course of their daily activities at their place of residence; in this case, exclusive of yard wastes and leaves;

tare weight---the weight of an empty container;

COMMERCIAL WASTE COMPOSITION STUDY

VOLUME II OF THE ONTARIO WASTE COMPOSITION STUDY

JULY 1991

Ontario
Environment
Environnement

ISBN 0-7729-8593-6

COMMERCIAL
WASTE COMPOSITION STUDY

VOLUME 11
OF THE ONTARIO WASTE COMPOSITION STUDY

Report prepared by:
GORE & STORRIE LIMITED

Report prepared for:
Waste Management Branch
Ontario Ministry of the Environment

JULY 1991

RECYCLABLE

Cette publication technique
n'est disponible qu'en anglais.

PIBS 1608

DISCLAIMER

This report was prepared for the Ontario Ministry of the Environment as part of a Ministry-funded project. The views and ideas expressed in this report are those of the author and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

study, in which the crew unloaded the refuse bins by hand to determine the total weight of the waste in the bin.

5. During the course of the study, insights were noted regarding the effectiveness of waste management practices of some firms. For example, for automotive repair businesses, it appears that employee's tend to use the general refuse bin for discarding metal waste materials, despite the fact that a scrap metal bin has been made available.

   Such insights, when communicated to the management of the firm provide an immediate opportunity to help that firm improve the efficiency of their recycling efforts.

   There is also an indication that differences exist in per employee waste generation rates in small grocery stores and in larger supermarkets.

   The demonstrated method for estimating the rate of employee waste generation has the potential to be used as a waste management tool by municipalities. The distribution of the daily waste generation rates versus employment data, exhibited in the graphs for each SIC sector, could enable municipal waste management personnel to prioritize their "remedial" waste reduction efforts by planning to visit those companies whose waste generation rates seem out of line with the general waste-to-employee relationship.

Recommendations

The methods employed in the commercial portion of the Ontario Waste Composition Study have been demonstrated on a selection of commercial businesses in the Regional Municipality of Waterloo. Within the commercial sectors in the Region there is a relatively high awareness of waste diversion options that will reduce waste disposal costs and encourage recycling. Therefore, The total annual tonnage received by the two Region of Waterloo landfill sites in 1989 was 439,000 tonnes. Based on the results of the present study, the commercial sector contributed an estimated 76,388 tonnes, or 17.4% of the total weight.

2. The most commonly encountered waste material in commercial refuse was corrugated cardboard (OCC) which ranged from a low of 4.0% to a high of 49.0% of the weight of refuse generated by the firms which were sampled.

The wide range in OCC content may be the result of some firms separating used OCC for recycling, possibly in anticipation of the proposed ban on the landfilling of OCC within the Regional Municipality of Waterloo in 1991.

Variations observed in the composition of other waste streams may be due to recycling activities, either under the auspices of company-wide programs or by conscientious employees who took materials to recycling locations in the municipality or home to their own Blue Boxes.

3. The statistical reliability of the waste composition data for some of the SIC groups is questionable because of the small number of waste samples that were sorted. Nevertheless, the data indicate the general proportion of materials in the waste streams from the 16, two-digit SIC groups that comprise the commercial business community in the Region. Waste from 65 businesses was sorted.

4. The installation of a truck-mounted scale, used to determine the weight of refuse in 2 to 8 cubic yards refuse bins, enabled us to obtain waste quantity data from an additional 80 commercial businesses. For estimating the per employee waste generation rates, this method is more efficient than the labour intensive method, used in the waste composition part of the

INFORMATION FOR THE READER

The results of the Ontario Waste Composition Study appear in three volumes.

Volume I contains the results of the residential portion of the Ontario Waste Composition Study. The emphasis in Volume I is on the development and testing of a method that municipalities can use to estimate per capita generation rates of residential refuse. The field work for Volume I took place in East York, Fergus, and North Bay, Ontario.

Volume II contains the results of the commercial portion of the Ontario Waste Composition Study, which are presented herein. Waste generation data for two light industrial businesses are also provided in Volume II. The emphasis in Volume II is on the development and testing of a method that municipalities can use to estimate per employee waste generation rates and, further, to estimate the quantity of waste generated from all commercial sources. The commercial component of the study took place in the Regional Municipality of Waterloo.

Volume III is a "user friendly" manual that outlines the procedures for conducting residential and commercial waste composition studies in municipalities of Ontario.

ABSTRACT

Volume II, the Commercial Waste Composition Study, is the second of the three volumes comprising the Ontario Waste Composition Study.

The commercial study was conducted in the Regional Municipality of Waterloo between May 15 and August 31, 1990. The study focuses on developing a cost effective method for conducting waste composition assessments, estimating per employee waste generation rates in commercial businesses and estimating the waste generated by the entire commercial sector in a municipality.

Statistics Canada, as part of their Standard Industrial Classification (SIC), has disaggregated the universe of economic activity in Canada into 18 divisions. The same classification is used for all of Statistics Canada's economic surveys. The SIC provides the basis for the selection of commercial activities to be studied, and for the extrapolation of sample results into municipal totals.

Within this universe of activity, the commercial waste composition study focuses on six divisions whose activities take place within the private sector and serve local communities. As these commercial activities are located within the communities they serve, the number and size of these activities can be readily predicted from a knowledge of the size and characteristics of the residential population.

Statistics Canada further disaggregates these six divisions of commercial activity into 27, two-digit SIC codes, each representing a familiar group of retail or service activities. In order to get the most information from a limited number of samples, these two-digit groups were further aggregated and disaggregated. The idea here was to aggregate those groups that appeared to have similar waste generation patterns, and to disaggregate those that had varied rates of waste generation. For example, the automotive group was disaggregated to reflect fundamentally different

kinds of operations in dealerships, garages and gas stations. Among financial services, only banks were sampled.

Waste composition information (65 separate collections) and per employee waste rates (212 samples) were obtained for representative commercial businesses. Per employee waste generation rates were estimated from regression analyses or data averaging.

Estimated average employee waste generation rates for each disaggregated commercial activity were multiplied by total Regional employment in the activity to obtain estimates of waste generation for the activity. The latter estimates were summed to give a total estimate of waste generated by commercial businesses in the Region.

The study did not include schools (see Volume I), hospitals and other health care facilities, government offices or wholesale activities. However, two "light" industries were sampled.

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EXECUTIVE SUMMARY

The two-fold purpose of the Commercial Waste Composition Study was to:

1. develop a simple, cost effective and reliable method for determining the composition and per employee generation rate of waste from commercial sources in Ontario (the study concentrated on that portion of the commercial waste stream that can be closely related to residential waste; that is, both waste streams stem from the same processes of consumption); and

2. apply the method and obtain current information on the characteristics of commercial waste streams.

A review of relevant literature and consultation with experts in the fields of employment, commercial structure, demographics and waste management indicated that commercial waste generation is related to the number of employees at a particular commercial establishment.

Commercial activity in Canada is organized by the Standard Industrial Classification (SIC) established by Statistics Canada. This classification was used as the basis for reporting waste composition and per employee generation rate data. Before the field study began, the commercial business SIC codes were reviewed with respect to retail service activities to determine whether certain sectors could be grouped together.

The Census of Canada (1986) gathered information about occupation, type of employment and place of work from a twenty percent (20%) sample of households. These data provide information about the number of employees in 36 different commercial sectors within each of the urban census areas in Ontario. This kind of information was gathered for the Regional Municipality of Waterloo, including the Cities of Kitchener, Waterloo and Cambridge, and the Townships of

Woolwich, Wilmot, Wellesley and North Dumfries. The field study was undertaken in the Region between May 15 and August 31, 1990.

A representative sample of businesses from the SIC groupings were identified and approached by the study team to gain permission to include them in the study. Data were then gathered on the composition of the waste stream from each SIC grouping, and an estimate of the average generation rate of total waste per employee was made for each of the SIC groupings. Sixty-five businesses were analyzed for both waste composition and per employee waste generation rates. Eighty additional companies were sampled only to obtain per employee waste generation rates. Some companies of the latter group were sampled twice for a total of 212 samples forming the per employee waste generation data base of this study.

The relationship between waste generation and employment was completed by regression analysis when the characteristics of the data set, (eg. sample size) permitted. In other cases an average of the waste generation data is reported where regression analysis was deemed inappropriate.

Estimated average per employee waste generation rates for each commercial activity were multiplied by the total Regional employment in the activity to obtain estimates of the waste generation for the activity throughout the entire Region.

<u>Conclusions</u>

1. Waste composition and per employee generation rates have been estimated for the commercial businesses in the Regional Municipality of Waterloo. The methods used in the present study provides direct estimates for 52% of the total employment in commercial business in the Region and indirect estimates for 100%. Thus, estimates of the waste generated by a segment of the commercial sector of the municipality have been made for the first time.

we cautiously regard the qualitative and quantitative data presented herein as a best estimate under constantly changing circumstances.

This report has developed a procedure for estimating the amount of waste generated by commercial activities within Ontario urban areas and began with the process of integrating the complex data inputs required. What are the next steps?

The study has employed a two-stage estimation process: (1) the development of ratios of waste generation per employee; and (2) the estimation of commercial employment composition for the municipality as a whole. Each step poses different problems. The following recommendations are submitted:

1. The waste generation and composition data base will require many more samples in order to cover the full range of commercial activities. No one study will have the resources to undertake a complete evaluation; the research results must be accumulated over many studies and evaluated over time. Fortunately, there is no inherent reason that a business in any part of the province cannot be used to estimate waste generated elsewhere--unless local waste management policies differ significantly.

   This means that each study should use the same SIC identification to code commercial activity and the same methodology for measuring waste output and composition. A central agency (e.g., the Ministry of Environment) may have to take the responsibility for organizing and evaluating the data.

2. It will also be necessary to monitor any changes over time in waste generation that may reflect innovations in policy, technology or corporate behaviour. The date of each sample must be retained and or it may be necessary to identify sample locations that can be restudied over time in order to minimize sampling error.

3. To better understand the effect of recycling behaviour on the data gathered, it is recommended that employees management of participating firms be asked to describe the nature and extent of any source separation recycling activities.

4. The immediate priorities for sampling can be identified from the results of this study. Those commercial activities that employ large numbers of people must be further investigated in order to improve sample size and reveal any significant variation within the SIC groups; this includes the diverse set of office and financial activities. Conversely, those activities with a high rate of waste generation per employee, such as food stores and restaurants, must be sampled repeatedly because of their importance to the overall waste generation. Those sectors where the observed sample variance (standard deviation) is high require larger samples to improve overall accuracy, possibly by isolating subgroups within the SIC. Activities that generate policy-relevant waste materials should be given special attention.

5. The future development of employment estimates requires two divergent approaches. First, substantial savings may result from a centralized, standardized analysis of employment that applies the same set of data, techniques and projections to all urban areas--much as the Ontario Statistical Centre has developed a common set of population forecasts.

   At the same time, municipalities have better information about local peculiarities and exceptions to the employment structure. These special cases, e.g., community colleges, tourist attractions, shopping concentrations, as well as manufacturing activities, may require special attention by a local agency.

SECTION 1

INTRODUCTION & LITERATURE REVIEW

1.0 INTRODUCTION & LITERATURE REVIEW

1.1 Introduction

In recognition of a pressing need to improve the way in which waste is managed in Ontario, the Ontario Ministry of the Environment has initiated programs and established specific goals designed to ensure the development of innovative and integrated waste management systems. For example, the Ministry has issued Terms of Reference and assisted in the funding of Waste Management Master Planning for municipalities. Specific objectives for diverting significant amounts of waste from disposal through reduction, reuse and recycling activities (25% by 1992 and 50% by 2000) have also been announced by the Government of Ontario.

In order to effectively plan and design waste management systems that will achieve those goals, reasonably accurate estimates of the types and quantities of waste must be available. For example, the design of material recovery facilities that will receive and process waste must be compatible with the range of wastes anticipated to be received by the facility.

The Ministry of the Environment contracted Gore & Storrie Limited, in association with Decima Research Limited, to develop and test methodologies that would assist waste management planners and municipalities in deriving reasonable estimates of the material composition and generation rate of wastes from residential and commercial sources. The results of that study are presented in three volumes:

Volume I - Residential
Volume II - Commercial
Volume III - Procedures Manual

The results of the commercial portion of the Ontario Waste Composition Study are presented herein, and describe the development and field trial of a methodology for estimating the type and quantity of waste generated by a variety of different types of commercial enterprises; i.e., those firms in the private sector that provide goods and services for consumers. Although these activities may be concentrated at a small number of locations within the urban area, such as "downtown", or a regional mall, the aggregate amount of commercial activity is very closely related to both the number of households and household income in the urban area. Commercial waste, in this sense, can be closely related to residential waste. Both waste streams stem from the same processes of consumption.

The Study focused on the commercial activities that are most closely linked to residential requirements. The waste generation from office buildings is an important component; but it is difficult to distinguish offices that serve local residents (e.g., a lawyer) from those that serve the province as a whole (e.g., an insurance firm). Wholesale activities, while part of the commercial waste system, also serve larger spacial units. They are too varied in their size and function to fit into the present sampling framework. They must be studied elsewhere, when a community studies the entire waste stream in their area. A review of relevant literature and consultation with experts in the fields of employment, commercial structure, demographics and waste management indicated that commercial waste generation is related to the number of employees at a particular commercial establishment.

The plan for the Study was developed during the winter of 1989 1990. The study uses the extensive information on the amount and composition of commercial employment provided by Statistics Canada and local government agencies to define a sampling framework for the field work.

Commercial activity in Canada is organized by the Standard Industrial Classification (SIC) established by Statistics Canada. This classification was used as the basis for reporting waste composition and per employee generation rate data. Before the field study began, the commercial business SIC codes were reviewed with respect to retail service activities to determine whether certain sectors could be grouped together.

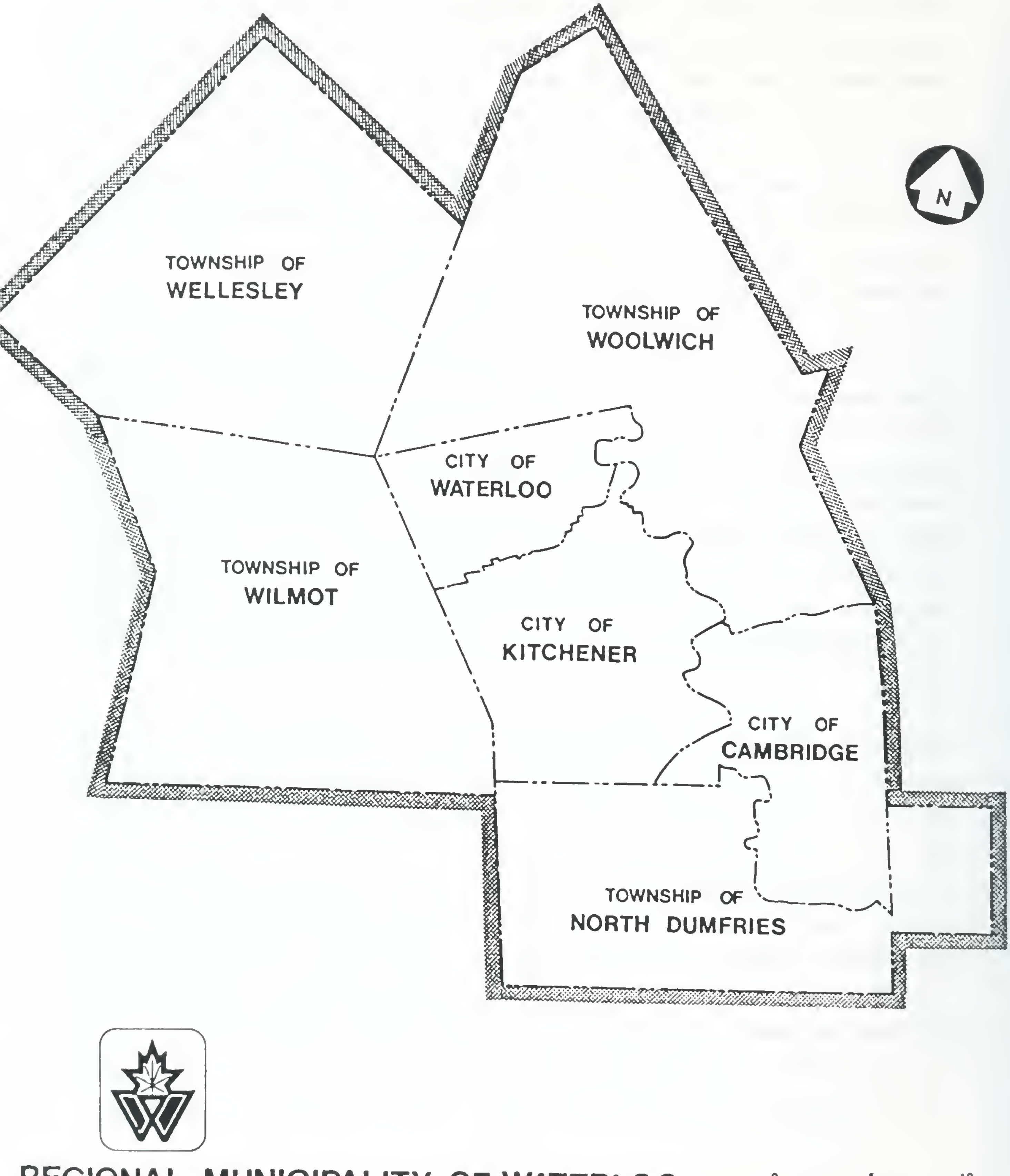
The Census of Canada (1986) gathered information about occupation, type of employment and place of work from a twenty percent (20%) sample of households. These data provide information about the number of employees in 36 different commercial sectors within each of the urban census areas in Ontario.

Figure 1 is a map of the field study area which is the Regional Municipality of Waterloo, including the Cities of Kitchener, Waterloo and Cambridge, and the Townships of Woolwich, Wilmot, Wellesley and North Dumfries. The field study was undertaken in the Region between May 15 and August 31, 1990.

A representative sample of businesses from the SIC groupings were identified and approached by the study team to gain permission to include them in the study. Data were then gathered on the composition of the waste stream from each SIC grouping, and an estimate of the average generation rate of total waste per employee was made for each of the SIC groupings. Sixty-five businesses were analyzed for both waste composition and per employee waste generation rates. Eighty additional companies were sampled only to obtain per employee waste generation rates. Some companies of the latter group were sampled twice for a total of 212 samples forming the per employee waste generation data base of this study.

This report establishes a methodology for measuring waste generation and waste composition for commercial activities, as defined above. For a number of reasons, the study of waste generation by these activities is a much more complex problem than that of residential activities reported in Volume I of the Ontario Waste Composition Study. First, very little published research is available for commercial activities (none for Canada in recent years) and therefore the research team had little a priori knowledge of expected values or variance to guide the design of an efficient sampling framework. Second, as apparent in the discussion of the results, commercial activities are characterized by very high variance, relative to the residential sector. That variance is observed in waste generation both within and among the various retail and service sectors. There was also a wide range in

FIGURE 1 MAP OF THE REGIONAL MUNICIPALITY OF WATERLOO



REGIONAL MUNICIPALITY OF WATERLOO
DEPARTMENT of PLANNING and DEVELOPMENT

store size (measured in level of sales or employment) within these sectors that must be taken into account. These variations mean that a much larger number of samples are required in order to provide the same degree of reliability obtained in the study on residential waste generation. Third, while detailed descriptions of household characteristics are provided by the Census of Canada, together with a variety of forecasts of growth and change provided by market research firms and government agencies, it is difficult to identify even the base population for a sample of commercial activities. It is not common for a single data source to provide counts or lists of the number of supermarkets or barber shops within a municipality. Sample locations must be identified in the field; extrapolations to obtain municipal or regional totals now and in the future require elaborate assumptions and indirect procedures.

Nonetheless, the report describes a workable method, and provides sufficient data to support an overall estimate of waste generation for the Region, together with the major components of the waste stream. While many more sample points will be required to increase the precision of estimates of waste streams for specific commercial activities, studies at the municipal level benefit from the effect of aggregation in which hundreds or thousands of activities are averaged together. The report also provides a methodology for future studies that overcomes each of the difficulties identified earlier. Data on commercial waste generation and composition are now available to guide the design of waste sampling procedures. The identification of high waste generation activities in this study permits agencies to target waste reduction and recycling programs on these activities. The difficulties, due to varying store size and unavailable data on the population of stores, have been overcome by focusing on number of employees as the key measure that connects the sample observation to the overall data analysis and ultimately to the aggregate waste generation by the municipality. The number of employees in each SIC code is listed by Statistics Canada in their data base.

It would have been possible to restrict the study to just a few well chosen SIC groups in order to achieve greater confidence in the waste estimates. However, we chose a broader study in order to assess the variances encountered in various SIC groups. This choice benefits subsequent workers who can target their efforts to develop and enhance a data base of waste generation for commercial activities in Ontario.

1.2 Literature Review

The Bird & Hale report (ref. 2) has been used as the baseline study for waste composition information on the municipal solid waste stream in Ontario. In the Bird & Hale study, the average annual composition of municipal solid waste entering landfill sites, transfer stations and incinerators, in Toronto, was derived from samples obtained during spring, summer, winter and fall. Twelve visits were made to six sites between October, 1976 and September, 1977, with two visits apiece at: Commissioners Street Incinerator, Ingram Incinerator, Dufferin Incinerator, Beare Road Landfill Site, Bermondsey Transfer Station and Wellington Incinerator. Sample weights of municipal solid waste ranged up to 400 lbs. (180.7 kg).

Municipal solid waste has been traditionally defined as a combination of waste from residential and commercial sources, so the Bird & Hale study--which collected and reported on this combined municipal solid waste data--does not serve as a suitable baseline for the present work which focuses on the commercial activities that are related to residential consumption.

The earliest studies of the composition of commercial solid waste were reported by Peter Middleton & Associates (ref. 11). They briefly described three studies: Louisville (1970), Proctor & Redfern (1972) and Proctor & Redfern (1975), each based on questionnaires sent out to commercial businesses. The Louisville study reportedly divided the commercial sector into 18 different categories but regrettably this detail was not provided in the main report or appendix. The same is true of the two Proctor & Redfern reports. The questionnaires reportedly contained information on the categories of commercial businesses, but the information was reportedly lost (ref. 11).

Franke (ref. 5) described the general composition of the commercial waste stream in Cologne, Germany (1980/81 data) and Evans (ref. 4) reported the weight and volume of components in the waste streams from "retail", restaurants and office towers in Toronto (1984 data). More recently, Rhyner & Green (ref. 14) compared published literature data on per capita or per employee waste generation rates for residential, commercial, industrial and construction/demolition wastes with actual waste data that they were obtaining at county-owned landfill sites in Brown County, Wisconsin. Annual solid waste generation estimates were calculated for a number of SIC codes in the commercial sector. Rhyner & Green's estimates of the annual generation of commercial refuse, using a daily employee generation rate of 0.73-0.77 kg and county employment data, was within 15% of the "actual quantity". Table 1 summarizes the available information on the composition of commercial waste streams, from sources reported above.

A key paper that became the basis for the data gathering procedures developed in the present study was published in 1971 by DeGeare & Ongerth (ref. 3). The authors explored the relationship between waste generation in clothing, drug, grocery, hardware stores, and restaurants as a function of a number of variables indicative of the physical and operational characteristics of commercial establishments. For example: (1) number of hours open per week; (2) number of business days open per week; (3) average annual gross receipts; (4) physical area of store, in square feet; (5) average inventory in dollars; (6) equipment value, in dollars; (7) number of delivery days per week; and (8) number of employees. Number of employees and store hours were the two variables that gave the best prediction of the waste generation rate for premises in the commercial sectors under study.

DeGeare and Ongerth, using "multiple stepwise regression analyses", demonstrated that the generation of commercial solid waste was found to be most closely related to the number of employees, hours open, and type of establishment involved. Graphs illustrating the correlation between actual and predicted waste quantities from the DeGeare and Ongerth study are reproduced in Appendix A.

TABLE 1 COMPARISON OF WASTE COMPOSITION INFORMATION FOR THE COMMERCIAL SECTOR - PUBLISHED DATA[1] (PERCENT OF TOTAL)

Material	Proctor & Redfern (1972; 1975)	Evans (1985) Retail	Evans (1985) Restaurant	Evans (1985) Office Towers	Louisville (1970)	Liblit (1990) Retail Trade	Liblit (1990) Restaurant	Liblit (1990) Office	Liblit (1990) School	Liblit (1990) Government	Franke (1987)
Newsprint		6.2	2.7	6.3		2.9	2.5	3.6	3.3	6.7	
Brown Paper		2.8	2.9	8.6							
OCC	51 - 65 total paper	16.5	4.0	2.9		22.0	16.6	11.5	11.6	8.4	27 total paper
Fine Paper		15.4	15.4	66.9		1.4		10.6	6.3	7.2	
Other Paper		24.3	22.5	10.6		15.2	18.5	38.5	26.6	31.5	
Food Waste		9.6	42.9	1.1		8.1	36.0	3.0	14.0	3.2	10 organics
Vegetation		0.0	0.0	0.0							
Plastic	1 - 2	19.1	4.8	1.1	9.4	12.0	13.7	4.3	5.1	3.5	9
Textile/Cloth		2.0	0.0	0.1							
Wood		0.9	0.0	0.1		10.7	0.6	7.8	21.0	20.0	11
Other Combustibles		1.1	0.6	0.8							
Ferrous Metals		1.05	1.7	0.4		19.7	4.2	2.4	3.9	9.0	
Non-ferrous metals		0.1	0.3	0.1		0.8	0.7	0.5	1.9	0.8	3 metals & glass
Glass	1 - 4	0.75	1.8	0.7	11.3	2.5	5.9	3.9	3.2	2.7	
Other non-combustibles		0.3	0.6	0.3							
Inert Materials											12
Production Wastes (Rubber, rags etc)											12
Other ("household-like" wastes)											15
Miscellaneous	1.1 - 17[2]					4.7	2.3	13.9	3.1	7.0	

[1] Data are given as percentages of the commercial waste stream. Canadian studies: Proctor & Redfern (1972; 1975), Evans (1985); U.S.A. studies: Louisville (1970), Liblit (1990); Germany: Franke (1987).

[2] Includes 12% construction wastes

Two points will clarify the relationship between waste generation and company employment. First, employment is a function of the intensity of retail activity; i.e., a small store with few customers will require a smaller sales staff than a larger store that serves a large clientele. Second, the items sold by stores are delivered in bulk, in packages, cartons, and other containers, with the individual items placed on shelves or otherwise displayed. Taken together, we see that as the size of a store's staff increases to serve increasing numbers of customers (and sales), the quantity of goods delivered to the store will grow in response to customer demand and the amount of bulk packaging and related administrative wastes will also increase.

The focus on waste generation per employee that is evident in the literature fits well with another reference that examines consumer behaviour and commercial structure (Jones & Simmons, ref. 8). This reference demonstrates that the amount of commercial activity is highly predictable from information about the size and income level of the market. Given the number of households and average income level in any city, it is possible to project first, the patterns of consumer expenditure, from toothpaste to bank deposits, in great detail; and second, to calculate the level and composition of commercial activity. Furthermore, the different measures of commercial activity (i.e., number of stores, floor area, retail sales, number of employees) are all closely interrelated. Employment happens to be the most frequently measured and readily obtained. It provides the key link between the samples from the field work and the larger municipal waste system. When one determines the waste generation per employee for a SIC group, this generation rate can be extrapolated, via Statistics Canada data on total employment in the SIC sector to get the waste generation rate for the entire company. It is then possible to determine whether a reasonable amount of waste is being disposed at a given company as compared to an average waste generation rate for a company of similar size in the same SIC sector.

The authors would like to point out that they discovered a paucity of information pertaining to this subject and have made every attempt to locate and examine all relative material.

SECTION 2

METHODOLOGY

The authors would like to point out that they discovered a paucity of information pertaining to this subject and have made every attempt to locate and evaluate all relevant material.

2.0 METHODOLOGY

2.1 Overview

The general approach used in the study included the following steps:

A. Selection of Commercial Businesses

The commercial business SIC codes were reviewed with respect to retail service activities to determine whether certain activities could be grouped together. Although the commodities or services provided by businesses may differ, similarities in the waste streams permitted aggregation of sectors, and reduced the requirement for field work.

B. Development and Implementation of the Waste Sampling Program

(1) Information on the composition of the waste stream from each SIC group was obtained.

(2) An average generation rate of total waste per employee for each of the commercial groups was estimated. Waste was collected from a number of premises in each SIC group, attempting to cover a range of small and large companies. The relationship between waste generation and employment was assessed by regression analyses when sample size permitted.

C. Development of a Region Employment Profile for Commercial Activities

Statistics Canada employment data and the Region of Waterloo's planning information were analyzed to generate an estimate of the total number of people employed in the commercial groupings for which waste generation estimates were obtained.

TABLE 2: LIST OF SIC DIVISIONS

Division A	Agricultural and Related Service Industries
Division B	Fishing and Trapping Industries
Division C	Logging and Forestry Industries
Division D	Mining (Including Milling), Quarrying and Oil Well Industries
Division E	Manufacturing Industries *
Division F	Construction Industries
Division G	Transportation and Storage Industries
Division H	Communication and Other Utility Industries *
Division I	Wholesale Trade Industries *
Division J	Retail Trade Industries **
Division K	Finance and Insurance Industries **
Division L	Real Estate Operator and Insurance Industries **
Division M	Business Service Industries **
Division N	Government Service Industries
Division O	Educational Service Industries
Division P	Health and Social Service Industries
Division Q	Accommodation, Food and Beverage Service ** Industries
Division R	Other Service Industries **

* Low emphasis in study

** High emphasis in study

D. Estimation of Waste by Commercial Activities in the Region

Regional employment was multiplied by the employee waste generation rate for each SIC group to estimate the quantity of waste generated by each of the commercial activities. The sum of the waste estimates for the groups gave an estimate of waste generation by a large segment of the commercial sector in the municipality.

2.2 Commercial Employment in the Regional Municipality of Waterloo

2.2.1 Defining Commercial Activity

Statistics Canada, as part of its Standard Industrial Classification (SIC), has disaggregated the universe of economic activity in Canada into 18 groups (ref. 15). Thus, the classification provides the basis for the selection of commercial activities to be studied, and for the extrapolation of the sample results into municipal totals. The same classification is used for all of Statistics Canada's economic surveys. It enables us to apply data from the Census of Canada, or the monthly Labour Force Survey, to the task of estimating waste generation for aggregations of commercial activities.

Within this universe of activity, the commercial study focused on six divisions: J, K, L, M, Q, and R (Table 2). The activities in these divisions take place within the private sector and serve local residential communities. Thus they are located within the communities they serve, and the number and size of these activities are quite predictable from a knowledge of the size and characteristics of the residential population. Within these six divisions, Statistics Canada identifies hundreds of smaller groups of specialized activities each of which includes a large number of stores that provide similar goods and services and operate in the same fashion. Given a base population of activities, these stores can be sampled and extrapolated to provide overall estimates of waste generation.

TABLE 3: LIST OF THE 13 SIC CODE MAJOR STUDY GROUPS

Major Group		Description
17	-	Leather and Allied Products Industries.
28	-	Printing, Publishing and Allied Industries.
48	-	Communications Industry.
56[1]	-	Metals, Hardware Plumbing, Heating and Building Materials Industry, Wholesale
60	-	Food, Beverage and Drug Industries, Retail.
61	-	Shoe, Apparel, Fabric and Yarn Industries, Retail.
62	-	Household Furniture, Appliances and Furnishings Industries, Retail.
63	-	Automotive Vehicles, Parts and Accessories Industries, Sales and Service.
65	-	Other Retail Store Industries (i.e. Florist Shops, Jewellery Stores etc.).
70	-	Deposit Accepting Intermediary Industries (i.e. Banks, Trust Companies).
91	-	Accommodation Service Industries.
92	-	Food and Beverage Service Industries.
96	-	Amusement and Recreational Service Industries.

[1]Retail hardware and building supplies are designated as wholesale activities in the SIC classification

In contrast, the primary manufacturing and wholesaling divisions are fewer in number and far more diverse in size and specialization. This is because they are not directly tied to or restricted by the size and requirements of local markets; i.e., those in close spatial proximity to the manufacturing or wholesaling activity. A factory may produce goods for markets across the continent using processes and materials that are quite different from a neighbouring plant--even if the plant has the same industrial classification. Some municipalities have many factories; others have virtually none. Waste generation by such activities must be studied on a site-by-site basis.

While many educational, health, and local governmental services serve local residents, some activities, such as universities or major hospitals, have been excluded from this study. As well, the lawn and yard maintenance service sector was not sampled in the present study.

The six divisions in this study include 32.8 percent of the total employment in the Regional Municipality of Waterloo. Divisions J and Q, which were sampled most thoroughly, include 18.1 percent of the total. Commercial activities are numerous and represent a significant component of the economic base of every community.

Statistics Canada further disaggregates these six divisions of commercial activity (which are included in the study) into 27, two-digit SIC codes, each representing a familiar group of retail or service activities. In order to get the most information from a limited number of samples, these two-digit groups were further aggregated and disaggregated as shown in Table 3. The general principles applied here were to aggregate those groups that appeared to have similar waste generation patterns, and to disaggregate those that had varied rates of waste generation. For example, the automotive group (SIC 63) was disaggregated to reflect fundamentally different kinds of operations in dealerships, garages and gas stations. Group 64 was estimated from the results for groups 61 and 62. Among financial services, only banks were sampled. Hotels and restaurants were each disaggregated to see if different waste generation patterns could be identified. The final results will identify further sub-groups which are discussed later.

In addition, a limited number of samples explored economic activities lying outside the targeted divisions. Building supply stores (SIC 56) were sampled within the framework, but are formally classified as wholesale activities within the SIC. They are excluded from the expansion of the sample for the municipal total. The printing and publishing manufacturing group (SIC 28) was also sampled.

2.2.2 Extrapolation of Sample Data to a Municipality

The problem of extrapolating the results from the waste generation samples to project the waste generation for an entire area or regional municipality is complicated by the lack of information that describes the overall magnitude of commercial activity. There is no Census of Retail and Service Activity, or its equivalent. Instead, data on commercial employment obtained from several different sources must be adapted to the problem. It should be underlined that the procedures used for this extrapolation may vary from place to place, depending on the mix of information that is available.

The starting point is the Census of Canada, 1986 (soon to be superseded by the 1991 version) for the residential population. For a twenty percent sample of households, each person over 15 is asked about employment; e.g., what kind of firm? These data are coded to the SIC categories. For each Census Metropolitan Area (CMA) we know how many people work in which kinds of activities is known. Unfortunately people do not always work in the same municipality where they live. If the municipality is isolated from other places (e.g., Timmins) the assumption can be made that the residents work in the same municipality that they reside; if it is embedded within a larger economic region (e.g., the City of Toronto or the City of Waterloo) further adjustments must be made. One could shift the scale of analysis from the smaller area municipality to the region as a whole (e.g., the Greater Toronto Area, the Region of Waterloo) or one could turn to other sources of data on employment. The Ministry of Transportation has compiled journey-to-work data for the major urban regions in Ontario that indicates how many people work in one community (e.g., the City of Cambridge) and live in another (e.g., the City of Waterloo), but these data are not broken down by SIC. Or there may be regional employment surveys that indicate how many jobs of various kinds are found in each component municipality--although they do not always use the same breakdown of commercial activities as Statistics Canada's SIC. The problem, then, is complex; and may require local expertise.

In the present study in the Region of Waterloo, the starting point was the Census of Canada material, augmented by the Region of Waterloo employment survey to provide more spatial data, and Statistics Canada's Labour Force survey, to provide a temporal update. The amount of spatial or temporal detail required will depend on the application of the information.

While there was no alternative to the use of employment data to link the waste generation sample to the projections for the municipalities, the relationship between employment and the volume of commercial activity is very strong (ref. 8). Sales, floor area, and employment are consistently linked together very closely. In the present work, employment is simply the total number of workers, both part-time and full-time--as defined by Statistics Canada. The ratio of part-time to full-time employees is consistent across each SIC sector, and the number of each type of employees should vary through time with the level of sales. Both employment and sales vary slightly from season to season (depending on the type of commercial activity). Early summer data (as used herein) provide a reasonable proxy for the annual levels as indicated by indices of seasonality computed by Statistics Canada (see ref. 16). These indices allow us to calibrate the seasonal effects at other times of the year.

2.2.3 Statistics Canada Employment Data

The Census of Canada, 1986 gathers information about occupation, type of firm and place of work from a twenty percent sample of households. A special tabulation of these data provided information about the number of employees in 36 different commercial sectors for each CMA in Ontario. The basic tabulation is by place of residence, which is not a problem for a regional municipality as a whole, but other "journey-to-work" tabulations indicate how this employment is allocated by municipality within the Region. These data can be updated by reference to the monthly survey of "The Labour Force" which estimates employment for each CMA, including Kitchener-Waterloo.

2.2.4 Regional Municipality of Waterloo Planning Information

The Regional Municipality of Waterloo, encompassing the cities of Kitchener, Waterloo and Cambridge, and four smaller Townships of Woolwich, Wilmot, Wellesley and North Dumphries, is located about 110 kilometres west of Toronto and about 60 kilometres northwest of Hamilton. The population of the Region (1988 Municipal Directory information) was 342,030. Information from an employment survey conducted by the Region's Planning Department provided additional information about the number of firms and employment in commercial activity in each of the local municipalities within the Region in 1989. The sectoral categories differ slightly from those used by Statistics Canada so the data could not be used directly in the estimate of waste generation. Instead, the information was used to estimate the share of Regional waste that is generated by each municipality.

2.3 Field Work: Methods

2.3.1 Personnel

The field crew consisted of three people; two were university graduates in environmental science and one was a college student in mechanical engineering technology. A basic background in science or engineering was deemed desirable because of the quantitative aspect of the work. The commercial portion of the Ontario Waste Composition Study was an exercise in quantitative analysis of commercial wastes conducted under field conditions, using skills learned in technical courses that are part of science and engineering education.

The crew received instruction on recognizing the categories of plastic and paper from R. Buggeln (Superintendent of Industrial/Commercial Waste Reduction), Region of Waterloo. Because the focus of the waste composition study was on method development, the crew was instructed to be critical of their procedures. The crew was encouraged to set aside all materials that were difficult to categorize, describe them in writing and include them in a 'miscellaneous' category (see Section 2.3.7 below).

2.3.2 Contacting Businesses

The field crew had considerable familiarity with a variety of businesses in the Region of Waterloo and they were able to recommend many companies to contact for the study; the Yellow Pages in the phone directory were also consulted for the names of firms. The decision on how best to approach businesses was left up to the field crew, after considering two alternatives: (a) contact by telephone and (b) direct company visits.

The field crew quickly realized that the most practical and efficient method of obtaining permission from local businesses to participate in the study was from a personal visit from the crew members themselves. The approach of contacting the firms by telephone was very time consuming and was inherently very unsuccessful. In the direct approach, store owners or managers could see first hand, who they would be dealing with. The waste study could be discussed in detail and questions could be answered and the logistical problems at each location could be assessed. A business card from the Region's Recycling Office legitimized the crew's intentions and a rapport between the field crew team and the business could be established. In fact, more than 90% of the businesses directly approached agreed to participate in the study.

2.3.3 Scheduling Waste Collection

One objective of the study was to obtain a "snap shot" of the composition of waste generated in a week by commercial businesses. Therefore, waste collections for the study were tailored to the waste collection for each business. In the simplest case (i.e., once a week collection), the crew visited the company 12 to 18 hours before the bulk-lift refuse bin was scheduled for dumping and removed the accumulated waste. Whenever Monday was the collection day, the crew had to make their collection on Sunday.

Many businesses had to be visited 3 or more times in order to obtain a week's worth of waste. In some cases, businesses stored their waste, especially if the putrescible content was low, in order to save the crew repeated trips.

2.3.4 Special Documentation

A letter from the Ministry of the Environment authorized the collection of the waste from commercial businesses for purposes of the composition study. The private waste hauler participating in the study requested and received a letter from the Region confirming the confidentiality of the waste information obtained in the study.

The procedure to obtain Ministry approval for solid waste sample collection by municipalities undertaking waste composition studies is as follows:

A letter requesting Ministry approval for temporary collection of solid waste samples shall be mailed by the interested municipality to:

Mr. Dave Crump
Operations Coordinator
Operations Division
Ministry of the Environment
14th Floor, 135 St. Clair Ave., West
Toronto, Ontario
M4V 1P5

The letter shall include, but not be limited to the following type of information:

- Background and reasons for undertaking the study.
- Study objectives.
- Study approach.
- Contractor's name.
- Collection area.
- Approximative number of samples to be collected.
- Approximative weight of each sample.
- Estimated duration of the project.

2.3.5 Equipment Used in the Waste Study

The following list of equipment includes a rented vehicle and purchased equipment:

one - 4.3 m. (14 ft.) cube van (for collection of bagged refuse);

one - electronic platform scale (150 kg capacity, Accu Weigh Model PAK-150 (electronic, battery operated scale with digital read-out), Exact Weight Scale Inc., Toronto, Ontario);

one -electronic bench scale (500 g capacity, Accurat, model 3670) one - chicken wire "crib": 1.2 m. (4 ft.) x 1.2 m. (4 ft.) x 1.3 cm. (1/2 in.) plywood base; 0.6 m. (2 ft.) high chicken wire and 2.5 cm. (1 in.) x 5.1 cm.(2 in.) furring sides. Nailed to the underside of the crib floor was a square frame which permitted the crib to be centred on the bed of the platform scale; the crib was used for weighing the refuse as it was being collected from the firms;

40 - 30 litre polyethylene garbage cans; these were used as containers into which sorted refuse was placed;

one - broad-mouth aluminum shovel; used for cleaning up spills;

one - broom; used for cleaning up spills and sweeping out the vehicle;

one - staple gun and 0.95 cm. (3/8 in.) staples for construction and repair of chicken wire dividers and crib;

one - claw hammer; 5.1 cm. (2 in.) common nails: used in the construction of the crib.

Personal Safety Equipment:

a) Certified steel toe safety boots
b) Coveralls
c) Orange safety vests
d) Hard hats (at the landfill)
f) Rubber safety gloves
g) Particle filter masks (dust in garbage bins)
h) Complete first aid kit (in truck)
i) Tetanus/polio vaccination (optional: diphtheria, Hepatitis A and B).

2.3.6 Waste Collection Methods

In the Regional Municipality of Waterloo, private waste haulers are usually contracted to remove the waste from commercial businesses, except in the downtown core of Kitchener and Waterloo where waste collection was three times per week or daily, respectively. The commercial haulers provided bulk-lift refuse containers of various sizes (2 to 8 cubic yards) in which a firm's waste was accumulated and picked up as required. In most cases, wastes were placed, loose, into the bulk bins; several businesses used compactor type bulk refuse containers.

Waste sampling procedures varied depending on whether the waste was loose or compacted. In the former case, the entire contents of the container were unloaded, weighed in a chicken wire wood "crib" mounted on a scale (see Figures 2 and 3) and placed in 4' x 4' x 4' heavy duty corrugated containers ("gaylords") in the back of a cube van and taken to the Waterloo landfill site (parking lot of the Recycling Office) for sorting (see Figure 4).

Unloading waste from a compacted entanglement of loose and bagged refuse in a 6 or 8 cubic yard bin was very difficult. It was decided that only half of the contents of the bin could be conveniently and efficiently unloaded and weighed, given the arduous task and the time requirement. The weight of the entire bin was estimated on a volume basis from the weight of the sample that was removed, i.e., usually several hundred kilograms. All loose waste was set aside for sorting; bags of refuse were randomly placed into two piles, with an equal number of bags in each pile. One pile was randomly selected for sorting, the other pile was returned to the bin. (See Section 2.3.4)

2.3.7 Sample Sorting and Data Management

The commercial waste composition data sheets (Table 4) were used for logging the weights of the various waste materials encountered in the samples. After sorting the waste into categories, each category was weighed and its relative contribution to the total sample weight was determined, i.e., percent of the waste composition. Waste materials that could not be easily categorized, were separately identified (described and weighed) on a "miscellaneous" table, accompanying the main waste composition table for each sample. The total weight of materials in the "main" and "miscellaneous" lists equalled 100% of the sample weight.

TABLE 4: WASTE COMPOSITION DATA FIELD SHEET

Town:
SIC:
Sample # :
Collection Dates:

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Category				
(1) Paper (a) Newsprint (b) Fine Paper / CPO / Ledger (c) Magazines / Flyers (d) Waxed / Plastic / Mixed (e) Boxboard (f) Kraft (g) Wallpaper (h) OCC (i) Tissues				
(2) Glass (a) Beer (i) refillable (ii) non-refillable (b) Liquor & Wine Containers (c) Food Containers (d) Soft Drink (i) refillable (ii) non-refillable (e) Other Containers (f) Plate (g) Other				
(3) Ferrous (a) Soft Drink Containers (b) Food Containers (c) Beer Cans (i) returnable (ii) non-returnable (d) Aerosol Cans (e) Other				
(4) Non-Ferrous (a) Beer Cans (i) returnable (ii) non-returnable (iii) American (b) Soft Drink Containers (c) Other Packaging (d) Aluminum (e) Other				
(5) Plastics (a) Polyolefins (b) PVC (c) Polystyrene (d) ABS (e) PET (f) Mixed Blend Plastic (g) Coated Plastic (i) Nylon (i) Vinyl				
(6) Organic (a) Food Waste / Rodent Bedding (b) Yard Waste				
(7) Wood				
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos				
(9) Diapers				
(10) Textiles/Leather/Rubber				
(11) Household Hazardous Wastes (a) Paints / Solvents (b) Waste Oils (c) Pesticides/Herbicides				
(12) Dry Cell Batteries				
(13) Kitty Litter				
(14) Miscellaneous				
	TOTAL kg		TOTAL kg	

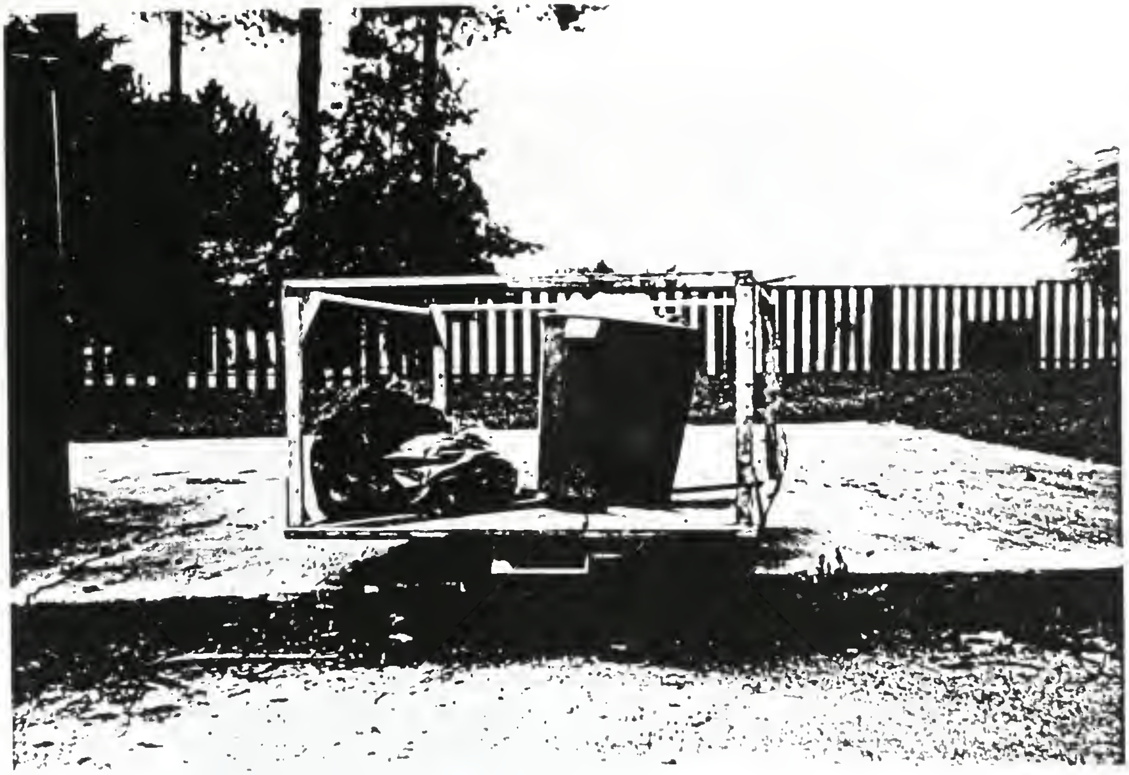


FIGURE 2: WEIGHTING COMMERCIAL WASTE IN A CRIB MOUNTED ON AN ELECTRONIC DIGITAL SCALE

FIGURE 3: REMOVING WASTE FROM A COMMERCIAL WASTE BIN

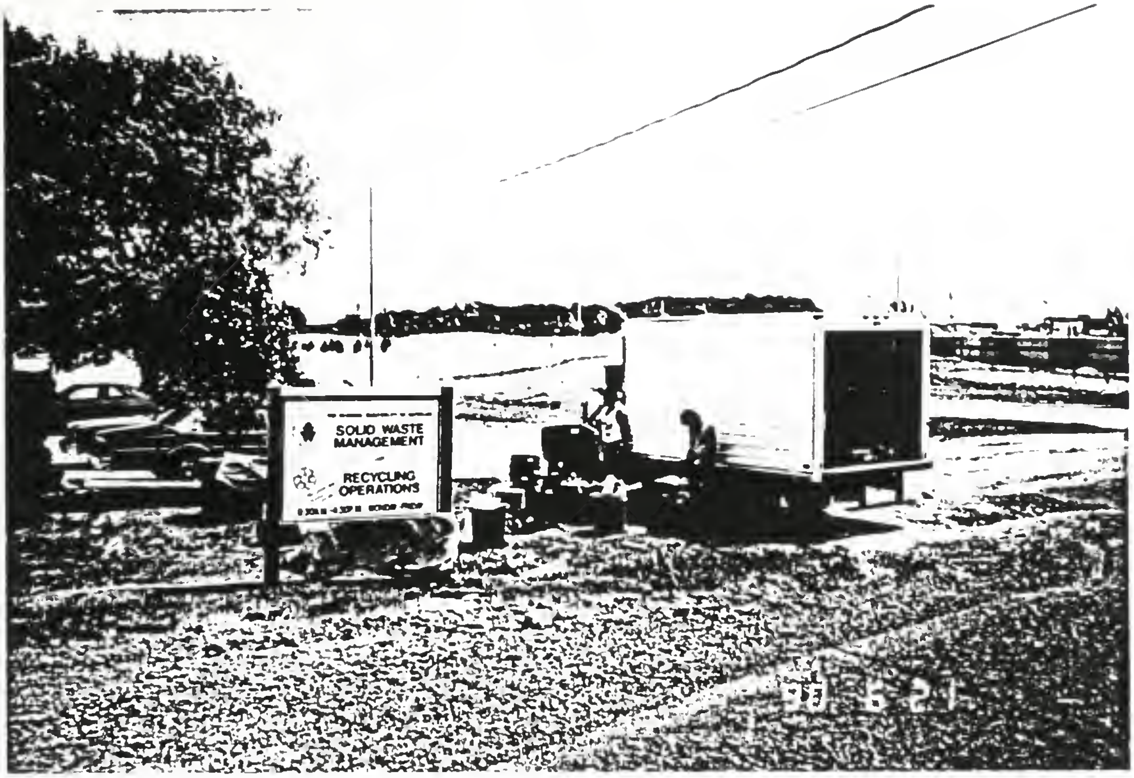


FIGURE 4: SORTING A WASTE SAMPLE AT THE LANDFILL SITE

SECTION 3

RESULTS

3.0 <u>RESULTS</u>

3.1 <u>Waste Composition of Commercial Groups</u>

A brief summary of the principal components in the waste streams from each of the two-digit SIC commercial groups is presented in the following sections. Each SIC group is listed separately. A complete waste composition for each of the samples is included in Appendix B. Table 7 summarizes the waste compositions of the 16 SIC groups.

The principal components of the waste streams sampled are in the following sections. Where more than one sample was taken, the mean percentage is shown ("n" indicates the number of samples sorted).

3.1.1 SIC 17--Leather and Allied Products Industries

SIC 1712--footwear manufacturer (n = 1)

The principal components, by weight, of the waste sampled from footwear manufacturing firms were:

textiles/leather/rubber 48.2%
wood 13.7%
OCC 12.0%

2.3.8 Data Obtained for Per Employee Waste Generation Rates

Two sampling methods were used to determine the quantity of waste generated at each firm. In the first method, the field crew weighed the waste in the refuse containers before putting the waste in the cube van for removal to the Waterloo landfill site for sorting. As noted above, the frequency of waste collection at each firm was obtained from the owner or manager. The field crew obtained the employment figure for each business at the time of the interview or by telephone.

When it was not possible to obtain the number of full- and part-time personnel from each firm, we used the figures for total employment were used in the regressions of employment versus waste quantity. This is compatible with the data gathered by Statistics Canada.

The first method enabled us to get waste quantity information from small and medium size businesses. The method was very labour intensive and time consuming but worked well for small loads of loose waste. The method was not satisfactory for refuse compacted in 6 to 8 cubic yards containers. The latter containers were frequently encountered at some of the larger locations.

The second procedure was applicable to all bulk containers irrespective of bin size or degree of waste compaction. A scale initially developed to weigh loads of sand and gravel carried in the scoop of a front end loader has been adapted for use on overhead (front-end) loading garbage trucks. The scale works off of the hydraulic lift system that raises and lowers the arms of the bin hoist. A Wray-Tech Model WT4000/6000 (obtained from Woolsey Equipment Sales Ltd., Ottawa) was installed on an overhead packer truck and calibrated with the assistance of the Toledo Scale Company, Hamilton, Ontario.

The bulk waste weighing procedure was a two-step process. First, the bin and waste contents were weighed. Then the contents of the bin were dumped into the truck and the empty bin was weighed. The weight of the bin contents was determined by subtracting the weight of the empty bin from the weight of the bin plus contents. Again, employment data were obtained for these firms, either by telephone or directly visiting these firms after the waste had been collected.

As noted above, participants in the study were assured of confidentiality of the waste generation and composition information. (NOTE: no locations will be identified by name in this report).

Bin collection frequency was determined from the hauler's records and a daily generation rate (kg/day) of waste was determined for each firm. At the conclusion of the field work, the employment and waste generation data were plotted on separate graphs for each of the commercial groupings. The length of the "work week" was different for different SIC groupings. Some businesses are open 7 days a week (restaurants, hotels, etc.) and some for 6 days (supermarkets, banks, automobile dealerships, etc.). Some printing shops were the only commercial businesses included in our study that operated on a 5-day work week.

2.4 Estimates of Average Per Employee Waste Generation Rates

Each sample observation provided information on the number of employees and the total weekly waste generation for the establishment. This permits two different kinds of statistical generalization. First, it is possible simply to divide the total waste by the number of employees to obtain an estimate of waste generation per employee. Several of these estimates can then be used to determine average values and standard deviations.

Second, more information can be extracted by plotting total waste against employment for each observation. This provides: (1) a visual pattern of the overall variability in the results, an evaluation of the relation between waste generation per employee and size of store (e.g., are big stores more or less efficient with respect to waste generation?); (2) a measure of the waste reduction efficiency of individual stores relative to the group; and (3) an evaluation of the effectiveness of the sample selection in relation to store size.

By fitting a regression line to the graph we obtain another measure of the regularity of waste generation, i.e., the regression coefficient r^2. Another estimate of the relation between waste generation and number of employees is the slope of the regression line (b).

In the next step in the analysis, estimates of waste generation per employee are used to estimate total waste generation within the study area. Either the mean value of waste per employee or the regression slope (b) could be selected. The regression slope was used as long as it was adjudged reliable; otherwise the mean value was used. The reliability depends on both the regression coefficient (over 0.5) and the scatter of observations on the graph. A sample with a wide variety of different stores sizes was deemed acceptable. Those where the observations were clustered together around the same size store were rejected. In the ideal case, where there is perfect correlation between waste generation and employment, the intercept (a) is expected to be zero and the mean value should equal the regression slope (b). For further discussion of regression analysis the reader should consult Modern Elementary Statistics (ref. 6).

2.4.1 Estimates From Average Waste Weight Per Employee Data

For each SIC group of commercial business, the daily waste weight generated at each firm was divided by the number of employees to obtain the weight of waste per employee per day. An average estimated waste generation rate ($\pm$ 1 Standard Error) was calculated for the SIC sector from the sample data.

2.5 Estimation of Waste Generation by Commercial Sector in the Regional Municipality of Waterloo

The estimation of commercial waste generation for the Regional Municipality of Waterloo combines two kinds of information. First, various employment data are used to estimate total commercial employment and employment for various types of commercial activity in municipalities within the Region. Second, the field work provides estimates of the amount of waste generated per employee by type of commercial activity. By combining these two kinds of information the final estimate of commercial waste generation is obtained for the Region and its area municipalities.

Consider the breakdown of employment by municipality (Table 5). Note first, the great size range among spatial units. Kitchener is approximately ten times the size of Woolwich and almost 100 times larger than Wellesley. It is much more important to make accurate estimates for the larger places than for the smaller ones. Second, the share of employment in commercial jobs ranges from 30.2 percent in industrial Cambridge to 41.7 percent in Kitchener with its downtown concentration.

(Note: Familiarity with the local economic structure is required to make minor adjustments to Statistic Canada employment information where needed).

For the Region as a whole, the share of commercial jobs was 32.8 percent in the 1986 Census and 38.7 percent in 1989 according to the Region's Planning Department--a difference that reflects variations in definitions in the two data sets. Despite these differences, the regional employment survey permits us to estimate the share of regional commercial employment to be allocated to each municipality (see the fourth column titled % Jobs in Table 5). This should assist in estimating the share of commercial waste generation.

TABLE 5

ESTIMATE OF COMMERCIAL WASTE GENERATION
IN THE REGION OF WATERLOO
(AS STUDIED)

Place	1989 All Jobs[a]	Commercial[b]	%	% Jobs	Regional Share Waste (kg./wk.x 10^3)
Woolwich	6700	2900	43.8%	4.2%	61.7
Waterloo	42300	17500	41.3	25.3	371.8
Kitchener	79700	33200	41.7	47.9	703.8
Cambridge	43700	13200	30.2	19.0	279.2
N. Dumfries	1900	450	24.0	0.6	8.8
Wilmot	4000	1650	40.0	2.4	35.3
Wellesley	900	400	39.9	0.6	8.8
Regional Munic.	179300	69300	38.7	100.0	1469.4
(Kitchener CMA	174400	67300	38.6	97.1	1426.8)

---

[a] Department of Planning, Regional Municipality of Waterloo, "Employment Survey, 1989".

[b] Jobs in the following categories: retail (502), repair (503), finance (601), services (602), technical (605) and social (606) organizations, recreation (700).

2.6 Sources of Potential Error in Employee Waste Generation Estimates

Table 6 lists the kinds of errors that will affect the accuracy of the employee waste generation estimates presented herein. An estimate of the magnitude and "direction" of the error is also given.

TABLE 6 ACCURACY IN WASTE ESTIMATION - SOURCES OF POTENTIAL ERROR

Type of Data	Type of Error	Magnitude of potential error (%)[1]	Bias	Level of Observation
Census Employment	Undercounting	2-5	negative	CMA, sector
	Misclassification	5 (?)	neutral	sector
	Employment Definition	5 (?)	positive	CMA, sector
	Location (JTW)[2]	5-10	small places	municipality
Labour Force Survey	Sampling Error	2-5	neutral	CMA
	(largely eliminated by tracking monthly estimates over time)			
Regional Employment Survey	Reporting & Tabulating	up to 10	neutral	municipality, sector
	Misclassification	up to 10	neutral	sector
	Employment Definition	minor		municipality, sector
Waste Survey	Sampling Error	standard deviation up to 15%	neutral	store
	Measurement	5 (?)	?	store
	Classification	10	10 (?)	store

[1]Best estimate based on professional judgement (J. Simmons)
[2]Journey-to-work

SECTION 3

RESULTS

	1	2	3	4
Paper				
Newsprint	2.69%	0.60%	5.57%	16
Fine Paper/CPO/Ledger	1.24%	70.88%	35.10%	3
Magazines/Flyers		0.13%	2.51%	
Waxed/Plastic/Mixed	1.24%	8.99%	16.41%	2
Boxboard	1.24%	2.15%	1.84%	10
Kraft	3.52%	4.06%	0.52%	4
Wallpaper				
OCC	12.01%	4.00%	6.31%	28
Tissues	2.28%	0.65%	2.36%	4
Glass				
Beer				
refillable				
non-refillable	2.07%			
Liquor & Wine containers				0
Food Containers	2.07%	0.29%	2.22%	1
Soft Drink				
refillable				0
non-refillable		0.13%	0.44%	3
Other Containers				
Plate				
Other				
Ferrous				
Soft Drink Containers	0.15%	0.06%	0.28%	1
Food Containers		0.18%	2.24%	0
Beer Cans				
returnable				
non-returnable				
Aerosol Cans				
Other		0.45%		0
Non-ferrous				
Beer Cans				
returnable				
non-returnable				
American				
Soft Drink Containers	0.07%	0.04%	0.23%	0
Other Packaging				
Aluminum		0.08%		0
Other				0
Plastics				
Polyolefins	1.24%	1.02%	5.31%	5
PVC				
Polystyrene	2.90%	0.08%	0.99%	0
ABS				
PET				0
Mixed Blend Plastic		0.01%	0.82%	0
Coated Plastic			0.07%	0
Nylon				
Vinyl		0.13%		
Organic				
Food Waste/Rodent Bedding	4.55%	3.83%	14.40%	15
Yard Waste				
Wood	13.66%	0.09%	0.70%	0
Ceramics/Rubble/Fiberglass/Gypsum Board/Asbestos				
Diapers				0
Textiles/Leather/Rubber	48.23%	0.61%	0.22%	
Household Hazardous Wastes				
Paints/Solvents	0.28%	1.05%		
Waste Oils				
Pesticides/Herbicides				
Dry Cell Batteries				
Kitty Litter				
Miscellaneous	0.84%	1.25%	0.42%	0
TOTAL	100.00%	99.99%	100.01%	10

LEGEND

Column #	Code	Industry Type
1	1712	(footware industry)
2	2819	(other commercial printing industry)
3	4813	(combined radio/television etc.)
4	6011	supermarket
	6012	grocery stores
	6019	specialty food stores i.e. health food
5	6111	shoe stores
	6149	other clothing stores i.e. leisure wear
	6151	fabric and yarn stores
6	6211	household furniture stores with appliances/furnishings
	6212	household furniture stores without appliances/furnishings
	6223	appliance, television, radio, and stereo repair shops
	6231	floor covering stores
	6239	other furnishing stores i.e. linen, glassware etc.
7	6311	"New" automobile dealers
8	6331	gasoline service station - specifically gas bars
9	6351	general repair garages
	6352	paint/body repair shops
	6353	muffler replacement shop
	6342	fire, battery, parts/accessories, stores
10	6521	florist shops
	6542	bicycle shops
	6562	watch/jewellery repairs shops
	6591	second-hand merchandise stores
11	7021	chartered banks
	7031	trust companies
	7051	local credit union
12	9111	hotels/motor hotels
	9112	motels
13	9211	licensed restaurant
14	9213	general take-out food services
15	9213	specialized take-out food services i.e. hamburger retaurants
16	9621	regular motion picture theatres
	9691	bowling alleys/billard parlours
	9692	amusement parks; carnivals
	9699	other amusement/recreational services i.e. horseback riding operations.

*Raw data in Appendix B

TABLE 7 AVERAGE WASTE COMPOSITION (%) DATA FOR COMMERCIAL SIC GROUPS*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Paper																
Newsprint	2.69%	0.60%	5.57%	16.78%	14.61%	1.38%	6.23%	12.76%	3.32%	7.63%	4.17%	14.44%	1.16%	6.56%	0.44%	1.22%
Fine Paper/CPO/Ledger	1.24%	70.88%	35.10%	3.18%	3.90%	5.24%	5.26%	5.19%	2.12%	5.76%	52.99%	2.74%	1.07%	0.14%	0.48%	1.95%
Magazines/Flyers		0.13%	2.51%		4.52%	1.46%	0.55%	0.08%	0.61%	1.02%	0.19%	0.52%				1.24%
Waxed/Plastic/Mixed	1.24%	8.99%	16.41%	2.22%	1.65%	0.89%	2.62%	3.75%	2.27%	2.33%	5.89%	4.30%	0.52%	2.43%	7.3%	5.99%
Boxboard	1.24%	2.15%	1.84%	10.68%	15.26%	1.95%	2.57%	2.57%	3.73%	4.98%	1.48%	5.61%	0.65%	5.23%	5.94%	7.79%
Kraft	3.52%	4.06%	0.52%	4.23%	1.64%	0.99%	3.49%	1.01%	5.56%	1.43%	1.15%	2.94%	0.36%	3.03%	4.66%	1.07%
Wallpaper																
OCC	12.01%	4.00%	6.31%	28.37%	28.65%	48.94%	14.8%	14.28%	7.39%	24.10%	4.35%	10.26%	8.84%	9.36%	27.97%	9.13%
Tissues	2.28%	0.65%	2.36%	4.34%	6.34%	0.42%	3.49%	6.44%	1.05%	2.57%	2.29%	5.03%	2.64%	3.97%	4.63%	6.38%
Glass																
Beer																
refillable							0.11%		0.15%			0.93%	0.18%	0.08%		0.03%
non-refillable	2.07%				0.65%							0.64%	2.17%			
Liquor & Wine containers				0.18%	0.32%		0.03%					4.44%	8.33%	0.09%		1.63%
Food Containers	2.07%	0.29%	2.22%	1.70%	1.58%	0.15%	0.47%	2.49%	0.95%	2.44%	5.35%	2.69%	9.85%	0.83%	7.24%	1.17%
Soft Drink												0.63%			0.46%	
refillable				0.29%								2.15%				
non-refillable		0.13%	0.44%	3.37%	0.45%	0.08%	0.55%	4.28%	0.61%		0.52%			0.17%		0.43%
Other Containers					0.04%		0.22%		0.08%							0.04%
Plate																
Other						1.23%						0.69%	0.94%	0.09%		0.2%
Ferrous																
Soft Drink Containers	0.15%	0.06%	0.28%	1.16%	0.46%	0.36%	0.45%	0.53%	0.65%	2.15%	0.96%	1.82%		0.39%	0.06%	0.72%
Food Containers		0.18%	2.24%	0.28%	0.16%	0.03%		0.14%	0.12%		0.22%	0.41%	1.11%	2.74%	3.64%	0.68%
Beer Cans																
returnable							0.13%					0.0005%			0.01%	
non-returnable					0.01%							0.46%				
Aerosol Cans						0.02%	0.15%		0.18%	0.17%		0.17%				0.04%
Other		0.45%		0.01%	0.02%	5.09%	25.09%	0.49%	11.91%	0.66%	0.26%	0.24%	0.04%		0.26%	1.29%
Non-ferrous																
Beer Cans																
returnable								0.04%	0.12%			0.53%	0.01%			0.02%
non-returnable						0.005%						0.01%				0.01%
American									0.004%			0.02%				
Soft Drink Containers	0.07%	0.04%	0.23%	0.34%	0.25%	0.06%	0.20%	1.83%	0.20%	0.61%	0.13%	1.16%	0.01%	0.02%		0.35%
Other Packaging												0.02%	0.03%			
Aluminum		0.08%		0.02%	0.01%	0.004%	0.02%	0.08%	0.01%	0.03%		0.18%	0.23%	0.02%		0.03%
Other				0.01%		0.01%	0.002%				0.16%	0.12%	0.03%			
Plastics																
Polyolefins	1.24%	1.02%	5.31%	5.21%	6.49%	6.76%	4.6%	25.05%	5.9%	5.44%	4.22%	6.57%	5.69%	4.28%	5.55%	4.59%
PVC																
Polystyrene	2.90%	0.08%	0.99%	0.69%	2.15%	0.42%	0.99%	0.77%	0.82%	2.34%	0.77%	2.08%	0.53%	2.55%	1.85%	2.24%
ABS						0.04%										
PET				0.06%								0.31%				0.15%
Mixed Blend Plastic		0.01%	0.82%	0.13%	0.28%		1.09%	2.03%	1.36%	0.29%	0.83%	0.29%	0.04%	0.36%	0.09%	0.04%
Coated Plastic			0.07%	0.15%			0.04%		0.02%			0.07%	0.01%		0.06%	
Nylon																
Vinyl		0.13%				0.13%										
Organic																
Food Waste/Rodent Bedding	4.55%	3.83%	14.40%	15.69%	2.24%	0.55%	3.07%	6.82%	1.23%	29.08%	13.24%	18.99%	54.76%	57.57%	28.26%	17.71%
Yard Waste																
Wood	13.66%	0.09%	0.70%	0.73%	2.36%	4.43%	3.89%		6.08%	0.25%		1.25%	0.63%			14.31%
Ceramics/Rubble/Fiberglass/Gypsum Board/Asbestos						0.03%	0.43%			0.12%	0.18%	0.17%	0.19%			0.06%
Diapers				0.17%	0.15%		0.01%	0.32%	4.81%			1.24%				0.52%
Textiles/Leather/Rubber	48.23%	0.61%	0.22%		2.02%	11.67%	4.37%	3.88%	12.53%	5.62%	0.44%	2.69%	0.01%		0.03%	2.4%
Household Hazardous Wastes																
Paints/Solvents	0.28%	1.05%				0.09%	2.54%	5.04%	1.52%							
Waste Oils							6.25%		4.53%							
Pesticides/Herbicides																
Dry Cell Batteries						0.002%						0.08%				0.03%
Kitty Litter												2.01%				
Miscellaneous	0.84%	1.25%	0.42%	0.02%	3.80%	7.59%	6.48%	0.12%	20.17%	0.99%	0.21%	1.09%	0.0%	0.09%	1.07%	16.52%
TOTAL	100.00%	99.99%	100.01%	100.01%	99.98%	100.02%	100.92%	99.99%	100.00%	100.01%	100.00%	99.99%	100.03%	100.0%	100.0%	99.95%

LEGEND

Column #	Code	Industry Type
1	1712	(footware industry)
2	2819	(other commercial printing industry)
3	4813	(combined radio/television etc.)
4	6011	supermarket
	6012	grocery stores
	6019	specialty food stores i.e. health food
5	6111	shoe stores
	6149	other clothing stores i.e. leisure wear
	6151	fabric and yarn stores
6	6211	household furniture stores with appliances/furnishings
	6212	household furniture stores without appliances furnishings
	6223	appliance, television, radio, and stereo repair shops
	6231	floor covering stores
	6239	other furnishing stores i.e. linen, glassware etc.
7	6311	"New" automobile dealers
8	6331	gasoline service station - specifically gas bars
9	6351	general repair garages
	6352	paint/body repair shops
	6353	muffler replacement shop
	6342	tire, battery, parts/accessories, stores
10	6521	florist shops
	6542	bicycle shops
	6562	watch/jewellery repairs shops
	6591	second-hand merchandise stores
11	7021	chartered banks
	7031	trust companies
	7051	local credit union
12	9111	hotels/motor hotels
	9112	motels
13	9211	licensed restaurant
14	9213	general take-out food services
15	9213	specialized take-out food services i.e hamburger retaurants
16	9621	regular motion picture theatres
	9691	bowling alleys/billard parlours
	9692	amusement parks; carnivals
	9699	other amusement/recreational services i.e horseback riding operations.

*Raw data in Appendix B

3.1.2 SIC 28--Printing, Publishing and Allied Industries

SIC 2819--printing (n=3)

The principal component, by weight, of the waste sampled from printing, publishing and allied industries was:

fine paper 71.0%
(some of the fine paper was contaminated with ink)

3.1.3 SIC 48--Communications Industry

SIC 4813--combined radio/television firm (n=1)

The principal components, by weight, of the waste sampled from communication firms were:

fine paper 35.1%
coated paper 16.4%
food waste 14.4%

The firm had cooking facilities for employees; staff worked in shifts and were on the premises throughout any 24 hour period.

3.1.4 SIC 60--Food, Beverage and Drug Industries (Retail)

a) SIC 6011--large supermarket (n=1)
b) SIC 6012--mid-size grocer (n=3)
c) SIC 6019--specialty food (n=1)

The overall waste composition for the three kinds of food stores was consistent, but there were large variations in the relative proportions of the components.

The principal components, by weight, of the waste sampled from the three types of food stores were: .

a) large supermarket:

food waste 53.0%

OCC 36.3%

b) mid-size grocers:

newsprint 27.1%

boxboard 14.6%

OCC 10.2%

food 8.2%

c) specialty food store:

OCC 75.0%

3.1.5 SIC 61--Shoe, Apparel, Fabric and Yarn Industries (Retail)

a) SIC 6111--shoe (n = 2);
b) SIC 6149--mens/womens clothing (n = 4);
c) SIC 6151--fabric/yarn (n = 2)

The major components, by weight, of the waste sampled for SIC 61 group were:

OCC 28.7%

boxboard 15.3%

In addition, the following observations were made regarding the principal waste components, from specific types of retail establishments:

a) shoe stores:

newsprint.. 14.4%

boxboard.. 26.6%

OCC...38.7%

b) mens/womens clothing industries (retail):

newsprint 19.7%

OCC 22.3%

c) fabric/yarn industries (retail):

boxboard 15.5%

OCC 31.3%

tissues 15.3%

3.1.6 SIC 62--Household Furniture/Appliance and Furnishings Industries (Retail)

a) SIC 6211--household furniture/appliances/furnishings (n = 1)
b) SIC 6212--household furniture, no appli./furnishings (n = 1)
c) SIC 6223--appliance, television, stereo repair shop (n = 1)
d) SIC 6231--floor covering store (n = 1)
e) SIC 6239--other furnishings, e.g., linen, glassware (n = 1)

On average, the major components, by weight, of the waste steams sampled in this SIC group were:

OCC 48.9%

textile/leather/rubber 11.7%

3.1.7 SIC 63--Automotive Vehicles, Parts and Accessories Industries (Sales and Service)

a) SIC 6311--dealerships (n = 6)
b) SIC 6331--service stations/gas bars (n = 3)
c) SIC 634--parts/accessories (n = 1)
d) SIC 635--vehicle repair (n = 3)

The waste streams for SIC group 63 contained an assortment of vehicle accessories and parts, e.g., gaskets, cables, air filters, mixed automotive plastics, spark plugs, lubricants, and paint spray cans (aerosol). A number of waste materials were not included in the survey because they were not recovered from the general refuse disposal bins. Nevertheless, they are part of the solid waste stream generated by this SIC sector. These wastes appeared to be stock piled for separate disposal, e.g., tires, oil/solvents in drums, scrap metal, and lead/acid batteries. These items were not quantified in the present study and could be included in subsequent work.

The principal components, by weight, of the waste streams for the SIC 63 group of industries sampled were:

a) dealerships:

ferrous 25.8%

OCC 14.8%

b) service station:

polyolefins 25%

OCC 14.3%

newsprint 12.8%

c) parts/accessories:

OCC 13.8%

ferrous 22.2%

textile/leather/rubber 19.6%

miscellaneous...................................... 16.8%
(used auto parts, filters, etc)

d) vehicle repair:

wood 10.1%

miscellaneous...................................... 22.4%
(used auto parts, filters, etc)

3.1.8 SIC 65--Other Retail Industries

a) SIC 6521--florists (n = 3)
b) SIC 6542--bicycle shop (n = 1)
c) SIC 6562--watch, jewelry repair (n = 1)
d) SIC 6591--second hand store (n = 1)

OCC and food/plant wastes were the dominant components of this SIC group. The following outlines specific SIC groups which were sampled and their respective principal components, by weight:

a) florists:

organic material 50.25%

OCC 18.51%

b) bicycle shop:

OCC 53.6%

textile/leather/rubber 23.6%

c) watch/jewelry repair:

OCC 35.1%

newsprint 24.2%

fine paper 12.1%

d) second-hand store:

Fine paper 17.0%

box board 13.3%

polyolefins 13.3%

food wastes 13.3%

3.1.9 SIC 70–Finance and Insurance Industries

a) SIC 7021--chartered banks (n=3)
b) SIC 7031--trust company (n=1)
c) SIC 7051--credit union (n=1)

The principal component, by weight, of the waste sampled from finance and insurance industries was:

fine paper 53.0%

It is significant to note that the trust company sampled produced no fine paper; in fact, this firm produced little waste. The total sample weight was 4.45 kg of which 52.1% was food waste. This may be the result of confidential documents being shredded and removed from the building. Future studies may consider addressing this diversion method of waste paper.

3.1.10 SIC 91–Accommodation Service Industries

a) SIC 9111--hotel/motor hotel (n=4)
b) SIC 9112--motel (n=2)

The presence or absence of restaurants partially determined the relative proportion of food wastes generated in this group; some establishments had efficiency units so food would also be processed/cooked at those locations.

The average principal components, by weight, of the waste streams of the hotels and motels sampled were:

food waste 19.0%
OCC .... 10.3% (ranged: 1% to 35%)
newsprint 14.4%

3.1.11 SIC 92--Food and Beverage Service Industries

a) SIC 9211-licensed restaurants (n = 3)
b) SIC 9213--take-out restaurants (n = 3)
c) SIC--hamburger take-out sit-down restaurants (n = 3)

The principal components, by weight, of the waste sampled from food and beverage establishments were:

a) licensed restaurants:

food waste 54.8%
glass 21.5%
OCC 8.8%

b) take-out restaurants:

food waste 57.6%
OCC 9.4%
newsprint 6.6%

c) "hamburger" take-out/sit down restaurants:

food waste 28.3%
OCC 28.0%
coated paper 7.3%

3.1.12 SIC 96--Amusement and Recreational Service Industries

a) SIC 9621--movie theatre (n = 1)
b) SIC 9691--bowling alley (n = 1)
c) SIC 9692--amusement park (n = 1)
d) SIC 9699--horseback riding (n = 1)

The four kinds of amusement activities are very different from each other and the composition of the waste streams have little in common. However, paper, food waste and plastics were predominant. Over the sector, the food waste component accounted for an average 17.7% of the refuse weight. The theatre generated a high percentage of coated paper (15.8%); wood waste, in the form of wood shavings (animal bedding) from the riding establishment was 45.6%.

3.2 Per Employee Waste Generation Rates

3.2.1 Overview Data Handling

For each company participating in the study, a daily, per employee waste generation rate was determined (kg per employee per day). The weight of waste generated by a company during one "work week" was divided by the number of days in their "work week", either 5, 6 or 7. The weight per day was divided by the total number of employees in the firm. An estimate of the employee waste generation rate per day for each SIC group, or sub-grouping, was obtained by averaging the information for all companies in the same SIC group or sub-grouping.

$$\frac{(kg/wk)}{6} = \text{weight per day}$$

$$\frac{\text{weight per day}}{\text{total no. of employees}} = \text{employee generation rate per day}$$

$$\frac{\text{sum: employee generation rates}}{\text{n (no. of employees)}} = \text{average employee generation rate per day}$$

For each two-digit SIC group or sub-grouping, the daily waste generation rate for each firm was also plotted against the number of employees. Linear regressions were calculated for the data and the resulting coefficients representing the employee waste generation rate (the coefficient b in the regression equation: $y = a + bx$) were compared with the estimates of daily waste generation for the SIC sector, determined by the averaging method.

In the following Sections (3.2.2 to 3.4), the per employee waste generation data are briefly evaluated with respect to the parameters of sample size, data scatter on the graph, regression coefficient and other anecdotal information which affected the decision to use either (1) the regression coefficient, b, or (2) the calculated average, for the SIC sector estimate of the rate of waste generation by employees in that sector.

Table 8 summarizes the estimation of waste generation presented in Sections 3.2.2 to 3.4 and should be referred to for the numerical calculations of the per employee waste generation rates. Figures 5 to 20, showing the distribution of the sample data for each SIC sector, are indicated in each sub-section heading. Numbered data points on these figures indicate sample numbers.

3.2.2 SIC Group 28--Printing, Publishing and Allied Industries (Table 11 & Figure 5)

Printing is considered a "light industry". Although the regression coefficient was 0.61, many data points were clustered at the low employment end of the scale. An average of all the data should be used as the waste generation estimate for the group, i.e., 4.9 kg/employee/day.

TABLE B ESTIMATION OF WASTE GENERATION BY COMMERCIAL SIC SECTORS

Commercial Sector Name	SIC code	Sample Size (n)	Regression Analysis a	Regression Analysis b	Regression Analysis r	r^2 (1)	Data averaging (mean)	Per Employee waste generation estimator	Commercial Sector Explanation for estimator choice	Working days per week	Value for b or mean multiplied by working days per week (kg/employee/wk)
Retail											
Printing	28	10	76.56	.35	0.657	0.37	4.9±	mean	data points clustered	6	
Building Supply	56	9	27.15	5.7	0.976	0.95	6.23±1.06	b	r value high	6	34.2
Specialty Food	60	28	51.66	9.85	0.839	0.70	7.85±1.27	b	regression acceptable	6	55.1
Small-Mid-size[2]	60	15	-20.26	7.66	0.867	0.75	5.82±1.73	b	regression acceptable	6	
Super markets[2]	60	11	558.4	6.1	0.490	0.24	12.2 ±1.54	mean	r value too low	6	
Clothes	61	8	2.06	0.6	0.587	0.34	0.75±0.17	b	regression acceptable	6	3.6
Furniture	62	6	7.39	0.76	0.739	0.55	1.49±	mean	single large observation biased regression	6	8.9
Automotive:											
Dealers	631	14	27.02	0.87	0.861	0.74	1.41±0.17	b	large n; large numbers of employees	6	5.2
Gasoline	633	3	0.69	0.22	0.614	0.36	0.36±0.06	mean	small n	7	2.5
Repair	635	22	30.12	-0.22	-0.117	0.01	4.60±0.08	mean	r value too low; samples clustered	6	27.6
General Retail[3]	64	-	-	1.05	-	-	-	-	-	6	6.8[3]
Misc. Retail	65	9	-4.42	6.7	0.365	0.13	4.94±2.46	mean	r value too low	6	29.6
Finance											
Banks	70	5	1.14	0.16	0.825	0.68	0.29±0.08	b	regression acceptable	6	.96
Other[4]	71-77	-	-		-	-	0.61	mean	see footnote 4	5	3.0
Hotels											
No Restaurant Efficiency units	91	6	30.40	0.13	0.058	0.003	6.21±1.43	mean	r value too low	7	43.5
With Restaurants	911	6	132.02	0.63	0.155	0.02	1.71±0.22	mean	r value too low	7	12.0
Restaurants	92	6	30.36	3.01	0.773	0.60	4.29±0.37	b	regression acceptable	7	21.1
Licensed[5]	(92)	30	38.64	2.68	0.769	0.59	4.25±0.14	b	regression acceptable	7	-
Unlicensed[5]	(921)	28	30.36	3.01	0.773	0.60	4.33±0.39	b	regression acceptable	7	
Entertainment	96	6	46.7	0.41	0.776	0.58	2.06±0.68	mean	data points clustered; single value biases regression	7	14.6
Other service Industries[6]	97-99	-	-	0.16	-	-	0.29±0.08	b	see footnote 6	6	.96

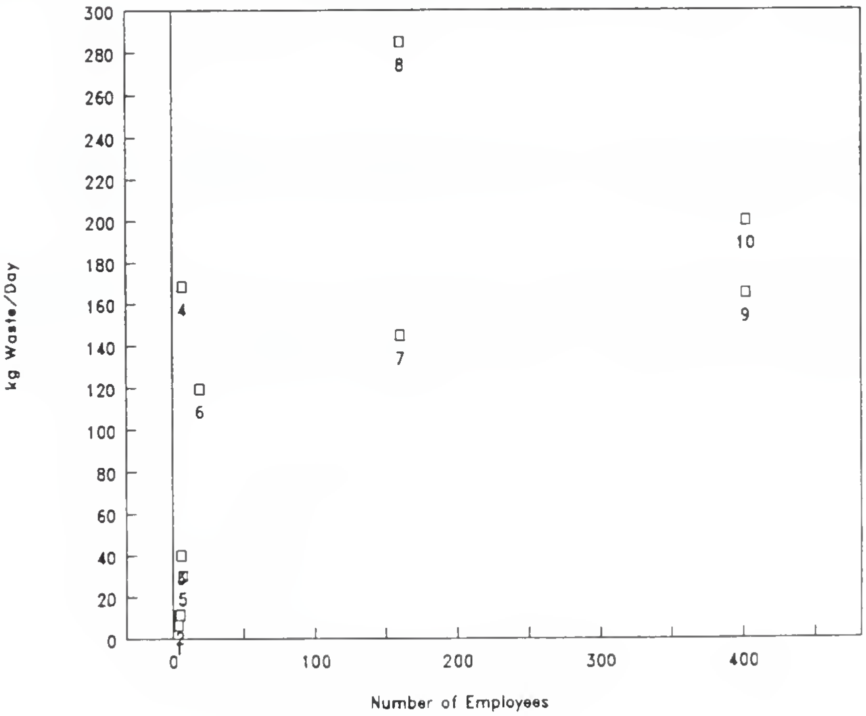
1 r^2 is the proportion of the variance of one variable y that can be explained by straight line dependance on the other variable x. For example, if r2=0.55, then the straight line dependance of the ys on the xs accounts for 55% of the variance of the ys.
2 The weekly waste generation estimate for this group is based on 9.2 kg/employee/day (see explannation in Section 3.2.4)
3 Estimate is the average of SIC 61 and 62
4 "See Section 2.4 in text; data from Onatrio Ministry of Government Services." (Note: data from study of government office buildings are tentative
5 All restaurant data
6 Waste generation was estimated to be the same as that for bank (SIC Group 70)

TABLE 11 *SIC GROUP 28, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE PRINTING, PUBLISHING AND ALLIED INDUSTRIES*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	4	6.73	1.68
2	5	11.66	2.33
3	6	40.00	6.67
4	7	168.33	24.05
5	7	30.00	4.29
6	19	119.56	6.29
7	160	145.00	0.91
8	160	285.00	1.78
9	402	165.00	0.41
10	402	200.00	0.50
		AVERAGE	4.89
		+/- SE	2.247

FIGURE 5: SIC GROUP 28.

GRAPH OF WASTE GENERATION DATA



3.2.3 SIC Sector 56 - Metals, Hardware, Plumbing, Heating and Building Materials Industries (Wholesale) (Table 12 & Figure 6)

Although this SIC group is considered as wholesale by the classification system, retail hardware and building supply stores have general retail activities as part of their business. Because the regression coefficient, r = 0.97, was strong, the regression estimate for the waste generation rate was used: 5.7 kg/employee/day.

3.2.4 SIC Group 60 Food, Beverage and Drug Industries, Retail (Tables 13 & 14, Figures 7 & 8)

Per employee waste generation rates for small/mid-size markets and variety stores is lower than that generated by larger "chain-store" supermarkets. For smaller/mid-size stores (Figure 7), the estimated rate was 7.7 kg/employee/day; for larger markets (Figure 8), the average rate was 12.2 kg/employee/day. The regression coefficient for the small store was 0.869 and 0.49 for the large markets. Regression analysis did not give a reasonable estimate for supermarket waste generation because of the scattered distribution of the data.

We have attributed 2/3 of the employment in this group to small and mid-size stores; 1/3 to the larger supermarkets. The waste generation estimate for the group is: 2/3 x 7.7 kg/employee/day + 1/3 x 12.2 kg/employee/day = 9.2 kg/employee/day.

3.2.5 SIC Group 61 - Shoe, Apparel, Fabric and Yarn Industries, Retail (Table 15 & Figure 9)

The regression coefficient of .0587 was judged to be marginally acceptable, giving an estimate of the waste generation rate of 0.6 kg/employee/day.

TABLE 12 *SIC GROUP 56, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE METALS, HARDWARE, PLUMBING, HEATING AND BUILDING MATERIALS INDUSTRIES (WHOLESALE)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	7	10.00	1.43
2	7	11.67	1.67
3	19	133.30	7.02
4	19	175.00	9.21
5	23	115.00	5.00
6	25	156.67	6.27
7	25	206.67	8.27
8	26	295.00	11.35
9	150	875.00	5.83
		AVERAGE	6.23
		+/- SE	1.089

FIGURE 6: SIC GROUP 56

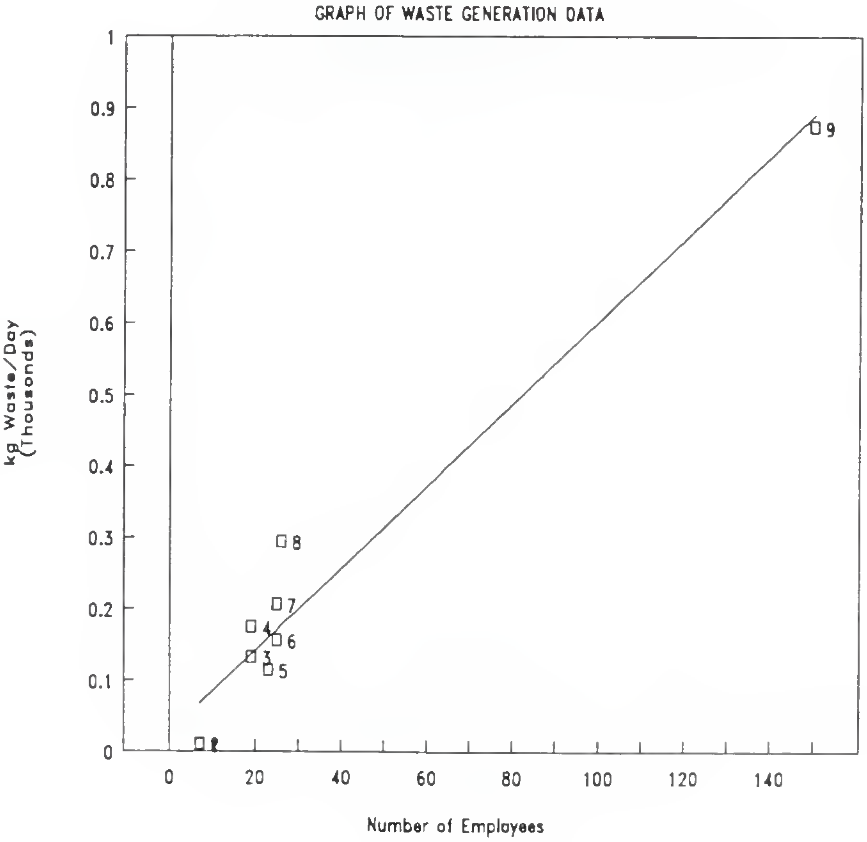


TABLE 13 *SIC GROUP 60, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE SMALL/MID-SIZE FOOD STORES (RETAIL)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	2	2.94	1.47
2	3	8.12	2.71
3	3	3.55	1.18
4	4	6.43	1.61
5	5	21.40	4.28
6	6	36.67	6.11
7	6	26.70	4.45
8	9	7.34	0.82
9	9	30.00	3.33
10	9	80.00	8.89
11	11	55.00	5.00
12	11	66.67	6.06
13	15	70.00	4.67
14	17	480.00	28.24
15	17	145.00	8.53
		AVERAGE	5.82
		+/- SE	1.725

FIGURE 7: SIC GROUP 60

GRAPH OF WASTE GENERATION DATA

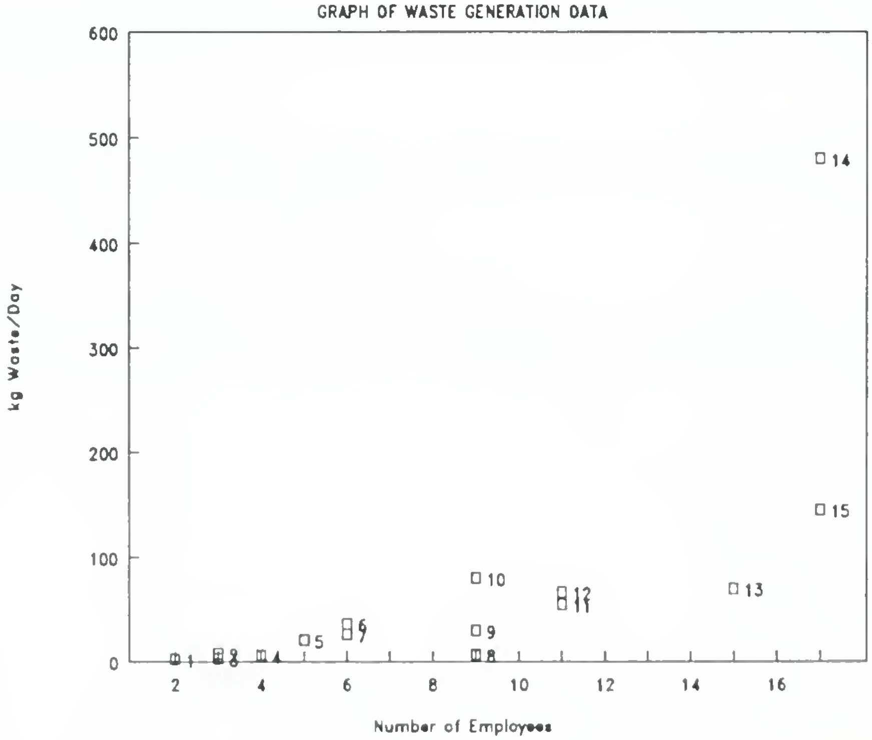


TABLE 14 *SIC GROUP 60, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE LARGE FOOD STORES (RETAIL)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	140	1721.20	12.29
2	37	686.30	18.55
3	142	1363.70	9.60
4	146	833.30	5.71
5	80	1089.30	13.62
6	95	1818.20	19.14
7	58	378.80	6.53
8	197	833.30	4.23
9	48	757.50	15.78
10	175	2651.50	15.15
11	110	1515.00	13.77
		AVERAGE	12.22
		+/- SE	1.535

FIGURE 8: SIC GROUP 60

GRAPH OF WASTE GENERATION DATA

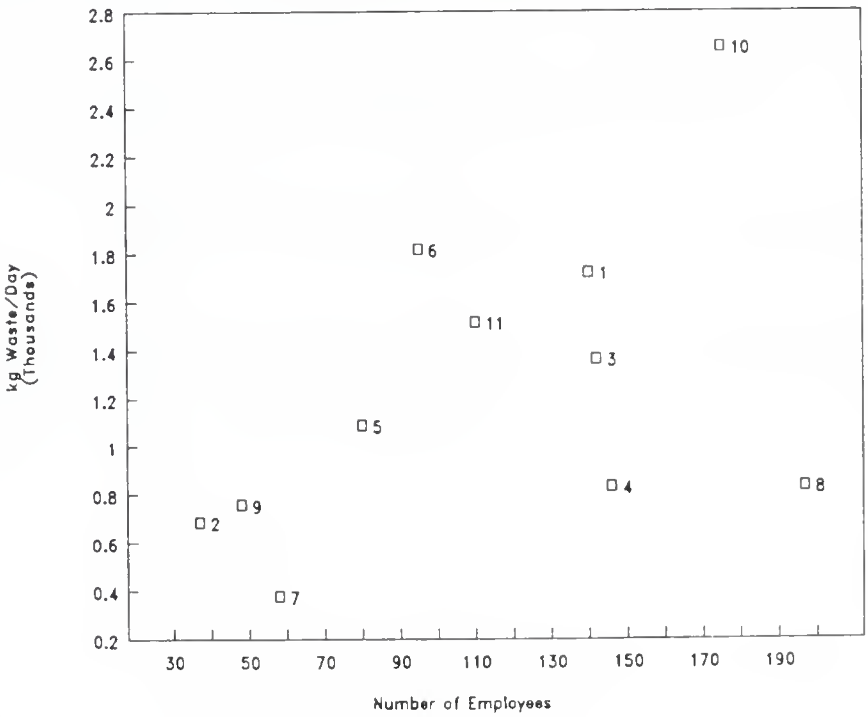
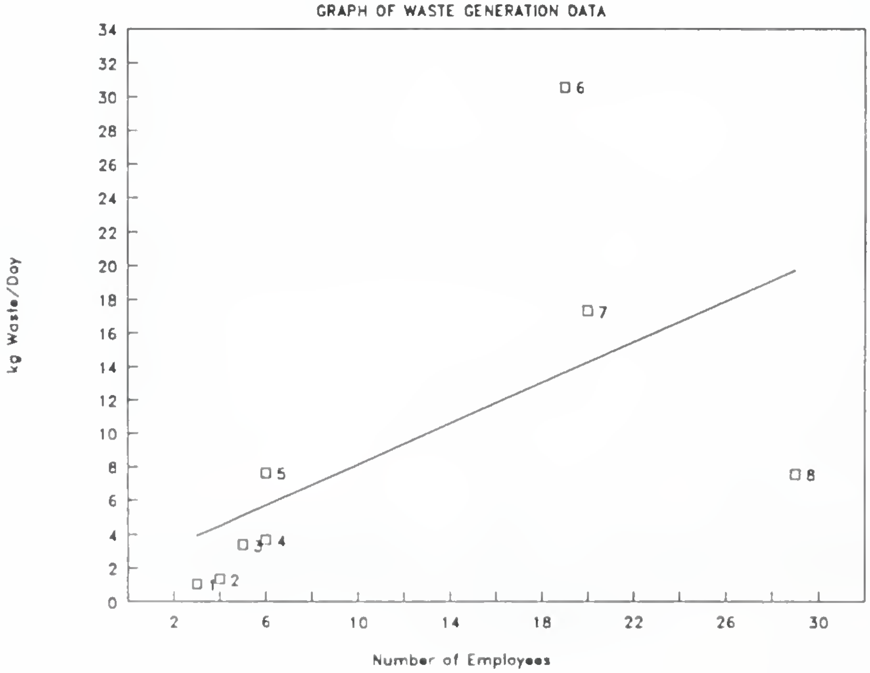


TABLE 15 *SIC GROUP 61, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE SHOE, APPAREL, FABRIC AND YARN INDUSTRIES (RETAIL)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	3	1.05	0.35
2	4	1.33	0.33
3	5	3.38	0.68
4	6	3.68	0.61
5	6	7.64	1.27
6	19	30.55	1.61
7	20	17.34	0.87
8	29	7.58	0.26
		AVERAGE	0.75
		+/- SE	0.170

FIGURE 9: SIC GROUP 61

GRAPH OF WASTE GENERATION DATA



3.2.6 SIC Group 62 - Household Furniture, Appliances, and Furnishings Industries, Retail (Table 16 & Figure 10)

A single datum for a large company biased the regression analysis so the average of all the data are used to estimate the waste generation rate which was 1.49 kg/employee/day.

3.2.7 SIC Group 63 - Automotive Vehicles, Parts and Accessories Industries, Sales and Service

3.2.7.1 SIC Group 631 - Automobile Dealers (Table 17 & Figure 11)

The study sample was relatively large (n=14) and included firms with a large number of employees. The regression coefficient, r = 0.86, showed a strong correlation between waste generation and employment. Based on the regression, the waste generation is estimated to be 0.87 kg/employee/day.

Why use the regression value of 0.87 kg/employee/day and not the sample mean (1.4 kg/employee/day), when all but two of the sample data are greater than 0.87 kg/employee/day? In practical terms, these two estimates do not differ significantly from each other; the data plotted in Figure 11 suggest a strong relationship between employment and waste generation (regression coefficient, r = 0.74). Additional sampling would strengthen this relationship further.

3.2.7.2 Group 633 - Gasoline Service Stations (Table 18 & Figure 12)

The sample size was too small (n=3) to use the regression estimate. Therefore, the sample average (0.36 kg/employee/day) was used as the waste generation estimate.

TABLE 16 *SIC GROUP 62, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE HOUSEHOLD FURNITURE, APPLIANCES AND FURNISHINGS (RETAIL)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	1	1.14	1.14
2	4	4.20	1.05
3	7	31.55	4.51
4	8	5.00	0.63
5	11	20.71	1.88
6	42	37.31	0.89
		AVERAGE	1.68
		+/- SE	0.591

FIGURE 10: SIC GROUP 62

GRAPH OF WASTE GENERATION DATA

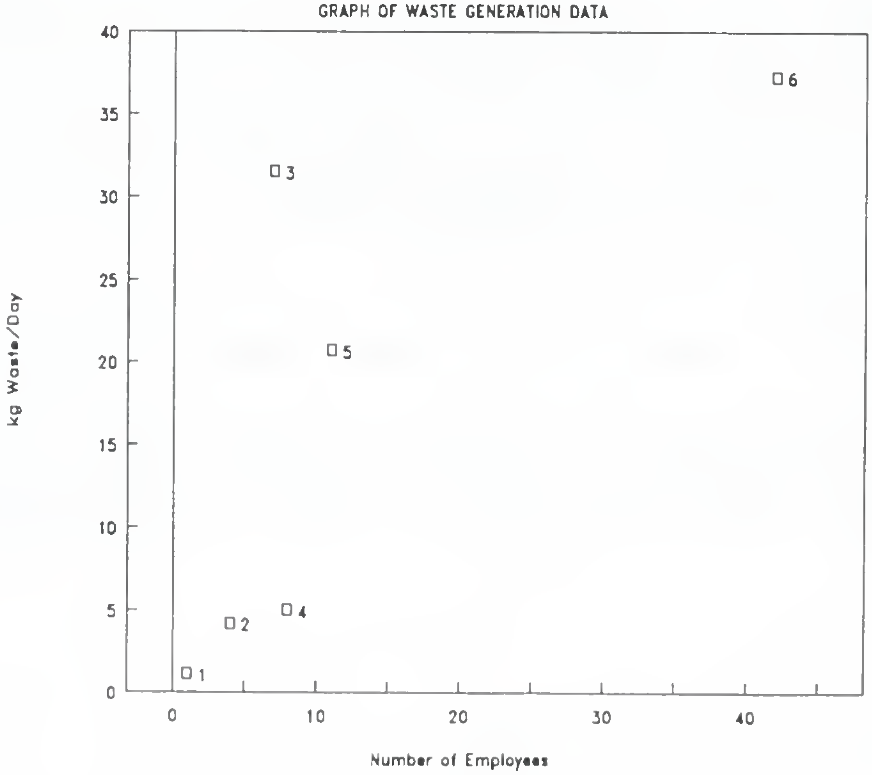


TABLE 17 *SIC GROUP 631, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE AUTOMOBILE DEALERS*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	3	1.71	0.57
2	18	47.52	2.64
3	19	33.86	1.78
4	40	46.93	1.17
5	40	25.06	0.63
6	43	95.00	2.21
7	43	85.00	1.98
8	69	105.00	1.52
9	69	95.00	1.38
10	75	69.70	0.93
11	85	160.00	1.88
12	85	105.00	1.24
13	170	170.00	1.00
14	170	150.00	0.88
		AVERAGE	1.41
		+/- SE	0.165

FIGURE 11: SIC GROUP 631

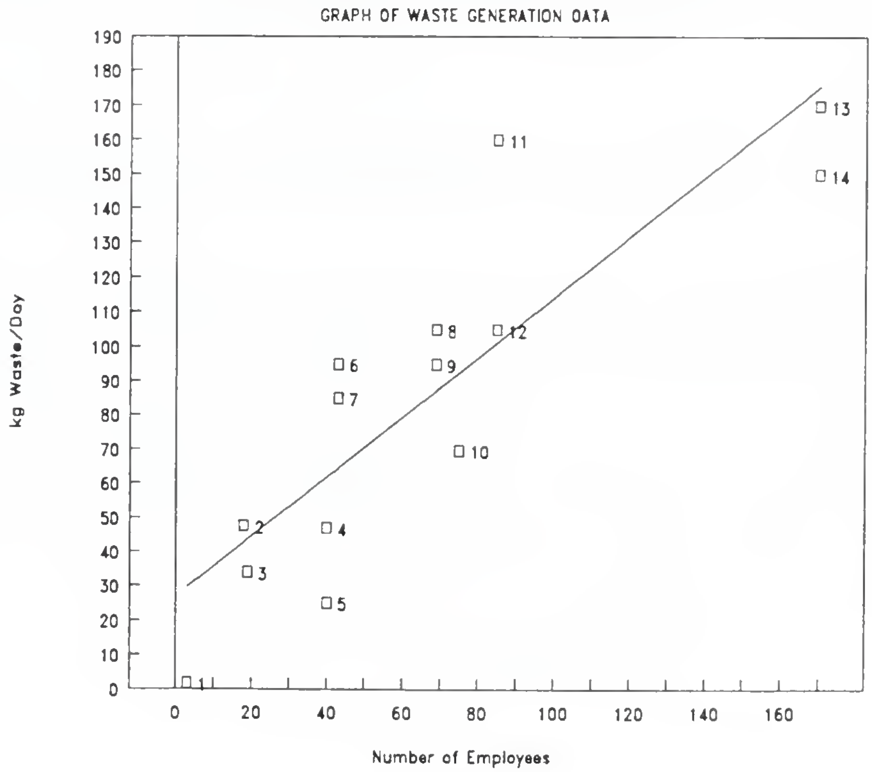
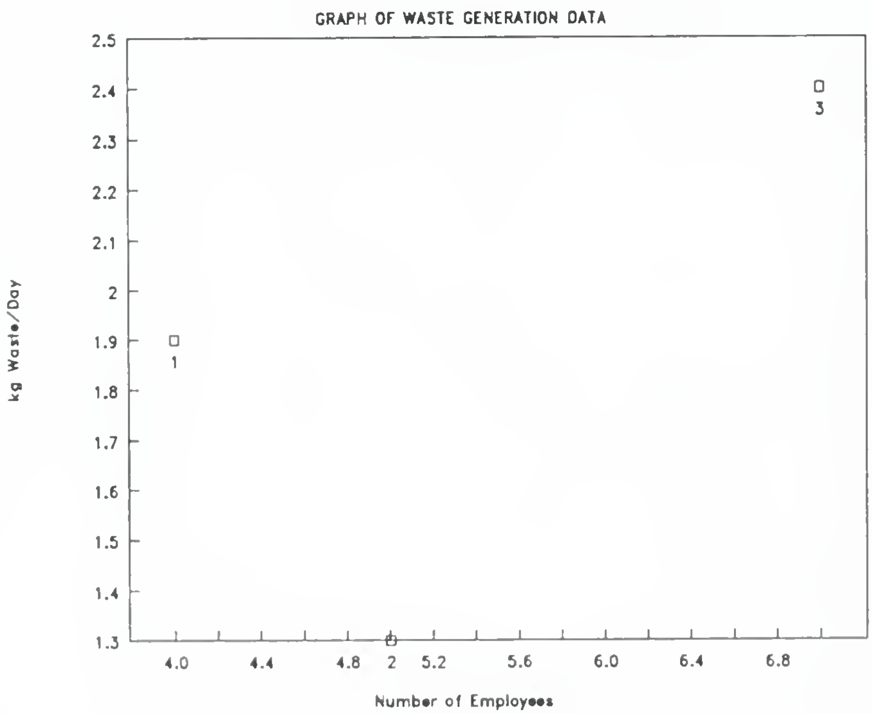


TABLE 18 *SIC GROUP 633, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE GASOLINE SERVICE STATIONS*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	4	1.90	0.48
2	5	1.30	0.26
3	7	2.40	0.34
		AVERAGE	0.36
		+/- SE	0.063

FIGURE 12: SIC GROUP 633



3.2.7.3 Group 635 - Motor Vehicle Repair Shops (Table 19 & Figure 13)

The wide range of weights over a very small employment range can be accounted for by the waste management practices of many firms. Although scrap metal bins were usually on the company's premises, metal items were routinely discarded in the general garbage bin.

Regression analysis was not applicable to the cluster of data. Therefore, the waste generation estimate of 4.6 kg/employee/day was obtained from averaging the data.

3.2.8 SIC Group 65 - Other (Miscellaneous) Retail Store Industries (Table 20 & Figure 14)

The regression coefficient, r = 0.365, was indicative of the wide scatter in the data. Therefore, the average of the sample data (4.94 kg/employee/day) was used.

3.2.9 SIC Group 70 - Deposit Accepting Intermediary Industries (Table 21 & Figure 15)

The regression of the data gave an acceptable regression coefficient of 0.825 and thus a regression estimate of 0.16 kg/employee/day.

3.2.10 SIC Group 91 - Accommodation Service Industries, Accommodation Without Restaurants but with many Efficiency Units (Table 22 & Figure 16)

The regression coefficient was too low to accept the regression estimate. The average of the sample data gave a waste generation estimate of 6.2 kg/employee/day. Although there was no restaurant associated with the facilities, the high waste generation rate is attributed to the efficiency units where long term residents were living and cooking meals. This type of accommodation becomes a residential dwelling and must be treated as a special waste stream.

3.2.11 SIC Group 91 - Accommodation Service Industries, Accommodation with Restaurants (Table 23 & Figure 17)

The regression coefficient was too low to accept the regression estimate. The average of the sample data gave a waste generation estimate of 1.7 kg/employee/day. The larger number of employees at these facilities led to a lower per employee wastes generation rate than for premises with efficiency units.

For SIC Group 91 as a whole, we assumed that hotels with restaurants might account for two thirds of the employment for this group.

3.2.12 SIC Group 92 - Food and Beverage Service Industries Licensed (Table 24 & Figure 18) and Unlicensed (Table 25 & Figure 19) for Alcoholic Beverages

The regression analyses for the licensed and unlicensed restaurants were similar (regression coefficient, r = 0.77), so the data were combined and analyzed together giving a regression coefficient, r = 0.77. The regression estimate for waste generation for the combined data was 3.0 kg/employee/day.

3.2.13 SIC Group 96-Amusement and Recreational Service Industries (Table 26 & Figure 20)

The data were clustered at the employment end of the scale, so use of the regression value was not appropriate. The sample average of 2.1 kg/employee/day was used as the waste generation estimate.

3.3 <u>Wastes Generation Estimates for Other SIC Groups</u>

SIC Group 64 (General Retail Merchandising Industries) includes department stores. A waste generation estimate for these firms was the average of the estimates for similar retail SIC Groups 61 and 62; i.e., 1.14 kg/employee/day.

TABLE 19 *SIC GROUP 635, W*
(KG/EMPLOYEE/D
REPAIR SHOPS

Sample #	Total # of Employees	kg
1	1	
2	3	
3	3	
4	3	
5	3	
6	4	
7	4	
8	5	
9	6	
10	6	
11	7	
12	8	
13	8	
14	8	
15	10	
16	10	
17	10	
18	11	
19	13	
20	13	
21	16	
22	63	

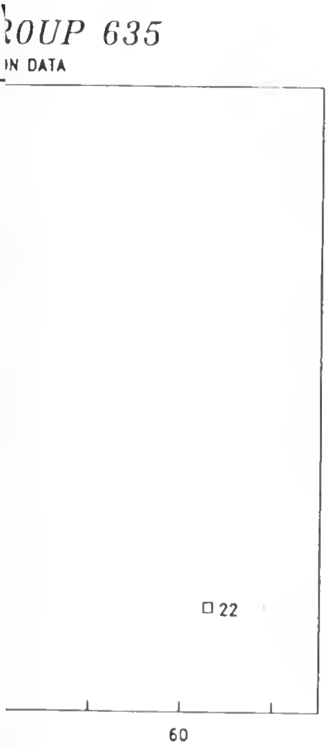


TABLE 19 *SIC GROUP 635, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE MOTOR VEHICLE REPAIR SHOPS*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	1	0.88	0.88
2	3	8.96	2.99
3	3	25.00	8.33
4	3	21.67	7.22
5	3	38.33	12.78
6	4	10.84	2.71
7	4	20.00	5.00
8	5	13.33	2.67
9	6	61.67	10.28
10	6	58.33	9.72
11	7	17.08	2.44
12	8	81.66	10.21
13	8	35.00	4.38
14	8	65.00	8.13
15	10	31.67	3.17
16	10	31.66	3.17
17	10	15.00	1.50
18	11	26.67	2.42
19	13	6.67	0.51
20	13	11.67	0.90
21	16	24.08	1.51
22	63	14.97	0.24
		AVERAGE	4.60
		+/- SE	0.801

FIGURE 13: SIC GROUP 635

GRAPH OF WASTE GENERATION DATA

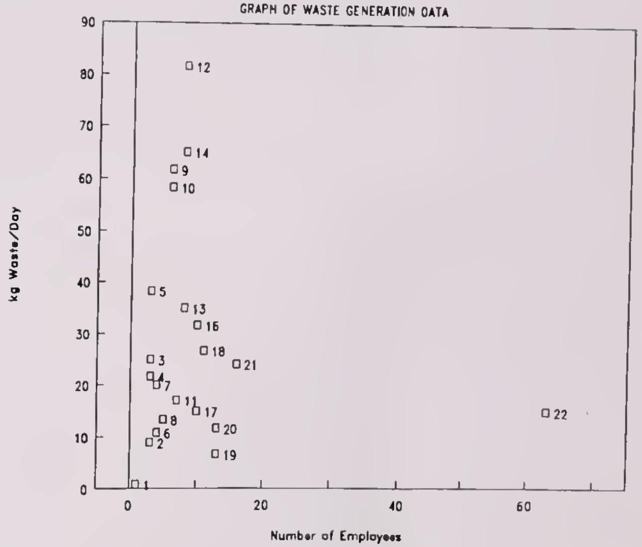


TABLE 20 *SIC GROUP 65, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE OTHER RETAIL STORE INDUSTRIES*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	2	2.25	1.13
2	2	0.47	0.24
3	3	0.69	0.23
4	4	4.38	1.10
5	5	90.00	18.00
6	6	6.30	1.05
7	7	32.00	4.57
8	7	122.50	17.50
9	9	5.75	0.64
		AVERAGE	4.94
		+/- SE	2.460

FIGURE 14: SIC GROUP 65

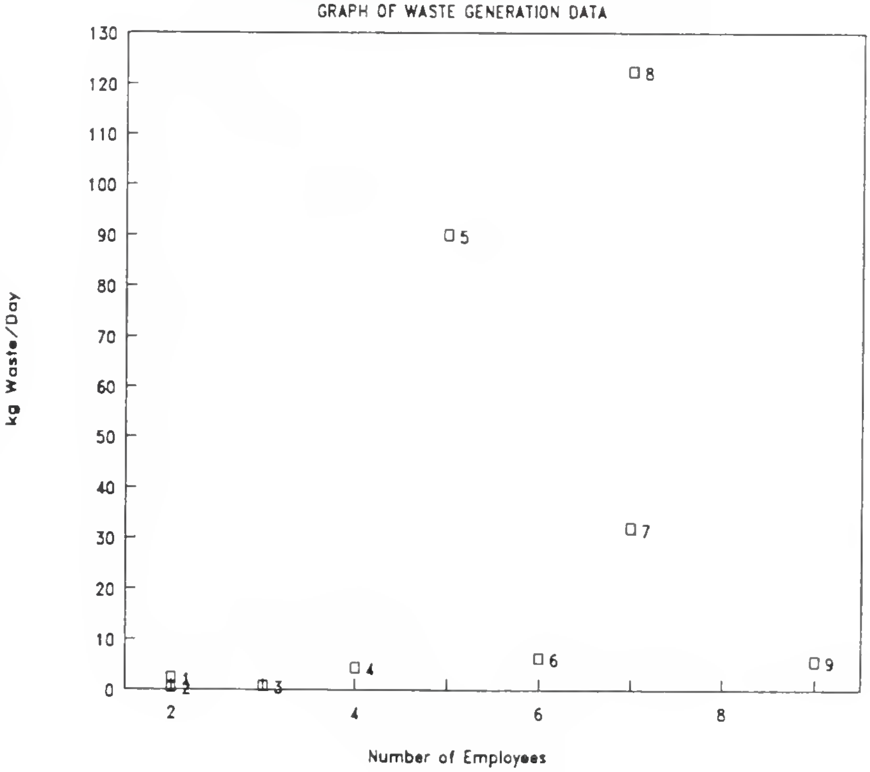


TABLE 21 *SIC GROUP 70, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE DEPOSIT ACCEPTING INTERMEDIARY INDUSTRIES*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	5	0.43	0.09
2	5	2.50	0.50
3	7	3.35	0.48
4	23	3.86	0.17
5	26	5.80	0.22
		AVERAGE	0.29
		+/- SE	0.084

FIGURE 15: SIC GROUP 70

GRAPH OF WASTE GENERATION DATA

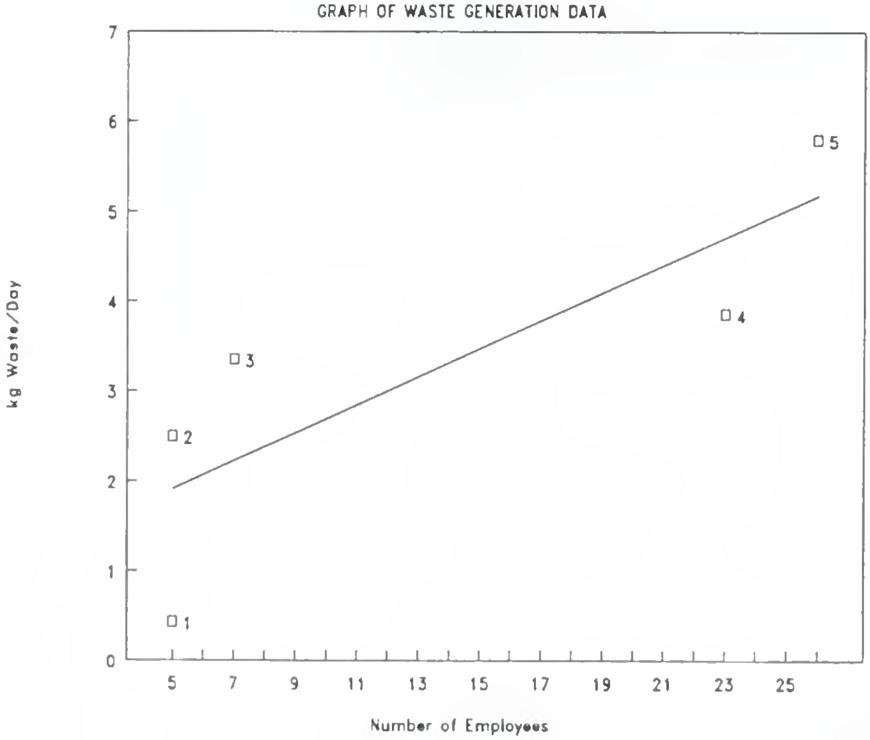


TABLE 22 *SIC GROUP 91, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE ACCOMMODATION SERVICE INDUSTRIES WITHOUT RESTAURANTS (MOTELS)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	2	7.10	3.55
2	2	14.00	7.00
3	4	24.90	6.23
4	6	55.70	9.28
5	6	61.40	10.23
6	27	25.80	0.96
		AVERAGE	6.21
		+/- SE	1.425

FIGURE 16: SIC GROUP 91

GRAPH OF WASTE GENERATION DATA

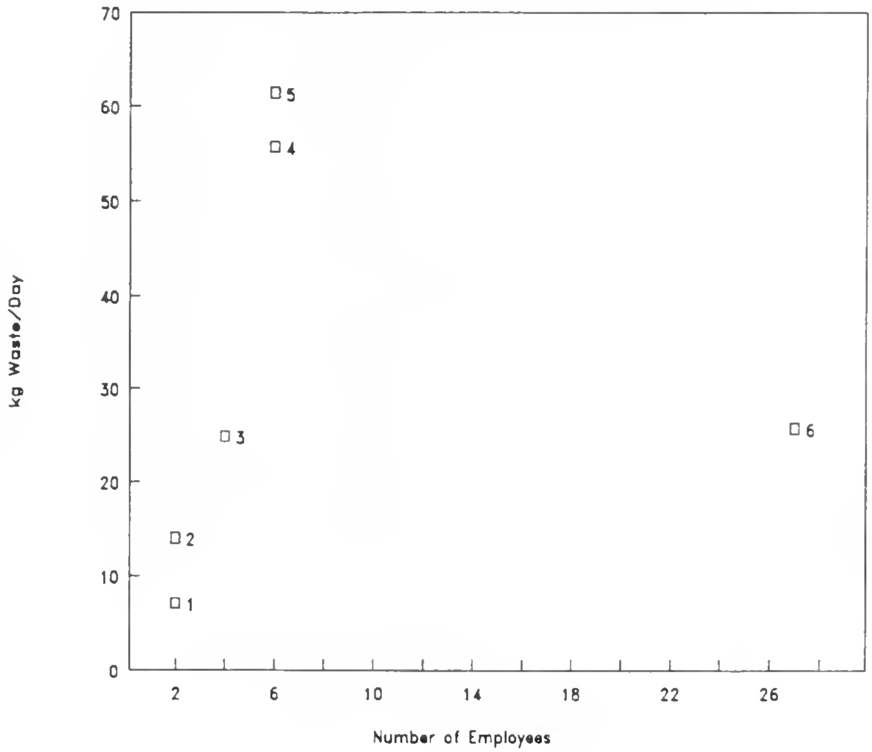


TABLE 23 *SIC GROUP 91, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE ACCOMMODATION SERVICE INDUSTRIES WITH RESTAURANTS (HOTELS)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	104	160.00	1.54
2	104	215.00	2.07
3	130	320.00	2.46
4	130	246.67	1.90
5	130	132.50	1.02
6	145	188.00	1.30
		AVERAGE	1.71
		+/- SE	0.216

FIGURE 17: SIC GROUP 91

GRAPH OF WASTE GENERATION DATA

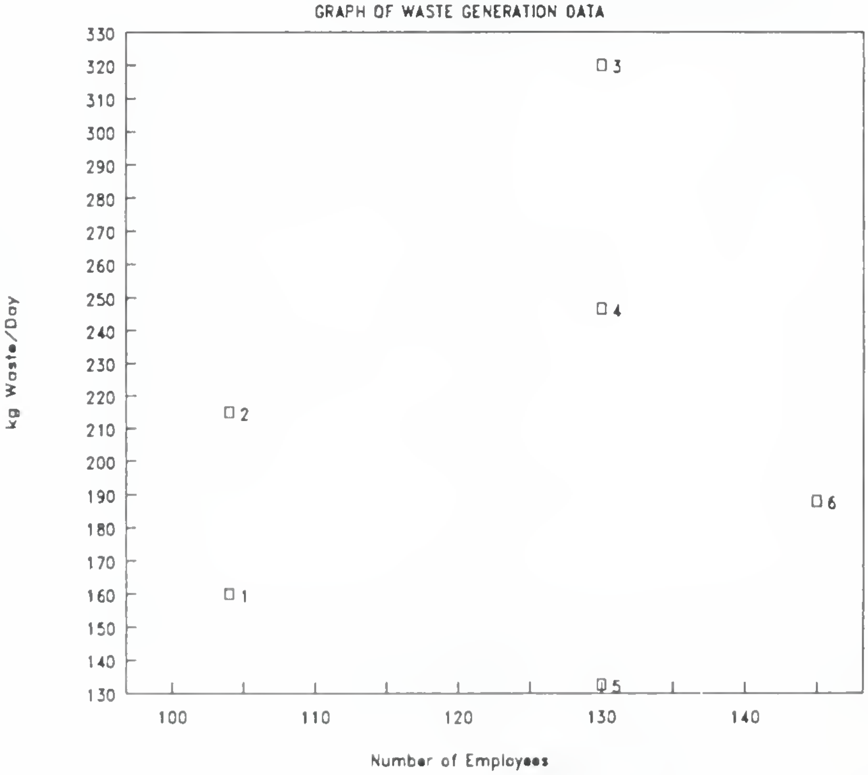


TABLE 24 *SIC GROUP 92, WAS (KG/EMPLOYEE/DAY SERVICE INDUSTRIE BEVERAGES)*

Sample #	Total # of Employees	kg W
1	3	
2	6	
3	8	
4	8	
5	14	
6	15	
7	15	
8	18	
9	20	
10	20	
11	24	
12	24	
13	43	
14	51	
15	51	
16	49	
17	49	
18	50	
19	50	
20	50	
21	55	
22	55	
23	55	
24	61	
25	61	
26	75	
27	75	
28	82	
29	82	
30	149	

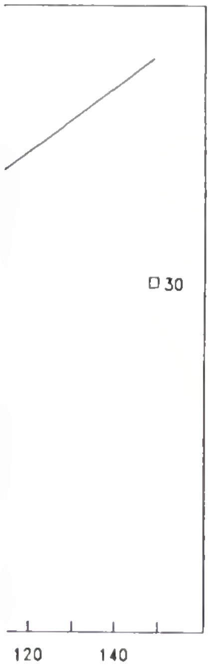


TABLE 24 *SIC GROUP 92, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE FOOD AND BEVERAGE SERVICE INDUSTRIES (LICENSED FOR ALCOHOLIC BEVERAGES)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	3	9.40	3.13
2	6	77.50	12.92
3	8	24.30	3.04
4	8	20.70	2.59
5	14	25.70	1.84
6	15	213.33	14.22
7	15	230.00	15.33
8	18	42.90	2.38
9	20	60.00	3.00
10	20	72.50	3.63
11	24	75.70	3.15
12	24	68.60	2.86
13	43	44.90	1.04
14	51	215.70	4.23
15	51	186.00	3.65
16	49	134.30	2.74
17	49	152.90	3.12
18	50	184.00	3.68
19	50	182.90	3.66
20	50	168.60	3.37
21	55	193.60	3.52
22	55	210.00	3.82
23	55	195.00	3.55
24	61	230.00	3.77
25	61	208.00	3.41
26	75	345.00	4.60
27	75	315.00	4.20
28	82	265.00	3.23
29	82	186.67	2.28
30	149	223.33	1.50
		AVERAGE	3.41
		+/- SE	0.136

FIGURE 18: SIC GROUP 92

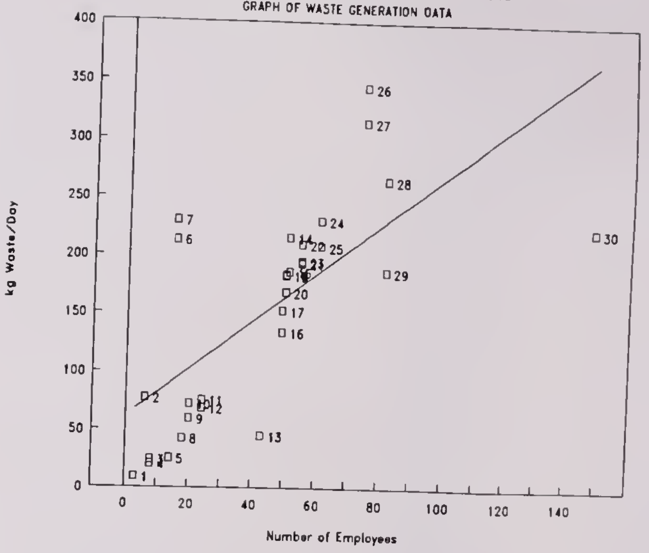


TABLE 25 *SIC GROUP !*
(KG/EMPLOY
SERVICE INL

Sample #	Total # of Employees
1	4
2	10
3	10
4	11
5	11
6	14
7	14
8	15
9	15
10	20
11	20
12	20
13	20
14	20
15	20
16	20
17	21
18	23
19	30
20	31
21	31
22	32
23	39
24	65
25	65
26	75
27	98
28	98

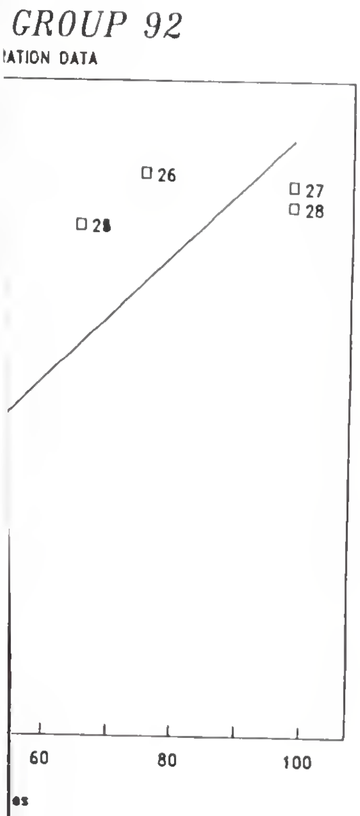


TABLE 25 *SIC GROUP 92, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE FOOD AND BEVERAGE SERVICE INDUSTRIES (UNLICENSED)*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	4	2.30	0.58
2	10	71.40	7.14
3	10	71.40	7.14
4	11	73.33	6.67
5	11	46.67	4.24
6	14	84.40	6.03
7	14	35.00	2.50
8	15	75.00	5.00
9	15	95.00	6.33
10	20	143.33	7.17
11	20	146.66	7.33
12	20	62.50	3.13
13	20	103.33	5.17
14	20	77.50	3.88
15	20	18.89	0.94
16	20	50.00	2.50
17	21	68.60	3.27
18	23	122.00	5.30
19	30	56.90	1.90
20	31	88.60	2.86
21	31	90.00	2.90
22	32	42.50	1.33
23	39	67.70	1.74
24	65	390.00	6.00
25	65	390.00	6.00
26	75	430.00	5.73
27	98	420.00	4.29
28	98	404.30	4.13
		AVERAGE	4.33
		+/- SE	0.391

FIGURE 19: SIC GROUP 92

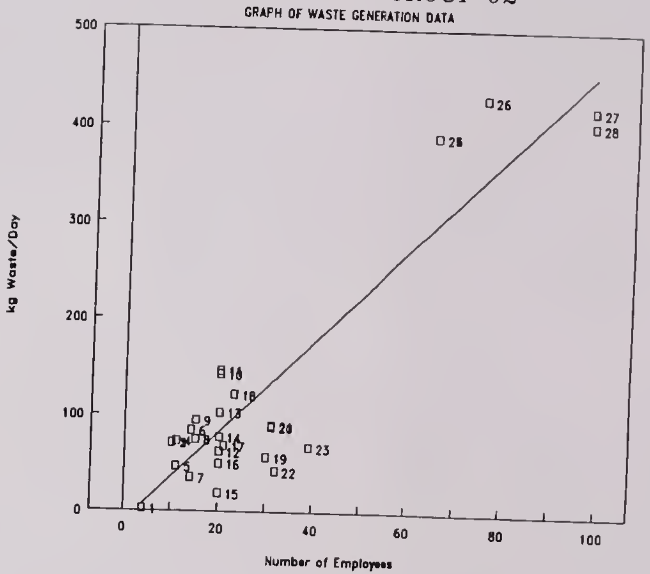
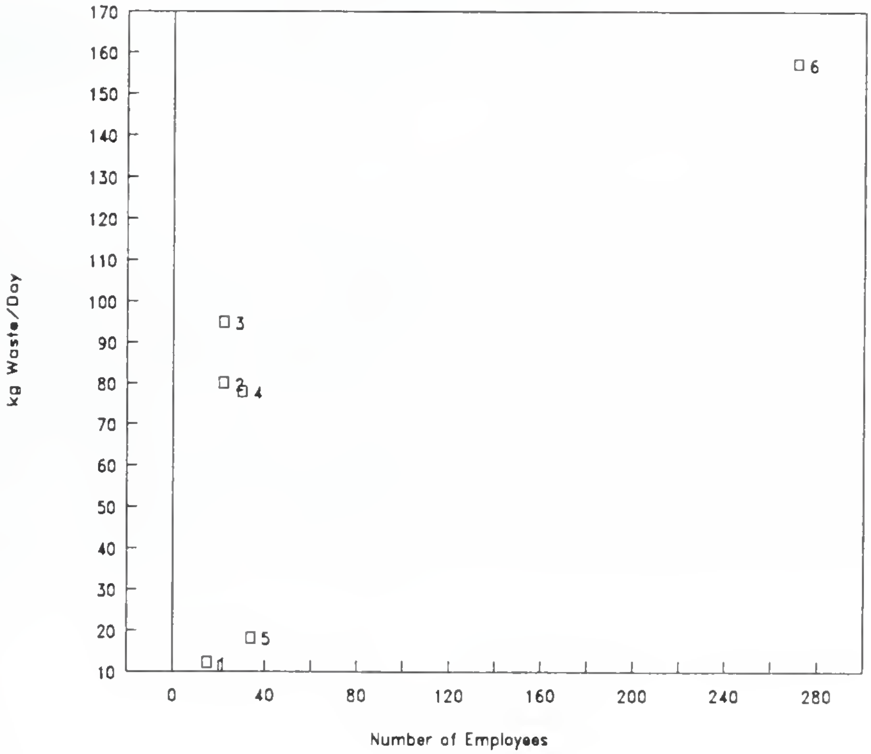


TABLE 26 *SIC GROUP 96, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE AMUSEMENT AND RECREATIONAL SERVICE INDUSTRIES*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	15	12.20	0.81
2	22	80.00	3.64
3	22	95.00	4.32
4	30	77.90	2.60
5	34	18.20	0.54
6	271	157.40	0.58
		AVERAGE	2.08
		+/- SE	0.682

FIGURE 20: SIC GROUP 96

GRAPH OF WASTE GENERATION DATA



For SIC Groups 71 to 77 (Finance, Insurance and Business Service Industries) wastes generation data were obtained from a study that was conducted for the Ontario Ministry of Government Services (personal communication: Ms. Marook Sidhwa, Regional Coordinator - Toronto East, Waste Management Program, November, 1990). The average wastes generation rate was reported as 1.34 lb/employee/day or 0.61 kg/employee/day.

Because of the similarities in activity, the waste generation estimates for SIC Groups 97 to 99 (Personal and Household Service, Membership Organizations and Other Service Industries) were estimated to be the same as that for banks (SIC Group 70).

As earlier discussed, Table 8 provides a summary of the estimation of waste generation by commercial sectors as discussed above.

3.4 Sources of Potential Error in Employee Waste Generation Estimates

Error in the estimates of waste generation for a municipality can occur in two ways. First, the labelled Waste Survey in Table 6 is derived from the evaluation of ratios of waste generation per employee (Section 3.2.1). The error occurs in the sampling procedure, due to store-to-store differences in the ratios; this error can be reduced by increasing the sample size. The results presented in Table 8 suggest that the standard deviation ranges from 10 to 30%.

Difficulty in identifying and clarifying the correct type of business SIC can also contribute to that error, and is more difficult to evaluate. The error depends on the significance of identifiable differences in subtypes of commercial activities, perhaps segmented by location or brand names or product mix. A store incorrectly identified could lead to a sizeable error in a small sample. In this study, local business directories provided the SIC for the businesses. Measurement errors, e.g., weight of waste, should be relatively minor.

The second form of error (possibly embodied in the remainder of Table 6) is related to the estimation of total commercial activity in various sectors, based on various data sources. Each data source has its own problems. Unlike the waste study data, these errors cannot be reduced by increasing the sample size. Census data are comprehensive, but begin with the undercounting bias that averages this percent across the population as a whole. There may be other systematic errors in reporting the SIC; such as, whether the person is actually working, or the location of the work place. Most of the error in the Labour Force survey is derived directly from the sample size, since there is not detailed information on location or SIC. The regional employment survey provides greater spatial detail but carries a high level of error due to non-response and errors in SIC or number of employees. Local governments are not professional data gathering agencies and employers are not required to respond.

The present study is thus an exploratory one, and the sampling errors in the waste survey predominate. As more information is integrated from additional work, and samples become larger and more precisely targeted, these waste survey errors can be reduced and made small, relative to the problems of employment estimations and projections.

3.5 Estimation of Commercial Waste Generation in the Regional Municipality of Waterloo

Table 9 disaggregates the various SIC categories from Statistics Canada to conform to the groups used in the present field study. Note that much of the commercial activity can simply be grouped together as office employment. The field study has focused on the variance in waste generation among retail and service activities. The table also contains estimates of total regional employment for each of the commercial sectors. To obtain an estimate of the Region's employment from the CMA data in the Census we simply multiplied by 1.028 to reflect the slight differences in the spatial definition of the study area (i.e., the Region's boundaries are slightly larger than those of Statistic Canada for the Region). To convert the

1986 employment to 1990 employment, we multiplied by the estimated commercial employment growth of 15 percent. The application of growth rates in this manner does not account for fluctuations occurring as a result of economic fluctuations, such as during a periods of recession. The joint effect of these two adjustments is 18.2 percent. These employment estimates are combined with the waste generation per employees to estimate total commercial waste for the SIC group listed.

Finance and service industries have been estimated to produce nearly 40% of the total commercial waste. This may be due to the high number of people employed in these sectors with the Region.

The data in the right hand column of Table 9 are estimates of weekly waste generation rates (kg/employee/week) for 13 commercial SIC Groups. The weekly per employee waste generation estimate for each SIC group was multiplied by the total regional employment for the group to obtain the weekly waste contribution (kg/week) from the SIC group. These calculations are shown in Table 8 (note: the kg/wk are presented in 1,000s, i.e., the actual values are 1,000 times higher than the number entered in the table; e.g., 342 x 1,000 = 342,000.

The total estimated weight generated by the commercial sector is 1,469,400 kg/wk, or approximately 1,469 tonnes/wk (76,388 tonnes/year). In 1989, the total waste landfilled in the Region of Waterloo was 439,000 tonnes. Waste from commercial sources is therefore estimated at 76,388/439,000 x 100 or 17.4% of the total tonnage.

Table 5 relates the size of the commercial work force in each area municipality with the proportion of waste generated by the respective municipalities in the Region. Kitchener, Waterloo and Cambridge account for approximately 92% of the commercial waste generated in the Region.

TABLE 9

ESTIMATES OF COMMERCIAL WASTE GENERATION

Activity	Employment CMA (1986)	Employment Region[a] (1990)	Waste Generation kg./empl./wk.	Total Waste kg./wk. x 10^3
Retail				
Food (SIC 60)	5240	6195	55.2	342.0
Clothes (61)	1875	2215	3.6	8.0
Furniture (62)	1210	1430	10.1	14.4
Auto (63)	4570	5400	12.6	68.1
General (64)	3235	3825	6.8[b]	26.0
Misc. Retail (65)	2925	3455	29.6	102.3
Bldg. Suppl. (56)	1265	1495	34.2	51.1
Non-store (69)	500	590	1.0[c]	0.6
Sub-total	20820	24605	-----	612.5
Finance and Services				
Banks (70)	2455	2900	1.0	2.9
Other Fin. (71-77)	16050	18970	3.0[f]	575.8
Services (97-99)	7685	9080	1.0[c]	9.1
Sub-total	26190	30950	-----	587.8
Hotels(91)				
No Restaurant[d]	440	520	43.5	22.6
With Restaurant	875	1035	12.0	13.0
Sub-total	1315	1555	-----	35.6
Restaurants(92)				
Licensed[e]	4670	5520	21.1	116.5
Unlicensed	2335	2760	21.1	58.2
Sub-total	7005	8280	-----	174.7
Recreation(96)	1525	1800	2.1	3.8
Total Commercial for SIC Groups Listed Above	56855	67190		1469.4

[a] 1986 CMA totals multiplied by 1.182; reflecting 2.8 percent adjustment of Region to CMA, plus an estimated growth rate of commercial employment of 15 per cent.

[b] The average of categories 61 and 62.

[c] Because of the similarities in activities, the employee waste generation estimates for non-store and service commercial entities were estimated to be the same as banks.

[d] Estimated as one-third of hotel employment.

[e] Estimated as two-thirds of restaurant employment.

[f] Estimate from Ministry of Government Services (personal communications with M. Sidhwa; note that this estimate is tentative and awaiting confirmation).

Table 10 presents a comparison of the per employee waste generation rates estimated in the present study and those estimated by Rhymer & Green (ref. 14). A discussion of these results is provided in Section 4.0.

TABLE 10

COMPARISON OF PER EMPLOYEE WASTE GENERATION RATES: RHYNER & GREEN (REF. 14) AND PRESENT STUDY[1]

SIC[2]	Description	Rhyner & Green (ref. 14) tonnes/emp /yr	Rhyner & Green (ref. 14) kg/emp /day[3]	Present study kg/emp /day
50-51	Wholesale trade	1.70	6.5[4]	
52	Retail building materials	1.44	4.6[5]	5.7
53	Retail general merchandise	0.25	0.8[5]	1.1
54	Retail Food	1.97	6.3[5]	9.2
55	Auto sales, service	0.41	1.3[5]	0.9-4.6
56	Retail apparel	0.41	1.3[5]	0.6
57	Furniture	1.06	3.4[5]	1.7
58	Eating & drinking place	2.07	5.7[6]	3.0
59	Miscellaneous retail trade	0.89	2.0[5]	4.9
60-67	Financial operation	1.18	4.5[4]	0.2-0.6
70	Hotels	1.95	5.4[6]	1.7-6.2
72	Personal services	0.38	1.5[4]	
73	Business services	0.68	2.6[4]	
76	Miscellaneous repair	1.51	4.8[5]	
79	Amusement recreation	0.66	1.8[6]	2.1
89	Miscellaneous services	0.68	2.2[5]	
90	Government[7]	0.68	2.6[4]	

[1] data from Table 7 herein.

[2] Numbering for the U.S. SIC code differs from the Canadian code.

[3] calculated from Rhyner & Green data for tonnes/emp/yr.

[4] five day work week (260 days/yr): tonnes/emp/yr ÷ 260 work days/yr x 1000 kg/tonne = kg/emp/day.

[5] six day work week (312 days/yr): tonnes/emp/yr ÷ 312 work days/yr x 1000 kg/tonne = kg/emp/day.

[6] seven day work week (365 days/yr): tonnes/emp/yr ÷ 365 work days/yr x 1000 kg/tonne = kg/emp/day.

[7] Value not reported; Miscellaneous Services value used.

SECTION 4

DISCUSSION

4.0 DISCUSSION

4.1 Overview of the Method

Waste Composition

Table 7 summarizes the waste streams from the 16, two-digit SIC commercial sectors. Because these are average percentages of the composition of waste samples collected from more than one company, the total will not add up to 100%. It is apparent that paper predominates as the major category of waste. In most cases, OCC is the largest fraction of the paper waste. Food waste from restaurants and markets is a significant portion of the waste streams from these businesses.

The waste composition data are presented as percentages of the total composition and indicate the relative proportion, i.e., the general picture of various waste materials generated by commercial businesses. However, to be useful to waste management personnel in municipalities, the waste composition data must be accompanied by quantitative information on waste generation. For example, if OCC is identified as a significant percentage of the waste from a particular commercial business the following questions must be addressed:

1) How many similar businesses are there in the municipality?
2) How much OCC is generated by all of those businesses in the municipality?
3) What percentage of the waste stream is represented by OCC in the other commercial groups?
4) What is the total tonnage of cardboard from all groups?

Waste Quantity

DeGeare & Ongerth (ref. 3) reported a relationship between the quantity of waste generated by commercial businesses and business employment. In about 50% of the two-digit SIC groups that we studied, reasonable regression coefficient values (r) for the relationship between waste generation and employment were obtained (Table 8). In the case of the remaining SIC sectors, one or more reasons were proposed to explain the poor regressions; e.g., sample size of businesses was too small; data were clumped; interfering waste management practices; etc. In these cases the average per employee waste generation rates were used in calculations rather than the value for 'b' (slope) in the regression equations.

On the basis of the DeGeare-Ongerth relationship, the waste generation rates for retail commercial activities were estimated on a Region-wide scale, using suitably adjusted Canada Census data for the Regional Municipality of Waterloo (see Section 2.0).

Referring to the OCC example above (i.e., where a relatively high proportion of OCC is identified in the commercial waste streams in a municipality) waste management planners can estimate the quantity of OCC generated by all of the commercial groups in a municipality, once they know the following: (1) per employee waste generation rate for each SIC group; (2) the total employment in the commercial groups within the municipality; and (3) the quantity of OCC in each of the waste streams that were studied as part of this waste composition study, i.e., those commercial activities that are related to residential consumption. (Note: this forms the basis of estimates in data base projections.)

4.2 Evaluation of the Methods

4.2.1 Waste Composition of Commercial Businesses

Timing of the Study

If the waste composition study had been conducted two or three years ago in the Region of Waterloo, we could probably have stated with certainty that the composition of the waste stream had been adequately assessed by our study methods. Presently however, waste reduction and waste diversion are being more frequently practised as company policy or by conscientious employees who take recyclable materials from places of work to recycling locations in municipalities or home to their Blue Boxes. We expect that these activities have reduced the quantities of some materials that otherwise would have been discarded in the bulk refuse containers. The impact of these waste diversion activities would be greater in companies with fewer employees than in those with larger employment. We cautiously regard the composition data as a best estimate under constantly changing circumstances. This study did not attempt to quantify the amount of materials being diverted from a company's waste stream; the waste composition, therefore, does not include those materials which were being diverted (if any) through any outside agencies.

Because of the scope of the work, it was not possible to design a waste sampling program that would permit the collection of a sufficient number of samples so that statistical analyses could be applied to the waste composition data. It must be pointed out that this study was a prerequisite study; the level of variance between the estimated and actual waste composition is not known. More field work must now be done in other municipalities to augment the data contained herein.

Waste Composition Variability

Does one expect a large variation in the composition of the waste streams generated by commercial businesses throughout the year? Given the "predictable character" of retail activities carried on within each SIC group, there is no reason to expect a significant variation in the composition in the waste generated by business within a given sector.

It is expected, however, that there may be variations in the quantity of waste, with increases occurring at certain times of the year, e.g., Christmas holidays, year-end inventory, etc. However, as was pointed out earlier (see Section 2.0), retail activity is dependent on consumer habits. Consumer waste generation is reportedly consistent, varying +/-10% of a yearly average over three quarters of the time (cf. Vesilind & Rimer, ref. 17). The implication of this consistency is that seasonal variations in residential refuse generation patterns will be mirrored in many of the commercial retail sectors. Financial institutions may also exhibit predictable fluctuations in waste composition and/or quantity, that may be correlated with cyclic business-related activities.

4.2.2 Per Employee Waste Generation

Waste Collection

Unloading waste from refuse bins by hand was unpleasant, time consuming and very awkward, particularly for compacted refuse. Nevertheless, this method enabled us to obtain the total weight of refuse discarded by 65 of the businesses surveyed in the study with four samples from "light industry". The remainder of the refuse weight data from 80 companies were obtained using a scale mounted on a garbage truck (see Section 2.0) and 10 samples were "dedicated" loads from single businesses, with load weights from landfill scalehouse data. A number of firms were sampled twice during the study. The total number of samples was 212 (Table 8).

The truck collection route varied each day but, in general, the Monday route was the same each week, Tuesday routes were similar, and so forth. Occasionally, additional pick-ups were radioed to the driver, for example, businesses scheduled for "on-call" collections, sporadic customers which require pick-ups once every three to four weeks, etc. The truck-mounted scale greatly enhanced the data collection expectations initially envisaged for the study. It should be noted that the weighing procedure significantly increased the length of time that the driver had to spend at commercial customers on the collection route.

Per Employee Waste Generation

The economic slow-down has been correlated with a reduction in the amount of refuse entering the Region of Waterloo landfill sites (personal communications, R. Martiuk, Director of Solid Waste). Notable reductions in construction refuse reflect the low number of new houses being built. In theory, a reduction in commercial sales will be followed by a reduction in the retail work force. The relationship between waste generation and employment will go through a period of adjustment until the SIC sector-specific waste generation versus employment ratio is re-established. At the present level of sophistication of this study, it was not judged important to account for these potential perturbations in the work force.

4.3 Graphical Presentation of Waste Generation Versus Employment--- Potential Method to Evaluate Company Waste Management Performance?

Graphs of the study data for waste generated by businesses, versus employment (Figures 5 to 20), display the variance of "waste management performance" that has been encountered in the sample of businesses. In theory, the waste generated by businesses should be closely correlated with employment and the data should tend to fall about an imaginary linear projection line. If there are data that are greatly removed from the linear tendency of the majority of the sample points, those businesses may be targeted for investigation with respect to their waste management practices. For example, a business with exceptional waste minimization efforts will show up as a data point that is well below the general linear grouping of businesses; a business with poor waste management policies will show up as a data point that lies well above the linear grouping of businesses.

Therefore, municipalities are advised to plot the employment/waste generation ratios in order to "get a feel" for practical problems that they can address in specific companies. A simple average of employee waste generation rates would suffice if rates, alone, were important.

While the per employee waste generation rates are simply taken as the values of `b' (slope) in Table 8, one may legitimately modify these rates, based on the number of employees in a given firm. In other words, one may divide the value for `a' (kg/day) by the number of employees in a firm and add this quotient (in units of kg/employee/day) to the value of `b'. As employment increases, the impact of the `a' (employment) on the value of `b' will decrease. No company-specific adjustments were made to waste generation estimates because we were interested only in an average estimate, representative of the SIC group as a whole, i.e., the value of `b' alone.

4.4 Usefulness of Landfill Data in Estimating Commercial Refuse Quantity

Generally, there are three systems for the collection of waste from commercial sources and delivery to landfill sites: (1) residential garbage trucks and (2) front end (or over-head) packer trucks and (3) "dedicated loads" from large supermarkets and large malls. Residential garbage trucks frequently make collections from commercial businesses as part of their daily routing through a municipality. The load is weighed at the scalehouse and the weight is normally recorded as "residential". The fraction of the waste collected from commercial businesses cannot be accurately determined under these circumstances.

Haulers using front end packer trucks frequently make between 25 and 50 refuse collections from customers before proceeding to a waste facility. A typical collection route for one of these trucks may include stops at: schools, senior citizen's homes, commercial businesses, industries, hospitals, condominiums, apartment houses, malls, etc. It is apparent that no matter what category is chosen to designate the "source" of the waste, when the load is weighed at a disposal facility, the choice will not reflect the heterogeneity of the waste in the truck. It is normal for these loads to be recorded as either "commercial" or "industrial".

Given the nature of the waste delivery systems from generator to transfer station or landfill site, most of the scalehouse data do not give a reliable picture of commercial and industrial waste generation, and to use that data in estimating waste composition would be misleading. Yet, scalehouse "records" are the basis for the widely held generalization that residential waste is "40%" of the total waste stream and commercial and industrial waste accounts for "60%". There is good reason to doubt the accuracy of this or any other percentages that rely on scalehouse weight data. The method that we have developed in the present study will enable municipalities to make a reasonable estimate of the waste generated by the commercial business sector. The method described in Volume I of the Waste Composition Study can be used to estimate the residential waste stream.

4.5 Verification of the Employee Waste Generation Estimates

In the absence of an alternative method to directly estimate the employee waste generation rates, one must defer to a comparison of the data with published literature values. Such a comparison is given in Table 10. With the exception of the generation rates for the financial operations, the results compared favourably with those of Rhyner & Green (ref. 14), especially if one were to estimate limits of ±10 to 30% around both sets of data.

The following verification method is suggested in future studies. Using small "strip malls", estimate the total waste generation rate for each business, using the SIC per employee waste generation rate estimates (from this study) and the employment figure for each business. Compare the estimated sum of waste generated for the entire sample mall with the actual weight of waste produced by the mall.

4.6 "Light Industry"

The Standard Industrial Classification system uses the term "industry" throughout (e.g., "Retail Trade Industries"), but no categorical distinction or definition is given to the term "light", with respect to any kind of industry. Commercial businesses are also called industries, so one cannot look to the SIC code to assist in distinguishing "light" industry from "heavy" industry.

Semantic arguments and clear problems of nomenclature aside, an arbitrary decision was made to call the shoe manufacturing industry (SIC 17) and the printing industry (SIC 28) "light industry". No special methods were applied to the data gathering procedures for these businesses and therefore the data are considered tentative. This study describes sampling procedures for commercial activities that closely serve the residential sector. Longer term sampling procedures are needed to assess industrial waste stream characteristics.

SECTION 5

CONCLUSIONS & RECOMMENDATIONS

The following calculation method is suggested in future studies [illegible] using "Step Three", estimate the total waste generation rate for each business, using the lbs. per employee waste generation rate estimated (from this study) and the employment figure for each business. Compare the estimated rate to weight generated by the entire sample [illegible] with the actual weight of waste generated by the route.

8.8 "Light Industry"

The standard industrial classification system uses the term "industry" throughout (note: "Retail Trade Industries"), but no categorical distinction or definition is given to the term "light", with respect to the kind of industry. Commercial recyclers and solid waste industries [illegible] use the SIC code to [illegible] distinguish "light" industry from "heavy" industry.

[illegible] generators [illegible] commercial waste [illegible] (SIC [illegible]) and the printing industry (SIC 27, "light industry"). [illegible] the data [illegible]. This study [illegible] commercial businesses [illegible] sampling [illegible] potential.

5.0 CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

1. Waste composition and per employee generation rates have been estimated for the commercial businesses in the Regional Municipality of Waterloo. The methods used in the present study provides direct estimates for 52% of the total employment in commercial business in the Region and indirect estimates for 100%. Thus, estimates of the waste generated by a segment of the commercial sector of the municipality have been made for the first time.

   The total annual tonnage received by the two Region of Waterloo landfill sites in 1989 was 439,000 tonnes. Based on the results of the present study, the commercial sector contributed an estimated 76,388 tonnes, or 17.4% of the total weight.

2. The most commonly encountered waste material in commercial refuse was corrugated cardboard (OCC) which ranged from a low of 4.0% to a high of 49.0% of the weight of refuse generated by the firms which were sampled.

   The wide range in OCC content may be the result of some firms separating used OCC for recycling, possibly in anticipation of the proposed ban on the landfilling of OCC within the Regional Municipality of Waterloo in 1991.

   Variations observed in the composition of other waste streams may be due to recycling activities, either under the auspices of company-wide programs or by conscientious employees who took materials to recycling locations in the municipality or home to their own Blue Boxes.

3. The statistical reliability of the waste composition data for some of the SIC groups is questionable because of the small number of waste samples that were sorted. Nevertheless, the data indicate the general proportion of

materials in the waste streams from the 16, two-digit SIC groups that comprise the commercial business community in the Region. Waste from 65 businesses was sorted.

4. The installation of a truck-mounted scale, used to determine the weight of refuse in 2 to 8 cubic yards refuse bins, enabled us to obtain waste quantity data from an additional 80 commercial businesses. For estimating the per employee waste generation rates, this method is more efficient than the labour intensive method, used in the waste composition part of the study, in which the crew unloaded the refuse bins by hand to determine the total weight of the waste in the bin.

5. During the course of the study, insights were noted regarding the effectiveness of waste management practices of some firms. For example, for automotive repair businesses, it appears that employee's tend to use the general refuse bin for discarding metal waste materials, despite the fact that a scrap metal bin has been made available.

   Such insights, when communicated to the management of the firm provide an immediate opportunity to help that firm improve the efficiency of their recycling efforts.

   There is also an indication that differences exist in per employee waste generation rates in small grocery stores and in larger supermarkets.

   The demonstrated method for estimating the rate of employee waste generation has the potential to be used as a waste management tool by municipalities. The distribution of the daily waste generation rates versus employment data, exhibited in the graphs for each SIC sector, could enable municipal waste management personnel to prioritize their "remedial" waste reduction efforts by planning to visit those companies whose waste generation rates seem out of line with the general waste-to-employee relationship.

5.2 Recommendations

The methods employed in the commercial portion of the Ontario Waste Composition Study have been demonstrated on a selection of commercial businesses in the Regional Municipality of Waterloo. Within the commercial sectors in the Region there is a relatively high awareness of waste diversion options that will reduce waste disposal costs and encourage recycling. Therefore, we cautiously regard the qualitative and quantitative data presented herein as a best estimate under constantly changing circumstances.

This report has developed a procedure for estimating the amount of waste generated by commercial activities within Ontario urban areas and began with the process of integrating the complex data inputs required. What are the next steps?

The study has employed a two-stage estimation process: (1) the development of ratios of waste generation per employee; and (2) the estimation of commercial employment composition for the municipality as a whole. Each step poses different problems. The following recommendations are submitted:

1. The waste generation and composition data base will require many more samples in order to cover the full range of commercial activities. No one study will have the resources to undertake a complete evaluation; the research results must be accumulated over many studies and evaluated over time. Fortunately, there is no inherent reason that a business in any part of the province cannot be used to estimate waste generated elsewhere--unless local waste management policies differ significantly.

   This means that each study should use the same SIC identification to code commercial activity and the same methodology for measuring waste output and composition. A central agency (e.g., the Ministry of Environment) may have to take the responsibility for organizing and evaluating the data.

2. It will also be necessary to monitor any changes over time in waste generation that may reflect innovations in policy, technology or corporate behaviour. The date of each sample must be retained and/or it may be necessary to identify sample locations that can be restudied over time in order to minimize sampling error.

3. To better understand the effect of recycling behaviour on the data gathered, it is recommended that employees/management of participating firms be asked to describe the nature and extent of any source separation recycling activities.

4. The immediate priorities for sampling can be identified from the results of this study. Those commercial activities that employ large numbers of people must be further investigated in order to improve sample size and reveal any significant variation within the SIC groups; this includes the diverse set of office and financial activities. Conversely, those activities with a high rate of waste generation per employee, such as food stores and restaurants, must be sampled repeatedly because of their importance to the overall waste generation. Those sectors where the observed sample variance (standard deviation) is high require larger samples to improve overall accuracy, possibly by isolating subgroups within the SIC. Activities that generate policy-relevant waste materials should be given special attention.

5. The future development of employment estimates requires two divergent approaches. First, substantial savings may result from a centralized standardized analysis of employment that applies the same set of data, techniques and projections to all urban areas--much as the Ontario Statistical Centre has developed a common set of population forecasts.

   At the same time, municipalities have better information about local peculiarities and exceptions to the employment structure. These special cases, e.g., community colleges, tourist attractions, shopping concentrations, as well as manufacturing activities, may require special attention by a local agency.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

Gore & Storrie Limited wish to acknowledge the assistance provided by the Regional Municipality of Waterloo for the commercial portion of the Ontario Waste Composition Study. Mr. Dick Buggeln of the Region co-ordinated the field work and wrote significant portions of the text.

The concept for the field study was developed following the advice of Dr. Virginia Maclaren that led to extensive discussions with Dr. Jim Simmons (both faculty members in the Geography Department, University of Toronto). Dr. Simmons worked with the Canada Census employment information and accessed other employment data bases in order to develop a picture of employment in the retail commercial businesses in the Regional Municipality of Waterloo. Dr. Simmons also assisted in the evaluating the field data and writing portions of the text. The project clearly benefitted from Dr. Simmons' many crucial contributions.

The field crew: David Fox (Gore & Storrie Limited), Ritchard Stevenson and Lisa Morgan (both from the Region of Waterloo) were responsible for contacting the companies, organizing an often complicated waste collection schedule and sorting the waste. They were a dedicated crew and their efforts are greatfully acknowledged.

A considerable portion of the field work was conducted with the participation of Big Bear Services, Waterloo, Ontario, and the cooperation of Messers. Bob Knarr, Gary Bell and Bruce Storrer.

Report preparation assistance was provided by David Fox, Brock Harrington, Rob Flindall, Debra Hayes and Chris Taylor of Gore & Storrie Limited, with additional support from Adam Buggeln and Barbara St. Hill.

The Project Managers for Gore & Storrie Limited were Les MacMillan and Jeff Flewelling.

We greatfully acknowledge the strong ongoing support and assistance of Messrs. Neal Ahlberg, Brendan Killackey and Dan Ionescu, Waste Management Branch, Ministry of the Environment.

REFERENCES

REFERENCES

1. AMS (1973) Applied Management Sciences Inc. The private sector in solid waste management: a profile of its resources and contribution to collection and disposal. Environmental Protection Agency Publication SW - 51d.1, U. S. Government Printing Office, Washington, D.C. (Cited by Rhyner & Green, 1988).

2. Bird & Hale. 1978. Municipal Refuse Statistics for Canadian Communities of over 100,000 (1976-1977). 37 pp. (EPS File No. 4672-1).

3. DeGeare, T. V. & J. E. Ongerth. 1971. Empirical analysis of commercial solid waste generation. Jour. Sanitary Engineering Division. Proc. Amer. Soc. Civil Engineering. 97(SA 6): 843 - 850.

4. Evans, B. W. 1985. How garbage analysis can reduce collection costs. Biocycle. March: 30 - 33.

5. Franke, B. 1987. Comparing solid waste management options: a case study. Unpublished manuscript. Institute for Energy and Environmental Research. Takoma Park, MD 20912. 15 pp + 6 figures.

6. Freund, John E. 1984. Modern elementary Statistics. 6th Edition. Prentice-Hall, Englewood Cliffs, N.J. xii + 561 pp.

7. Golueke, C. G. 1971. Comprehensive studies of solid waste management, third annual report. NTIS Report PB 213 576, National Technical Information Service, U. S. Department of Commerce, Washington, D. C. (Cited by Rhyner & Green, 1988).

8. Jones, K. & J. Simmons. 1987. Location, Location, Location. Methuen Publications, Agincourt, Ontario. Canada. xix + 438 pp.

9. Liblit, E. R. 1990. Commercial recycling in Babylon, New York: how the other half operates. Resource Recycling 9(11): 48-52.

10. Louisville. 1970. (Cited by Peter Middleton & Associates but not referenced in their report).

11. Peter Middleton & Associates Limited. 1975. Composition and quantity: a critical evaluation of existing data. A Municipal Solid Waste Management Study by the Pollution Probe Foundation. 86 pp.

12. Proctor & Redfern Ltd. 1972. Hamilton-Wentworth Waste Management Study. First and Second Interim Report, May and October. (Cited by Peter Middleton & Associates).

13. Proctor & Redfern Ltd. 1975. (Cited by Peter Middleton & Associates but not referenced in their report).

14. Rhyner, C. R. & B. D. Green. 1988. The predictive accuracy of published solid waste generation factors. Waste Management & Research 6: 329 - 338. Smith, F. A. 1975. A solid waste estimation procedure: materials flows approach. Environmental Protection Publication SW - 147, U. S. Environmental Protection Agency, Washington, D. C. (Cited by Rhyner & Green, 1988).

15. Statistics Canada. 1980. Standard Industrial Classification. Ottawa

16. Statistics Canada. 1985. Seasonal Variation in the Canadian Economy: Retail Trade. Categories 16-502.

17. Vesilind, P. A. & A. E. Rimer. 1981. Unit Operations in Resource Recovery Engineering. Prentice-Hall, Inc., Englewood Cliffs, N. J. x + 452 pp.

APPENDIX A

Reeve & Redfern Ltd. 1975. (Cited by Peter Middleton & Associates but not referenced in their report).

Rhyner, C. R. & B. D. Green. 1988. The predictive accuracy of published solid waste generation factors. Waste Management & Research. 6: 329-338. Smith, F. A. 1975. A solid waste estimation procedure: material flows approach. Environmental Protection Publication SW - 147. U. S. Environmental Protection Agency. Washington, D. C. (Cited by Rhyner & Green, 1988).

Statistics Canada. 1980. Standard Industrial Classification. Ottawa.

Statistics Canada. 1985. Seasonal Variation in the Canadian Economy, Retail Trade. Catalogue 16-507.

Vesilind, P. A. & A. E. Rimer. 1981. Unit Operations in Resource Recovery Engineering. Prentice-Hall Inc., Englewood Cliffs, N. J. x + 452 pp.

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APPENDIX A

Results of an Empirical Analysis of Commercial Solid Waste Generation Undertaken by T.V. DeGeare and J. E. Ongerth (1971) (ref. 3)

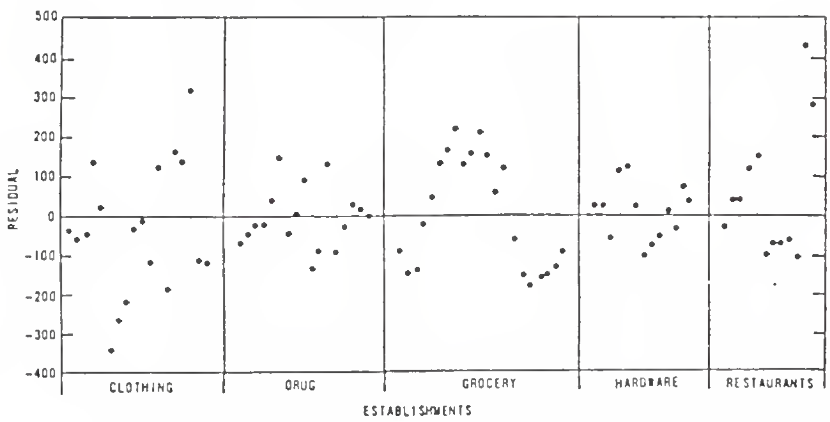

FIG. 1.—REGRESSION EQUATION RESIDUALS (See Table 1 for Data Information)

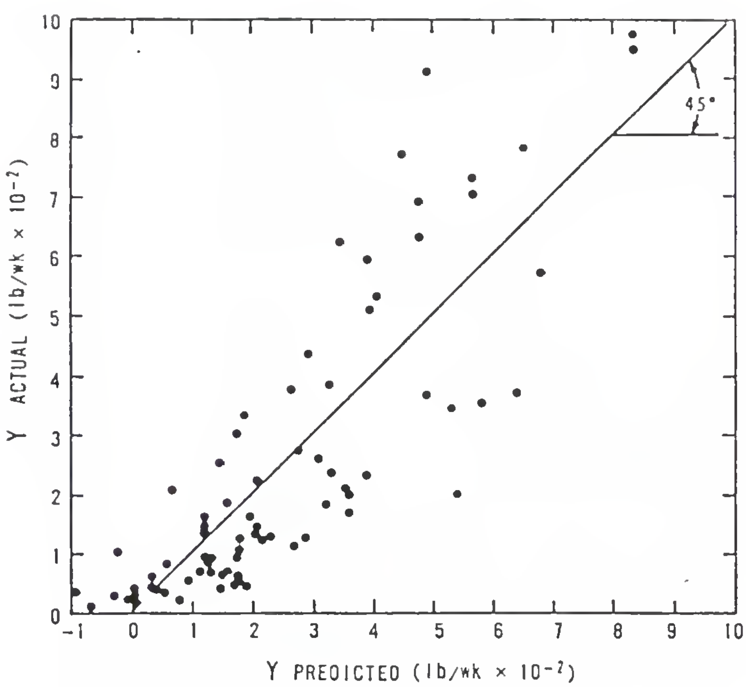

FIG. 2.—ACTUAL VERSUS PREDICTED SOLID WASTE QUANTITIES (All Stores)

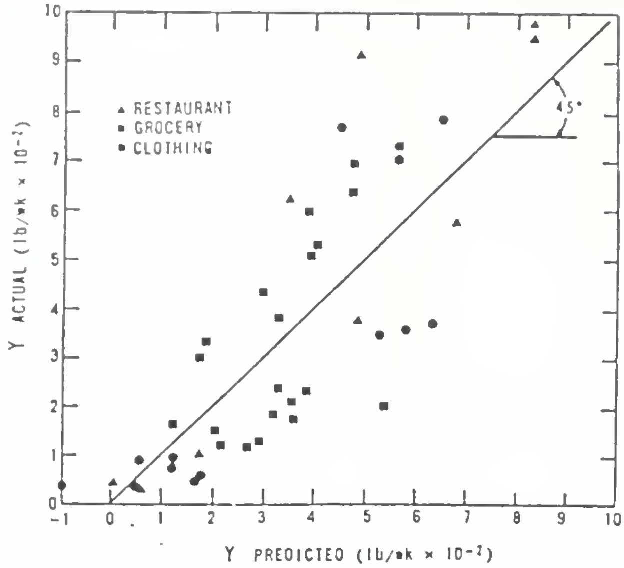

FIG. 3.—ACTUAL VERSUS PREDICTED SOLID WASTE QUANTITIES (Restaurant, Grocery, and Clothing Stores)

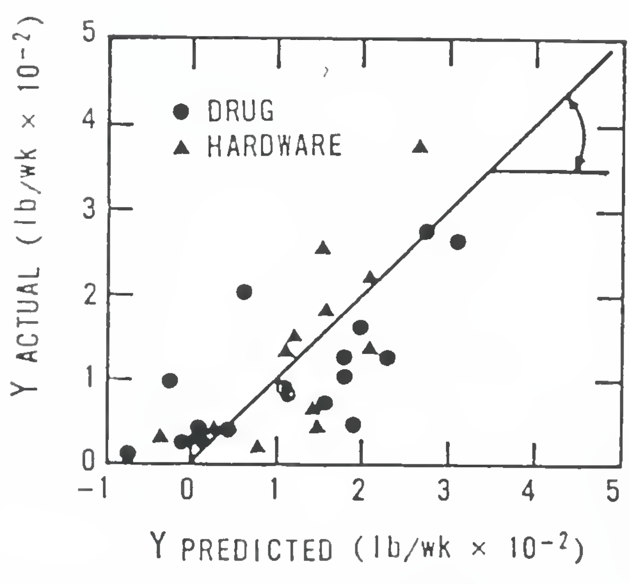

FIG. 4.—ACTUAL VERSUS PREDICTED SOLID WASTE QUANTITIES (Drug and Hardware Stores)

APPENDIX B

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC: 1712
Sample # : 1
Collection Dates: July 1990

SIC code description:
#1712 (footwear industry)

	SAMPLE #: 1 kg	% wt
(1) Paper (a) Newsprint	0.591	2.69%
(b) Fine Paper / CPO / Ledger	0.273	1.24%
(c) Magazines / Flyers		
(d) Waxed / Plastic / Mixed	0.273	1.24%
(e) Boxboard	0.273	1.24%
(f) Kraft	0.773	3.52%
(g) Wallpaper		
(h) OCC	2.636	12.01%
(i) Tissues	0.500	2.28%
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable	0.455	2.07%
(b) Liquor & Wine Containers		
(c) Food Containers	0.455	2.07%
(d) Soft Drink (i) refillable		
(ii) non-refillable		
(e) Other Containers		
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers	0.032	0.15%
(b) Food Containers		
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers	0.015	0.07%
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	0.273	1.24%
(b) PVC		
(c) Polystyrene	0.636	2.90%
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic		
(g) Coated Plastic		
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	1.000	4.55%
(b) Yard Waste		*******
(7) Wood	3.000	13.66%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber	10.591	48.23%
(11) Household Hazardous Wastes (a) Paints / Solvents		
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous	0.184	0.84%
TOTAL kg	21.958	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	tetrapaks	0.184
		0.184

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC:2819 SIC
Sample # : 1-3
Collection Dates: JULY-AUGUST 1990

SAMPLE #:		1 kg	1 %
(1) Paper	(a) Newsprint	0.136	0
	(b) Fine Paper / CPO / Ledger	45.818	78
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	4.682	8
	(e) Boxboard	1.409	2
	(f) Kraft	1.955	3
	(g) Wallpaper		
	(h) OCC		
	(i) Tissues	0.727	1
(2) Glass	(a) Beer (i) refillable		
	(ii) non-refillable		
	(b) Liquor & Wine Containers		
	(c) Food Containers	0.500	0.
	(d) Soft Drink (i) refillable		
	(ii) non-refillable	0.227	0.
	(e) Other Containers		
	(f) Plate		
	(g) Other		
(3) Ferrous	(a) Soft Drink Containers	0.045	0.
	(b) Food Containers	0.318	0.
	(c) Beer Cans (i) returnable		
	(ii) non-returnable		
	(d) Aerosol Cans		
	(e) Other	0.182	0.
(4) Non-Ferrous	(a) Beer Cans (i) returnable		
	(ii) non-returnable		
	(iii) American		
	(b) Soft Drink Containers		
	(c) Other Packaging		
	(d) Aluminum	0.136	0.
	(e) Other		
(5) Plastics	(a) Polyolefins	0.864	1.
	(b) PVC		
	(c) Polystyrene	0.019	0.
	(d) ABS		
	(e) PET		
	(f) Mixed Blend Plastic	0.020	0.
	(g) Coated Plastic		
	(i) Nylon		
	(i) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	0.318	0.
	(b) Yard Waste		
(7) Wood			
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos			
(9) Diapers			
(10) Textiles/Leather/Rubber			
(11) Household Hazardous Wastes	(a) Paints / Solvents		
	(b) Waste Oils		
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries			
(13) Kitty Litter			
(14) Miscellaneous		0.955	1.
		58.31	100.
		TOTAL kg	

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC:2819
Sample # : 1-3
Collection Dates:JULY-AUGUST 1990

SIC code description: #2819 (other commercial printing industry)

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE(kg) MIN.	MAX.	MEAN ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	0.136	0.23%	0.500	1.39%	0.591	0.17%	0.41	0.136	0.591	0.60%
(b) Fine Paper / CPO / Ledger	45.818	78.57%	19.636	54.59%	274.818	79.49%	113.42	19.636	274 618	70.88%
(c) Magazines / Flyers					1.318	0.38%	0.44		1.318	0.13%
(d) Waxed / Plastic / Mixed	4.682	8.03%	6.364	17.69%	4.273	1.24%	5.11	4.273	6.364	8.99%
(e) Boxboard	1.409	2.42%	1.091	3.03%	3.500	1.01%	2.00	1.091	3.500	2.15%
(f) Kraft	1.955	3.35%	3.000	8.34%	1.682	0.49%	2.21	1.682	3.000	4.06%
(g) Wallpaper										
(h) OCC			0.273	0.76%	38.909	11.25%	13.06	0.273	38.909	4.00%
(i) Tissues	0.727	1.25%	0.229	0.64%	0.227	0.07%	0.39	0.227	0.727	0.65%
(2) Glass (a) Beer (i) refillable										
(ii) non-refillable										
(b) Liquor & Wine Containers										
(c) Food Containers	0.500	0.86%					0.17	0.500	0.500	0.29%
(d) Soft Drink (i) refillable										
(ii) non-refillable	0.227	0.39%					0.08	0.227	0.227	0.13%
(e) Other Containers										
(f) Plate										
(g) Other										
(3) Ferrous (a) Soft Drink Containers	0.045	0.08%	0.030	0.08%	0.064	0.02%	0.05	0.030	0.064	0.06%
(b) Food Containers	0.318	0.55%					0.11	0.318	0.318	0.18%
(c) Beer Cans (i) returnable										
(ii) non-returnable										
(d) Aerosol Cans										
(e) Other	0.182	0.31%	0.227	0.63%	1.409	0.41%	0.61	0.182	1.409	0.45%
(4) Non-Ferrous (a) Beer Cans (i) returnable										
(ii) non-returnable										
(iii) American										
(b) Soft Drink Containers			0.047	0.13%			0.02	0.047	0.047	0.04%
(c) Other Packaging										
(d) Aluminum	0.136	0.23%	0.005	0.01%			0.05	0.005	0.136	0.08%
(e) Other										
(5) Plastics (a) Polyolefins	0.864	1.48%	0.545	1.52%	0.227	0.07%	0.55	0.227	0.864	1.02%
(b) PVC										
(c) Polystyrene	0.019	0.03%	0.075	0.21%			0.03	0.019	0.075	0.06%
(d) ABS										
(e) PET										
(f) Mixed Blend Plastic	0.020	0.03%					0.01	0.020	0.020	0.01%
(g) Coated Plastic										
(i) Nylon										
(i) Vinyl					1.364	0.39%	0.45	1.364	1.364	0.13%
(6) Organic (a) Food Waste / Rodent Bedding	0.318	0.55%	3.818	10.61%	1.182	0.34%	1.77	0.318	3.818	3.83%
(b) Yard Waste		*******		*******		*******				
(7) Wood					0.909	0.26%	0.30	0.909	0.909	0.09%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos										
(9) Diapers										
(10) Textiles/Leather/Rubber					6.318	1.83%	2.11	6.318	6.318	0.61%
(11) Household Hazardous Wastes (a) Paints / Solvents					2.955	0.85%	0.98	2.955	2.955	0.28%
(b) Waste Oils										
(c) Pesticides/Herbicides										
(12) Dry Cell Batteries										
(13) Kitty Litter										
(14) Miscellaneous	0.955	1.64%	0.131	0.36%	6.000	1.74%				
	58.31 TOTAL kg	100.00%	35.97 TOTAL kg	100.00%	345.75 TOTAL kg	100.00%	146.68	35.97	345.75	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE	ITEM	WEIGHT (kg)
1	carbon-plastic printing plates	0.955
		0.955
2	tetrapaks	0.131
		0.131
3	small generator motor	6.000
		6.000

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC code description: #4813 (combined radio\television broadcasting industry)

Municipality: Region of Waterloo
SIC: 4813
Sample # : 1
Collection Dates: June 1990

SAMPLE #:	1 kg	1 % wt
(1) Paper (a) Newsprint	8.682	5.57%
(b) Fine Paper / CPO / Ledger	54.727	35.10%
(c) Magazines / Flyers	3.909	2.51%
(d) Waxed / Plastic / Mixed	25.591	16.41%
(e) Boxboard	2.864	1.84%
(f) Kraft	0.818	0.52%
(g) Wallpaper		
(h) OCC	9.832	6.31%
(i) Tissues	3.682	2.36%
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable		
(b) Liquor & Wine Containers		
(c) Food Containers	3.455	2.22%
(d) Soft Drink (i) refillable		
(ii) non-refillable	0.682	0.44%
(e) Other Containers		
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers	0.434	0.28%
(b) Food Containers	3.500	2.24%
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers	0.364	0.23%
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	8.273	5.31%
(b) PVC		
(c) Polystyrene	1.545	0.99%
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic	1.273	0.82%
(g) Coated Plastic	0.102	0.07%
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	22.455	14.40%
(b) Yard Waste		*******
(7) Wood	1.091	0.70%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber	0.340	0.22%
(11) Household Hazardous Wastes (a) Paints / Solvents	1.636	1.05%
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous	0.656	0.42%
TOTAL kg	155.910	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	misc. plastic parts	0.056
	tetrapak	0.007
	video/audio tape	0.457
	air filter	0.136
		0.656

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6011, 6012, 6019
Sample #: 1-5
Collection Dates: May, June, July 1990

SIC # 6019

SAMPLE #:		kg	% wt
(1) Paper	(a) Newsprint	0.636	2.56
	(b) Fine Paper / CPO / Ledger	0.182	0.73
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	0.045	0.18
	(e) Boxboard	2.136	8.58
	(f) Kraft	2.773	11.14
	(g) Wallpaper		
	(h) OCC	18.682	75.04
	(i) Tissues		
(2) Glass	(a) Beer (i) refillable		
	(ii) non-refillable		
	(b) Liquor & Wine Containers		
	(c) Food Containers		
	(d) Soft Drink (i) refillable		
	(ii) non-refillable		
	(e) Other Containers		
	(f) Plate		
	(g) Other		
(3) Ferrous	(a) Soft Drink Containers		
	(b) Food Containers		
	(c) Beer Cans (i) returnable		
	(ii) non-returnable		
	(d) Aerosol Cans		
	(e) Other		
(4) Non-Ferrous	(a) Beer Cans (i) returnable		
	(ii) non-returnable		
	(iii) American		
	(b) Soft Drink Containers	0.032	0.13
	(c) Other Packaging		
	(d) Aluminum		
	(e) Other		
(5) Plastics	(a) Polyolefins	0.182	0.73
	(b) PVC		
	(c) Polystyrene	0.045	0.18
	(d) ABS		
	(e) PET		
	(f) Mixed Blend Plastic		
	(g) Coated Plastic		
	(i) Nylon		
	(l) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	0.182	0.73
	(b) Yard Waste		
(7) Wood			
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos			
(9) Diapers			
(10) Textiles/Leather/Rubber			
(11) Household Hazardous Wastes	(a) Paints / Solvents		
	(b) Waste Oils		
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries			
(13) Kitty Litter			
(14) Miscellaneous			
TOTAL kg		24.90	100.0

ITEMS

WT RECORDED

WEIGHT (kg)
0.026
0.026

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6011, 6012, 6019
Sample #: 1-5
Collection Dates: May, June, July 1990

SIC code description: #6011 (supermarket)
#6012 (grocery stores)
#6019 (specialty food stores i.e. health food)

SAMPLE #	1 (SIC # 6019) kg	1 % wt	2 (SIC # 6011) kg	2 % wt	3 (SIC # 6012) kg	3 % wt	4 (SIC # 6012) kg	4 % wt	5 (SIC # 6012) kg	5 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE (kg) MIN.	MAX.	MEAN ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	0.636	2.56%			1.045	4.37%	36.636	72.05%	0.947	4.94%	7.85	0.636	36.636	16.78%
(b) Fine Paper / CPO / Ledger	0.182	0.73%	23.636	0.41%	2.682	11.22%	0.273	0.54%	0.575	3.00%	5.47	0.182	23.636	3.18%
(c) Magazines / Flyers											0.01			
(d) Waxed / Plastic / Mixed	0.045	0.18%	21.818	0.38%	0.591	2.47%	0.818	1.61%	1.238	6.46%	5.32	0.045	21.818	2.22%
(e) Boxboard	2.136	8.58%	54.818	0.95%	4.455	18.64%	3.364	6.62%	3.567	18.61%	13.80	2.136	54.818	10.68%
(f) Kraft	2.773	11.14%	14.591	0.25%	1.273	5.33%	0.682	1.34%	0.589	3.07%	3.98	0.589	14.591	4.23%
(g) Wallpaper														
(h) OCC	18.682	75.04%	2098.955	36.30%	1.045	4.37%	1.818	3.58%	4.318	22.53%	424.96	1.045	2098.955	28.37%
(i) Tissues			186.727	3.23%	3.409	14.26%	0.545	1.07%	0.604	3.15%	38.26	0.545	186.727	4.34%
(2) Glass (a) Beer (i) refillable														
(ii) non-refillable														
(b) Liquor & Wine Containers							0.449	0.88%			0.09	0.449	0.449	0.18%
(c) Food Containers					0.682	2.85%			1.080	5.64%	0.35	0.682	1.080	1.70%
(d) Soft Drink (i) refillable							0.728	1.43%			0.15	0.728	0.728	0.29%
(ii) non-refillable					0.909	3.80%	2.310	4.54%	1.630	8.51%	0.97	0.909	2.310	3.37%
(e) Other Containers														
(f) Plate														
(g) Other														
(3) Ferrous (a) Soft Drink Containers					0.773	3.23%	0.909	1.79%	0.149	0.78%	0.37	0.149	0.909	1.16%
(b) Food Containers					0.045	0.19%	0.074	0.15%	0.202	1.05%	0.06	0.045	0.202	0.28%
(c) Beer Cans (i) returnable														
(ii) non-returnable														
(d) Aerosol Cans														
(e) Other									0.005	0.03%	0.001	0.005	0.005	0.01%
(4) Non-Ferrous (a) Beer Cans (i) returnable														
(ii) non-returnable														
(iii) American														
(b) Soft Drink Containers	0.032	0.13%			0.091	0.38%	0.182	0.36%	0.155	0.81%	0.09	0.032	0.182	0.34%
(c) Other Packaging														
(d) Aluminum					0.011	0.05%			0.012	0.06%	0.005	0.011	0.012	0.02%
(e) Other							0.032	0.06%			0.01	0.032	0.032	0.01%
(5) Plastics (a) Polyolefins	0.182	0.73%	80.545	1.39%	3.545	14.83%	1.318	2.59%	1.249	6.52%	17.37	0.182	80.545	5.21%
(b) PVC														
(c) Polystyrene	0.045	0.18%	25.318	0.44%	0.500	2.09%	0.136	0.27%	0.089	0.46%	5.22	0.045	25.318	0.69%
(d) ABS														
(e) PET							0.164	0.32%			0.03	0.164	0.164	0.06%
(f) Mixed Blend Plastic							0.045	0.09%	0.111	0.58%	0.03	0.045	0.111	0.13%
(g) Coated Plastic					0.091	0.38%			0.071	0.37%	0.03	0.071	0.091	0.15%
(i) Nylon														
(l) Vinyl														
(6) Organic (a) Food Waste / Rodent Bedding	0.182	0.73%	3064.864	53.01%	2.727	11.41%	0.364	0.72%	2.412	12.59%	614.11	0.182	3064.864	15.69%
(b) Yard Waste														
(7) Wood			210.545	3.64%							42.11		210.545	0.73%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos														
(9) Diapers									0.161	0.84%	0.03	0.161	0.161	0.17%
(10) Textiles/Leather/Rubber														
(11) Household Hazardous Wastes (a) Paints / Solvents														
(b) Waste Oils														
(c) Pesticides/Herbicides														
(12) Dry Cell Batteries														
(13) Kitty Litter														
(14) Miscellaneous					0.026	0.11%								
TOTAL kg	24.90	100.00%	5781.82	100.00%	23.90	100.00%	50.85	100.00%	19.16	100.00%	1180.13	19.16	5781.82	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1		
2		
3	light bulbs	0.026
		0.026
4		
5		

Ministry of the Environment
Waste Composition Study

GORE &

Municipality: Region of Waterloo
SIC code: 6111, 6149, 6151
Sample #: 1-8
Collection Dates: June, July 1990

SIC# 611

SAMPLE #:		1 kg	1 %
(1) Paper	(a) Newsprint	10.455	22
	(b) Fine Paper / CPO / Ledger	0.227	0
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	0.227	0
	(e) Boxboard	18.136	39
	(f) Kraft	0.062	0
	(g) Wallpaper		
	(h) OCC	4.636	10.
	(i) Tissues	4.545	9
(2) Glass	(a) Beer (i) refillable		
	(ii) non-refillable		
	(b) Liquor & Wine Containers		
	(c) Food Containers	0.818	1,
	(d) Soft Drink (i) refillable		
	(ii) non-refillable		
	(e) Other Containers		
	(f) Plate		
	(g) Other		
(3) Ferrous	(a) Soft Drink Containers		
	(b) Food Containers	0.227	0.
	(c) Beer Cans (i) returnable		
	(ii) non-returnable	0.032	0.
	(d) Aerosol Cans		
	(e) Other		
(4) Non-Ferrous	(a) Beer Cans (i) returnable		
	(ii) non-returnable		
	(iii) American		
	(b) Soft Drink Containers	0.016	0.
	(c) Other Packaging		
	(d) Aluminum		
	(e) Other		
(5) Plastics	(a) Polyolefins	1.773	3.
	(b) PVC		
	(c) Polystyrene	0.136	0.
	(d) ABS		
	(e) PET		
	(f) Mixed Blend Plastic		
	(g) Coated Plastic		
	(i) Nylon		
	(i) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	0.591	1.
	(b) Yard Waste		
(7) Wood			
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos			
(9) Diapers		0.545	1.2
(10) Textiles/Leather/Rubber		3.182	6.9
(11) Household Hazardous Wastes	(a) Paints / Solvents		
	(b) Waste Oils		
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries			
(13) Kitty Litter			
(14) Miscellaneous			
TOTAL kg		45.61	100.0

EAN A PERCENT ASIS

MEAN (%)
14.61%
3.90%
4.52%
1.65%
15.26%
1.64%
28.65%
6.34%
0.65%
0.32%
1.58%
0.45%
0.04%
0.46%
0.16%
0.01%
0.02%
0.25%
0.01%
6.49%
2.15%
0.28%
2.24%
2.36%
0.15%
2.02%
3.80%
00.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1		
2	plexiglass	2.500
		2.500
3	light bulbs	0.030
	tetrapaks	0.156
		0.186
4		
5		
6	electrical wire	0.160
	coated wire hanger	0.046
	tetrapaks	0.060
		0.266
7	tetrapaks	0.044
		0.044
8	instant start ballasts	10.000
	synthetic canvas	0.500
	tetrapaks	0.030
		10.530

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC code description: #6111 (shoe stores)
#6149 (other clothing stores ie.leisure wear; combination mens\womens)
#6151 (fabric and yarn stores)

Municipality: Region of Waterloo
SIC code: 6111, 6149, 6151
Sample #: 1-8
Collection Dates: June, July 1990

SAMPLE #:	1 (SIC# 6111) kg	1 % wt	2 (SIC# 6111) kg	2 % wt	3 (SIC# 6149) kg	3 % wt	4 (SIC# 6149) kg	4 % wt	5 (SIC# 6149) kg	5 % wt	6 (SIC# 6149) kg	6 % wt	7 (SIC# 6151) kg	7 % wt	8 (SIC# 6151) kg	8 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE(kg) MIN.	MAX.	MEAN ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	10.455	22.92%	2.500	5.37%	0.136	0.39%	3.409	48.81%	1.409	23.88%	1.045	5.59%	1.182	6.93%	1.364	2.95%	2.69	0.136	10.455	14.61%
(b) Fine Paper / CPO / Ledger	0.227	0.50%	0.545	1.17%	2.091	6.00%	0.591	8.46%	0.500	8.47%	0.818	4.38%	0.227	1.33%	0.409	0.89%	0.68	0.227	2.091	3.90%
(c) Magazines / Flyers					1.227	3.52%			1.864	31.58%	0.136	0.73%			0.136	0.30%	0.42	0.136	1.864	4.52%
(d) Waxed / Plastic / Mixed	0.227	0.50%	0.591	1.27%	0.909	2.61%	0.227	3.25%	0.045	0.77%	0.591	3.16%	0.091	0.53%	0.500	1.08%	0.40	0.045	0.909	1.65%
(e) Boxboard	18.136	39.76%	6.227	13.38%	3.500	10.04%	0.136	1.95%	0.091	1.54%	4.545	24.31%	3.455	20.26%	5.000	10.83%	5.14	0.091	18.136	15.26%
(f) Kraft	0.062	0.14%	0.091	0.20%	0.091	0.26%	0.545	7.81%	0.045	0.77%	0.045	0.24%	0.045	0.27%	1.591	3.45%	0.31	0.045	1.591	1.64%
(g) Wallpaper																				
(h) OCC	4.636	10.17%	31.318	67.29%	8.971	25.74%	0.455	6.51%	1.455	24.65%	6.045	32.33%	7.318	42.93%	9.063	19.63%	8.66	0.455	31.318	28.65%
(i) Tissues	4.545	9.97%	1.455	3.13%	0.727	2.09%	0.136	1.95%	0.045	0.77%	0.409	2.19%	3.455	20.26%	4.773	10.34%	1.94	0.045	4.773	6.34%
(2) Glass (a) Beer (i) refillable																				
(ii) non-refillable							0.364	5.21%									0.05	0.364	0.364	0.65%
(b) Liquor & Wine Containers					0.880	2.52%											0.11	0.880	0.880	0.32%
(c) Food Containers	0.818	1.79%			0.236	0.68%	0.455	6.51%			0.500	2.67%			0.455	0.98%	0.31	0.236	0.818	1.58%
(d) Soft Drink (i) refillable																				
(ii) non-refillable									0.182	3.08%					0.227	0.49%	0.05	0.182	0.227	0.45%
(e) Other Containers					0.114	0.33%											0.01	0.114	0.114	0.04%
(f) Plate																				
(g) Other																				
(3) Ferrous (a) Soft Drink Containers					0.346	0.99%	0.136	1.95%	0.032	0.54%					0.090	0.20%	0.08	0.032	0.346	0.46%
(b) Food Containers	0.227	0.50%									0.036	0.19%	0.063	0.37%	0.091	0.20%	0.05	0.036	0.227	0.16%
(c) Beer Cans (i) returnable																				
(ii) non-returnable	0.032	0.07%															0.004	0.032	0.032	0.01%
(d) Aerosol Cans																				
(e) Other					0.058	0.17%											0.01	0.058	0.058	0.02%
(4) Non-Ferrous (a) Beer Cans (i) returnable																				
(ii) non-returnable																				
(iii) American																				
(b) Soft Drink Containers	0.016	0.03%			0.145	0.42%	0.030	0.43%	0.030	0.51%	0.091	0.49%	0.013	0.08%	0.030	0.06%	0.04	0.013	0.145	0.25%
(c) Other Packaging																				
(d) Aluminum															0.045	0.10%	0.01	0.045	0.045	0.01%
(e) Other																				
(5) Plastics (a) Polyolefins	1.773	3.89%	1.091	2.34%	4.909	14.08%	0.182	2.60%	0.091	1.54%	1.818	9.72%	0.545	3.20%	6.727	14.57%	2.14	0.091	6.727	6.49%
(b) PVC																				
(c) Polystyrene	0.136	0.30%	0.091	0.20%	0.364	1.04%	0.091	1.30%	0.045	0.77%	2.273	12.16%	0.045	0.27%	0.545	1.18%	0.45	0.045	2.273	2.15%
(d) ABS																				
(e) PET																				
(f) Mixed Blend Plastic					0.773	2.22%											0.10	0.077	0.773	0.28%
(g) Coated Plastic																				
(i) Nylon																				
(j) Vinyl																				
(6) Organic (a) Food Waste / Rodent Bedding	0.591	1.30%	0.091	0.20%	1.091	3.13%	0.227	3.25%	0.045	0.77%			0.545	3.20%	2.818	6.10%	0.68	0.045	2.818	2.24%
(b) Yard Waste																				
(7) Wood			0.045	0.10%	5.727	16.43%					0.073	0.39%			0.909	1.97%	0.84	0.045	5.727	2.36%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos																				
(9) Diapers	0.545	1.20%															0.07	0.545	0.545	0.15%
(10) Textiles/Leather/Rubber	3.182	6.98%			2.372	6.81%			0.022	0.37%	0.004	0.02%	0.018	0.11%	0.864	1.87%	0.81	0.004	3.182	2.02%
(11) Household Hazardous Wastes (a) Paints / Solvents																				
(b) Waste Oils																				
(c) Pesticides/Herbicides																				
(12) Dry Cell Batteries																				
(13) Kitty Litter																				
(14) Miscellaneous			2.500	5.37%	0.186	0.53%					0.266	1.42%	0.044	0.26%	10.530	22.81%	1.69	0.044	10.530	3.80%
TOTAL kg	45.61	100.00%	46.55	100.00%	34.85	100.00%	6.98	100.00%	5.90	100.00%	18.70	100.00%	17.05	100.00%	46.17	100.00%	27.73	5.90	46.55	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1		
2	plexiglass	2.500
		2.500
3	light bulbs	0.030
	tetrapaks	0.156
		0.186
4		
5		
6	electrical wire	0.160
	coated wire hanger	0.046
	tetrapaks	0.060
		0.266
7	tetrapaks	0.044
		0.044
8	instant start ballasts	10.000
	synthetic canvas	0.500
	tetrapaks	0.030
		10.530

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6211, 6212, 6223, 6231, 6239
Sample #: 1-5
Collection Dates: JUNE-AUGUST 1990

SIC # 6223		
SAMPLE #:	1	
	kg	% wt
(1) Paper (a) Newsprint	0.136	2.19%
(b) Fine Paper / CPO / Ledger	1.273	20.40%
(c) Magazines / Flyers	0.455	7.28%
(d) Waxed / Plastic / Mixed	0.080	1.28%
(e) Boxboard	0.182	2.91%
(f) Kraft	0.032	0.51%
(g) Wallpaper		
(h) OCC	2.242	35.93%
(i) Tissues	0.005	0.08%
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable		
(b) Liquor & Wine Containers		
(c) Food Containers		
(d) Soft Drink (i) refillable		
(ii) non-refillable		
(e) Other Containers		
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers	0.060	0.96%
(b) Food Containers		
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers		
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	0.227	3.64%
(b) PVC		
(c) Polystyrene	0.003	0.05%
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic		
(g) Coated Plastic		
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding		
(b) Yard Waste		
(7) Wood	0.091	1.46%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber		
(11) Household Hazardous Wastes (a) Paints / Solvents		
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous	1.455	23.32%
TOTAL kg	6.24	100.00%

MS

RECORDED

WEIGHT (kg)
1.455
1.455
4.045
1.136
1.864
1.353
16.773
0.037
25.208
0.035
0.035
1.000
0.318
0.591
1.909

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6211, 6212, 6223, 6231, 6239
Sample #: 1-5
Collection Dates: JUNE-AUGUST 1990

with appliances\furnishings)
#6212 (household furniture stores-without appliances\furnishings)
#6223 (appliance,television,radio and sterio repair shops)
#6231 (floor covering stores)
#6239 (other furnishing stores i.e. linen;glassware etc.)

	SIC # 6223		SIC # 6211		SIC # 6231		SIC # 6212		SIC # 6239		MEAN ON A WEIGHT BASIS	RANGE ON A WEIGHT BASIS		MEAN ON A PERCENT BASIS
SAMPLE #:	1		2		3		4		5					
	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	MEAN (kg)	RANGE(kg) MIN.	MAX.	MEAN (%)
(1) Paper (a) Newsprint	0.136	2.19%	0.136	0.06%	2.791	2.44%			1.409	2.21%	0.89	0.136	2.791	1.38%
(b) Fine Paper / CPO / Ledger	1.273	20.40%	6.773	3.12%	1.909	1.67%			0.636	1.00%	2.12	0.636	6.773	5.24%
(c) Magazines / Flyers	0.455	7.28%									0.09	0.455	0.455	1.46%
(d) Waxed / Plastic / Mixed	0.080	1.28%	2.955	1.36%	1.818	1.59%			0.136	0.21%	1.00	0.080	2.955	0.89%
(e) Boxboard	0.182	2.91%	2.227	1.02%	0.955	0.83%			3.182	4.99%	1.31	0.182	3.182	1.95%
(f) Kraft	0.032	0.51%	3.864	1.78%	2.541	2.22%			0.273	0.43%	1.34	0.032	3.864	0.99%
(g) Wallpaper														
(h) OCC	2.242	35.93%	69.513	31.98%	24.864	21.71%	18.773	74.55%	51.352	80.55%	33.35	2.242	69.513	48.94%
(i) Tissues	0.005	0.08%	2.636	1.21%	0.093	0.08%			0.455	0.71%	0.64	0.005	2.636	0.42%
(2) Glass (a) Beer (i) refillable														
(ii) non-refillable														
(b) Liquor & Wine Containers														
(c) Food Containers			0.838	0.39%	0.398	0.35%					0.25	0.396	0.838	0.15%
(d) Soft Drink (i) refillable														
(ii) non-refillable			0.425	0.20%	0.229	0.20%					0.13	0.229	0.425	0.08%
(e) Other Containers														
(f) Plate														
(g) Other			6.364	2.93%					2.045	3.21%	1.68	2.045	6.364	1.23%
(3) Ferrous (a) Soft Drink Containers	0.060	0.96%	0.817	0.38%	0.366	0.32%			0.079	0.12%	0.26	0.060	0.817	0.36%
(b) Food Containers			0.366	0.17%							0.07	0.366	0.366	0.03%
(c) Beer Cans (i) returnable														
(ii) non-returnable														
(d) Aerosol Cans			0.177	0.08%							0.04	0.177	0.177	0.02%
(e) Other			54.636	25.14%	0.337	0.29%					10.99	0.337	54.636	5.09%
(4) Non-Ferrous (a) Beer Cans (i) returnable														
(ii) non-returnable									0.015	0.02%	0.003	0.015	0.015	0.005%
(iii) American														
(b) Soft Drink Containers			0.059	0.03%	0.157	0.14%			0.078	0.12%	0.06	0.059	0.157	0.06%
(c) Other Packaging														
(d) Aluminum			0.031	0.01%	0.009	0.01%					0.01	0.009	0.031	0.004%
(e) Other					0.049	0.04%					0.01	0.049	0.049	0.01%
(5) Plastics (a) Polyolefins	0.227	3.64%	10.414	4.79%	9.864	8.61%	3.818	15.16%	1.000	1.57%	5.06	0.227	10.414	6.76%
(b) PVC														
(c) Polystyrene	0.003	0.05%	3.273	1.51%					0.364	0.57%	0.73	0.003	3.273	0.42%
(d) ABS					0.224	0.20%					0.04	0.224	0.224	0.04%
(e) PET														
(f) Mixed Blend Plastic														
(g) Coated Plastic														
(i) Nylon														
(i) Vinyl					0.773	0.67%					0.15	0.773	0.773	0.13%
(6) Organic (a) Food Waste / Rodent Bedding			1.909	0.88%	0.864	0.75%			0.727	1.14%	0.70	0.727	1.909	0.55%
(b) Yard Waste														
(7) Wood	0.091	1.46%	22.500	10.35%	0.062	0.05%	2.591	10.29%			5.05	0.062	22.500	4.43%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos									0.091	0.14%	0.02	0.091	0.091	0.03%
(9) Diapers														
(10) Textiles/Leather/Rubber			1.236	0.57%	66.203	57.80%					13.49	1.236	66.203	11.67%
(11) Household Hazardous Wastes (a) Paints / Solvents			0.981	0.45%							0.20	0.981	0.981	0.09%
(b) Waste Oils														
(c) Pesticides/Herbicides														
(12) Dry Cell Batteries			0.021	0.01%							0.004	0.021	0.021	0.002%
(13) Kitty Litter														
(14) Miscellaneous	1.455	23.32%	25.208	11.60%	0.035	0.03%			1.909	2.99%				
TOTAL kg	6.24	100.00%	217.36	100.00%	114.54	100.00%	25.18	100.00%	63.75	100.00%	85.41	6.24	217.36	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	electrical wire	1.455
		1.455
2	furnace air filters	4.045
	light bulbs	1.136
	floor tiles	1.864
	concrete	1.353
	compressor	16.773
	tetrapaks	0.037
		25.208
3	tetrapaks	0.035
		0.035
4		
5	plastic dishes	1.000
	acrylic dishes	0.318
	floodlights	0.591
		1.909

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6311
Sample #: 1-6
Collection Dates: May, June, July, 1990

SAMPLE #:	1 kg	1 % wt
(1) Paper (a) Newsprint	2.818	20.23
(b) Fine Paper / CPO / Ledger	1.000	7.18
(c) Magazines / Flyers		
(d) Waxed / Plastic / Mixed	0.591	4.24
(e) Boxboard	0.682	4.90
(f) Kraft	0.318	2.28
(g) Wallpaper		
(h) OCC		
(i) Tissues	1.182	8.49
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable		
(b) Liquor & Wine Containers		
(c) Food Containers		
(d) Soft Drink (i) refillable		
(ii) non-refillable	0.448	3.22
(e) Other Containers		
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers	0.096	0.69
(b) Food Containers		
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers	0.068	0.49%
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	1.227	8.81%
(b) PVC		
(c) Polystyrene	0.364	2.61%
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic	0.500	3.59%
(g) Coated Plastic	0.021	0.15%
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	0.864	6.20%
(b) Yard Waste		
(7) Wood		
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.357	2.56%
(9) Diapers		
(10) Textiles/Leather/Rubber	2.445	17.56%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.619	4.45%
(b) Waste Oils	0.261	1.87%
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous	0.067	0.48%
TOTAL kg	13.93	100.00%

EIGHT (kg)

0.067
0.067
0.591
1.682
0.528
0.260
0.147
0.307
0.727
1.887
2.591
2.500
1.409
4.955
17.584
5.000
5.818
1.364
3.395
15.577
5.136
1.182
1.455
0.249
4.136
8.727
20.886
3.818
0.364
0.515
4.697
13.955
1.045
0.136
15.136

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6311
Sample #: 1-6
Collection Dates: May, June, July, 1990

SIC code description: #6311 ("new" automobile dealers)

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	4 kg	4 % wt	5 kg	5 % wt	6 kg	6 % wt
(1) Paper (a) Newsprint	2.818	20.23%	7.045	4.80%	16.318	5.81%	3.955	2.22%	4.364	3.39%	2.591	0.94%
(b) Fine Paper / CPO / Ledger	1.000	7.18%	6.909	4.71%	6.636	2.36%	5.182	2.90%	11.273	8.76%	15.500	5.62%
(c) Magazines / Flyers			0.099	0.07%					3.409	2.65%	1.591	0.58%
(d) Waxed / Plastic / Mixed	0.591	4.24%	6.409	4.37%	5.773	2.06%	6.455	3.62%	0.636	0.49%	2.636	0.96%
(e) Boxboard	0.682	4.90%	3.682	2.51%	5.455	1.94%	2.455	1.38%	4.318	3.35%	3.773	1.37%
(f) Kraft	0.318	2.28%	8.227	5.61%	14.000	4.99%	9.000	5.04%	0.409	0.32%	7.500	2.72%
(g) Wallpaper												
(h) OCC			17.809	12.13%	65.727	23.41%	22.000	12.32%	6.360	4 94%	99.288	36 03%
(i) Tissues	1.182	8.49%	5.409	3.69%	11.773	4.19%	0.636	0.36%	2.409	1.87%	6.545	2.37%
(2) Glass (a) Beer (i) refillable			0.034	0.02%	1.802	0.64%						
(ii) non-refillable												
(b) Liquor & Wine Containers									0.248	0.19%		
(c) Food Containers			2.522	1.72%	1.360	0.48%			0.393	0.31%	0.909	0.33%
(d) Soft Drink (i) refillable												
(ii) non-refillable	0.448	3.22%									0.227	0.08%
(e) Other Containers					0.283	0.10%						
(f) Plate												
(g) Other												
(3) Ferrous (a) Soft Drink Containers	0.096	0.69%	0.913	0.62%	0.824	0.29%	0.497	0.28%	0.237	0.18%	1.727	0.63%
(b) Food Containers												
(c) Beer Cans (i) returnable					2.270	0.81%						
(ii) non-returnable												
(d) Aerosol Cans			0.726	0.49%			0.401	0.22%			0.500	0.18%
(e) Other			23.812	16.22%	74.565	26.55%	59.182	33.15%	54.288	42.16%	89.409	32.44%
(4) Non-Ferrous (a) Beer Cans (i) returnable												
(ii) non-returnable												
(iii) American												
(b) Soft Drink Containers	0.068	0.49%	0.132	0.09%	0.507	0.18%	0.031	0.02%	0.262	0.20%	0.545	0.20%
(c) Other Packaging												
(d) Aluminum			0.039	0.03%	0.060	0.02%	0.035	0.02%			0.091	0.03%
(e) Other							0.025	0.01%				
(5) Plastics (a) Polyolefins	1.227	8.81%	7.409	5.05%	9.591	3.42%	6.045	3.39%	3.045	2.37%	12.545	4.55%
(b) PVC												
(c) Polystyrene	0.364	2.61%	0.636	0.43%	2.136	0.76%	2.227	1.25%	0.318	0.25%	1.773	0.64%
(d) ABS												
(e) PET												
(f) Mixed Blend Plastic	0.500	3.59%	3.001	2.04%	2.398	0.85%			0.049	0.04%		
(g) Coated Plastic	0.021	0.15%	0.132	0.09%					0.013	0.01%		
(i) Nylon												
(j) Vinyl												
(6) Organic (a) Food Waste / Rodent Bedding	0.864	6.20%	10.091	6.87%	9.864	3.51%	0.909	0.51%	0.955	0.74%	1.682	0.61%
(b) Yard Waste												
(7) Wood							15.591	8.73%	18.818	14.62%		
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.357	2.56%										
(9) Diapers			0.129	0.09%								
(10) Textiles/Leather/Rubber	2.445	17.56%	1.962	1.34%	2.755	0.98%	3.771	2.11%	3.706	2.88%	3.662	1.34%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.619	4.45%	1.526	1.04%	8.102	2.89%	7.136	4.00%				
(b) Waste Oils	0.261	1.87%	20.545	14.00%	23.045	8.21%	12.091	6.77%	8.545	6.64%	7.955	2.89%
(c) Pesticides/Herbicides												
(12) Dry Cell Batteries												
(13) Kitty Litter												
(14) Miscellaneous	0.067	0.48%	17.584	11.98%	15.577	5.55%	20.886	11.70%	4.697	3.55%	15.136	5.49%
TOTAL kg	13.93	100.00%	146.78	100.00%	280.62	100.00%	178.51	100.00%	128.75	100.00%	275.61	100.00%

MISCELLANEOUS ITEMS

NOTE: "**" = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	silicon sealant (aluminum tube	0.067
		0.067
2	head light	0.591
	body filler	1.682
	foam packing	0.528
	spark plugs	0.260
	respirator	0.147
	gaskets	0.307
	clutch cables	0.727
	filters	1.887
	oil cooler	2.591
	mixed auto plastic	2.500
	side stripping	1.409
	shocks	4.955
		17.584
3	auto plastic	5.000
	air filters	5.818
	audio speakers	1.364
	headlights, misc. lightbulbs	3.395
		15.577
4	mixed auto plastic	5.136
	clutch plates	1.182
	gaskets	1.455
	fibreglass autoparts	0.249
	filters	4.136
	van hood(heavy plastic)	8.727
		20.886
5	auto plastic	3.818
	air filter	0.364
	headlights, misc. lightbulbs	0.515
		4.697
6	air filters	13.955
	auto plastic	1.045
	wind shield wiper blades	0.136
		15.136

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC: 6331
Sample # : 1-3
Collection Dates: May 1990

	SAMPLE #: 1
	kg
(1) Paper (a) Newsprint	0.051
(b) Fine Paper / CPO / Ledger	0.227
(c) Magazines / Flyers	
(d) Waxed / Plastic / Mixed	0.227
(e) Boxboard	0.136
(f) Kraft	0.136
(g) Wallpaper	
(h) OCC	2.636
(i) Tissues	0.682
(2) Glass (a) Beer (i) refillable	
(ii) non-refillable	
(b) Liquor & Wine Containers	
(c) Food Containers	0.424
(d) Soft Drink (i) refillable	
(ii) non-refillable	
(e) Other Containers	
(f) Plate	
(g) Other	
(3) Ferrous (a) Soft Drink Containers	0.087
(b) Food Containers	
(c) Beer Cans (i) returnable	
(ii) non-returnable	
(d) Aerosol Cans	
(e) Other	
(4) Non-Ferrous (a) Beer Cans (i) returnable	
(ii) non-returnable	
(iii) American	
(b) Soft Drink Containers	0.187
(c) Other Packaging	
(d) Aluminum	
(e) Other	
(5) Plastics (a) Polyolefins	0.864
(b) PVC	
(c) Polystyrene	0.057
(d) ABS	
(e) PET	
(f) Mixed Blend Plastic	0.500
(g) Coated Plastic	
(i) Nylon	
(i) Vinyl	
(6) Organic (a) Food Waste / Rodent Bedding	0.409
(b) Yard Waste	
(7) Wood	
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	
(9) Diapers	0.081
(10) Textiles/Leather/Rubber	0.952
(11) Household Hazardous Wastes (a) Paints / Solvents	0.726
(b) Waste Oils	
(c) Pesticides/Herbicides	
(12) Dry Cell Batteries	
(13) Kitty Litter	
(14) Miscellaneous	0.024
TOTAL kg	8.41

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC: 6331
Sample # : 1-3
Collection Dates: May 1990

SIC code description: #6331 (gasoline service station i.e.gas bar)

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE(kg) Min.	Max.	Mean ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	0.051	0.61%	0.818	6.06%	4.136	31.60%	1.67	0.051	4.136	12.76%
(b) Fine Paper / CPO / Ledger	0.227	2.70%	1.455	10.78%	0.273	2.08%	0.65	0.227	1.455	5.19%
(c) Magazines / Flyers			0.034	0.25%			0.01	0.034	0.034	0.08%
(d) Waxed / Plastic / Mixed	0.227	2.70%	0.591	4.38%	0.545	4.17%	0.45	0.227	0.591	3.75%
(e) Boxboard	0.136	1.62%	0.773	5.73%	0.045	0.35%	0.32	0.045	0.773	2.57%
(f) Kraft	0.136	1.62%	0.143	1.06%	0.045	0.35%	0.11	0.045	0.143	1.01%
(g) Wallpaper										
(h) OCC	2.636	31.36%	1.364	10.11%	0.182	1.39%	1.39	0.182	2.636	14.28%
(i) Tissues	0.682	8.11%	1.136	8.42%	0.364	2.78%	0.73	0.364	1.136	6.44%
(2) Glass (a) Beer (i) refillable										
(ii) non-refillable										
(b) Liquor & Wine Containers										
(c) Food Containers	0.424	5.04%			0.318	2.43%	0.25	0.318	0.424	2.49%
(d) Soft Drink (i) refillable										
(ii) non-refillable			0.843	6.25%	0.864	6.60%	0.57	0.843	0.864	4.28%
(e) Other Containers										
(f) Plate										
(g) Other										
(3) Ferrous (a) Soft Drink Containers	0.087	1.03%	0.030	0.22%	0.045	0.35%	0.05	0.030	0.087	0.53%
(b) Food Containers			0.056	0.41%			0.02	0.056	0.056	0.14%
(c) Beer Cans (i) returnable										
(ii) non-returnable										
(d) Aerosol Cans										
(e) Other			0.198	1.47%			0.07	0.198	0.198	0.49%
(4) Non-Ferrous (a) Beer Cans (i) returnable			0.018	0.13%			0.01	0.018	0.018	0.04%
(ii) non-returnable										
(iii) American										
(b) Soft Drink Containers	0.187	2.22%	0.065	0.48%	0.364	2.78%	0.21	0.065	0.364	1.83%
(c) Other Packaging										
(d) Aluminum			0.032	0.24%			0.01	0.032	0.032	0.06%
(e) Other										
(5) Plastics (a) Polyolefins	0.864	10.27%	3.273	24.25%	5.318	40.63%	3.15	0.864	5.318	25.05%
(b) PVC										
(c) Polystyrene	0.057	0.68%	0.128	0.95%	0.091	0.69%	0.09	0.057	0.128	0.77%
(d) ABS										
(e) PET										
(f) Mixed Blend Plastic	0.500	5.95%	0.021	0.16%			0.17	0.021	0.500	2.03%
(g) Coated Plastic										
(i) Nylon										
(i) Vinyl										
(6) Organic (a) Food Waste / Rodent Bedding	0.409	4.87%	1.591	11.79%	0.500	3.82%	0.83	0.409	1.591	6.82%
(b) Yard Waste										
(7) Wood										
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos										
(9) Diapers	0.081	0.96%					0.03	0.081	0.081	0.32%
(10) Textiles/Leather/Rubber	0.952	11.32%	0.042	0.31%			0.33	0.042	0.952	3.88%
(11) Household Hazardous Wastes (a) Paints / Solvents	0.726	8.64%	0.875	6.48%			0.53	0.726	0.875	5.04%
(b) Waste Oils										
(c) Pesticides/Herbicides										
(12) Dry Cell Batteries										
(13) Kitty Litter										
(14) Miscellaneous	0.024	0.29%	0.009	0.07%						
	8.41 (TOTAL kg)	100.00%	13.49 (TOTAL kg)	100.00%	13.09 (TOTAL kg)	100.00%	11.66	8.41	13.49	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE	ITEM	WEIGHT (kg)
1	tetrapaks	0.024
		0.024
2	twist ties, zipper	0.009
		0.009
3		

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6351, 6352, 6353, 6342
Sample #: 1-5
Collection Dates: May, June, July 1990

SIC # 6351

SAMPLE #:		1 kg	1 % wt
(1) Paper	(a) Newsprint	3.364	7.9
	(b) Fine Paper / CPO / Ledger	0.909	2.1
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	0.545	1.28
	(e) Boxboard	1.909	4.48
	(f) Kraft	0.091	0.21
	(g) Wallpaper		
	(h) OCC	3.909	9.18
	(i) Tissues	0.137	0.32
(2) Glass	(a) Beer (i) refillable		
	(ii) non-refillable		
	(b) Liquor & Wine Containers		
	(c) Food Containers	0.170	0.40
	(d) Soft Drink (i) refillable		
	(ii) non-refillable	0.462	1.08
	(e) Other Containers		
	(f) Plate		
	(g) Other		
(3) Ferrous	(a) Soft Drink Containers	0.331	0.78
	(b) Food Containers	0.163	0.38
	(c) Beer Cans (i) returnable		
	(ii) non-returnable		
	(d) Aerosol Cans		
	(e) Other		
(4) Non-Ferrous	(a) Beer Cans (i) returnable		
	(ii) non-returnable		
	(iii) American		
	(b) Soft Drink Containers		
	(c) Other Packaging		
	(d) Aluminum		
	(e) Other		
(5) Plastics	(a) Polyolefins	1.409	3.31%
	(b) PVC		
	(c) Polystyrene	0.136	0.32%
	(d) ABS		
	(e) PET		
	(f) Mixed Blend Plastic		
	(g) Coated Plastic		
	(i) Nylon		
	(i) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	0.545	1.28%
	(b) Yard Waste		
(7) Wood			
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos			
(9) Diapers			
(10) Textiles/Leather/Rubber		2.045	4.80%
(11) Household Hazardous Wastes	(a) Paints / Solvents	1.097	2.58%
	(b) Waste Oils	7.500	17.61%
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries			
(13) Kitty Litter			
(14) Miscellaneous		17.865	41.95%
TOTAL kg		42.59	100.00%

ITEMS

HT RECORDED

	WEIGHT (kg)
ers	2.409
	1.139
ugs,wire..)	3.418
	5.591
	2.036
	0.455
	2.818
	17.865
	9.364
	9.364
	1.213
	0.888
	0.427
	0.010
	0.025
	1.801
ads, etc.)	17.955
	22.319
	3.727
	3.727
	0.909
	0.909

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC code description: #6351 (general repair garages)
#6352 (paint\body repair shops)
#6353 (muffler replacement shop)
#6342 (tire;battery;parts\ accessories stores)

Municipality: Region of Waterloo
SIC Code: 6351, 6352, 6353, 6342
Sample #: 1-5
Collection Dates: May, June, July 1990

	SIC # 6351		SIC # 6352		SIC # 6342		SIC # 6342		SIC # 6353		MEAN ON A WEIGHT BASIS	RANGE ON A WEIGHT BASIS		MEAN ON A PERCENT BASIS
SAMPLE #:	1		2		3		4		5					
	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	MEAN (kg)	RANGE (kg) MIN.	MAX.	MEAN (%)
(1) Paper (a) Newsprint	3.364	7.90%			4.864	6.02%	1.682	2.70%			1.98	1.682	4.864	3.32%
(b) Fine Paper / CPO / Ledger	0.909	2.13%	1.682	2.38%	3.273	4.05%	1.273	2.04%			1.43	0.909	3.273	2.12%
(c) Magazines / Flyers							1.909	3.06%			0.38	1.910	1.909	0.61%
(d) Waxed / Plastic / Mixed	0.545	1.28%	2.455	3.47%	3.955	4.90%	0.500	0.80%	0.067	0.89%	1.50	0.067	3.955	2.27%
(e) Boxboard	1.909	4.48%	2.136	3.02%	2.273	2.82%	3.818	6.12%	0.167	2.21%	2.06	0.167	3.818	3.73%
(f) Kraft	0.091	0.21%	18.409	26.06%	0.773	0.96%	0.364	0.58%			3.93	0.091	18.409	5.56%
(g) Wallpaper														
(h) OCC	3.909	9.18%	0.136	0.19%	16.564	20.52%	4.409	7.07%			5.00	0.163	16 564	7.39%
(i) Tissues	0.137	0.32%	2.636	3.73%	0.136	0.17%	0.500	0.80%	0.016	0.21%	0.69	0.016	2.636	1.05%
(2) Glass (a) Beer (i) refillable							0.455	0.73%			0.09	0.450	0.455	0.15%
(ii) non-refillable														
(b) Liquor & Wine Containers														
(c) Food Containers	0.170	0.40%	1.318	1.87%			1.545	2.48%			0.61	0.170	1.545	0.95%
(d) Soft Drink (i) refillable														
(ii) non-refillable	0.462	1.08%	0.818	1.16%			0.500	0.80%			0.36	0.462	0.818	0.61%
(e) Other Containers					0.339	0.42%					0.07	0.340	0.339	0.08%
(f) Plate														
(g) Other														
(3) Ferrous (a) Soft Drink Containers	0.331	0.78%	0.818	1.16%	0.393	0.49%	0.136	0.22%	0.047	0.62%	0.35	0.047	0.818	0.65%
(b) Food Containers	0.163	0.38%	0.088	0.12%			0.045	0.07%			0.06	0.045	0.163	0.12%
(c) Beer Cans (i) returnable														
(ii) non-returnable														
(d) Aerosol Cans					0.561	0.69%	0.136	0.22%			0.14	0.136	0.561	0.18%
(e) Other			11.409	16.15%	0.020	0.02%	26.636	42.70%	0.052	0.69%	7.62	0.020	26 636	11.91%
(4) Non-Ferrous (a) Beer Cans (i) returnable							0.227	0.36%	0.017	0.22%	0.05	0.017	0.227	0.12%
(ii) non-returnable														
(iii) American					0.015	0.02%					0.003	0.015	0.015	0.004%
(b) Soft Drink Containers			0.273	0.39%	0.109	0.14%	0.015	0.02%	0.033	0.44%	0.09	0.015	0.273	0.20%
(c) Other Packaging														
(d) Aluminum			0.029	0.04%							0.01	0.029	0.029	0.01%
(e) Other														
(5) Plastics (a) Polyolefins	1.409	3.31%	3.955	5.60%	2.591	3.21%	1.091	1.75%	1.182	15.63%	2.05	1.091	3.955	5.90%
(b) PVC														
(c) Polystyrene	0.136	0.32%	0.182	0.26%	0.591	0.73%	0.227	0.36%	0.182	2.40%	0.26	0.136	0.591	0.82%
(d) ABS														
(e) PET														
(f) Mixed Blend Plastic			2.500	3.54%	0.590	0.73%	1.591	2.55%			0.94	0.590	2.500	1.36%
(g) Coated Plastic			0.068	0.10%							0.01	0.068	0.068	0.02%
(i) Nylon														
(i) Vinyl														
(6) Organic (a) Food Waste / Rodent Bedding	0.545	1.28%	1.955	2.77%	1.682	2.08%					0.84	0.545	1.955	1.23%
(b) Yard Waste														
(7) Wood									2.300	30.41%	0.46	2.300	2.300	6.08%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos														
(9) Diapers									1.818	24.04%	0.36	1.820	1.818	4.81%
(10) Textiles/Leather/Rubber	2.045	4.80%	5.958	8.43%	16.645	20.62%	11.591	18.58%	0.773	10.22%	7.40	0.773	16.645	12.53%
(11) Household Hazardous Wastes (a) Paints / Solvents	1.097	2.58%	3.545	5.02%							0.93	1.097	3.545	1.52%
(b) Waste Oils	7.500	17.61%	0.909	1.29%	3.039	3.76%					2.29	0.909	7.500	4.53%
(c) Pesticides/Herbicides														
(12) Dry Cell Batteries														
(13) Kitty Litter														
(14) Miscellaneous	17.865	41.95%	9.364	13.26%	22.319	27.65%	3.727	5.97%	0.909	12.02%				
TOTAL kg	42.59	100.00%	70.64	100.00%	80.73	100.00%	62.38	100.00%	7.56	100.00%	52.78	7.56	80.73	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	air, oil, fuel filters	2.409
	light bulbs	1.139
	misc parts(spark plugs,wire..)	3.418
	brake pads	5.591
	auto lights	2.036
	speaker	0.455
	shocks	2.818
		17.865
2	oil filters	9.364
		9.364
3	air filters	1.213
	lights	0.888
	air flow sensor	0.427
	fuse	0.010
	oil filters	0.025
	shocks	1.801
	misc(brake cables, pads, etc.)	17.955
		22.319
4	air filters	3.727
		3.727
5	antifreeze	0.909
		0.909

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 6521, 6542, 6562, 6591
Sample #: 1-6
Collection Dates: May, June, July, 1990

SIC # 6591

SAMPLE #:	1 kg	1 % wt
(1) Paper (a) Newsprint	0.045	1.89%
(b) Fine Paper / CPO / Ledger	0.409	17.04%
(c) Magazines / Flyers	0.147	6.12%
(d) Waxed / Plastic / Mixed	0.136	5.68%
(e) Boxboard	0.318	13.26%
(f) Kraft	0.019	0.80%
(g) Wallpaper		
(h) OCC	0.008	0.34%
(i) Tissues	0.038	1.59%
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable		
(b) Liquor & Wine Containers		
(c) Food Containers	0.136	5.68%
(d) Soft Drink (i) refillable		
(ii) non-refillable		
(e) Other Containers		
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers	0.273	11.36%
(b) Food Containers		
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers	0.030	1.25%
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	0.318	13.26%
(b) PVC		
(c) Polystyrene	0.182	7.57%
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic		
(g) Coated Plastic		
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	0.318	13.26%
(b) Yard Waste		*******
(7) Wood		
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber	0.022	0.91%
(11) Household Hazardous Wastes (a) Paints / Solvents		
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous		
	2.40	100.00%

TOTAL kg

MISCELLANEOUS ITEMS

: *** = NO WEIGHT RECORDED

ITEM	WEIGHT (kg)
a pak	0.039
rett lighter (plastic)	0.016
on (wet)	0.010
	0.065
cle foam	0.182
	0.182
apaks	0.024
s (wet)	0.864
	0.888

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC code description:
#6521 (florist shops)
#6542 (bicycle shops)
#6562 (watch\jewellery repair shops)
#6591 (second-hand merchandise stores)

Municipality: Region of Waterloo
SIC Code: 6521, 6542, 6562, 6591
Sample #: 1-6
Collection Dates: May, June, July, 1990

	SIC # 6591		SIC # 6521		SIC # 6542		SIC # 6521		SIC # 6562		SIC # 6521		MEAN ON A WEIGHT BASIS	RANGE ON A WEIGHT BASIS		MEAN ON A PERCENT BASIS
SAMPLE #:	1		2		3		4		5		6					
	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	MEAN (kg)	RANGE (kg) MIN.	MAX.	MEAN (%)
(1) Paper (a) Newsprint	0.045	1.89%	1.455	4.31%	0.030	0.09%	0.227	1.38%	0.909	24.24%	3.136	13.89%	0.97	0.030	3.136	7.63%
(b) Fine Paper / CPO / Ledger	0.409	17.04%	0.318	0.94%	0.500	1.48%	0.227	1.38%	0.455	12.12%	0.364	1.61%	0.38	0.227	0.500	5.76%
(c) Magazines / Flyers	0.147	6.12%											0.02	0.147	0.147	1.02%
(d) Waxed / Plastic / Mixed	0.136	5.68%	0.636	1.88%	0.409	1.21%	0.091	0.55%	0.136	3.64%	0.227	1.01%	0.27	0.091	0.636	2.33%
(e) Boxboard	0.318	13.26%	1.000	2.96%	1.182	3.49%	0.409	2.48%	0.227	6.06%	0.364	1.61%	0.58	0.227	1.182	4.98%
(f) Kraft	0.019	0.80%	0.227	0.67%	0.227	0.67%	0.136	0.83%	0.091	2.42%	0.727	3.22%	0.24	0.019	0.727	1.43%
(g) Wallpaper																
(h) OCC	0.008	0.34%	2.173	6.44%	18.136	53.59%	4.818	29.16%	1.318	35.14%	4.500	19.93%	5 16	0.008	18.136	24.10%
(i) Tissues	0.038	1.59%	0.591	1.75%	0.409	1.21%	0.227	1.38%	0.273	7.27%	0.500	2.21%	0.34	0.038	0.591	2.57%
(2) Glass (a) Beer (i) refillable																
(ii) non-refillable																
(b) Liquor & Wine Containers																
(c) Food Containers	0.136	5.68%					1.364	8.25%			0.162	0.72%	0.28	0.162	1.364	2.44%
(d) Soft Drink (i) refillable																
(ii) non-refillable																
(e) Other Containers																
(f) Plate																
(g) Other																
(3) Ferrous (a) Soft Drink Containers	0.273	11.36%	0.182	0.54%	0.054	0.16%	0.091	0.55%			0.059	0.26%	0.11	0.054	0.273	2.15%
(b) Food Containers																
(c) Beer Cans (i) returnable																
(ii) non-returnable																
(d) Aerosol Cans							0.136	0.83%			0.045	0.20%	0.03	0.045	0.136	0.17%
(e) Other			0.012	0.03%	1.318	3.90%							0.22	0.012	1.318	0.66%
(4) Non-Ferrous (a) Beer Cans (i) returnable																
(ii) non-returnable																
(iii) American																
(b) Soft Drink Containers	0.030	1.25%	0.033	0.10%	0.013	0.04%	0.182	1.10%	0.036	0.96%	0.047	0.21%	0.06	0.013	0.182	0.61%
(c) Other Packaging																
(d) Aluminum			0.010	0.03%							0.030	0.13%	0.01	0.010	0.030	0.03%
(e) Other																
(5) Plastics (a) Polyolefins	0.318	13.26%	1.136	3.37%	0.864	2.55%	0.955	5.78%	0.136	3.64%	0.909	4.03%	0.72	0.136	1.136	5.44%
(b) PVC																
(c) Polystyrene	0.182	7.57%	1.409	4.17%	0.136	0.40%	0.136	0.83%	0.033	0.88%	0.045	0.20%	0.32	0.033	1.409	2.34%
(d) ABS																
(e) PET																
(f) Mixed Blend Plastic							0.273	1.65%			0.020	0.09%	0.05	0.020	0.273	0.29%
(g) Coated Plastic																
(i) Nylon																
(i) Vinyl																
(6) Organic (a) Food Waste / Rodent Bedding	0.318	13.26%	24.182	71.61%	2.318	6.85%	4.727	28.61%	0.136	3.64%	11.409	50.53%	7.18	0.136	24.182	29.08%
(b) Yard Waste																
(7) Wood			0.102	0.30%	0.136	0.40%	0.136	0.83%					0.06	0.102	0.136	0.25%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos			0.237	0.70%									0.04	0.237	0.237	0.12%
(9) Diapers																
(10) Textiles/Leather/Rubber	0.022	0.91%			7.980	23.58%	1.500	9.08%			0.036	0.16%	1.59	0.022	7.980	5.62%
(11) Household Hazardous Wastes (a) Paints / Solvents																
(b) Waste Oils																
(c) Pesticides/Herbicides																
(12) Dry Cell Batteries																
(13) Kitty Litter																
(14) Miscellaneous			0.065	0.19%	0.128	0.38%	0.888	5.37%								
	2.40	100.00%	33.77	100.00%	33.84	100.00%	16.52	100.00%	3 75	100.00%	22.58	100.00%	18.81	2.40	33.84	100.00%
	TOTAL kg		TOTAL kg		TOTAL		TOTAL kg		TOTAL kg		TOTAL kg					

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1		
2	tetra pak	0.039
	cigarett lighter (plastic)	0.016
	cotton (wet)	0.010
		0.065
3	bicycle foam	0.182
		0.182
4	tetrapaks	0.024
	oasis (wet)	0.864
		0.888
5		
6		

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC Code: 7021, 7031, 7051
Sample #: 1-5
Collection Dates: June 1990

SIC # 7021

SAMPLE #:		1 kg	1 % wt
(1) Paper	(a) Newsprint	2.045	8.7
	(b) Fine Paper / CPO / Ledger	16.103	68.8
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	0.018	0.08
	(e) Boxboard	0.182	0.78
	(f) Kraft	0.031	0.13
	(g) Wallpaper		
	(h) OCC	0.955	4.08
	(i) Tissues	0.591	2.53
(2) Glass	(a) Beer (i) refillable		
	(ii) non-refillable		
	(b) Liquor & Wine Containers		
	(c) Food Containers		
	(d) Soft Drink (i) refillable		
	(ii) non-refillable		
	(e) Other Containers		
	(f) Plate		
	(g) Other		
(3) Ferrous	(a) Soft Drink Containers		
	(b) Food Containers		
	(c) Beer Cans (i) returnable		
	(ii) non-returnable		
	(d) Aerosol Cans		
	(e) Other		
(4) Non-Ferrous	(a) Beer Cans (i) returnable		
	(ii) non-returnable		
	(iii) American		
	(b) Soft Drink Containers		
	(c) Other Packaging		
	(d) Aluminum		
	(e) Other		
(5) Plastics	(a) Polyolefins	0.682	2.92%
	(b) PVC		
	(c) Polystyrene	0.080	0.34%
	(d) ABS		
	(e) PET		
	(f) Mixed Blend Plastic		
	(g) Coated Plastic		
	(i) Nylon		
	(i) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	2.182	9.33%
	(b) Yard Waste		
(7) Wood			
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		0.206	0.88%
(9) Diapers			
(10) Textiles/Leather/Rubber		0.293	1.25%
(11) Household Hazardous Wastes	(a) Paints / Solvents		
	(b) Waste Oils		
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries			
(13) Kitty Litter			
(14) Miscellaneous		0.014	0.06%
TOTAL kg		23.38	100.00%

TEMS

T RECORDED

WEIGHT (kg)
0.014
0.014
0.113
0.146
0.259

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC code description: #7021 (chartered banks)
#7031 (trust companies)
#7051 (local credit union)

Municipality: Region of Waterloo
SIC Code: 7021, 7031, 7051
Sample #: 1-5
Collection Dates: June 1990

	SIC # 7021		SIC # 7021		SIC # 7031		SIC # 7021		SIC # 7051		MEAN ON A WEIGHT BASIS	RANGE ON A WEIGHT BASIS		MEAN ON A PERCENT BASIS
SAMPLE #:	1		2		3		4		5		MEAN	RANGE(kg)		MEAN
	kg	% wt	kg	% wt	kg	% wt	kg	% wt	kg	% wt	(kg)	MIN.	MAX.	(%)
(1) Paper (a) Newsprint	2.045	8.75%	0.510	1.89%	0.455	10.22%					0.60	0.455	2.045	4.17%
(b) Fine Paper / CPO / Ledger	16.103	68.87%	18.091	66.96%			9.091	62.70%	2.136	66.42%	9.08	2.136	18.091	52.99%
(c) Magazines / Flyers			0.255	0.94%							0.05	0.255	0.255	0.19%
(d) Waxed / Plastic / Mixed	0.018	0.08%	1.500	5.55%			3.455	23.83%			0.99	0.018	3.455	5.89%
(e) Boxboard	0.182	0.78%	0.364	1.35%	0.136	3.06%	0.318	2.19%			0.20	0.136	0.364	1.48%
(f) Kraft	0.031	0.13%	0.691	2.56%	0.018	0.40%	0.364	2.51%	0.004	0.12%	0.22	0.004	0.691	1.15%
(g) Wallpaper														
(h) OCC	0.955	4.08%			0.591	13.28%	0.636	4.39%			0.44	0.591	0.955	4.35%
(i) Tissues	0.591	2.53%	0.419	1.55%	0.273	6.13%	0.035	0.24%	0.033	1.03%	0.27	0.033	0.591	2.29%
(2) Glass (a) Beer (i) refillable														
(ii) non-refillable														
(b) Liquor & Wine Containers														
(c) Food Containers									0.861	26.77%	0.17	0.861	0.861	5.35%
(d) Soft Drink (i) refillable														
(ii) non-refillable			0.708	2.62%							0.14	0.708	0.708	0.52%
(e) Other Containers														
(f) Plate														
(g) Other														
(3) Ferrous (a) Soft Drink Containers			0.486	1.80%	0.124	2.79%	0.031	0.21%			0.13	0.031	0.486	0.96%
(b) Food Containers			0.298	1.10%							0.06	0.298	0.298	0.22%
(c) Beer Cans (i) returnable														
(ii) non-returnable														
(d) Aerosol Cans														
(e) Other			0.138	0.51%					0.025	0.78%	0.03	0.025	0.138	0.26%
(4) Non-Ferrous (a) Beer Cans (i) returnable														
(ii) non-returnable														
(iii) American														
(b) Soft Drink Containers			0.059	0.22%					0.014	0.44%	0.01	0.014	0.059	0.13%
(c) Other Packaging														
(d) Aluminum														
(e) Other									0.025	0.78%	0.01		0.025	0.16%
(5) Plastics (a) Polyolefins	0.682	2.92%	1.009	3.73%	0.455	10.22%	0.455	3.14%	0.036	1.12%	0.53	0.036	1.009	4.22%
(b) PVC														
(c) Polystyrene	0.080	0.34%	0.275	1.02%	0.080	1.80%			0.022	0.68%	0.09	0.022	0.275	0.77%
(d) ABS														
(e) PET														
(f) Mixed Blend Plastic			0.955	3.53%			0.091	0.63%			0.21	0.091	0.955	0.83%
(g) Coated Plastic														
(i) Nylon														
(i) Vinyl														
(6) Organic (a) Food Waste / Rodent Bedding	2.182	9.33%	0.789	2.92%	2.318	52.10%			0.060	1.87%	1.07	0.060	2.318	13.24%
(b) Yard Waste														
(7) Wood														
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	0.206	0.88%									0.04	0.206	0.206	0.18%
(9) Diapers														
(10) Textiles/Leather/Rubber	0.293	1.25%	0.214	0.79%			0.023	0.16%			0.11	0.023	0.293	0.44%
(11) Household Hazardous Wastes (a) Paints / Solvents														
(b) Waste Oils														
(c) Pesticides/Herbicides														
(12) Dry Cell Batteries														
(13) Kitty Litter														
(14) Miscellaneous	0.014	0.06%	0.259	0.96%										
	23.38	100.00%	27.02	100.00%	4.45	100.00%	14.50	100.00%	3.22	100.00%	14.51	3.22	27.02	100.00%
	TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg		TOTAL kg					

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	tetrapaks	0.014
		0.014
2	tetrapaks	0.113
	power cord	0.146
		0.259
3		
4		
5		

Ministry of the Environment
Waste Composition Study

Municipality: Region of Waterloo
SIC Code: 9111, 9112
Sample #: 1-6
Collection Dates: May, June, July, 1990

GORE & ST

SIC # 9111

Category	Item	Sample # 1 kg	%
(1) Paper	(a) Newsprint	46.500	1(
	(b) Fine Paper / CPO / Ledger	6.818	[illegible]
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	3.909	[illegible]
	(e) Boxboard	7.000	[illegible]
	(f) Kraft	1.636	(
	(g) Wallpaper		
	(h) OCC	86.591	3(
	(i) Tissues	6.727	[illegible]
(2) Glass	(a) Beer (i) refillable	0.227	(
	(ii) non-refillable	0.455	(
	(b) Liquor & Wine Containers	3.693	1
	(c) Food Containers	5.545	2
	(d) Soft Drink (i) refillable		
	(ii) non-refillable	3.219	1
	(e) Other Containers		
	(f) Plate		
	(g) Other	2.273	0
(3) Ferrous	(a) Soft Drink Containers	0.636	0
	(b) Food Containers	1.045	0
	(c) Beer Cans (i) returnable		
	(ii) non-returnable		
	(d) Aerosol Cans		
	(e) Other		
(4) Non-Ferrous	(a) Beer Cans (i) returnable	0.227	0
	(ii) non-returnable		
	(iii) American	0.091	0
	(b) Soft Drink Containers	0.606	0
	(c) Other Packaging		
	(d) Aluminum	0.045	0
	(e) Other		
(5) Plastics	(a) Polyolefins	14.818	5
	(b) PVC		
	(c) Polystyrene	1.500	0
	(d) ABS		
	(e) PET	0.059	0
	(f) Mixed Blend Plastic	0.737	0
	(g) Coated Plastic	0.051	0
	(i) Nylon		
	(i) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	47.318	18.
	(b) Yard Waste		***
(7) Wood		1.136	0
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		1.005	0.
(9) Diapers		1.455	0.
(10) Textiles/Leather/Rubber		4.727	1.
(11) Household Hazardous Wastes	(a) Paints / Solvents		
	(b) Waste Oils		
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		0.255	0.
(13) Kitty Litter			
(14) Miscellaneous		0.012	0.
	TOTAL kg	250.32	100.

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

#	ITEM	WEIGHT (kg)
	tetrapaks	0.012
		0.012
	flourescent light bulb	0.091
	light bulbs	0.058
	tetrapaks	0.269
	dum poles	1.409
		1.827
	light bulbs	0.030
		0.030
	tetrapaks	0.130
	light bulb	0.030
		0.160
	flourescent bulbs	0.682
	light bulbs	0.088
	tetrapaks	0.047
	propane tank	0.461
		1.278
	air filter	1.909
		1.909

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC code description: #9111 (hotels\motor hotels)
#9112 (motels)

Municipality: Region of Waterloo
SIC Code: 9111, 9112
Sample #: 1-6
Collection Dates: May, June, July, 1990

SAMPLE #:	1 (SIC # 9111) kg	1 % wt	2 (SIC # 9111) kg	2 % wt	3 (SIC # 9111) kg	3 % wt	4 (SIC # 9112) kg	4 % wt	5 (SIC # 9112) kg	5 % wt	6 (SIC # 9111) kg	6 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE(kg) MIN.	MAX.	MEAN ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	46.500	18.58%	62.091	11.49%	21.455	20.31%	7.909	16.31%	3.455	3.93%	6.955	15.99%	24.73	3.455	62.091	14.44%
(b) Fine Paper / CPO / Ledger	6.818	2.72%	17.045	3.15%	4.909	4.65%	0.818	1.69%	1.318	1.50%	1.182	2.72%	5.35	0.818	17.045	2.74%
(c) Magazines / Flyers			4.500	0.83%	1.520	1.44%					0.364	0.84%	1.06	0.364	4.500	0.52%
(d) Waxed / Plastic / Mixed	3.909	1.56%	40.727	7.54%	4.955	4.69%	2.000	4.12%	4.364	4.97%	1.273	2.93%	9.54	1.273	40.727	4.30%
(e) Boxboard	7.000	2.80%	17.909	3.31%	7.318	6.93%	6.000	12.37%	3.773	4.30%	1.727	3.97%	7.29	1.727	17.909	5.61%
(f) Kraft	1.636	0.65%	3.091	0.57%	2.364	2.24%	0.818	1.69%	2.682	3.05%	4.091	9.41%	2.45	0.818	4.091	2.94%
(g) Wallpaper																
(h) OCC	86.591	34.59%	80.596	14.91%	3.680	3.48%	0.455	0.94%	2.940	3.35%	1.872	4.30%	29.36	0.455	86.591	10.26%
(i) Tissues	6.727	2.69%	23.500	4.35%	8.959	8.48%	1.909	3.94%	5.091	5.80%	2.136	4.91%	8.05	1.909	23.500	5.03%
(2) Glass (a) Beer (i) refillable	0.227	0.09%	1.032	0.19%	0.760	0.72%			0.819	0.93%	1.591	3.66%	0.74	0.227	1.591	0.93%
(ii) non-refillable	0.455	0.18%									1.591	3.66%	0.34	0.455	1.591	0.64%
(b) Liquor & Wine Containers	3.693	1.48%	35.000	6.48%	5.227	4.95%	1.136	2.34%	7.545	8.59%	1.227	2.82%	8.97	1.136	35.000	4.44%
(c) Food Containers	5.545	2.22%	13.091	2.42%	4.825	4.57%	1.114	2.30%	0.573	0.65%	1.727	3.97%	4.48	0.573	13.091	2.69%
(d) Soft Drink (i) refillable							0.727	1.50%	2.000	2.28%			0.45	0.727	2.000	0.63%
(ii) non-refillable	3.219	1.29%	9.157	1.69%			1.591	3.28%	2.227	2.54%	1.773	4.08%	2.99	1.591	9.157	2.15%
(e) Other Containers																
(f) Plate																
(g) Other	2.273	0.91%	5.614	1.04%	0.233	0.22%	0.514	1.06%	0.173	0.20%	0.318	0.73%	1.52	0.173	5.614	0.69%
(3) Ferrous (a) Soft Drink Containers	0.636	0.25%	2.034	0.38%	3.761	3.56%			3.864	4.40%	1.000	2.30%	1.68	0.636	3.864	1.82%
(b) Food Containers	1.045	0.42%	2.300	0.43%	0.555	0.53%	0.333	0.69%	0.196	0.22%	0.091	0.21%	0.75	0.091	2.300	0.41%
(c) Beer Cans (i) returnable			0.016	0.003%									0.003	0.016	0.016	0.0005%
(ii) non-returnable			0.158	0.03%			1.318	2.72%					0.25	0.158	1.318	0.46%
(d) Aerosol Cans					0.178	0.17%	0.273	0.56%			0.136	0.31%	0.10	0.136	0.273	0.17%
(e) Other			2.088	0.39%	0.527	0.50%	0.076	0.16%	0.079	0.09%	0.136	0.31%	0.48	0.076	2.088	0.24%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.227	0.09%	1.995	0.37%			0.500	1.03%	0.081	0.09%	0.682	1.57%	0.58	0.081	1.995	0.53%
(ii) non-returnable					0.072	0.07%							0.01	0.072	0.072	0.01%
(iii) American	0.091	0.04%	0.136	0.03%	0.088	0.08%							0.05	0.088	0.136	0.02%
(b) Soft Drink Containers	0.606	0.24%	1.595	0.30%	0.050	0.05%	0.500	1.03%	2.513	2.86%	1.091	2.51%	1.06	0.050	2.513	1.16%
(c) Other Packaging			0.091	0.02%					0.032	0.04%	0.034	0.08%	0.03	0.032	0.091	0.02%
(d) Aluminum	0.045	0.02%	0.756	0.14%	0.128	0.12%	0.203	0.42%	0.261	0.30%	0.045	0.10%	0.24	0.045	0.756	0.18%
(e) Other			3.142	0.58%					0.141	0.16%			0.55	0.141	3.142	0.12%
(5) Plastics (a) Polyolefins	14.818	5.92%	26.227	4.85%	6.318	5.98%	2.954	6.09%	6.398	7.29%	4.045	9.30%	10.13	2.954	26.227	6.57%
(b) PVC																
(c) Polystyrene	1.500	0.60%	4.000	0.74%	3.364	3.18%	1.000	2.06%	3.864	4.40%	0.636	1.46%	2.39	0.636	4.000	2.08%
(d) ABS																
(e) PET	0.059	0.02%	4.741	0.88%	0.155	0.15%	0.062	0.13%	0.318	0.36%	0.136	0.31%	0.91	0.059	4.741	0.31%
(f) Mixed Blend Plastic	0.737	0.29%	3.271	0.61%	0.581	0.55%			0.157	0.18%	0.045	0.10%	0.80	0.045	3.271	0.29%
(g) Coated Plastic	0.051	0.02%					0.136	0.28%	0.098	0.11%			0.05	0.051	0.136	0.07%
(i) Nylon																
(i) Vinyl																
(6) Organic (a) Food Waste / Rodent Bedding (b) Yard Waste	47.318	18.90%	126.795	23.46%	19.273	18.25%	10.864	22.41%	16.136	18.38%	5.455	12.54%	37.64	5.455	126.795	18.99%
(7) Wood	1.136	0.45%	3.000	0.56%	0.050	0.05%	0.006	0.01%	5.546	6.32%	0.045	0.10%	1.63	0.006	5.546	1.25%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos	1.005	0.40%					0.156	0.32%	0.251	0.29%			0.24	0.156	1.005	0.17%
(9) Diapers	1.455	0.58%	5.818	1.08%			2.273	4.69%	0.591	0.67%	0.182	0.42%	1.72	0.182	5.818	1.24%
(10) Textiles/Leather/Rubber	4.727	1.89%	37.105	6.87%	4.195	3.97%	1.091	2.25%	1.043	1.19%			8.03	1.043	37.105	2.69%
(11) Household Hazardous Wastes (a) Paints / Solvents (b) Waste Oils (c) Pesticides/Herbicides																
(12) Dry Cell Batteries	0.255	0.10%			0.086	0.08%			0.260	0.30%			0.10	0.086	0.260	0.08%
(13) Kitty Litter							1.591	3.28%	7.727	8.80%			1.55	1.591	7.727	2.01%
(14) Miscellaneous	0.012	0.00%	1.827	0.34%	0.030	0.03%	0.160	0.33%	1.278	1.46%	1.909	4.39%				
TOTAL kg	250.32	100.00%	540.45	100.00%	105.61	100.00%	48.49	100.00%	87.79	100.00%	43.50	100.00%	179.36	43.50	540.45	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE #	ITEM	WEIGHT (kg)
1	tetrapaks	0.012
		0.012
2	flourescent light bulb	0.091
	light bulbs	0.058
	tetrapaks	0.269
	dum poles	1.409
		1.827
3	light bulbs	0.030
		0.030
4	tetrapaks	0.130
	light bulb	0.030
		0.160
5	flourescent bulbs	0.682
	light bulbs	0.088
	tetrapaks	0.047
	propane tank	0.461
		1.278
6	air filter	1.909
		1.909

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC:9211
Sample # : 1-3
Collection Dates:JUNE-AUGUST 1990

SAMPLE #:	kg	1
(1) Paper (a) Newsprint	14.773	
(b) Fine Paper / CPO / Ledger	4.659	
(c) Magazines / Flyers		
(d) Waxed / Plastic / Mixed		
(e) Boxboard	0.277	
(f) Kraft	0.955	
(g) Wallpaper		
(h) OCC	7.920	
(i) Tissues		
(2) Glass (a) Beer (i) refillable	2.591	
(ii) non-refillable		
(b) Liquor & Wine Containers		
(c) Food Containers	131.727	2
(d) Soft Drink (i) refillable		
(ii) non-refillable		
(e) Other Containers		
(f) Plate		
(g) Other	6.909	1
(3) Ferrous (a) Soft Drink Containers		
(b) Food Containers	12.568	2
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers	0.148	0.
(c) Other Packaging		
(d) Aluminum		
(e) Other	0.010	0.
(5) Plastics (a) Polyolefins	37.250	7.
(b) PVC		
(c) Polystyrene	0.032	0.
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic		
(g) Coated Plastic		
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	245.136	52.0
(b) Yard Waste		
(7) Wood	5.727	1.2
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber		
(11) Household Hazardous Wastes (a) Paints / Solvents		
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous		
	470.68	100.00
	TOTAL kg	

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC:9211
Sample # : 1-3
Collection Dates: JUNE-AUGUST 1990

SIC code description: #9211 (licensed restaurant)

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	MEAN ON A WEIGHT BASIS MEAN (kg)	RANGE ON A WEIGHT BASIS RANGE (kg) MIN.	MAX.	MEAN ON A PERCENT BASIS MEAN (%)
(1) Paper (a) Newsprint	14.773	3.14%			0.517	0.35%	5.10	0.517	14.773	1.16%
(b) Fine Paper / CPO / Ledger	4.659	0.99%	2.227	0.62%	2.318	1.59%	3.07	2.227	4.659	1.07%
(c) Magazines / Flyers										
(d) Waxed / Plastic / Mixed			3.409	0.95%	0.909	0.62%	1.44	0.909	3.409	0.52%
(e) Boxboard	0.277	0.06%	2.636	0.73%	1.682	1.15%	1.53	0.277	2.636	0.65%
(f) Kraft	0.955	0.20%	2.091	0.58%	0.409	0.28%	1.15	0.409	2.091	0.36%
(g) Wallpaper										
(h) OCC	7.920	1.68%	34.204	9.53%	22.356	15.29%	21.49	7.920	34.204	8.84%
(i) Tissues			14.136	3.94%	5.818	3.98%	6.65	5.818	14.136	2.64%
(2) Glass (a) Beer (i) refillable	2.591	0.55%					0.86	2.591	2.591	0.18%
(ii) non-refillable			2.545	0.71%	8.500	5.81%	3.68	2.545	8 500	2.17%
(b) Liquor & Wine Containers			11.227	3.13%	31.955	21.85%	14.39	11.227	31.955	8.33%
(c) Food Containers	131.727	27.99%	2.000	0.56%	1.455	0.99%	45.06	1.455	131.727	9.85%
(d) Soft Drink (i) refillable										
(ii) non-refillable										
(e) Other Containers										
(f) Plate										
(g) Other	6.909	1.47%	0.364	0.10%	1.818	1.24%	3.03	0.364	6.909	0.94%
(3) Ferrous (a) Soft Drink Containers										
(b) Food Containers	12.568	2.67%	2.318	0.65%			4.96	2.318	12.568	1.11%
(c) Beer Cans (i) returnable										
(ii) non-returnable										
(d) Aerosol Cans										
(e) Other			0.409	0.11%			0.14	0.409	0.409	0.04%
(4) Non-Ferrous (a) Beer Cans (i) returnable			0.060	0.02%			0.02	0.060	0.060	0.01%
(ii) non-returnable										
(iii) American										
(b) Soft Drink Containers	0.148	0.03%					0.05	0.148	0.148	0.01%
(c) Other Packaging			0.136	0.04%	0.070	0.05%	0.07	0.070	0.136	0.03%
(d) Aluminum			2.057	0.57%	0.192	0.13%	0.75	0.192	2.057	0.23%
(e) Other	0.010	0.00%			0.112	0.08%	0.04	0.010	0.112	0.03%
(5) Plastics (a) Polyolefins	37.250	7.91%	25.591	7.13%	2.955	2.02%	21.93	2.955	37.250	5.69%
(b) PVC										
(c) Polystyrene	0.032	0.01%	2.045	0.57%	1.500	1.03%	1.19	0.032	2.045	0.53%
(d) ABS										
(e) PET										
(f) Mixed Blend Plastic			0.157	0.04%	0.108	0.07%	0.09	0.108	0.157	0.04%
(g) Coated Plastic			0.110	0.03%			0.04	0.110	0.110	0.01%
(i) Nylon										
(j) Vinyl										
(6) Organic (a) Food Waste / Rodent Bedding	245.136	52.08%	248.545	69.29%	62.727	42.90%	185.47	62.727	248.545	54.76%
(b) Yard Waste										
(7) Wood	5.727	1.22%	2.364	0.66%			2.70	2.364	5.727	0.63%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos					0.822	0.56%	0.27	0.822	0.822	0.19%
(9) Diapers										
(10) Textiles/Leather/Rubber			0.089	0.02%			0.03	0.089	0.089	0.01%
(11) Household Hazardous Wastes (a) Paints / Solvents										
(b) Waste Oils										
(c) Pesticides/Herbicides										
(12) Dry Cell Batteries										
(13) Kitty Litter										
(14) Miscellaneous										
	470.68 TOTAL kg	100.00%	358.72 TOTAL kg	100.00%	146.22 TOTAL kg	100.00%	325.21	146.22	470.68	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE	ITEM	WEIGHT (kg)
1		
2		
3		

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC:9213
Sample # : 1-3
Collection Dates: JULY-AUGUST

SIC code descr

Category		SAMPLE #: 1 kg	1 % wt
(1) Paper	(a) Newsprint		
	(b) Fine Paper / CPO / Ledger		
	(c) Magazines / Flyers		
	(d) Waxed / Plastic / Mixed	5.727	11.63
	(e) Boxboard	1.955	3.97
	(f) Kraft	0.591	1.20
	(g) Wallpaper		
	(h) OCC	2.636	5.35
	(i) Tissues	3.091	6.28
(2) Glass	(a) Beer (i) refillable		
	(ii) non-refillable		
	(b) Liquor & Wine Containers		
	(c) Food Containers	0.227	0.46
	(d) Soft Drink (i) refillable	0.682	1.38
	(ii) non-refillable		
	(e) Other Containers		
	(f) Plate		
	(g) Other		
(3) Ferrous	(a) Soft Drink Containers	0.090	0.18
	(b) Food Containers	0.318	0.65
	(c) Beer Cans (i) returnable	0.020	0.04
	(ii) non-returnable		
	(d) Aerosol Cans		
	(e) Other		
(4) Non-Ferrous	(a) Beer Cans (i) returnable		
	(ii) non-returnable		
	(iii) American		
	(b) Soft Drink Containers		
	(c) Other Packaging		
	(d) Aluminum		
	(e) Other		
(5) Plastics	(a) Polyolefins	4.636	9.41
	(b) PVC		
	(c) Polystyrene	1.318	2.68
	(d) ABS		
	(e) PET		
	(f) Mixed Blend Plastic		
	(g) Coated Plastic	0.090	0.18
	(h) Nylon		
	(i) Vinyl		
(6) Organic	(a) Food Waste / Rodent Bedding	26.227	53.26
	(b) Yard Waste		
(7) Wood			
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos			
(9) Diapers			
(10) Textiles/Leather/Rubber		0.045	0.09
(11) Household Hazardous Wastes	(a) Paints / Solvents		
	(b) Waste Oils		
	(c) Pesticides/Herbicides		
(12) Dry Cell Batteries			
(13) Kitty Litter			
(14) Miscellaneous		1.590	3.23
TOTAL kg		49.24	100.00

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC:9213
Sample # : 1-3
Collection Dates:JULY-AUGUST

SIC code description: #9213 (take-out food services i.e. hamburger restaurant)

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	MEAN ON A WEIGHT BASIS MEAN (kg)	RANGE ON A WEIGHT BASIS RANGE(kg) MIN.	MAX.	MEAN ON A PERCENT BASIS MEAN (%)
(1) Paper (a) Newsprint			0.045	0.05%	1.182	1.26%	0.41	0.045	1.182	0.44%
(b) Fine Paper / CPO / Ledger			0.636	0.65%	0.727	0.77%	0.45	0.636	0.727	0.48%
(c) Magazines / Flyers										
(d) Waxed / Plastic / Mixed	5.727	11.63%	3.955	4.07%	5.818	6.20%	5.17	3.955	5.818	7.30%
(e) Boxboard	1.955	3.97%	9.318	9.58%	4.000	4.26%	5.09	1.955	9.318	5.94%
(f) Kraft	0.591	1.20%	3.091	3.18%	9.000	9.59%	4.23	0.591	9.000	4.66%
(g) Wallpaper										
(h) OCC	2.636	5.35%	62.045	63.79%	13.856	14.76%	26.18	2.636	62.045	27.97%
(i) Tissues	3.091	6.28%	3.591	3.69%	3.682	3.92%	3.45	3.091	3.682	4.63%
(2) Glass (a) Beer (i) refillable										
(ii) non-refillable										
(b) Liquor & Wine Containers										
(c) Food Containers	0.227	0.46%			19.955	21.26%	6.73	0.227	19.955	7.24%
(d) Soft Drink (i) refillable	0.682	1.38%					0.23	0.682	0.682	0.46%
(ii) non-refillable										
(e) Other Containers										
(f) Plate										
(g) Other										
(3) Ferrous (a) Soft Drink Containers	0.090	0.18%					0.03	0.090	0.090	0.06%
(b) Food Containers	0.318	0.65%			9.636	10.27%	3.32	0.318	9.636	3.64%
(c) Beer Cans (i) returnable	0.020	0.04%					0.01	0.020	0.020	0.01%
(ii) non-returnable										
(d) Aerosol Cans										
(e) Other					0.727	0.77%	0.24	0.727	0.727	0.26%
(4) Non-Ferrous (a) Beer Cans (i) returnable										
(ii) non-returnable										
(iii) American										
(b) Soft Drink Containers										
(c) Other Packaging										
(d) Aluminum										
(e) Other										
(5) Plastics (a) Polyolefins	4.636	9.41%	1.773	1.82%	5.091	5.42%	3.83	1.773	5.091	5.55%
(b) PVC										
(c) Polystyrene	1.318	2.68%	1.773	1.82%	1.000	1.07%	1.36	1.000	1.773	1.85%
(d) ABS										
(e) PET										
(f) Mixed Blend Plastic			0.273	0.28%			0.09	0.270	0.273	0.09%
(g) Coated Plastic	0.090	0.18%					0.03	0.090	0.090	0.06%
(i) Nylon										
(i) Vinyl										
(6) Organic (a) Food Waste / Rodent Bedding	26.227	53.26%	10.773	11.07%	19.182	20.44%	18.73	10.773	26.227	28.26%
(b) Yard Waste		*******		*******		*******				
(7) Wood										
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos										
(9) Diapers										
(10) Textiles/Leather/Rubber	0.045	0.09%					0.02	0.045	0.045	0.03%
(11) Household Hazardous Wastes (a) Paints / Solvents										
(b) Waste Oils										
(c) Pesticides/Herbicides										
(12) Dry Cell Batteries										
(13) Kitty Litter										
(14) Miscellaneous	1.590	3.23%								
	49.24 TOTAL kg	100.00%	97.27 TOTAL kg	100.00%	93.86 TOTAL kg	100.00%	80.12	49.24	97.27	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE	ITEM	WEIGHT (kg)
1	fluorescent tubes	1.591
		1.591
2		
3		

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

SIC cod

Municipality: Region of Waterloo
SIC: 9213 GENERAL
Sample # : 1-3
Collection Dates: JUNE-JULY 1990

SAMPLE #:	1 kg	1 % wt
(1) Paper (a) Newsprint	6.273	18.52%
(b) Fine Paper / CPO / Ledger	0.045	0.13%
(c) Magazines / Flyers		
(d) Waxed / Plastic / Mixed	1.773	5.23%
(e) Boxboard	4.136	12.21%
(f) Kraft	2.409	7.11%
(g) Wallpaper		
(h) OCC	1.875	5.53%
(i) Tissues	1.273	3.76%
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable		
(b) Liquor & wine Containers		
(c) Food Containers	0.409	1.21%
(d) Soft Drink (i) refillable		
(ii) non-refillable		
(e) Other Containers		
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers		
(b) Food Containers	0.091	0.27%
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable		
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers		
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	1.682	4.96%
(b) PVC		
(c) Polystyrene	1.091	3.22%
(d) ABS		
(e) PET		
(f) Mixed Blend Plastic		
(g) Coated Plastic		
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	12.818	37.84%
(b) Yard Waste		
(7) Wood		
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber		
(11) Household Hazardous Wastes (a) Paints / Solvents		
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous		
	33.87	100.00%

TOTAL kg

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Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Municipality: Region of Waterloo
SIC: 9213 GENERAL
Sample # : 1-3
Collection Dates: JUNE-JULY 1990

SIC code description: #9213 (general take-out food services i.e. Chinese food)

SAMPLE #:	1 kg	1 % wt	2 kg	2 % wt	3 kg	3 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE (kg) MIN.	MAX.	MEAN ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	6.273	18.52%			2.455	1.16%	2.91	2.455	6.273	6.56%
(b) Fine Paper / CPO / Ledger	0.045	0.13%			0.591	0.28%	0.21	0.045	0.591	0.14%
(c) Magazines / Flyers										
(d) Waxed / Plastic / Mixed	1.773	5.23%	0.060	0.35%	3.636	1.72%	1.82	0.060	3.636	2.43%
(e) Boxboard	4.136	12.21%	0.091	0.53%	6.227	2.95%	3.48	0.091	6.227	5.23%
(f) Kraft	2.409	7.11%	0.132	0.77%	2.545	1.20%	1.70	0.132	2.545	3.03%
(g) Wallpaper										
(h) OCC	1.875	5.53%	1.773	10.32%	25.876	12.24%	9.84	1.773	25.876	9.36%
(i) Tissues	1.273	3.76%	0.409	2.38%	12.227	5.78%	4.64	0.409	12.227	3.97%
(2) Glass (a) Beer (i) refillable					0.500	0.24%	0.17	0.500	0.500	0.08%
(ii) non-refillable										
(b) Liquor & wine Containers					0.545	0.26%	0.18	0.545	0.545	0.09%
(c) Food Containers	0.409	1.21%			2.682	1.27%	1.03	0.409	2.682	0.83%
(d) Soft Drink (i) refillable										
(ii) non-refillable					1.091	0.52%	0.36	1.091	1.091	0.17%
(e) Other Containers										
(f) Plate										
(g) Other					0.591	0.28%	0.20	0.591	0.591	0.09%
(3) Ferrous (a) Soft Drink Containers			0.191	1.11%	0.136	0.06%	0.11	0.136	0.191	0.39%
(b) Food Containers	0.091	0.27%	1.364	7.94%			0.48	0.091	1.364	2.74%
(c) Beer Cans (i) returnable										
(ii) non-returnable										
(d) Aerosol Cans										
(e) Other										
(4) Non-Ferrous (a) Beer Cans (i) returnable										
(ii) non-returnable										
(iii) American										
(b) Soft Drink Containers					0.136	0.06%	0.05	0.136	0.136	0.02%
(c) Other Packaging										
(d) Aluminum					0.116	0.05%	0.04	0.116	0.116	0.02%
(e) Other										
(5) Plastics (a) Polyolefins	1.682	4.96%	0.773	4.50%	7.136	3.38%	3.20	0.773	7.136	4.28%
(b) PVC										
(c) Polystyrene	1.091	3.22%	0.025	0.15%	9.045	4.28%	3.39	0.025	9.045	2.55%
(d) ABS										
(e) PET										
(f) Mixed Blend Plastic					2.273	1.08%	0.76	2.273	2.273	0.36%
(g) Coated Plastic										
(i) Nylon										
(i) Vinyl										
(6) Organic (a) Food Waste / Rodent Bedding	12.818	37.84%	12.364	71.96%	133.000	62.91%	52.73	12.364	133.000	57.57%
(b) Yard Waste										
(7) Wood										
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos										
(9) Diapers										
(10) Textiles/Leather/Rubber										
(11) Household Hazardous Wastes (a) Paints / Solvents										
(b) Waste Oils										
(c) Pesticides/Herbicides										
(12) Dry Cell Batteries										
(13) Kitty Litter										
(14) Miscellaneous					0.591	0.28%				
	33.87 TOTAL kg	100.00%	17.18 TOTAL kg	100.00%	211.40 TOTAL kg	100.00%	87.49	17.18	211.40	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE	ITEM	WEIGHT (kg)
1		
2		
3	light bulbs	0.591
		0.591

Municipality: Region of Waterloo
SIC: 9621, 9691, 9692, 9699
Sample # : 1-4
Collection Dates: June, July 1990

SIC # 9699

SAMPLE #:	1 kg	1 % wt
(1) Paper (a) Newsprint	1.636	3.09%
(b) Fine Paper / CPO / Ledger	1.591	3.00%
(c) Magazines / Flyers		
(d) Waxed / Plastic / Mixed	1.500	2.83%
(e) Boxboard	1.273	2.40%
(f) Kraft	1.455	2.74%
(g) Wallpaper		
(h) OCC	0.939	1.77%
(i) Tissues	4.773	9.01%
(2) Glass (a) Beer (i) refillable		
(ii) non-refillable		
(b) Liquor & Wine Containers		
(c) Food Containers	0.273	0.51%
(d) Soft Drink (i) refillable		
(ii) non-refillable		
(e) Other Containers	0.091	0.17%
(f) Plate		
(g) Other		
(3) Ferrous (a) Soft Drink Containers	1.182	2.23%
(b) Food Containers	0.136	0.26%
(c) Beer Cans (i) returnable		
(ii) non-returnable		
(d) Aerosol Cans		
(e) Other		
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.015	0.03%
(ii) non-returnable		
(iii) American		
(b) Soft Drink Containers	0.455	0.86%
(c) Other Packaging		
(d) Aluminum		
(e) Other		
(5) Plastics (a) Polyolefins	2.318	4.37%
(b) PVC		
(c) Polystyrene	0.364	0.69%
(d) ABS		
(e) PET	0.318	0.60%
(f) Mixed Blend Plastic		
(g) Coated Plastic		
(i) Nylon		
(i) Vinyl		
(6) Organic (a) Food Waste / Rodent Bedding	6.136	11.58%
(b) Yard Waste		
(7) Wood	24.182	45.63%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber	3.995	7.54%
(11) Household Hazardous Wastes (a) Paints / Solvents		
(b) Waste Oils		
(c) Pesticides/Herbicides		
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Miscellaneous	0.364	0.69%
TOTAL kg	52.99	100.00%

IT (kg)
0.364
0.364
0.025
.025
.091
.455
.364
.273
.227
.012
421
864
091
909
364
773
00
39
0
0.
0.
190.
TOTA
kg

Municipality: Region of Waterloo
SIC: 9621, 9691, 9692, 9699
Sample # : 1-4
Collection Dates: June, July 1990

#9691 (bowling alleys\billiard parlours)
#9692 (amusement park;carnival)
#9699 (other amusement\recreation -al services i.e. horseback riding operations)

SAMPLE #:	1 (SIC # 9699) kg	1 % wt	2 (SIC # 9621) kg	2 % wt	3 (SIC # 9691) kg	3 % wt	4 (SIC # 9692) kg	4 % wt	MEAN ON A WEIGHT BASIS: MEAN (kg)	RANGE ON A WEIGHT BASIS: RANGE (kg) MIN.	MAX.	MEAN ON A PERCENT BASIS: MEAN (%)
(1) Paper (a) Newsprint	1.636	3.09%	1.545	0.81%	0.727	0.82%	0.455	0.17%	1.09	0.455	1.636	1.22%
(b) Fine Paper / CPO / Ledger	1.591	3.00%	1.455	0.76%	2.364	2.68%	3.636	1.37%	2.26	1.455	3.636	1.95%
(c) Magazines / Flyers			9.500	4.98%					2.37	9.500	9.500	1.24%
(d) Waxed / Plastic / Mixed	1.500	2.83%	30.182	15.81%	1.182	1.34%	10.591	3.98%	10.86	1.182	30.182	5.99%
(e) Boxboard	1.273	2.40%	33.000	17.29%	6.455	7.32%	11.045	4.15%	12.94	1.273	33.000	7.79%
(f) Kraft	1.455	2.74%	1.136	0.60%			2.545	0.96%	1.28	1.136	2.545	1.07%
(g) Wallpaper												
(h) OCC	0.939	1.77%	14.789	7.75%	12.809	14.53%	33.178	12.47%	15.43	0.939	33.178	9.13%
(i) Tissues	4.773	9.01%	25.500	13.36%	0.773	0.88%	6.045	2.27%	9.27	0.773	25.500	6.38%
(2) Glass (a) Beer (i) refillable												
(ii) non-refillable							0.273	0.10%	0.07	0.273	0.273	0.03%
(b) Liquor & Wine Containers			0.532	0.28%	1.636	1.86%	11.682	4.39%	3.46	0.532	11.682	1.63%
(c) Food Containers	0.273	0.51%	2.989	1.57%			6.955	2.61%	2.55	0.273	6.955	1.17%
(d) Soft Drink (i) refillable												
(ii) non-refillable			2.008	1.05%	0.182	0.21%	1.227	0.46%	0.85	0.182	2.008	0.43%
(e) Other Containers	0.091	0.17%							0.02	0.091	0.091	0.04%
(f) Plate												
(g) Other					0.045	0.05%	2.000	0.75%	0.51	0.045	2.000	0.20%
(3) Ferrous (a) Soft Drink Containers	1.182	2.23%	0.557	0.29%	0.030	0.03%	0.864	0.32%	0.66	0.030	1.182	0.72%
(b) Food Containers	0.136	0.26%			0.273	0.31%	5.727	2.15%	1.53	0.136	5.727	0.68%
(c) Beer Cans (i) returnable												
(ii) non-returnable												
(d) Aerosol Cans			0.330	0.17%					0.08	0.330	0.330	0.04%
(e) Other			6.409	3.36%	0.182	0.21%	4.273	1.61%	2.72	0.182	6.409	1.29%
(4) Non-Ferrous (a) Beer Cans (i) returnable	0.015	0.03%	0.016	0.01%			0.136	0.05%	0.04	0.015	0.136	0.02%
(ii) non-returnable			0.042	0.02%					0.01	0.042	0.042	0.01%
(iii) American												
(b) Soft Drink Containers	0.455	0.86%	0.532	0.28%			0.727	0.27%	0.43	0.455	0.727	0.35%
(c) Other Packaging												
(d) Aluminum					0.045	0.05%	0.182	0.07%	0.06	0.045	0.182	0.03%
(e) Other												
(5) Plastics (a) Polyolefins	2.318	4.37%	15.909	8.34%	1.591	1.80%	10.227	3.84%	7.51	1.591	15.909	4.59%
(b) PVC												
(c) Polystyrene	0.364	0.69%	4.500	2.36%	3.091	3.51%	6.455	2.43%	3.60	0.364	6.455	2.24%
(d) ABS												
(e) PET	0.318	0.60%							0.08	0.318	0.318	0.15%
(f) Mixed Blend Plastic					0.136	0.15%			0.03	0.136	0.136	0.04%
(g) Coated Plastic												
(i) Nylon												
(i) Vinyl												
(6) Organic (a) Food Waste / Rodent Bedding (b) Yard Waste	6.136	11.58%	39.364	20.62%	7.773	8.82%	79.318	29.81%	33.15	6.136	79.318	17.71%
(7) Wood	24.182	45.63%			10.045	11.39%	0.591	0.22%	8.70	0.519	24.182	14.31%
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos							0.591	0.22%	0.15	0.591	0.591	0.06%
(9) Diapers			0.318	0.17%			5.045	1.90%	1.34	0.318	5.045	0.52%
(10) Textiles/Leather/Rubber	3.995	7.54%	0.227	0.12%	1.409	1.60%	0.955	0.36%	1.65	0.227	3.995	2.40%
(11) Household Hazardous Wastes (a) Paints / Solvents (b) Waste Oils (c) Pesticides/Herbicides												
(12) Dry Cell Batteries							0.318	0.12%	0.08	0.318	0.318	0.03%
(13) Kitty Litter												
(14) Miscellaneous	0.364	0.69%	0.025	0.01%	37.421	42.44%	61.000	22.93%				
TOTAL kg	52.99	100.00%	190.87	100.00%	88.17	100.00%	266.04	100.00%	149.52	52.99	266.04	100.00%

MISCELLANEOUS ITEMS

NOTE: *** = NO WEIGHT RECORDED

SAMPLE	ITEM	WEIGHT (kg)
1	tetrapaks	0.364
		0.364
2	tetrapak	0.025
		0.025
3	press board	3.091
	tree cuttings	25.455
	paint shavings	7.364
	drywall	1.273
	fluorescent tubes	0.227
	tetrapaks	0.012
		37.421
4	golf balls	5.864
	light bulbs	0.091
	fluorescent tubes	1.909
	tetrapaks	0.364
	tree limbs	52.773
		61.000

PROCEDURES FOR THE ASSESSMENT OF SOLID WASTE RESIDENTIAL AND COMMERCIAL

VOLUME III

OF THE

ONTARIO WASTE COMPOSITION STUDY

JULY 1991

Environment
Environnement
Ontario

ISBN 0-7729-9131-6

PROCEDURES FOR THE ASSESSMENT OF SOLID WASTE

RESIDENTIAL AND COMMERCIAL

VOLUME III OF THE ONTARIO WASTE COMPOSITION STUDY

Report prepared for:

Waste Reduction Office
Ministry of the Environment

Report prepared by:

Gore & Storrie Limited

July 1991
Revised December 1991

PRINTED ON RECYCLED PAPER
IMPRIMÉ SUR DU PAPIER RECYCLÉ

Cette publication technique
n'est disponible qu'en anglais.

PIBS 1609

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INFORMATION FOR THE READER

The results of the Ontario Waste Composition Study appear in three volumes.

Volume I contains the results of the residential portion of the Ontario Waste Composition Study. The emphasis in Volume I is on the development and testing of a method that municipalities can use to estimate per capita generation rates of residential refuse. The field work for Volume I took place in East York, Fergus, and North Bay, Ontario.

Volume II contains the results of the commercial portion of the Ontario Waste Composition Study. Waste generation data for two light industrial businesses are also provided in Volume II. The emphasis in Volume II is on the development and testing of a method that municipalities can use to estimate per employee waste generation rates and, further, to estimate the quantity of waste generated from all commercial sources. The commercial component of the study took place in the Regional Municipality of Waterloo.

Volume III is a "user friendly" manual that outlines the procedures for conducting residential and commercial waste composition studies in municipalities of Ontario. While every effort has been made to present as complete a description of the method as possible there will be instances where the persons conducting a waste study will find it necessary to make adjustments to this method to suit particular circumstances.

Volume III is divided in two parts. Part A provides a description of the methodology used to conduct the Residential Waste Composition Study. Part B describes the methodology used to conduct the Commercial Waste Composition Study.

PART A

RESIDENTIAL WASTE COMPOSITION STUDY METHODS

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Methodology

The two-fold purpose of the residential portion of the Ontario Waste Composition Study was to:

1. develop a simple, cost effective and statistically reliable method for determining the composition and per capita generation rate of waste from residential sources in Ontario municipalities; and

2. apply the method in several municipalities and obtain current information on the characteristics of residential waste streams.

The pre-study literature survey, summarized in Volume I - Residential Waste Composition Study, indicated that residential waste generation was a function of the socio-economic and demographic characteristics of a population. An assessment of the residential waste generation characteristics of a municipality should take population demographics into consideration.

The socio-economic and demographic parameters incorporated in the Residential Waste Composition Study are: income level and housing type. Statistics Canada provides census data with respect to these parameters for municipalities across the country and this kind of information was obtained for the three municipalities participating in the waste composition study in Ontario: the Town of Fergus (population: 6,757); the Borough of East York (population: 101,085); and the City of North Bay (population 51,313). The field studies were conducted in the three municipalities during the following periods: July 15 to August 31, 1989; October 24 to December 28, 1989; and February 21 to February 28, 1990 respectively.

Statistics Canada provides socio-economic and demographic information on small geographical sectors of municipalities called Enumeration Areas (EAs) that are made up of approximately 300 dwellings and typically have a residential population of 600-800 persons. Some highrise apartment buildings may have a large enough number of units that they are designated as EAs unto themselves.

In the work reported herein, the EA was the basic population unit whose waste composition and per capita generation rates were studied as representative segments of the entire municipal population. First, all of the EAs in the municipality were classified in a three-by-three, two dimensional matrix of:

Average annual income:	high, medium, and low; and
Housing type:	single detached dwellings, predominantly multiple dwellings (apts.), and predominantly mixed (detached/apts.).

This classification matrix resulted in nine possible combinations of income levels and housing types with each combination termed a "cell". One EA was randomly selected from each cell, unless the cell contained few or no EAs, which was often the case for the low income/single detached dwelling cell. The residential waste assessments in the Town of Fergus and the Borough of East York were based on data from EAs that were representative of the EA distribution in the income/housing matrix for the respective municipalities. Based on the results of these two municipalities, it was decided to conduct a reduced sampling program in the City of North Bay.

After the Study EAs in the municipality were randomly selected, a curbside refuse sampling plan was designed, based on a procedure that assigned random starting points for refuse collections at street intersections throughout the EA.

For each EA, both the number and weight of the refuse samples that had to be collected and sorted in order to obtain the statistical accuracy that was desired for the kitchen waste fraction (only) of residential waste was based on the pioneering work of Dr. A. Klee and co-workers. The sample number was a minimum of nine per EA; and the minimum sample weight was 100 kg. To achieve similar levels of statistical accuracy for waste components occurring at lower concentrations in the waste stream (for example, glass and ferrous metals), a greater number of samples, which may be economically impractical, would be required. To determine the number of samples required to accurately assess these waste components refer to Volume I, Section 1.2.

It took a crew of four, approximately 5.5 days to collect and sort the bagged refuse and Blue Box materials in a single EA. Records were kept of the number of dwellings from which bagged refuse and Blue Box materials were collected in order to compute estimates of total residential waste generation on a per capita basis, using Statistics Canada data on the average population per dwelling in the EA. Blue Box materials were sorted, weighed and recorded separately in order to estimate the capture rate of certain recyclable items from the residential waste stream.

Yard wastes were weighed and recorded whenever they were encountered, but this waste stream was not included in the computations of the residential waste composition and the weight was not included in the estimates of per capita generation rates either, for seasonal generation reasons discussed herein.

The moisture content of the combustible fractions of the waste stream was determined by drying. The BTU content of some mixed plastics (laminates), as well as disposable diapers, was determined by bomb calorimetry. Samples of vacuum cleaner bag dust were analyzed for heavy metals. The results of these analyses are presented in Volume I.

Special sampling procedures were devised for those apartment buildings where the waste was compacted in containers. Samples of the required weight were removed from the containers for the waste composition analysis. Then the residual contents were collected and weighed, courtesy of special arrangements made with a local waste hauler and transfer station scale house.
The weekly waste streams for seven schools in East York were also collected and the waste composition was determined. Per capita generation rates for the student body and total staff were computed.

A survey was also conducted to assess the yearly tonnages of white goods and other bulky items generated by residential areas in 10 municipalities in Ontario.

The methods developed and used in this study were found to be cost effective and capable of being used by municipal staff. Recommendations are presented in this volume and in Volume I to further refine and improve the methods used.

Ontario municipalities are encouraged to use the methods demonstrated in this study to satisfy municipal needs, to generate further data on a consistent province-wide basis and to assist in assessing the effectiveness of new waste management programs and identifying trends in waste composition and generation rates.

Recommendations for Further Refinement

Municipalities conducting a waste composition study might consider the following recommendations when designing the sampling protocol and implementing the study methodology.

1) For sampling and sorting convenience, municipalities may choose to conduct the waste composition studies in late spring or mid-fall when refuse odours are less intense and maggots are less frequently encountered. According to Vesling & Rimer (ref. 47), the average residential waste composition does not vary by more than +/- 10% over three quarters of the year. Therefore, aesthetics of the working conditions can be taken into account without risk to obtaining skewed data. The inclusion of yard waste in overall residential waste composition percent profiles should be avoided so that baseline composition percentages are not misrepresented.

2) Municipalities may choose to set up independent collection systems to study the seasonal generation of yard waste and leaves. This would require a coordinated effort between garbage collection personnel, private horticultural firms and other agencies generating and collecting these waste streams.

3) In order to avoid the sampling problems that we encountered with the large apartment buildings in East York, where apparent sampling biases were difficult to avoid, arrangements could be made, for example, with 30 units within the building to participate in a refuse study. This would give a more accurate appraisal of the waste composition in these large apartment buildings. As a check, the method described herein for

obtaining the per capita generation rate for the entire building could then be compared with the per capita generation rate for the 30 units.

4) Municipalities in Ontario should follow the waste composition procedure in conducting their own waste composition analysis, for reasons of consistent data generation using a cost effective approach. Periodically, municipalities should conduct additional waste composition studies to monitor trends in residential waste management and the effectiveness of waste management programs.

SECTION 1

WHY CONDUCT A WASTE GENERATION AND COMPOSITION STUDY

1.0 WHY CONDUCT A WASTE GENERATION AND COMPOSITION STUDY

The waste management challenges facing Ontario communities involve two problems:

1. The need to reduce the amount of waste entering Ontario landfills and incinerators. Many municipalities in Ontario are faced with landfills that are at or near capacity, and building new landfills is a costly and often a political and environmental challenge.

   This challenge is being met in part through the Ontario Ministry of the Environment waste diversion targets. These targets are aimed at reducing waste entering landfills by 25% by 1992, and 50% by 2001. Activities such as residential Blue Box, commercial recycling, waste composting, and recyclable material bans from landfills, and efforts to reduce waste such as excess packaging are being implemented to achieve these objectives.

2. The general societal need to reduce the amount of waste generated on a per capita basis. This need grows greater every day as renewable and non-renewable resources dwindle while population and economies continue to grow.

These two problems require careful consideration and planning by waste managers. If solutions are to be found, these managers will require reliable and current data concerning per capita waste generation rates and percent composition.

By knowing the approximate tonnages involved and the composition of the municipal waste stream, efforts can be made to maximize reduction, reuse and recycling efforts. Per capita generation rates for the total waste stream and for its component parts are needed to correctly design waste management programs and facilities.

1.1 Waste Management Planning

Waste generation information and waste composition data are required for the following reasons:

i) Quantities of waste generated in various neighbourhoods and districts within the municipality must be known to properly assign collection vehicles - therefore a per capita generation rate is needed;

ii) Proper design of waste management facilities such as transfer stations, landfills, recycling depots, composting plants and so on require information concerning the per capita generation rate and waste composition;

iii) When planning for population growth, a per capita generation rate is needed to estimate increases in total waste quantity;

iv) Waste generation rate and waste composition data are needed to assess the effects of waste diversion programs and policies.

1.1.1 Estimation of Total Waste Tonnage

A waste composition study such as the one described herein estimates tonnages of waste generated by every person in the municipality from both residential sources (Part A) and commercial sources (Part B). Waste tonnages can be estimated on a daily, weekly, monthly, or yearly basis. In addition to total tonnage generated, a waste composition study allows an estimation to be made of the tonnage of each material in the waste stream.

1.1.2 Estimation of Tonnage of Recyclable and Recoverable Material

A waste composition study allows accurate estimations to be made of the tonnages of materials being recycled by current recycling programs, the amount of material that could be recovered by those programs (capture rates), and estimates of the amount of material that could be recovered from the waste stream by additional diversion programs.

1.1.3 Estimation of Tonnage of Hazardous Materials

Of concern in the design of landfills and other waste management facilities is the amount of hazardous materials, such as paints, waste oil, used batteries, pesticides, and medical wastes that are found in the waste stream. A waste composition study will provide an estimation of the quantities of these materials present in the solid waste stream.

SECTION 2

WASTE STUDY PARAMETERS AND CONSIDERATIONS

2.0 WASTE STUDY PARAMETERS AND CONSIDERATIONS

Conducting a waste composition and generation study requires careful planning with regard to the type of data required, and how the data will be collected.

2.1 Required Waste Generation Rate and Waste Composition Data

The data collected in a waste composition study fall into two categories:

1. per capita generation rate information;
2. percent composition of the waste by component materials.

2.1.1 Waste Generation Rate

For the purposes of the Ontario Waste Composition Study the residential waste generation rate is defined as kilograms per capita per day (kg/capita/day). These units can easily be multiplied by constants to obtain weekly, monthly, or yearly generation rates in kilograms or tonnes. As well, a total tonnage of waste generated for the municipality can be calculated by multiplying by the total number of persons in the municipality by the per capita generation rate.

2.1.2 Waste Composition

The percent composition of waste by its material components is dependent on the waste stream studied, and on the definition of the categories of material used.

The waste component categories used in the Ontario Waste Composition Study were based in part on the physical or chemical make-up of the component and, in part, on the form the waste material takes. As such there are several subcategories for most materials. The subcategories could be based on physical and chemical make-up, such as those for paper (fine paper, newspaper, corrugated cardboard etc.), or the sub-categories could be based on form and usage such as with ferrous metal (food containers, returnable beverage containers, non-food containers). A list of the waste component categories and sub categories used in the Ontario Waste Composition Study is given in Table 1.

Note that in Table 1 there are no categories for bulky items such as used appliances and furniture. These items are usually collected separately from regular waste.

The category of yard waste listed in Table 1 is meant to record the quantity of yard waste co-mingled with regular waste. To assess the quantity of leaves and other yard waste collected seasonally such as during fall leaf collection programs of other spring/fall clean-ups additional data collection procedures should be used.

In addition to material composition, the Ontario Waste Composition Study also defined waste by the way in which it was collected and its subsequent destination. As such, composition of Blue Box materials, where present, are analyzed separately from the identical materials found in regular curbside waste, and yard wastes are analyzed separately from the other organic components.

2.2 Income and Housing Basis for Defining Residential Waste Generation

The Ontario Waste Composition Study used the pioneering work of Rathje et al. as a basis for designing the sampling approach and framework (ref. 4,5,6,7,8). Rathje and Thompson (1981) demonstrated during the MILWAUKEE GARBAGE PROJECT the relationship between socio-economic stratification of populations and the composition of residential refuse. Income and housing-type reflect lifestyle and as such influence waste generation.

The methodology of the Ontario Waste Composition Study used an income/housing stratification to describe discrete areas within the municipality called Census of Canada Enumeration Areas, and to select locations for the collection of waste samples.

TABLE 1: WASTE COMPOSITION CATEGORIES

(1) Paper	(a) Newsprint	
	(b) Fine Paper / CPO / Ledger	
	(c) Magazines / Flyers	
	(d) Waxed / Plastic / Mixed	
	(e) Boxboard	
	(f) Kraft	
	(g) Wallpaper	
	(h) OCC	
	(i) Tissues	
(2) Glass	(a) Beer	(i) refillable
		(ii) non-refillable
	(b) Liquor & Wine Containers	
	(c) Food Containers	
	(d) Soft Drink	(i) refillable
		(ii) non-refillable
	(e) Other Containers	
	(f) Plate	
	(g) Other	
(3) Ferrous	(a) Soft Drink Containers	
	(b) Food Containers	
	(c) Beer Cans	(i) returnable
		(ii) non-returnable
	(d) Aerosol Cans	
	(e) Other	
(4) Non-Ferrous	(a) Beer Cans	(i) returnable
		(ii) non-returnable
		(iii) American
	(b) Soft Drink Containers	
	(c) Other Packaging	
	(d) Aluminum	
	(e) Other	
(5) Plastics	(a) Polyolefins	
	(b) PVC	
	(c) Polystyrene	
	(d) ABS	
	(e) PET	
	(f) Mixed Blend Plastic	
	(g) Coated Plastic	
	(i) Nylon	
	(i) Vinyl	
(6) Organic	(a) Food Waste / Rodent Bedding	
	(b) Yard Waste	
(7) Wood		
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos		
(9) Diapers		
(10) Textiles/Leather/Rubber		
(11) Household Hazardous Wastes	(a) Paints / Solvents	
	(b) Waste Oils	
	(c) Pesticides/Herbicides	
(12) Dry Cell Batteries		
(13) Kitty Litter		
(14) Medical Wastes		

2.2.1 Knowing Your Community - Census Canada Information

The data required to characterize the income and housing type in a community can be obtained from Census of Canada information for the municipality. The census data is collected every five years and is available from Statistics Canada for a nominal service fee.

Census data is collected in a municipality using discreet areas mapped out by Census Canada called Enumeration Areas (EA). An enumeration area is laid out to encompass an area containing approximately 300 dwellings. As such the geographical area covered varies greatly depending on the density of housing. The EA may be a large rural area, a few city blocks, or one single highrise apartment building.

Enumeration areas were selected as the sampling frame for this study because they are the smallest statistical unit for which census data are available. As such a single EA is likely to have a relatively uniform income level and housing type. These facts allow each enumeration area to be classified into groups based on relatively distinct and real income and housing type strata.

2.2.1.1 Enumeration Areas and the Study Matrix

Census Canada reports the following data for each enumeration area within a municipality: average combine household income; the number of single detached residences, apartments, and other residences; and average number of persons per dwelling. These data are used to create a income/housing matrix for classifying all of the enumeration areas in the municipality. The matrix lay-out is shown in Table 2.

2.2.1.2 Classification of Enumeration Areas By Income

Using the most recent Statistics Canada Census data, each EA in the study community is stratified according to income level. The format for the stratification is as follows:

TABLE 2: INCOME/HOUSING MATRIX USED FOR CLASSIFYING MUNICIPAL POPULATIONS.

Dwelling Type

Income Level	(1) Primarily single Detached Dwellings	(2) Mixed Dwellings	(3) Primarily multiple Dwellings
(A) High	A1	A2	A3
(B) Medium	B1	B2	B3
(C) Low	C1	C2	C3

High Income:	average household income is at least 1/2 standard deviation greater than the mean income for the entire community;
Medium Income:	average household income is no more than 1/2 standard deviation greater than, or less than the mean income for the entire community;
Low Income:	average household income is at least 1/2 standard deviation less than the mean income for the entire community.

Figure 1 illustrates the concept of population stratification by income, described above.

2.2.1.3 Classification of Enumeration Areas By Housing Type

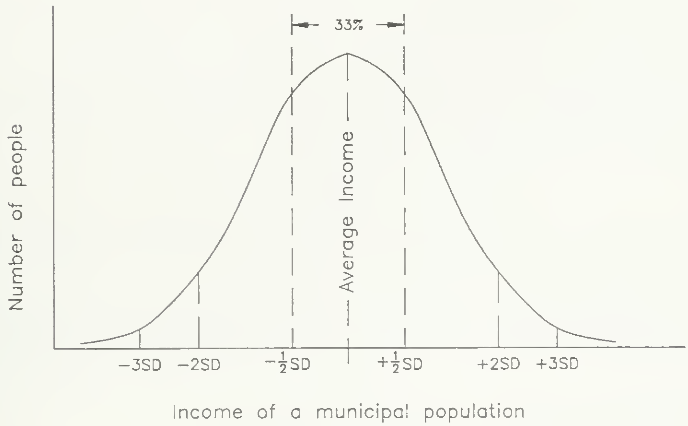
Within each income category, each EA is further classified according to housing type. For each EA, Statistics Canada reports the number of Single Detached residences, Apartments, and Other residences. These numbers, expressed as a percentage of occupied dwellings in the EA are used to identify the predominant housing type for the EA.

Primarily Single Detached:	EAs with 60% to 70% of dwellings reported as "single detached dwellings";
Primarily Multiple Dwellings:	EAs with 60% to 70% of dwellings reported as "apartments" (typically multiple story highrises).
Mixed Dwellings:	EAs with a "mixture" of single detached, apartment buildings with fewer than 30 units, and other dwelling types; having less than 60% of the dwellings listed as single detached or 60% of the dwellings listed as apartments;

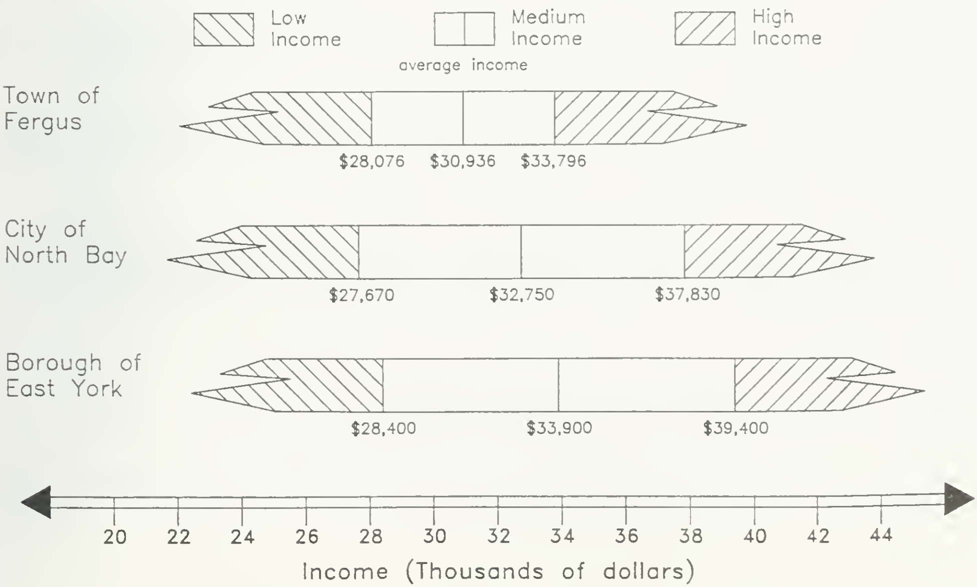
An exact boundary line between dwelling classifications is not rigorously specified in this Study because of the need for flexibility to consider the distribution of the minor components of the residential mix for a particular EA. The distribution of types of residences across the whole municipality should be examined to ensure that

FIGURE 1: CATEGORIZING A MUNICIPAL POPULATION WITH RESPECT TO INCOME:

- THEORETICAL DISTRIBUTION (1A)
- PRACTICAL APPLICATION (1B)



(1A) Idealized representation of normal income distribution over a municipal population. The middle income range extends between −1/2 SD and +1/2 SD and includes 33% of the population.



(1B) Comparison of the low, medium and high income categories for the three municipalities in the Study.

specific cells in the income/housing matrix were not grossly out of proportion to the total number of EAs or the "character" of the municipality.

Once the housing type is determined then each EA can be assigned to its respective cell in the income/housing matrix. Typically a community may have only six or seven of the nine possible income and housing types. This is expected since not all municipalities will have very large multi-story apartment building, or some housing types may not exist for given income strata.

2.2.2 Knowing Your Community - Current Waste Management Practices

The next parameter that must be known before beginning the waste study is the current waste management practices in the municipality.

The following information should be assessed:

1. waste collection frequency: once per week, or twice per week;
2. collection routes and schedules;
3. collection practices and scheduling during holidays etc.;
4. presence of Blue Box programs or other recycling activities and days on which blue box materials are collected;
5. presence of special waste collection programs such as spring and fall clean-up collections, leaf and yard-waste collections, bulky item collection days, white metal collections, hazardous waste collections and so on.

This information is needed to coordinate the collection of waste samples with regular waste collection so that conflicts do not occur, and to ensure that data are collected regarding special waste collections.

2.2.3 Effect of Seasonality On Waste Generation

In any waste composition study there is always the question of seasonality and its effect on waste composition and generation rates. There is a large body of literature (ref. 1, ref. 9) that suggests if yard waste and leaves are omitted from the calculation of composition and generation rate, the fluctuations in composition and generation rate of household waste are less than 10% over the course of the year. The methodology presented herein treats yard waste and bulky items as separate waste categories, therefore the time of year at which the waste composition study takes place is of secondary consideration. Efforts should be made, however, to assess the tonnages of leaves, yard waste and bulk items generated each year.

2.2.4 Bulk Item and Special Collection Days

Some municipalities have special collections for bulk items, spring and fall clean-up days, and leaf collection programs. These special waste streams need to be assessed individually because they do not fit into to the normal weekly generation of waste by households.

The relatively small number of samples (snap-shot approach) taken when using this methodology precludes taking of any waste that would not be generated on a daily or weekly basis. For a discussion of this problem see Volume I, Residential Waste Composition Study.

2.3 Sampling of Residential Waste

2.3.1 Number of Samples Required in Each Enumeration Area

In the three communities studied as part of the Ontario Waste Composition Study, typically six or seven EAs would be chosen for sampling, corresponding to the income/housing matrix classifications. These EAs form the sampling framework for the study.

Within each enumeration area ten (nine as a minimum) samples of regular curbside residential waste and blue box materials (where present) were taken for analysis. Nine or ten samples were required for statistically accurate results (see Volume I). This number of samples also proved to be the appropriate number for a four or five person crew to analyze in one week. This allowed the crew to study one EA per week, thus meshing with the existing collection schedules of the communities.

2.3.2 Size of Samples Required

Previous work in waste composition analysis conducted in the United States by Klee and Carruth (1971) indicated that the optimal size of each of the ten samples collected within an EA is 90-150 kilograms (200-300 pounds). As such with an EA the total weight of refuse analyzed would be approximately 1 tonne (1000 kg).

The sample weight of 90-125 kg is for regular curbside waste only. Additional collections of leaves, separated yard wastes, and bulk items will be necessary to assess the total residential waste stream. Inclusions of such materials would skew the analysis in favour of the bulky materials which may be generated infrequently over the year, and hence provide a poor representation of regular waste generation.

SECTION 3

MANPOWER, EQUIPMENT AND COST

3.0 MANPOWER, EQUIPMENT AND COST

The following is a description of the manpower requirements, necessary equipment and costs associated with conducting a waste composition study. In the manpower section a dollar value of the wage for the workers is not specified as this must be determined by the municipality conducting the study. Instead, only an estimation of the number of work days and hours required to complete the study is given. Lists of required and optional equipment is provided, but no dollar amounts for the purchase or rental of this equipment. These details should be carefully considered by any municipality undertaking a waste composition study.

3.1 Field Crew Size Requirements

Four or five people were needed for the waste collection task where a Class 1 Blue Box program exists (for example Town of Fergus; Borough of East York): two truck drivers, one collection data recorder and one (or two) people to pick up the bagged refuse and Blue Box materials. Occasionally, a 5 day work-week was not long enough to complete the collection and sorting operations and an additional work day (Saturday) was required.

In North Bay, where there was no Blue Box program in place, a three member crew carried out the refuse collection. It should be noted that the reduced crew number required that they work an extra full day, i.e., Saturdays, to complete the sorting and weighing of waste.

The field crews for the Ontario Waste Composition Study were comprised of community college students and university graduates. It was emphasized that the Study was really a "laboratory situation". Thus attention was given to organization, routine, reproducibility, consistency--even the cleanliness of garbage cans, van floor etc. This approach attempted to maximize a scientific attitude and thoughtful responsibility leading to careful work habits that the students learn as part of their analytical training. If students are not available, dedicated members of the municipal staff, or other workers could be employed.

In addition to the field crew, a project manager is required. This person must have a technical background and a high level of respect and responsibility within the municipality's works and engineering department. The project leader will be responsible (in the absence of an outside consultant) for performing the calculations necessary to define the income/housing matrix, selecting the EAs for the study, determining the sampling locations, contacting and liaisoning with waste haulers and collectors, ensuring accurate records are kept, and general management of the project.

The Project Manager will in all likelihood be required to generate a report presenting the results of the study. The amount of time required for this task will depend on the purpose for which the study was undertaken.

3.2 Equipment Requirements

The following equipment and hardware is required for the study.

3.2.1 Waste Sample Collection Equipment

The following list of equipment includes rented vehicles and purchased equipment:

- one - 4.3 m.(14 ft.) cube van (for collection of bagged refuse);
- one - pick-up truck (for collection of Blue Box contents);
- one - electronic platform scale (150 kg capacity, Accu Weigh Model PAK-150 (electronic, battery operated scale with digital read-out), Exact Weight Scale, Inc., Toronto, Ontario);
- six - 1.2 m.(4 ft.) x 1.2 m.(4 ft.) x 1.2 m. (4 ft.) heavy duty corrugated containers ("gaylords"); these containers were used for storing the bagged (non-Blue Box) refuse samples as they were being collected;
- four - 1.2 m.(4 ft.) x 1.2 m.(4 ft.) divider frames (2.5 cm. x 5.1 cm. wood furring stock/chicken wire); these were used as horizontal partitions in the back of the cube van for separating the collections of bagged (non-Blue Box) refuse which were stacked on top of each other;

two - 46 cm.(18 in.) x 2.4 m.(8 ft.) divider frames (2.5 cm. x 5.1 cm. wood furring stock/chicken wire); these were used as the two main partitions in the back of the pick-up truck for segregating the collections of Blue Box materials (see Figure 2);

nine - 46 cm.(18 in.) x 41 cm.(16 in.) (approx.) plywood panels; used as partitions in the back of the pick-up truck (see Figure 2);

one - chicken wire "crib": 1.2 m.(4 ft.) x 1.2 m.(4 ft.) x 1.3 cm.(1/2 in.) plywood base; 0.6 m.(2 ft.) high chicken wire and 2.5 cm. x 5.1 cm. furring sides. Nailed to the underside of the crib floor was a square frame which permitted the crib to be centred on the bed of the platform scale (see Figure 3); the crib was used for weighing the refuse as it was being collected from curb-side;

150 - 50.8 cm.(20 in.) x 76.2 cm.(30 in.) x 6 mil polyethylene bags (Oxford Packaging Inc., Mississauga, Ontario); these were used for bagging refuse that was set out loose in garbage cans; the bags were also used for storing refuse samples for moisture and chemical analysis;

40 - 30 litre polyethylene garbage cans; these were used as containers into which sorted refuse was placed (see Figure 4);

one - 2.7 m.(9 ft.) x 3.7 m.(12 ft.) reinforced plastic tarpaulin for covering Blue Box materials in the pickup truck;

six - elastic straps to secure the tarpaulin in place;

one - broad-mouth aluminum shovel; used for cleaning up spills;

one - broom; used for cleaning up spills and sweeping out the vehicles;

one - staple gun and 0.95 cm.(3/8 in.) staples for construction and repair of chicken wire dividers and crib;

one - claw hammer; 5.1 cm.(2 in.) common nails: used in the construction of the crib and divider frames.

FIGURE 2: PHOTOGRAPH OF PICKUP TRUCK WITH COMPARTMENTS FOR BLUE BOX MATERIALS

FIGURE 3: PHOTOGRAPH OF CHICKEN WIRE CRIB MOUNTED ON THE PLATFORM SCALE (REAR VIEW OF CUBE VAN)

FIGURE 4: PHOTOGRAPH SHOWING THE POSITIONING OF THE STUDY TEAM AROUND THE TAILGATE SORTING TABLE

3.2.2 Waste Sample Sorting and Measurement Equipment

The following equipment and supplies were needed for the waste sorting and composition analysis:

- 1-150 kg capacity platform scale (noted previously);
- 1-5 kg capacity scale (Accurate model 5000 (electronic, battery operated with digital read-out), Exact Weight Scale Inc., Toronto, Ontario);
- 40-polyethylene garbage cans (note above);
- 1-claw hammer;
- 1-slotted screw driver;
- 1-electrician's pliers;
- 4-magnets
- pairing knives for opening plastic bags
- Personal safety equipment listed below Section 3.2.3

3.2.3 Personal Safety Equipment

Personal equipment required:

- heavy duty, waterproof (PVC-coated) gloves;
- work clothes or coveralls; rubber apron; hat (hard hat if desired)
- steel-toed work boots;
- eye protection (goggles preferable or safety glasses);
- tetanus/polio vaccination (optional: diphtheria, Hepatitis A and Hepatitis B);
- traffic safety vest;
- particle masks, worn by crew members concerned with dust and the possibility of disease transmission;
- anti-bacterial soap, used to clean gloves, hands and face before meal breaks and at the end of the day.

Safety must be stressed at all times during the study including personal hygiene. It is important to remember that within each bag of garbage there may be disease carrying organisms, sharp objects including hypodermic needles, containers that may explode, combustibles, corrosive and caustic agents, harmful chemicals, and dust.

3.2.4 Seasonal Effects on Equipment Requirements - Shelter and Clothing

The season of the year in which the study is conducted has a great bearing on the clothing and shelter requirements of the field crew, and general carrying out of the study.

For several reasons it may be advisable to conduct the study during the fall or winter months. The waste will have less odour and fewer maggots and flies at this time of year. In addition the cool or freezing temperatures will keep the organic fraction of the waste from rotting which will makes the work more manageable from an objective and aesthetic standpoint. The cooler weather will also reduce the amount of moisture lost by the waste, due to evaporation, from the time the sample is collected to the time it is actually sorted (several days in some cases).

If the study is conducted in the autumn or winter months some form of shelter is required by the field crew while sorting the waste. Shelter is required to protect the field crew (and the waste samples!) from wind, rain, snow and cold. During the Ontario Waste Composition Study the following locations were used during the fall and winter study periods. In the Borough of East York, the tipping floor of the former Commissioners Street Incinerator was used. When this location became too cold in December, the sorting location was moved into a heated workshop adjacent to the tipping floor. In North Bay sorting was conducted in a large carnival tent. Heating in the tent was supplied by propane heaters.

In the summer protection from the wind, rain, and direct sun will be required.

In addition to a sheltered work space, the sorting crew must be provided with a warm, dry break-room, and washroom facilities.

3.3 Cost of Conducting a Typical Waste Study

The following is an estimate of the cost associated with conducting a waste composition study.

The length of time required to conduct the residential phase of the waste study is dependent on the number of EAs identified in the income/housing matrix. At most there will be nine EAs to study, although most communities will have fewer since not all cells of the matrix will have representative EAs. In addition to the nine (maximum) EAs identified in the matrix, additional EAs may be studied to confirm the results from the other EAs. Each EA studied requires one week (5-6 days) to complete the sample collection and sorting.

3.3.1 Anticipated Personnel Time Requirements and Costs

STAGE 1: PROJECT INITIATION AND CLASSIFICATION OF ENUMERATION AREAS INTO AN INCOME/HOUSING MATRIX

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Project Initiation	Project Manager[1]	3.0
Task: Obtaining Census Data from Statistics Canada Archive Libraries	Project Manager Project Assistant[2]	1.0 1.0
Task: EA Classification by Income/Housing Types	Project Manager	1.0
Task: Selection of EAs for Inclusion in the Study (Matrix Classification allows for 9 EAs. More may be included in the study as required)	Project Manager	2.25 (0.25 days/EA)
SUB TOTAL:	Project Manager Project Assistant	7.75 1.0
COSTS:	Statistics Canada Service Fee for Materials Travel, Telephone Use, Office Supplies, Computer Time	

[1]The Project Manager will typically be a person from the Municipal Engineering Department or some other member of the Municipal Staff familiar with Waste Management procedures.

[2]The Project Assistant would ideally be a member of the field crew and also a member of the municipal staff familiar with waste management procedures.

3.3.1 Anticipated Personnel Time Requirements and Costs Continued

STAGE 2: DETERMINING SAMPLE POINTS WITHIN THE CHOSEN ENUMERATION AREAS

PROJECT REQUIREMENTS		PERSONNEL	WORK DAYS
Task: Determining Sample Points Within the Selected Study EAs.		Project Manager Project Assistant	4.5 (0.5 days/EA) 2.25 (0.25 days/EA)
	SUB TOTAL:	Project Manager Project Assistant	4.5 2.25
	COSTS:	Travel (inspection of EAs required), Telephone Use, Office Supplies	

Stage 1 and Stage 2 can be carried out by the Project Manager, or in association with an outside consulting agency familiar with Census of Canada data and sampling procedures.

3.3.1 Anticipated Personnel Time Requirements and Costs Continued

STAGE 3: COLLECTION OF RESIDENTIAL WASTE SAMPLES

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Obtaining/Constructing All Required Equipment and Supplies (See Section 3.2)	Project Manager	3
	Project Assistant	3
Task: Contacting Municipal/Private Waste Haulers; Contacting Apartment Building Managers; Contacting Other Officials as Required (See Section 6.6)	Project Manager	0.5 days/EA
(A) Once per week municipal waste collection Task: Collection of Waste Sample	Project Manager	0.5 days/EA
	Field Crew[3]	0.5 days/EA x 4 Persons
(B) Twice per week municipal waste collection Task: Collection of Waste Sample	Project Manager	1.0 days/EA
	Field Crew	1.0 days/EA x 4 Persons
SUB TOTAL:	Project Manager	3.0 days
(A) Once per week waste collection		
	Project Manager	1.0 days/EA (Field Work)
	Field Crew	0.5 days/EA
(B) Twice per week waste collection		
	Project Manager	1.5 days/EA (Field Work)
	Field Crew	1.0 days/EA
	Project Assistant	2.0

[3]The four (4) person field crew would ideally be composed of persons dedicated to the study and familiar with waste management procedures, and aware of the need for accurate waste management information. The field crew members should have some education in standard laboratory skills such as proper use of scales, accurate record keeping and the necessity of replication of study results. The 4 person field crew may include the project assistant, who could act as a supervisor in the absence of the Project Manager.

3.3.1 Anticipated Personnel Time Requirements and Costs Continued

STAGE 4: WASTE SORTING AND ANALYSIS

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Field Crew Training - Sorting and Classifying Waste; Data Recording Procedures; Safety	Project Manager	2.0
	Field Crew	1.0 x 4 persons
Task: Waste Sorting	Project Manager	1.0 day/EA
	Field Crew	5.0 days/EA x 4
SUB TOTAL:	Project Manager	2.0 (training)
	Project Manager	1.0 day/EA (field work)
	Field Crew	1.0 (training)
	Field Crew	5.0 days/EA (field work)

COSTS: Equipment purchases and rentals including obtaining shelter for the field crew, provision of safety equipment, and tetanus/polio/diphtheria immunization of the field crew (see Section 3.2) Tipping/disposal fee for sorted waste after analysis Telephone Use, Travel Cost, Office Supplies

Additional Costs associated with optional laboratory analyses such as heating value (BTU) analysis, moisture content and leachable metal content should be included in budget calculation.

Additional time should be allocated for the collection and analysis of yard waste/leaves, white metal goods, and other bulk items. Requirements for a field crew will vary between municipalities and study approaches taken. See section 6.3 and 6.4 for a discussion of approaches to analyzing these waste streams.

3.3.1 Anticipated Personnel Time Requirements and Costs Continued

STAGE 5: DATA ANALYSIS AND REPORT WRITING

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Data Entry to Spreadsheets	Project Assistant	1.0 day/EA
Task: Data Analysis, Calculations and Report Writing	Project Manager	10.0
	Project Assistant	3.0
SUB TOTAL:	Project Manager	10.0
	Project Assistant	1.0 days/EA (data entry)
	Project Assistant	3.0 (clerical)
COSTS:	Office Supplies, Computer Time	

WORK DAYS TOTAL

Administrative:	Project Manager	26.25
	Project Assistant	9.25
Training Period:	Project Manager	2.0
	Field Crew	1.0 x 4
Field Work:		
(A) Once per week waste collection		
	Project Manager	2.0 days/EA
	Field Crew	5.5 days/EA x 4
(B) Twice per week waste collection		
	Project Manager	2.5 days/EA
	Field Crew	6.0 days/EA x 4

SECTION 4

STAGE 1 - DEFINING THE INCOME/HOUSING TYPE MATRIX

4.0 STAGE 1 - DEFINING THE INCOME/HOUSING MATRIX

As outlined above, the first task of the study is to classify all of the enumeration areas in the study areas (EAs) according to the income/housing matrix. This task defines the sampling framework for the study. The EAs that will be sampled are selected from the matrix cells corresponding to each of the nine possible income and housing types.

4.1 Obtaining Statistics Canada Data

Statistics Canada census data needed for this study can be obtained from the following Statistics Canada library:

Statistics Canada, Toronto
Telephone number:(416) 973-6586
Address: 25 St. Clair Ave. East
Toronto, Ontario
M4T 1M4

Data can be obtained in a printed format or on computer disk or tape. Larger municipalities may find the computer disk format more useful owing to the large volume of data required.

4.2 Municipal Income Stratification

Using the most recent Statistics Canada Census data available, each EA in the study municipality is stratified according to income level. The format for the stratification is:

High Income:	average household income is at least 1/2 standard deviation greater than the mean income for the entire community;
Medium Income:	average household income is no more than 1/2 standard deviation greater than, or less than the mean income for the entire community;
Low Income:	average household income is at least 1/2 standard deviation less than the mean income for the entire community.

To carry-out the classification by income it is necessary to perform the following calculations:

1. calculate the overall mean household income of all EAs in the municipality;
2. calculate the standard deviation of household incomes from the overall mean household income
3. Subtract the average household income for each EA from the overall mean household income for the municipality.
4. Divide the difference of the two means by the standard deviation to determine the number of standard deviations away from the overall mean.

4.2.1 Anytown: Stratifying Income Levels

The stratification of income levels in the fictional town of Anytown is presented in Table 3.

The example classification of EAs in Anytown by income level demonstrates the relationship between the reported average combined household income, the mean household income for the municipality, and the half standard deviation measure.

TABLE 3: ANYTOWN: CLASSIFYING ENUMERATION AREAS BY INCOME LEVEL

ENUMERATION AREA	AVERAGE COMBINED HOUSEHOLD INCOME IN EACH EA	STANDARD DEVIATIONS FROM THE MEAN	CLASSIFICATION
101	$26,010	-0.83	LOW INCOME
102	$22,371	-1.26	LOW INCOME
103	$29,786	-0.38	LOW INCOME
104	$31,851	-0.15	MEDIUM INCOME
105	$34,739	+0.20	MEDIUM INCOME
106	$31,957	-0.13	MEDIUM INCOME
107	$49,655	+1.96	HIGH INCOME
108	$45,726	+1.50	HIGH INCOME
109	$22,246	-1.27	LOW INCOME
110	$35,482	+0.29	MEDIUM INCOME
111	$31,920	-0.13	MEDIUM INCOME
112	$36,728	+0.43	MEDIUM INCOME
113	$31,746	-0.15	MEDIUM INCOME
114	$41,640	+1.01	HIGH INCOME
115	$36,741	+0.44	MEDIUM INCOME

Mean Income of all Enumeration Areas: $33,906
Standard Deviation of the Mean Income: 7446
Half of the Standard Deviation: 3723

4.3 Municipal Housing Type Characteristics

Each EA is further classified according to housing type. Statistics Canada reports the number of Single Detached residences, Apartments, and Other residences in each EA. These numbers, expressed as a percentage of occupied dwellings in the EA are used to identify the predominant housing type for the EA.

Primarily Single Detached:	EAs with 60% to 70% of dwellings reported as single detached;
Primarily Multiple Dwellings:	EAs with 60% to 70% of dwellings reported as "apartments".
Mixed Dwellings:	EAs with a mixture of single detached, apartment buildings with fewer than 30 units, and "other" dwelling types;

An exact boundary line between dwelling classifications is not rigorously specified in this Study because of the need for flexibility to consider the distribution of the minor components of the residential mix for a particular EA. The distribution of types of residences across the whole municipality should be examined to ensure that specific cells in the income/housing matrix were not grossly out of proportion to the total number of EAs.

4.3.1 Anytown: Classifying Housing Type

The Classification of Housing Type in the fictional town of Anytown is presented in Table 4.

The example classification of EAs in Anytown by housing type level demonstrates the relationship between the percentage of dwelling reported in each of the categories: single detached dwellings, apartments, and other dwellings.

TABLE 4: ANYTOWN: CLASSIFYING ENUMERATION AREAS BY HOUSING TYPE

ENUMERATION AREA	TOTAL OCCUPIED DWELLINGS	NUMBER OF SINGLE DETACHED HOUSES	NUMBER OF APARTMENTS	NUMBER OF OTHER DWELLINGS	CLASSIFICATION
101	305	30 (10%)	200 (66%)	75 (25%)	MULTIPLE DWELLINGS
102	335	10 (3%)	195 (58%)	130 (39%)	MIXED DWELLINGS
103	345	145 (42%)	90 (26%)	110 (32%)	MIXED DWELLINGS
104	240	200 (83%)	5 (2%)	35 (15%)	SINGLE DETACHED
105	345	140 (41%)	0 (0%)	205 (59%)	MIXED DWELLINGS
106	220	0 (0%)	215 (98%)	5 (2%)	MULTIPLE DWELLINGS
107	360	360 (100%)	0 (0%)	0 (0%)	SINGLE DETACHED
108	225	0 (0%)	225 (100%)	0 (0%)	MULTIPLE DWELLINGS
109	325	130 (40%)	80 (25%)	115 (35%)	MIXED DWELLINGS
110	370	350 (95%)	0 (0%)	20 (5%)	SINGLE DETACHED
111	335	190 (57%)	0 (0%)	145 (43%)	MIXED DWELLINGS
112	175	0 (0%)	175 (100%)	0 (0%)	MULTIPLE DWELLINGS
113	220	220 (100%)	0 (0%)	0 (0%)	SINGLE DETACHED
114	300	215 (72%)	0 (0%)	85 (28%)	SINGLE DETACHED
115	325	290 (89%)	10 (3%)	25 (8%)	SINGLE DETACHED

4.4 Allocating Individual EAs to the Matrix Cells

Once each EA has been classified according the relative income level and predominant housing type, the EAs are assigned to the income housing matrix cell they correspond to. This can best be done by sorting the EAs according to their income classification (high, medium, low). Then within each income class sort the EAs according to their housing type classification.

4.4.1 Anytown: Allocating Individual EAs to Matrix Cells

In the example for the fictional town of Anytown, the income/housing classification is shown in Table 5. The matrix cells corresponding to the classifications of High income/Mixed Dwellings, and Low Income/Single Detached Dwellings are not represented. It is not unusual for a municipality to lack representation in one or more matrix cells.

The number of EAs in each classification will be needed for the calculation of the per capita generation rates during the data analysis stage of the study.

4.5 Selecting the Study EAs

Once all of the EAs have been classified it is a simple procedure to select the EAs for inclusion in the study. The EAs should be selected at random, using a random number table where more than one EA is present in a given Matrix cell.

4.5.1 Anytown: Selecting the Study EAs

The classification of EAs in the fictional town of Anytown revealed that the following classes had more than one EA assigned to them: high income/single detached dwellings, medium income/single detached dwellings; medium income/mixed dwellings; medium income/multiple dwellings; low income/ mixed dwellings. From these groups only one EA per classification is needed for the study.

TABLE 5: ANYTOWN: ALLOCATING INDIVIDUAL ENUMERATION AREAS TO THE INCOME/HOUSING MATRIX CELLS

ENUMERATION AREA	INCOME / HOUSING CLASSIFICATION
107	HIGH INCOME / SINGLE DETACHED DWELLINGS
114	HIGH INCOME / SINGLE DETACHED DWELLINGS
---	HIGH INCOME / MIXED DWELLINGS
108	HIGH INCOME / MULTIPLE DWELLINGS
104	MEDIUM INCOME / SINGLE DETACHED DWELLINGS
110	MEDIUM INCOME / SINGLE DETACHED DWELLINGS
113	MEDIUM INCOME / SINGLE DETACHED DWELLINGS
115	MEDIUM INCOME / SINGLE DETACHED DWELLINGS
103	LOW INCOME / MIXED DWELLINGS
105	MEDIUM INCOME / MIXED DWELLINGS
111	MEDIUM INCOME / MIXED DWELLINGS
106	MEDIUM INCOME / MULTIPLE DWELLINGS
112	MEDIUM INCOME / MULTIPLE DWELLINGS
---	LOW INCOME / SINGLE DETACHED DWELLINGS
102	LOW INCOME / MIXED DWELLINGS
109	LOW INCOME / MIXED DWELLINGS
101	LOW INCOME / MULTIPLE DWELLINGS

To randomly select the EAs to be used in the study, assign each of the EAs a number. From the random number table select a number for each classification and use the EA with the corresponding number for the study. Table 6 provides an example of how to randomly select enumeration areas for inclusion in the study from a list of several enumeration areas that may fall within a single classification.

Note that for the classification Medium Income/Mixed Dwellings the random numbers 7 and 9 correspond to Enumeration Areas 103 and 111. Either enumeration area could be chosen but by convention the first (random number 7, EA 103) would be used for the study.

TABLE 6: ANYTOWN: RANDOMLY SELECTING ENUMERATION AREAS TO BE INCLUDED IN THE WASTE COMPOSITION STUDY

CLASSIFICATION	ENUMERATION AREA	ASSIGNED NUMBER	SELECTED
HIGH INCOME / SINGLE DETACHED DWELLINGS	107	1	
	114	2	YES
MEDIUM INCOME / SINGLE DETACHED DWELLINGS	104	3	
	110	4	
	113	5	
	115	6	YES
MEDIUM INCOME / MIXED DWELLINGS	105	7	YES
	111	8	
MEDIUM INCOME / MULTIPLE DWELLINGS	106	9	YES
	112	10	
LOW INCOME / MIXED DWELLINGS	102	11	YES
	103	12	
	109	13	YES

RANDOM NUMBERS: 2, 7, 9, 11, 6, 13

All other income/housing classifications had one or less enumeration areas assigned to them, and therefore were automatically selected for use in the waste composition study.

SECTION 5

STAGE 2 - SELECTING SAMPLE POINTS WITHIN AN EA

5.0 STAGE 2 - SELECTING SAMPLE POINTS WITHIN AN EA

In Stage 1 the municipality or study area was characterized by enumeration area using an income/housing matrix. From the matrix of income and housing types, one enumeration area per matrix cell was selected at random for study.

Within each chosen EA ten (nine as a minimum) samples must be collected. These samples should be taken so that the samples collected are evenly spread over the entire EA. In addition every household in the EA must have an equal chance of being included in the study.

To achieve these goals ten collection starting points are selected in the EA using a random method. Samples are collected from every house encountered with waste set out for collection while driving along the street(s) containing the starting point until approximately 100 kg of waste is taken. Following the collection of the first 100 kg sample the crew moves on to the next starting point and collects the next 100 kg sample. The process continues until all ten samples have been collected.

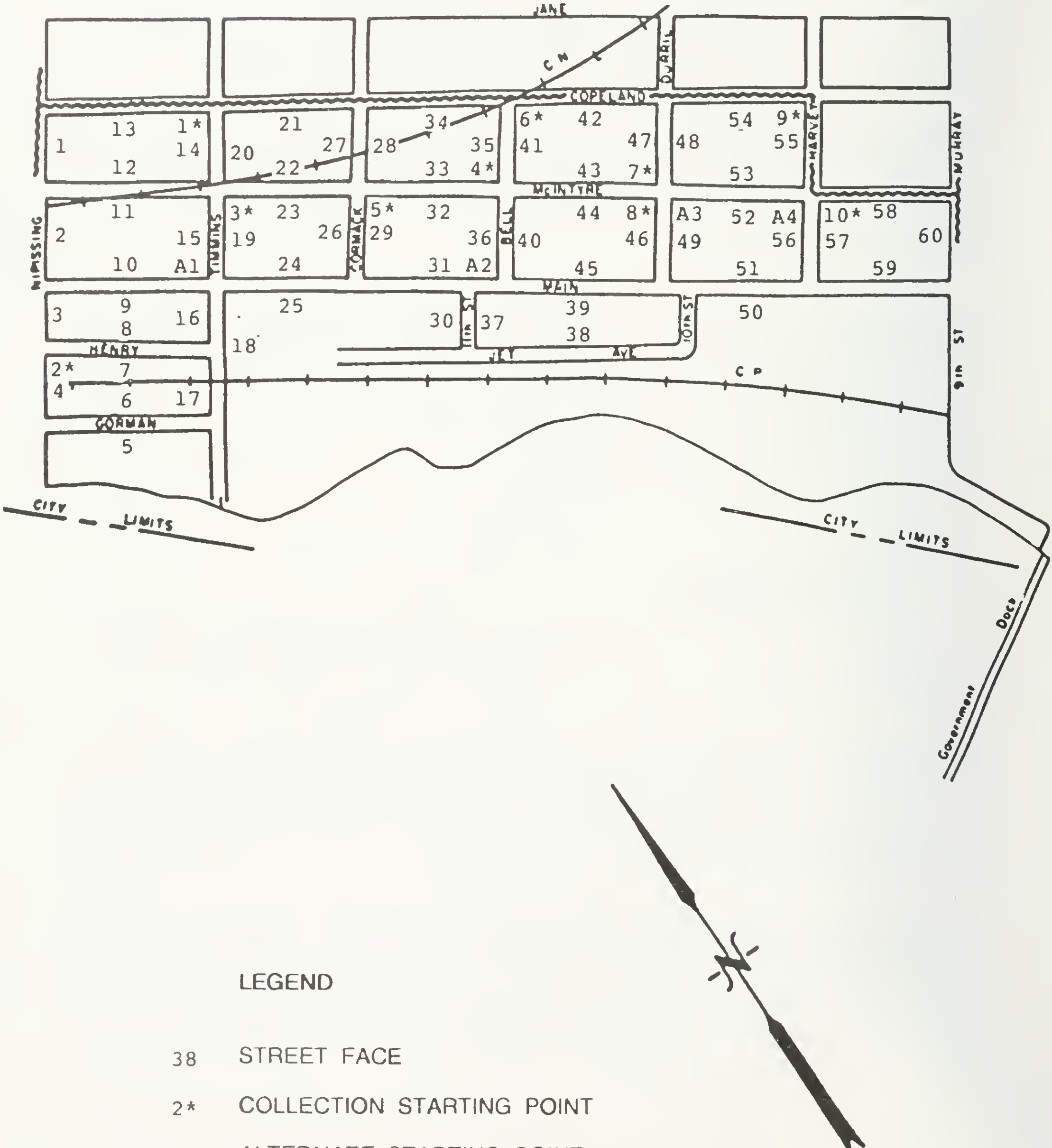
5.1 Street Face Numbering

The first step in selecting the sampling start points is to number each street face in the EA.

By convention, during the Ontario Waste Composition Study, this numbering started in the upper left corner of the EA map (see example Figure 5) and proceeded down and up the page, moving left to right, to the bottom right corner. Every street face was given an individual number.

In addition to the identification of street face starting points, large apartment buildings (10 or more units) in the mixed housing classification should be identified if they exist. These buildings are given a number, like a street face, and may be selected as a sampling location. Buildings of this size will usually generate more than enough waste for one sample.

FIGURE 5: EXAMPLE OF ONE EA SHOWING NUMBERING OF BLOCK FACES AND SAMPLE COLLECTION "STARTING POINTS"



LEGEND

38	STREET FACE
2*	COLLECTION STARTING POINT
A3	ALTERNATE STARTING POINT

5.2 Random Selection of Starting Points

Using a random number table ten staring points where selected. By convention collection would start on the street face selected at the eastern, or northern end of the street. In addition to the ten start points selected, three or four alternate start points would also be identified. The need for alternate starting point will be discussed in STAGE 3 - Collection of Waste Samples.

SECTION 6

STAGE 3 -COLLECTION OF WASTE SAMPLE

6.0 STAGE 3 - COLLECTION OF WASTE SAMPLE

Stage 1 described the method used to classify each of the EAs in the municipality, and described the method for selecting EAs to be used in the study. Stage 2 described the method of determining where in the study EAs the samples would be taken from, and outlined the number and size of samples to be taken.

Stage 3 describes in detail the actual sampling of residential waste. Each of the housing types used in the classification of EAs typically has different waste set out practices and collection procedures. These differences require slightly different waste sample collection procedures.

6.1 Regular Curbside Waste

Waste from single detached dwellings, duplexes, houses with apartments, and small apartment buildings is usually set out at the curb by the occupants for collection by the municipal garbage collection brigade. The waste will typically be set out in plastic bags or garbage pails. In addition to regular waste there may be Blue Box Materials, bundles of yard waste, bags of leaves, and items too bulky to be bagged or put in a garbage pail.

6.1.1 Waste Collection Process: Detached Dwellings--General Procedures

The goal of the waste collection process, on any one day, was to obtain 10 (9 as a minimum), 100 kg (minimum weight) samples of residential waste--exclusive of the weight of Blue Box materials and yard waste that were also coincidentally collected if they were placed curbside. This task proceeded as quickly as possible, with a 0700 h start, so that the normal collection of waste and Blue Box items by the municipality was not seriously inconvenienced.

The waste sample collection began at one of the starting points (refer to Figure 5). Waste was collected in front of every dwelling where it was set out, until approximately 100 kg were accumulated in the crib (see Figure 3), some variations to this are noted below. An "en route" collection record was kept of the number of dwellings that had waste set out: general waste and/or Blue Boxes. Single and duplex dwellings were also indicated.

The importance of the "en route" collection record and the accuracy of the recording of the number of dwellings that were sampled should be noted. The team member who recorded the trip data did not have time to concentrate on any other aspect of the curb-side collection process.

Loose waste set out in garbage cans was rebagged in clear polyethylene bags. These bags were reused and not included in the analyzed waste sample. The collected waste was placed in the chicken wire crib which was mounted on the platform scale on the floor of the van (see Figure 3). The scale was tared with the empty crib on it, prior to filling the crib with waste. When the minimum required weight of waste had been collected (with an allowance for the estimated inclusions of yard waste co-disposed with household waste), the crib was unloaded and the sample was stored in the van. Samples were collected such that no waste was left at the curb.

Corrugated gaylords were used to store six of the waste collections. Two of the remaining collections were piled on top of 1.2 m (4 ft.) x 1.2 m (4 ft.) chicken wire dividers placed on top of the collections in the gaylords. The ninth collection of bagged refuse was piled on top of the Blue Box materials, stored in compartments in the pick-up truck (see below), while the tenth collection was kept in the weighing crib.

Yard waste set out at the curb was weighed at the time of sample collection. The weight was recorded and the yard waste was placed back at the curb for municipal waste collection.

Blue Box items were placed in the corresponding sample compartment in the back of the pick-up truck (Figure 4). There was space for 9 collections in the truck; the tenth collection was stored in polyethylene garbage cans in the van.

It took between 2 and 2.5 hours to make 9-10 collections within an EA. Following the last collection, the contents in the pick-up truck were covered with a tarpaulin.

Elastic straps secured the crib and contents in the back of the van. The Study team proceeded to the base of operations in the municipality and began sorting the samples.

6.1.2 Required Number of Samples

As described above, ten samples (nine as a minimum) are required from each EA. If for various reasons fewer than ten samples are taken, the results for the EA with fewer than ten samples will be reliable but less accurate.

6.1.3 Required Weight of Each Sample

Each of the ten samples taken should weigh 90-125 kg (200-300 lbs). A target weight of 100 kg should be made for each sample with the bias toward larger samples rather than smaller samples. If, for instance, 95 kg of waste have been collected and the next house on the collection route has 10 to 15 kg of waste (typical weight) then that waste should also be taken to guard against weighing errors, loss of materials later on, or other factors which could reduce the weight of that sample.

6.1.4 Collection Equipment Requirements

The following list of equipment includes rented vehicles and purchased equipment:

- one - 4.3 m (14 ft.) cube van (for collection of bagged refuse);
- one - pick-up truck (for collection of Blue Box contents);
- one - electronic platform scale (150 kg capacity, Accu Weigh Model PAK-150 (electronic, battery operated scale with digital read-out), Exact Weight Scale, Inc., Toronto, Ontario);
- six - 1.2 m (4 ft.) x 1.2 m (4 ft.) x 1.2 m (4 ft.) heavy duty corrugated containers ("gaylords"); these containers were used for storing the bagged (non-Blue Box) refuse samples as they were being collected;
- four - 1.2 m (4 ft.) x 1.2 m (4 ft.) divider frames (2.5 cm x 5.1 cm wood furring stock/chicken wire); these were used as horizontal partitions in

the back of the cube van for separating the collections of bagged (non-Blue Box) refuse which were stacked on top of each other;

two - 46 cm (18 in.) x 2.4 m (8 ft.) divider frames (2.5 cm x 5.1 cm wood furring stock/chicken wire); these were used as the two main partitions in the back of the pick-up truck for segregating the collections of Blue Box materials (see Figure 2);

nine - 46 cm (18 in.) x 41 cm (16 in.) (approx.) plywood panels; used as partitions in the back of the pick-up truck (see Figure 2);

one - chicken wire "crib": 1.2 m (4 ft.) x 1.2 m (4 ft.) x 1.3 cm (1/2 in.) plywood base; 0.6 m (2 ft.) high chicken wire and 2.5 cm x 5.1 cm furring sides. Nailed to the underside of the crib floor was a square frame which permitted the crib to be centred on the bed of the platform scale (see Figure 3); the crib was used for weighing the refuse as it was being collected from curb-side;

150 - 50.8 cm (20 in.) x 76.2 cm (30 in.) x 6 mil polyethylene bags (Oxford Packaging Inc., Mississauga, Ontario); these were used for bagging refuse that was set out loose in garbage cans; the bags were also used for storing refuse samples for moisture and chemical analysis;

40 - 30 litre polyethylene garbage cans; these were used as containers into which sorted refuse was placed (see Figure 4);

one - 2.7 m (9 ft.) x 3.7 m (12 ft.) reinforced plastic tarpaulin for covering Blue Box materials in the pickup truck;

six - elastic straps to secure the tarpaulin in place;

one - broad-mouth aluminum shovel; used for cleaning up spills;

one - broom; used for cleaning up spills and sweeping out the vehicles;

one - staple gun and 0.95 cm (3/8 in.) staples for construction and repair of chicken wire dividers and crib;

one - claw hammer; 5.1 cm (2 in.) common nails: used in the construction of the crib and divider frames.

6.1.5 Twice Weekly Garbage Collection Sampling Protocol

Some municipalities will have twice weekly collection of garbage. In these communities it will be necessary to collect samples on both collection days since the waste sample must reflect the waste generation characteristics of the enumeration area for the entire week. This presents some problems during sample collection in that a decision must be made regarding the weight of waste to be taken on each sample day.

As an example of this problem staff in the Borough of East York indicated that about 60% of the weekly volume of refuse was placed at curb-side for the first of the two weekly collections, with about 40% set out for the second collection. This ratio was not universally reliable for all of the EAs in the Borough. With a target of 100 kg (minimum weight) of waste that had to be collected for a sample of adequate size, the following collection protocol was developed and illustrated in the example below.

For a given sample, approximately 60 kg of bagged refuse was collected, for example, from 7 houses on the first collection day. Sample collection on the second day started from the same "starting point" assigned on the first day and waste was collected from <u>the same number of dwellings</u>. In theory, the 60/40 relationship would result in approximately 40 kg of refuse collected on the second collection day, for total of 100 kg of waste for the composition analysis.

It is absolutely imperative that waste be collected from the same number of dwellings on the second collection day. Calculation of the per capita generation rate is dependent on knowing the number of dwellings waste was collected from (and average number of occupants per dwelling), and the total weight of refuse collected.

The uncertainty of the 60/40 ratio, required the collection crew to "overcompensate" the weight of the first collection in each sample by picking up more than 60 kg, e.g., 70 kg. This "insurance" weight meant that the crew <u>was required</u> to pick up from 7 dwellings on the second collection day. The sum of two collections would not likely be less than 100 kg.

There were instances in East York where the 60/40 relationship was not accurate. This resulted in either less than 100 kg of waste being collected for the week or a weight greatly in excess of 100 kg being collected. Neither of these occurrences is of great concern so long as they occur infrequently.

Waste collection from apartment buildings with twice weekly collection did not present this kind of a sampling problem (see below).

6.1.6 Recording Number of Houses Passed and Weight of Sample

As note previously, one member of the collection team was assigned the duty of recording information as the sample collection proceeded. The collection record is extremely important later when the per capita generation rate is being calculated.

The sample collection notes must accurately record:
1. Date and time of collection
2. Enumeration area sample
3. Address of "starting point" for each sample
4. Number of houses waste was taken from
5. Number of houses Blue Box materials were collected from
6. Weather conditions (e.g. rain that would wet the sample)

6.2 Blue Box Materials

Blue Box materials are collected along with regular waste, but their weight is not included (initially) in the 100 kg sample taken. Samples of Blue Box materials were stored in the back of the pick-up truck in the compartments constructed out of wood and chicken wire (Figure 2). The number of dwellings setting out Blue Boxes was often different from the number of dwellings regular waste was collected from. It is important to record the number of dwellings blue box materials were collected from for later use in calculating the per capita generation rate and "capture rate" of Blue Box materials.

6.3 Yard Waste and Seasonality

Residential waste from detached dwellings usually contains a certain amount of yard waste (e.g., leaves, grass clippings, brush, etc.) This material can represent a significant proportion of the waste at certain times of the year. The amount of yard waste will typically be very high in the spring and fall during yard clean-up times, and may also be high during the summer grass growing and gardening times. During the rest of the year very little yard waste is generated.

In a study designed to analyze the composition of residential waste by taking a limited number of samples, it is suggested that yard waste be excluded from the calculation of per capita generation rates and percent composition of residential waste. Depending on the exact time of the study, yard waste may represent too large or too small a proportion of the yearly average generation rate for the municipality. Yard waste generation rates require a long term (yearly) monitoring program to accurately describe their generation rate.

6.3.1 Collection and Analysis of Yard Waste

During collection of residential waste samples, yard waste may be encountered. Where possible, yard waste should be separated at the curbside, weighed, its weight recorded, and returned to the curb. The weight of yard waste should not be included in the 100 kg sample. Bags of refuse suspected of being entirely yard waste should be opened and examined during the collection process. The weight of yard waste is recorded on the composition data sheets but is not included in the per capita generation rate calculation for the reasons stated above.

On occasion yard waste will go undetected at the curbside or is commingled with regular waste. The weight of this material should be recorded at the time of sorting, but will not be used in the calculation of per capita generation rates or percent composition.

6.4 Large and Bulk Items

Large and bulk items present a problem for the sample collection and data analysis. Often a large or heavy item(s) will be placed at the curbside with the regular waste. These heavy items will have the effect of increasing the percent composition of the waste sample toward material component of the large item, and lowering the other material component percentages. Large heavy items that are clearly not part of the regular waste stream should be excluded from the 100 kg sample.

A statistical basis for this subjective decision is based on the concept of the standard deviation and the normalized "bell curve" of percent composition of waste materials. If the weight of a single item in a sample would cause the percent composition for that material to be greater than three standard deviations from the average percent composition of that material, the item should not be included in the sample. This information is never available in the field, therefore a judgement based on what should be considered "normal" residential waste and what should be included in the sample must be made. A person experienced in waste composition analysis should make this decision.

Large or bulk items are often collected by the municipality on special collection days. These collection days may be weekly, monthly, seasonal (spring/fall), or yearly. For the purposes of determining the per capita generation rates and composition of such materials a yearly monitoring scheme should be set up. This monitoring program could be initiated at the same time as the monitoring program for yard waste since these two waste streams may be linked by collection practices in the municipality.

6.5 Apartment Buildings

During the collection of waste samples, two types of apartment buildings will be encountered that will require special sampling and data collection procedures.

6.5.1 Small Apartment Buildings

In the housing classification of "Mixed Dwellings" the collection crew will often come across small apartment buildings, rooming houses and interconnected dwellings.

Apartment buildings with a small number of units will usually have all the waste set out at the curbside. This waste should be included in the sample, and the number of occupied units in the building recorded.

Larger apartment buildings will often generate enough waste to make up one entire 100 kg sample. Such buildings should be noted during the selection of starting points, and may be selected as sampling locations. The total weight of all refuse set out from the building must be recorded along with the number of occupied dwellings. Any additional waste above the required 100 kg sample size may be returned to the curb to reduce sample sorting time later on.

On occasion waste will not be set out at the curbside, but may be present in a dumpster or storage room. All waste should be removed from the dumpster or storage room and its weight recorded. This activity will require consent of the building superintendent or operator, and such permission should be obtained before the collection begins.

6.5.2 Highrise Apartment Buildings With Dumpsters and Compactors

The housing classification of "Multiple Dwellings" refers to enumeration areas comprised entirely or in part by apartment buildings of 30 or more units. These buildings present several practical problems for the waste study which must be addressed.

1. The ten 100 kg samples should be taken equally from all the dumpsters or compactors, if more than one dumpster is present. This can be achieved by skimming a layer of waste off the top of one dumpster to make up one sample, then moving on to the next dumpster for the next sample. It may be necessary to return to each dumpster more than once to collect all 10 samples.
   Samples of loose waste from broken or compacted bags should be rebagged in 6 mil polyethylene bags.

2. After the ten samples are have been collected the remaining waste must be weighed, and its weight recorded along with the number of occupied dwellings in the building. Weighing of the remaining waste is often best accomplished by contracting a waste hauler to dedicate one truck to pick up the waste from the apartment building, take it directly to a transfer station, and return the weigh scale receipt to the study team.

In the absence of such an arrangement with a private hauler, or where only small amounts of waste remain, the study crew can weigh and record the weight of the waste on the portable scale, and return the excess waste to the dumpster.

6.6 Logistics of Sample Collection

The collection of waste samples and supporting data requires a large degree of co-ordination between the study team, Ministry of the Environment officials, municipal authorities and staff, building owners, waste haulers and others.

6.6.1 Documents and Meetings

Two important documents must be obtained from the Ministry of the Environment, Waste Management Branch. The first authorizes the collection of waste for the Waste Composition Study; the second is a letter to be given to any individual in the municipality who is interested in learning more about the residential study.

The procedure to obtain Ministry approval for solid waste sample collection by municipalities undertaking waste composition studies, is as follows:

A letter requesting Ministry approval for temporary collection of solid waste samples shall be mailed by the interested municipality to:

Mr. Dave Crump
Operations Coordinator
Operations Division
Ministry of the Environment
14th Floor, 135 St. Clair Ave., West
Toronto, Ontario
M4V 1P5

The letter shall include, but not be limited to the following type of information:

- Background and reasons for undertaking the study.
- Study objectives.
- Study approach.

- Contractor's name.
- Collection area.
- Approximative number of samples to be collected.
- Approximative weight of each sample.
- Estimated duration of the project.

A high level of coordination is required between the Study Project Manager, municipal staff and waste haulers to ensure scheduling of refuse collections. Each week, a map of the EA scheduled for inclusion in the refuse study should be delivered to municipal staff and/or the waste haulers.

The study team must be informed of the regular collection day in the study enumeration area, whether there is once or twice weekly collection, the ratio between first and second day set-out rates (e.g. 60/40 spilt) when there is twice weekly collection, and any other potential collection problems such as rescheduling at holiday times.

The municipal waste collection crews should be directed away from the study area for at least three hours to allow the study team to collect samples.

A similar level of coordination is required in order to obtain permission to include small and large apartment buildings in the Study. Usually the details can be arranged through phone conversations with apartment owners and building managers and waste haulers, but occasionally written requests for permission are required.

In North Bay, a press release was issued by the City to inform its residents about the City's participation in the Ontario Waste Composition Study. This may be helpful in facilitating the collection crew's activities.

SECTION 7

STAGE 4 - WASTE SORTING AND ANALYSIS

7.0 STAGE 4 - WASTE SORTING AND ANALYSIS

Stage 4 describes the methods to be used by the study team to analyze the waste samples after they have been collected. These analyses include sorting the waste into its material components and weighing each material, determining moisture content, and optional analyses such as BTU (heating value analyses) and metal content.

7.1 Sorting Location

Samples of waste are returned to a central location where sorting and weighing can take place. The sorting location varied with the municipality being studied and the seasonal weather. In general the sorting location had to be large enough to allow the sorting team to set up a work table and an array of plastic buckets, and should provide some protection from the elements.

In the Town of Fergus, sorting was conducted at the Guelph Landfill Site. No shelter was provided except for a large tarpaulin which was used as a sun-screen during the hot summer months.

In Borough of East York sorting was conducted on the tipping floor of the former Commissioners Street Incinerator. This location provided adequate protection from the wind and cold during the months of November and December. On very cold days the work was moved into a heated work room adjacent to the tipping floor.

In the City of North Bay sorting was carried out in a large (20 ft. by 20 ft.) carnival-type tent. The study took place during the month of February, during which times temperatures were continually well below freezing. The tent was heated with two 15,000 BTU propane heaters.

7.2 Sorting Equipment and Set-up

Sorting of waste samples was conducted on a large wooden table around which all of the sorting team could stand. The table was constructed out of one inch plywood sheets, supported either by the tail-gate of the pick-up truck or on saw horses (see Figure 4).

The sorting team position themselves around the table and set up the array of plastic sorting buckets (30 litre plastic garbage cans) into which the various components of the waste are sorted (see Figure 4).

The sorting buckets are arranged to promote the idea of "handedness". To begin with, a bucket for putrescibles which is placed directly in front of each sorter. This provides the least amount of handling for the largest component by weight, and the most difficult component to handle.

Each sorter then shares a bucket for each of the other components with either the sorter on the right or on the left. For example, the buckets could be arranged so that a sorter is placing all paper categories to the left side and all plastic categories to the right side. Buckets for the larger and heavier objects can be placed behind the sorters, at a further distance but should be shared by two or more sorters. This arrangement of buckets allows the sorters to pick up an item and deposit it in the correct bucket without having to transfer the object from hand to hand, once the idea of " handedness" is established.

Additional equipment required for the sorting procedure includes:

- 150 kg capacity platform scale (noted previously);
- 1.5 kg capacity scale (Accurate model 5000 (electronic, battery operated with digital read-out), Exact Weight Scale Inc., Toronto, Ontario.);
- 40 polyethylene garbage cans (noted above);
- 1 claw hammer
- 1 slotted screw driver;
- 1 electrician's pliers;
- 4 magnets
- paring knives for opening plastic bags
- personal equipment listed Section 7.6.6

7.3 Waste Component Categories

The samples of waste are sorted into the categories shown in Table 7. The categories were listed on data collection sheets which allowed the weight of each component to be recorded opposite of it. Space should also be available on the data sheet for recording of miscellaneous items that do not fit the predetermined categories. The information recorded on the data collection sheet for each sample can then be transferred directly to computer spreadsheets for analysis.

Notes On the Categories

While sorting/classifying the waste samples certain items, such as a glass bottle, are simple to categorize. Some waste materials may be composed of several different materials in layers or otherwise combined which makes identification difficult. Other waste materials, due to their unique physical or chemical structure, will not fall into obvious categories. The degree and level of detail to which the Ontario Waste Composition Study waste material categories have been subdivided reflects an effort to deal with these sorting problems.

In general, if a material could be identified by a unique identifying keyword or phrase in addition to its generic material composition, that descriptor formed the basis for its classification. The generic categories of paper, glass, ferrous metal, non-ferrous metal, plastics and organics each have several subcategories. In addition several unique categories are used such as diapers (disposable), dry cell batteries, kitty litter, and medical waste are used.

TABLE 7: WASTE COMPOSITION DATA COLLECTION SHEET

Town:
Enumeration Area:
Collection Dates:

Category	Item				
(1) Paper	(a) Newsprint				
	(b) Fine Paper / CPO / Ledger				
	(c) Magazines / Flyers				
	(d) Waxed / Plastic / Mixed				
	(e) Boxboard				
	(f) Kraft				
	(g) Wallpaper				
	(h) OCC				
	(i) Tissues				
(2) Glass	(a) Beer (i) refillable				
	(ii) non-refillable				
	(b) Liquor & Wine Containers				
	(c) Food Containers				
	(d) Soft Drink (i) refillable				
	(ii) non-refillable				
	(e) Other Containers				
	(f) Plate				
	(g) Other				
(3) Ferrous	(a) Soft Drink Containers				
	(b) Food Containers				
	(c) Beer Cans (i) returnable				
	(ii) non-returnable				
	(d) Aerosol Cans				
	(e) Other				
(4) Non-Ferrous	(a) Beer Cans (i) returnable				
	(ii) non-returnable				
	(iii) American				
	(b) Soft Drink Containers				
	(c) Other Packaging				
	(d) Aluminum				
	(e) Other				
(5) Plastics	(a) Polyolefins				
	(b) PVC				
	(c) Polystyrene				
	(d) ABS				
	(e) PET				
	(f) Mixed Blend Plastic				
	(g) Coated Plastic				
	(i) Nylon				
	(j) Vinyl				
(6) Organic	(a) Food waste / Rodent Bedding				
	(b) Yard waste				
(7) Wood					
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos					
(9) Diapers					
(10) Textiles/Leather/Rubber					
(11) Household Hazardous Wastes	(a) Paints / Solvents				
	(b) Waste Oils				
	(c) Pesticides/Herbicides				
(12) Dry Cell Batteries					
(13) Kitty Litter					
(14) Medical wastes					
(15) Miscellaneous					
(16) BLUE BOX ITEMS	(a) Newsprint				
	(b) Liquor / wine Bottles				
	(c) Food Jars / Other Bottles				
	(d) Food Cans (i) ferrous				
	(ii) non-ferrous				
	(e) Beer Cans (i) ferrous				
	(ii) non-ferrous				
	(iii) American				
	(f) Pop Cans (i) ferrous				
	(ii) non-ferrous				
	(g) PET Bottles				
	(h) Plastic Jugs				
	(i) OCC				

When an item was found to be composed of several materials, the most predominant material by weight was used as the basis for classification. For example a paper container with a thin coat of plastic would be classified as waxed/plastic/mixed paper (item 1d). Similarly a plastic bag with a thin aluminum foil liner (potato chip bags) would be classified as coated plastic (item 5g).

Dr. Fred Edgecombe, Executive Director, EPIC (Environment & Plastics Institute of Canada) recommended that all polyethylene and polypropylene containers and film plastics be grouped together as "polyolefins" (item 5a), rather than trying to distinguish between polyethylene of different densities and crystal linearity. A small amount of SARAN wrap (polyvinylidene chloride) would also have been included in this category.

The PVC category (item 5b) was restricted to rigid containers; the vinyl category was reserved for other materials such as scraps of vinyl siding.

A simple "smoke and drip" test, provided by Dr. Edgecombe, was used to assist in determining the category for a particular plastic item. The test is included as Appendix D of Volume I, but it should not be viewed as a definitive qualitative method when used by itself and the test is not presented in this report. The sorting team should receive training from a person knowledgable in distinguishing plastic types during their general job training.

Mixed blended plastics (item 5f) were used to classify plastic packaging around meat products. Coated plastics (item 5g) were used to classify packaging in which the plastic portion was judged to be the greatest percentage by weight, e.g., potato chip bags. The "Tetrapak" boxes were categorized as mostly paper (boxboard) and included in item 1d.

Rodent bedding (item 6a) was routinely encountered in small quantities of urine-soaked cedar shavings and faecal pellets. The material was included in the food waste category because of the putrescible nature of both of the components. Likewise, individual "packages" of canine excreta--presumably contributed by citizens obeying the "poop-and-scoop" statutes--were included in this category. Kitty litter (item **13**) was more frequently encountered and because of the inorganic nature of the granular product was given a single, separate category.

Sanitary napkins were included in the paper subcategory of tissues (item **1i**).

Medical wastes (item **14**) included medicines, insulin bottles and associated used syringes (needles protected and unprotected) and syringes without accompanying evidence of medicinal application.

Aerosol cans were collectively weighed and included in the ferrous section as item **3d**. At the time, we felt that one category for ferrous/non-ferrous pressurized containers would be adequate owing to the small number of non-ferrous aerosol containers. An additional category for non-ferrous aerosol containers may be incorporated into the sorting routine.

7.4 Weighing Sorted Waste - Use of Tared Buckets and Electronic Scales

After sorting, each material can be weighed in its bucket. The electronic platform scale (150 kg capacity) should be "tared" with an empty bucket so that the scale reads only the weight of the material in the bucket. Scale tare should be checked frequently to ensure that the scale is operating properly. One person can be designated as the data recorder, while the remainder of the crew load the scale, and empty the buckets that have been weighed.

Often there will be several small items that are too small to be weighed on the 150 kg capacity platform scale. These small items should be weighed separately on a smaller (1.5 kg capacity) scale.

7.5 Use of Standard Data Sheets - Recording Weights

Standardized data recording sheets such as shown in Table 7 should be used to record all weights. The sample being analyzed, the enumeration area from which it was taken, and the date of sorting should be clearly indicated on each sheet. If one person acts as the designated record keeper, fewer mistakes and omissions are likely to occur.

7.6 Personnel Training - Safety

During the sorting exercise several safety precautions should be taken. Safety includes proper handling of the waste samples, protective clothing, hygiene, and immunization. With limiting the generality of safety requirements, several comments regarding safety are made.

7.6.1 Waste Handling

When handling waste the collection crew and sorters must be aware of sharp and pointed objects, corrosive and caustics chemicals, hazardous and poisonous chemicals, and potential disease carrying objects such as dead animals, insects, medical waste and so on. Careful and watchful work will allow workers to spot these items and avoid coming into contact with them.

7.6.2. Protective Clothing, Hygiene, and Immunization

All members of the collection and sorting crew should dress appropriately for the work conditions, and wear the proper protective equipment. Personal equipment includes:

- heavy duty, water proof (PVC coated) gloves;
- work clothes (pants and long sleeve shirts) or coveralls; rubber apron, hat;
- steel toed work boots;
- eye protection;
- tetanus/polio vaccination (optional: diphtheria, Hepatitis A and Hepatitis B);

- traffic safety vest
- particle masks, worn by crew members concerned with dust and the possibility of disease transmission;
- anti-bacterial soap, used to clean gloves hands and face before meal breaks and at the end of the day.

Efforts should be made to maintain personal hygiene during sorting, as this will reduce any possible disease transmission. Contact with eyes, ears and mouth should be avoided until hands and face have been thoroughly washed with anti-bacterial soap.

7.7 Moisture Content Analysis - Optional

Analysis of moisture content is optional for the purposes of this study, but is useful when comparing percent composition and per capita generation rates between enumerations, during different seasons, and between different years. The moisture content of the waste allows you to identify samples that may be very wet or very dry, and hence have a greater or lesser weight than expected. Samples of waste should be analyzed as soon after collection and sorting to reduce the amount of moisture transfer taking place.

After the waste sample has been sorted into the designated categories and weighed, samples of plastics, paper, food waste, disposable diapers, and textiles are placed in large polyethylene bags, folded and stapled shut, and transported to a drying laboratory. The contents of the bags are weighed, and placed in a waste drying oven at 95 C for 48 hours. The samples are reweighed after the 48 hour period to determine the weight loss due to evaporation of moisture.

7.8 Other Optional Analyses - BTU, Leachable Metals

Other analyses were undertaken during the Ontario Waste Composition Study which may include determining the heating value of the waste by assessing its BTU value, and determining the leachable metal content of various waste components. Results of the BTU analysis and heavy metal content of vacuum cleaner bag dust are presented in Volume I.

7.9 Yard Waste Data Collection

During collection of waste samples, yard waste (leaves, grass clippings, tree trimmings) should be omitted from the 100+ kg sample. When yard waste is encountered at the curb its weight should be recorded, and the yard waste returned to the curb. The total weight of yard waste found in the sorted waste and the weight of yard waste weighed and returned to the curb during sample collection is recorded on the data collection sheets, but the weight of yard waste is not included in the calculation of the percent composition of waste.

SECTION 8

STAGE 5 - DATA ANALYSIS AND MANIPULATION

8.0 STAGE 5 - DATA ANALYSIS AND MANIPULATION

Data collected in Stage 3 and Stage 4 must be summarized and analyzed. This section describes the calculations necessary to determine the per capita generation rate (kg/capita/day), and the percent composition of residential waste.

8.1 Using a Computerized Spreadsheet to Summarize Data

For the Ontario Waste Composition Study, Gore & Storrie Limited created a computerized spreadsheet to calculate and summarize percent composition for each 100 kg sample and each enumeration area. Similar data spreadsheets can be created for each community.

The Gore & Storrie spreadsheets are designed such that the data entry operator enters the weight of each waste component recorded during the sorting procedure, and the computer calculates:

- percent composition of each waste component in the 100 kg sample;
- average percent composition for the enumeration area;
- average weight of each waste component in the 100 kg sample;
- standard deviation of the average percent composition and average weight of each waste component;
- standard error of the average percent composition and average weight of each waste component.

Computerized spreadsheets can be printed out in report format if needed.

8.1.1 Percent Composition of Waste

Percent composition is calculated by dividing the weight of each sorted material (MATERIAL WEIGHT) by the sum of the material weights (TOTAL WEIGHT), and expressing the result as a percent.

MATERIAL WEIGHT ÷ TOTAL WEIGHT x 100% = PERCENT COMPOSITION

The percent composition of each component of the waste stream is only relevant if an estimate of the per capita generation rate (kg/capita/day) of waste is available. The per capita generation rate of all wastes (calculation of which is described in Section 8.2 below) combined with the percent composition of waste allows an estimation to be made of the tonnage of each component generated by the municipality. Reporting the percent composition of the waste stream, without reporting a total tonnage figure or per capita generation rate for the municipality is meaningless.

8.2 Calculation of Per Capita Waste Generation Rate

Calculation of per capita generation of residential waste requires the following:
Per capita generation rate of waste is calculated based on the number of dwellings waste is collected from, the average number of persons per dwelling, the weight of waste collected, and the number of days over which the waste was generated.

Refer to Table 8 for an example of per capita generation rate calculation.

TABLE 8: SAMPLE CALCULATION OF THE PER CAPITA GENERATION RATE IN AN EA. DATA FROM THE FICTIONAL TOWN OF ANYTOWN, EA # 107

Town: Anytown
EA: 107 / High Income; Primarily Single Detached Dwellings
Pop: 1020
Dwellings: 360
PPD: 2.83

Sample Number	Dwellings with Refuse	Dwellings with Blue Boxes	Sampled Refuse Weight (kg)	Sampled Blue Box Weight (kg)	Daily Weight /Dwelling (kg/day)	Waste /person /day (kg)	S.E.
31	8	5	115.80	31.11	2.51	0.887	
32	11	5	96.39	26.38	1.63	0.576	
33	6	3	123.52	24.30	3.52	1.244	
34	8	7	96.82	39.50	2.13	0.753	
35	12	8	103.06	45.80	1.64	0.580	
36	9	7	113.69	37.20	2.18	0.770	
37	2	2	42.12	40.36	4.45	1.572	
38	5	5	89.83	15.58	2.79	0.986	
39	7	4	122.68	12.65	2.73	0.965	
40	11	6	141.71	22.39	2.11	0.746	
Sample Ave.	7.9	5.2	104.56	29.53	2.57	0.908	0.097

8.2.1 Municipalities with Blue Box Recycling

In communities with Blue Box recycling programs calculation of the per capita generation rate of waste requires determining the generation rate of regular waste, and the generation rate of Blue Box materials. This presents a minor problem in that the households do not usually set their Blue Box out every week. The Blue Box is normally only set out when it is full. The time for the blue box to fill up may be one, two or more weeks, therefore some estimate of the put-out rate or timing set out of blue boxes must be made.

It is erroneous to assume that Blue Boxes are set out each week. Making this assumption will cause the per capita generation rate of all wastes to be too high, and will give false information regarding the effectiveness or capture rate of the Blue Box program. Accurate estimates of the typical put-out rate can only be made by carefully monitoring the Blue Box program. The persons riding the collection trucks may have valuable insight into the put-out frequency in the municipality or even the enumeration area being studied.

Calculation of generation rate proceeds as follows:

- Determine the total sample weight (WASTE WEIGHT) of waste collected (for each 100+ kg sample). These data are recorded in the trip note book.
- Determine the number of dwellings (DWELLINGS) waste was collected from to achieve each 100 kg sample. These data are recorded in the trip notebook.
- Determine the total weight of Blue Box (BLUE BOX WEIGHT) material collected (for each 100+ kg sample).
- Determine the number of dwellings Blue Boxes (BLUE BOXES) recyclable material was collected from. These data are recorded in the trip notebook.
- Determine, by consultation with municipal officials, the typical put-out rate of Blue Boxes (PUT-OUT RATE). For example, Blue Boxes may be put out every two weeks by the residents, as opposed to weekly. Therefore the PUT-OUT RATE is once every 14 days
- Determine the average number of persons per dwelling (PPD) from the Census information
- The daily weight of waste generated by each <u>dwelling</u> is calculated:

(WEIGHT (kg) ÷ DWELLINGS ÷ 7 (days)) +
(BLUE BOX WEIGHT (kg) ÷ BLUE BOXES ÷ PUT-OUT RATE (days)) =
DAILY WEIGHT/DWELLING (kg/dwelling/day)

- The <u>per capita generation rate</u> is calculated:

  DAILY WEIGHT/DWELLING ÷ PPD = WASTE/PERSON/DAY (kg/capita/day)

8.2.1.1 Anytown: Calculation of Per Capita Generation Rate of Waste

In Anytown, enumeration area 107 was studied as part of the waste composition study. The data and calculations for the average per capita generation rate in enumeration area 107 are shown in Table 8.

In Anytown it was determined that Blue Boxes were set out by the residents every two weeks, for a put-out rate of 14 days (PUT-OUT RATE = 14 days). Ten samples of regular household waste and Blue Box Materials were collected in enumeration area 107.

For sample number 31, the calculation of the per capita generation rate is as follows (see Table 8). Note that regular waste was collected from 8 dwellings, while Blue Box material was collected from only 5 dwellings.

- The daily weight of waste generated by each <u>dwelling</u> is calculated:

  (WEIGHT (kg) ÷ DWELLINGS ÷ 7 (days)) +
  (BLUE BOX WEIGHT (kg) ÷ BLUE BOXES ÷ PUT-OUT RATE (days)) =
  DAILY WEIGHT/DWELLING (kg/dwelling/day)

  (115.80 kg ÷ 8 DWELLINGS ÷ 7 days) +
  (31.11 kg ÷ 5 DWELLINGS ÷ 14 days) = 2.51 kg/dwelling/day

- The <u>per capita generation rate</u> is calculated:

  DAILY WEIGHT/DWELLING ÷ PPD = WASTE/PERSON/DAY (kg/capita/day)
  2.51 kg/dwelling/day ÷ 2.93 persons/dwelling = 0.857 kg/capita/day

8.2.2 Municipalities With No Blue Box Recycling

In the absence of Blue Box recycling the calculation of the per capita generation rate is much more simple. The estimation involved in determining how many days or weeks blue box materials are accumulated over before being set out for collection is not required.

Calculation of the per capita generation rate proceeds as follows.

- Determine the total sample weight (WASTE WEIGHT) of waste collected (for each 100+ kg sample). These data are recorded in the trip note book.
- Determine the number of dwellings (DWELLINGS) waste was collected from to achieve each 100 kg sample. These data are recorded in the trip notebook.
- Determine the average number of persons per dwelling (PPD) from the Census information
- The daily weight of waste generated by each dwelling is calculated:

  (WEIGHT (kg) ÷ DWELLINGS ÷ 7 (days)) =
  DAILY WEIGHT/DWELLING (kg/dwelling/day)

- The per capita generation rate is calculated:

  DAILY WEIGHT/DWELLING ÷ PPD = WASTE/PERSON/DAY (kg/capita/day)

8.2.3 Estimation of a Weighted Generation Rate for the Municipality

The average per capita generation rate for the enumeration area is calculated by taking the mean of the per capita generation rates of each of the 100+ kg samples taken. The average per capita generation rate for each enumeration area studied is then used to estimate the overall weighted generation rate for the municipality.

In the municipality there may be one or more enumeration areas assigned to each income/housing classification type. The number of enumeration areas in each cell of the income/housing matrix, expressed as a percentage of the total number of enumeration areas in the municipality, acts as the weighting factor for the calculation of the weighted per capita generation rate.

The calculation is as follows:

- Determine the average per capita generation rate (AVERAGE WASTE/PERSON/DAY) (kg/capita/day) for the each income/housing type classification from the enumeration areas studied.

- Determine the number of enumeration areas in each income/housing classification matrix cell, expressed as a percentage (PERCENT) of the total number of enumeration areas in the municipality.

- AVERAGE WASTE/PERSON/DAY x PERCENT = WEIGHTED PER CAPITA GENERATION RATE

8.2.3.1 Anytown: Calculation of the Weighted Per Capita Generation Rate

Table 9 shows the calculation of the weighted per capita generation rate for the entire town of Anytown. Each of the cells of the income/housing classification matrix has been assigned a "weight" based on the number of enumeration area falling into that cell.

The calculation of the weighted per capita generation rate is as follows.

WEIGHTED PER CAPITA GENERATION RATE (kg/cap/day)

Weighted Sum of Cells A1-C3 in income/housing matrix	=	waste generation rate in a matrix cell	x	EAs in the cell as percentage of total number of EAs in the municipality (for Study purposes)

8.3 Waste Component Generation Rate

The percent composition of waste is only meaningful given an estimate of the per capita generation rate of waste for the municipality. To determine how many kilograms or tonnes of a certain material are generated (GENERATED) in an enumeration area, or the municipality, over a set time period the percent composition

TABLE 9: RESIDENTIAL WASTE GENERATION DATA INCORPORATED INTO THE INCOME/HOUSING MATRIX TO ESTIMATE THE WEIGHTED PER CAPITA GENERATION RATE (KG/CAPITA/DAY) FOR THE FICTIONAL TOWN OF ANYTOWN.

	(1) Primarily Single Detached	(2) Mixed Dwellings	(3) Primarily Multiple Dwellings
(A) High Income	0.908 (13.3%)	0 (0%)	0.867 (6.7%)
(B) Medium Income	0.879 (26.7%)	0.811 (20.0%)	0.622 (13.3%)
(C) Low Income	0 (0%)	0.798 (13.3%)	0.783 (6.7%)

Weighted per capita generation rate (kg/capita/day) = 0.817

(PERCENT) of that material is multiplied by the per capita generation rate (GENERATION RATE) estimated for the enumeration area, or for the municipality.

- PERCENT (%) x GENERATION RATE (kg/capita/day) = GENERATED (kg/capita/day)

SECTION 9

ANALYSIS OF WASTE FROM SCHOOLS & OTHER INSTITUTIONS

9.0 ANALYSIS OF WASTE FROM SCHOOLS & OTHER INSTITUTIONS

9.1 Per Capita Waste Generation

Determination of the per capita generation rate is conducted in the same way as it is for large multi-unit apartment buildings. The total weight of waste generation for the week is determined by weighing all the waste set out for collection. This weighing procedure may often be facilitated by contracting the normal waste hauler to make a dedicated pick of the waste (picking up no other waste in an empty truck), and returning the weigh scale information from the landfill or transfer station.

The total number of school students or residents in the institution is determined by contacting the institution. The "per capita" generation rate is then calculated based on the total weight of refuse and the total number of persons. In the case of schools, care should be made to determine the number of days people are at the institution, such as only 5 days per week for public and secondary schools.

9.2 Percent Waste Composition

Waste composition from schools and institutions can be determined by taking 100 kg samples and sorting the waste according to the composition categories used for residential waste. As with residential waste, ten samples (nine as a minimum) are required to obtain statistically valid results.

SECTION 10

RECOMMENDATIONS FOR FURTHER REFINEMENT

10.0 RECOMMENDATIONS FOR FURTHER REFINEMENT

Municipalities conducting a waste composition study might consider the following recommendations when designing the sampling protocol and implementing the study methodology.

1) For sampling and sorting convenience, municipalities may choose to conduct the waste composition studies in late spring or mid-fall when refuse odours are less intense and maggots are less frequently encountered. According to Vesling & Rimer (ref. 47), the average residential waste composition does not vary by more than +/- 10% over three quarters of the year. Therefore, aesthetics of the working conditions can be taken into account without risk to obtaining skewed data. The inclusion of yard waste in overall residential waste composition percent profiles should be avoided so that baseline composition percentages are not misrepresented.

2) Municipalities may choose to set up independent collection systems to study the seasonal generation of yard waste and leaves. This would require a coordinated effort between garbage collection personnel, private horticultural firms and other agencies generating and collecting these waste streams.

3) In order to avoid the sampling problems that we encountered with the large apartment buildings in East York, where apparent sampling biases were difficult to avoid, arrangements could be made, for example, with 30 units within the building to participate in a refuse study. This would give a more accurate appraisal of the waste composition in these large apartment buildings. As a check, the method described herein for obtaining the per capita generation rate for the entire building could then be compared with the per capita generation rate for the 30 units.

4) Municipalities in Ontario should follow the waste composition procedure in conducting their own waste composition analysis, for reasons of consistent data generation using a cost effective approach. Periodically, municipalities should conduct additional waste composition studies to monitor trends in residential waste management and the effectiveness of waste management programs.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

There were many people who contributed to this research project for this manual and they are acknowledged, hopefully without omission.

Town of Fergus:

The Study crew of Bruno D'Addairo, Cila Dadd, Jasmine Essue, Don Tooley and Andrea O'Malley were committed to the task of breaking new ground as they Study unfolded, working the bugs out of the Study methods and labouring under environmental conditions and logistical distances that were trying. They performed admirably.

Mr. George Woods, Clerk-Treasurer, Town of Fergus, and Mr. Don Taylor (Wellington Recycling Group) gave their support to our study in the Town of Fergus. Mr. Adolph Plein (Plein Disposal) and Mr. Peter Armer (McLellan Disposal) were patient and went out of their way to accommodate the Study team's presence in the Town of Fergus. Their cooperation was greatly appreciated.

The staff in the Engineering Department, City of Guelph, particularly, Messrs. Dan Hoornweg and John Bull, smoothly arranged for the landfill site to be our base of operations. The staff at the landfill site were ready with assistance and witty rejoinders, making the task a bit lighter.

Mr. Robert Ferguson, Commissioner of Works, Metro Toronto, gave permission to use the laboratory in the former Ontario Centre for Resource Recovery (OCRR) for the moisture analyses. Mr. Brad Guglietti, Waste Management Branch, MOE, arranged for the loan of a Sartorious balance for this work.

Borough of East York:

The transition of the year from fall to winter saw three new faces; the Study team was: Jasmine Essue (from Fergus), Rob Flindall, Gord McLaren and Cria Pettingill.

They were steadfast and dedicated to fine tuning the procedures that were initiated by the Fergus crew.

The friendly cooperation of the East York Works Department, in particular: Messrs. Paul Cockburn, Jeff Walker, Elliot Hill, Al Karns and Ms. Kathy Killinger, facilitated the curbside collection of residential and school wastes.

Mr. Robert Ferguson, Commissioner of Works, Metro Toronto, gave us permission to sort the East York refuse on the tipping floor of the Commissioners Street incinerator and to continue using the OCRR for the moisture analyses.

A & M Disposal and Industrial Disposal provided important refuse collection services in this phase of the Study.

City of North Bay:

Rob Flindall, Gord McLaren and Dean Wilde (City employee) braved the elements to continue the refuse collecting and sorting in this last phase of the residential Study.

Friendly cooperation was demonstrated by the city of North Bay Engineering Department, in particular, Mr. John Simmonds. The City provided vehicles, the sorting tent and the propane heaters.

In addition to those noted above for the three municipalities, we gratefully acknowledge support and cooperation provided by Messrs. Neal Ahlberg, Brendan Killackey and Dan Ionescu, Waste Management Branch, Ministry of the Environment.

The Gore & Storrie team consisted of: Dick Buggeln, Jeff Flewelling, Leslie MacMillan, Rob Flindall, Peter Kurtz, Barbara St. Hill, David Fox and Brock Harrington.

The team from Decima Research was Messrs. Ian McKinnon, Russ Wilton, and Raj Matuk.

REFERENCES

REFERENCES

1. Brickner, R.H. 1989. "Refuse quantification in the first person". Waste Age April. pgs. 157-162.

2. Freund, John E. 1984. Modern Elementary Statistics. 6th Edition. Prentice-Hall, Englewood Cliffs, N.J. xii + 561 pp.

3. Klee, A. J. & D. Carruth. 1970. "Sample Weights in Solid Waste Composition Studies". Jour. Sanitary Engineer. Division; Proc. Amer. Soc. Civil Eng. pgs. 945-54.

4. Rathje, W. L. 1979. "Modern Material Culture Studies". In: (M. Schiffer, ed.). Advances in Archaeological Method & Theory. 2: 1-37. Academic Press, New York.

5. Rathje, W.L. & B. Thompson 1981. The Milwaukee Garbage Project. The Solid Waste Council of the Paper Industry.

6. Rathje, W. L., D. C. Wilson & W. W. Hughes. 1988. The Phoenix Recycling Project. A Characterization of Recyclable Materials in Residential Solid Wastes: Initial Results (Executive Summary) 16 pp + appendix.

7. Rathje, W.L., D.C. Wilson, W.W. Hughes and T. Jones, 1989. The Phoenix recyclables report. Characterization of recyclable materials in residential solid wastes. The City of Phoenix, Arizona, Department of Public Works. v + 178 pp.

8. Rathje, W.L. 1989. "Rubbish!" The Atlantic Monthly, December pp 1-10.

9. Vesilind, P.A. & A.E. Rimer. 1981. Unit Operations in Resource Recovery Engineering. Prentice-Hall, Inc., Englewood Cliffs, NJ. x + 452 pp.

GLOSSARY

GLOSSARY OF TERMS

ABS	acryl butyl styrene; a dense plastic found in computer housings, telephone casings, pipe.
accuracy	in a statistical sense, the term gives an indication of the closeness of the results, estimates, etc. to the "true" value.
BTU	British Thermal Unit; the amount of heat required to raise the temperature of 1 pound of water 1 Fahrenheit degree
capture rate	The percentage of blue material diverted from landfill compared to the total quantity available for recycling;
commercial wastes	discarded materials generated by commercial businesses as a result of normal activities in the workplace;
ferrous	a metal object containing elemental iron, giving a `positive' or attractive response to a magnet;
mean	the mean or arithmetic mean of a set of values is the sum of the values divided by their number; average;
MSW	municipal solid waste, usually defined as the sum of residential and commercial solid wastes, and excluding industrial wastes;
non-ferrous	a metal object which does not give a `positive' or attractive response to a magnet, e.g., brass, lead, aluminum, etc.
OCC	old corrugated containers; variously called, old corrugated cardboard;

PET	polyethylene terephthalate; the plastic used to manufacture the common 2 litre pop bottles;
polyolefin	in the sense used here, a grouping of chemically related plastics whose chemical building blocks are either ethylene or propylene;
precision	in a statistical sense, the term gives an indication of the repeatability of a series of observations, estimates, etc. The Standard Error is one kind of estimate of the precision or repeatability or "tightness" of the grouping of the observations (=data);
putrescible	a material which is biodegradable; usually a term reserved for animal or vegetable matter;
PVC	polyvinyl chloride; a plastic containing chlorine; well known as siding, plastic window sashes and frames, pipe and a few rigid containers;
Random Number Table	These tables (which are found in many statistical textbooks) consist of blocks of numbers that meet certain properties of "randomness", including that numbers in the range 0 to 9 are equally likely to occur; and that the numbers are not serially ordered in any way. Starting at any point on the Table, the user moves systematically through the Table taking the required number of digits;
residential waste	discarded materials generated by individuals in the course of their daily activities at their place of residence; in this case, exclusive of yard wastes and leaves;
Standard Deviation	a measure of the variation or difference of sample measurements from the mean of all measurements taken;

Standard Error	a measure of how much sample means can be expected to fluctuate (±) from the true mean due to chance;
tare weight	the weight of an empty container;

PART B

COMMERCIAL WASTE COMPOSITION STUDY

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Ministry of the Environment contracted Gore & Storrie Limited, in association with Decima Research Limited, to develop and test methodologies that would assist waste management planners and municipalities in deriving reasonable estimates of material composition and generation rate of wastes from residential and commercial sources. The two-fold purpose of the Commercial Waste Composition Study was to:

1. develop a simple, cost effective and reliable method for determining the composition and per employee generation rate of waste from commercial sources in Ontario (the study concentrated on that portion of the commercial waste stream that can be closely related to residential waste; that is, both waste streams stem from the same processes of consumption); and

2. apply the method and obtain current information on the characteristics of commercial waste streams.

A review of relevant literature and consultation with experts in the fields of employment, commercial structure, demographics and waste management indicated that commercial waste generation is related to the number of employees at a particular commercial establishment.

Commercial activity in Canada is organized by the Standard Industrial Classification (SIC) established by Statistics Canada. This classification was used as the basis for reporting waste composition and per employee generation rate data. Before the field study began, the commercial business SIC codes were reviewed with respect to retail/service activities to determine whether certain sectors could be grouped together.

The Census of Canada (1986) gathered information about occupation, type of employment and place of work from a twenty percent (20%) sample of households. These data provide information about the number of employees in 36 different commercial sectors within each of the urban census areas in Ontario. The

development of methodology for the commercial waste sector was tested in the Regional Municipality of Waterloo (Region/Waterloo), as presented in Volume II and made use of this kind of information. The field study was undertaken in the Region between May 15 and August 31, 1990.

A representative sample of businesses from the SIC groupings were identified and approached by the study team to gain permission to include them in the study. Data were then gathered on the composition of the waste stream from each SIC grouping, and an estimate of the average generation rate of total waste per employee was made for each of the SIC groupings.

The relationship between waste generation and employment was completed by regression analysis when the characteristics of the data set, (eg. sample size) permitted. In other cases an average of the waste generation data is reported where regression analysis was deemed inappropriate.

Estimated average per employee waste generation rates for each commercial activity were multiplied by the total Regional employment in the activity to obtain estimates of the waste generation for the activity throughout the entire Region.

Part B of Volume III, presented herein, describes the methodology utilized in the aforementioned study for measuring waste generation and waste composition for commercial activities.

Canada Census refers to commercial businesses as industries but does not distinguish between "light" and "heavy" industries. Compared to commercial establishments, light manufacturing industries and wholesale divisions are fewer in number and far more diverse in size and specialization. Some municipalities have many factories, others have virtually none. Waste generated by such activities must be studied on site-by-site basis. Nevertheless, the methodology described herein offers a "starting point" for persons studying the waste generated by light industries and wholesale activities.

The methods developed and used in this study were found to be cost effective and capable of being used by municipal staff. Recommendations are presented in this volume to further refine the methods used.

Ontario municipalities are encouraged to use the methods demonstrated in this manual to satisfy municipal needs, to generate further data on a consistent province-wide basis and to assist in assessing the effectiveness of new waste management programs and identifying trends in waste composition and generation rates.

The study of waste composition from commercial activities is more complex than that from residential sources (refer to Volume I of the Ontario Waste Composition Study and Part A of the procedures manual). First, very little information was available regarding commercial waste composition (none for Canada in recent years) and therefore the research team had little a priori knowledge of expected values or variance to guide the design of an efficient sampling framework. Second, commercial activities are characterized by very high variance relative to the residential sector. Third, it is difficult to identify the population base for a sample of commercial activities. Therefore, the qualitative and quantitative data presented herein should be cautiously regarded as best estimates only.

Recommendations for Further Refinement

The methods employed in the commercial portion of the Ontario Waste Composition Study have been demonstrated on a selection of commercial businesses in the Regional Municipality of Waterloo. Within the commercial sectors in the Region there is a relatively high awareness of waste diversion options that will reduce waste disposal costs and encourage recycling. Therefore, the qualitative and quantitative data presented herein is cautiously regarded as a best estimate for the Region of Waterloo and may be different in other municipalities under constantly changing circumstances.

This report has developed a procedure for estimating the amount of waste generated by commercial activities within Ontario urban areas and began with the process of integrating the complex data inputs required.

The study has employed a two-stage estimation process: (1) the development of ratios of waste generation per employee; and (2) the estimation of commercial employment composition for the municipality as a whole. Each step poses different problems. The following recommendations are submitted:

1. The waste generation and composition data base will require many more samples in order to cover the full range of commercial activities. No one study will have the resources to undertake a complete evaluation; the research results must be accumulated over many studies and evaluated over time. Fortunately, there is no inherent reason that a business in any part of the province cannot be used to estimate waste generated elsewhere--unless local waste management policies differ significantly.

   This means that each study should use the same SIC identification to code commercial activity and the same methodology for measuring waste output and composition. A central agency (e.g., the Ministry of Environment) may have to take the responsibility for organizing and evaluating the data.

2. It will also be necessary to monitor any changes over time in waste generation that may reflect innovations in policy, technology or corporate behaviour. The date of each sample must be retained and/or it may be necessary to identify sample locations that can be restudied over time in order to minimize sampling error.

3. To better understand the effect of recycling behaviour on the data gathered, it is recommended that employees/management of participating firms be asked to describe the nature and extent of any source separation recycling activities.

4. The immediate priorities for sampling can be identified from the results of this study. Those commercial activities that employ large numbers of people must be further investigated in order to improve sample size and reveal any significant variation within the SIC groups; this includes the diverse set of office and financial activities. Conversely, those activities with a high rate of waste generation per employee, such as food stores and restaurants, must be sampled repeatedly because of their importance to the overall waste generation. Those sectors where the observed sample variance (standard

deviation) is high require larger samples to improve overall accuracy, possibly by isolating subgroups within the SIC. Activities that generate policy-relevant waste materials should be given special attention.

5. The future development of employment estimates requires two divergent approaches. First, substantial savings may result from a centralized, standardized analysis of employment that applies the same set of data, techniques and projections to all urban areas--much as the Ontario Statistical Centre has developed a common set of population forecasts.

   At the same time, municipalities have better information about local peculiarities and exceptions to the employment structure. These special cases, e.g., community colleges, tourist attractions, shopping concentrations, as well as manufacturing activities, may require special attention by a local agency.

6. During the course of the Waterloo Study, insights were noted regarding the effectiveness of waste management practices of some firms. For example, for automotive repair businesses, it appears that employee's tend to use the general refuse bin for discarding metal waste materials, despite the fact that a scrap metal bin has been made available.

   Such insights, when communicated to the management of the firm provide an immediate opportunity to help that firm improve the efficiency of their recycling efforts.

   There is also an indication that differences exist in per employee waste generation rates in small grocery stores and in larger supermarkets.

   The demonstrated method for estimating the rate of employee waste generation has the potential to be used as a waste management tool by municipalities. The distribution of the daily waste generation rates versus employment data, exhibited in the graphs for each SIC sector, could enable municipal waste management personnel to prioritize their "remedial" waste reduction efforts by planning to visit those companies whose waste generation rates seem out of line with the general waste-to-employee relationship.

SECTION 1

INTRODUCTION & LITERATURE REVIEW

1.0 INTRODUCTION & LITERATURE REVIEW

1.1 Introduction

In recognition of a pressing need to improve the way in which waste is managed in Ontario, the Ontario Ministry of the Environment has initiated programs and established specific goals designed to ensure the development of innovative and integrated waste management systems. For example, the Ministry has issued Terms of Reference and assisted in the funding of Waste Management Master Planning for municipalities. Specific objectives for diverting significant amounts of waste from disposal through reduction, reuse and recycling activities (25% by 1992 and 50% by 2000) have also been announced by the Government of Ontario.

In order to effectively plan and design waste management systems that will achieve those goals, reasonably accurate estimates of the types and quantities of waste must be available. For example, the design of material recovery facilities that will receive and process waste must be compatible with the range of wastes anticipated to be received by the facility.

The Ministry of the Environment contracted Gore & Storrie Limited, in association with Decima Research Limited, to develop and test methodologies that would assist waste management planners and municipalities in deriving reasonable estimates of the material composition and generation rate of wastes from residential and commercial sources. The findings of that study are presented in three volumes:

Volume I - Residential
Volume II - Commercial
Volume III - Procedures Manual

For the commercial portion of the Ontario Waste Composition Study (Waterloo Study), the Regional Municipality of Waterloo (Region/Waterloo) was used as a sample municipality for the development and field trial of a methodology for estimating the type and quantity of waste generated by a variety of different types of commercial enterprises; i.e., those firms in the private sector that provide goods and services for consumers. Although these activities may be concentrated at a small number of locations within the urban area, such as "downtown", or a regional mall, the aggregate amount of commercial activity is very closely related to both the number of households and household income in the urban area. Commercial waste, in this sense, can be closely related to residential waste. Both waste streams stem from the same processes of consumption.

The Waterloo Study focused on the commercial activities that are most closely linked to residential requirements. The waste generation from office buildings is an important component; but it is difficult to distinguish offices that serve local residents (e.g., a legal firm) from those that serve the province as a whole (e.g., an insurance company). Wholesale activities, while part of the commercial waste system, also serve larger spacial units. They are too varied in their size and function to fit into the present sampling framework. They must be studied elsewhere, when a community studies the entire waste stream in their area. A review of relevant literature and consultation with experts in the fields of employment, commercial structure, demographics and waste management indicated that commercial waste generation is related to the number of employees at a particular commercial establishment.

The method was developed during the winter of 1989/1990 and applied in the Waterloo Study in the spring and summer of 1990. The study used the extensive information on the amount and composition of commercial employment provided by Statistics Canada and local government agencies to define a sampling framework for the field work.

Commercial activity in Canada is organized by the Standard Industrial Classification (SIC) established by Statistics Canada. This classification can be used as the basis for reporting waste composition and per employee generation rate data. Before beginning a waste composition field study, the commercial business SIC codes should be reviewed with respect to retail service activities to determine whether certain sectors can be grouped together.

The Census of Canada (1986) gathered information about occupation, type of employment and place of work from a twenty percent (20%) sample of households.

These data provide information about the number of employees in 36 different commercial sectors within each of the urban census areas in Ontario. Canada Census updates its census information every five years.

In the Waterloo Study, a representative sample of businesses from the SIC groupings were identified and approached by the study team to gain permission to include them in the study. Data were then gathered on the composition of the waste stream from each SIC grouping, and an estimate of the average generation rate of total waste per employee was made for each of the SIC groupings.

This manual describes a methodology for measuring waste generation and waste composition for commercial activities, as defined above. For a number of reasons, the commercial composition study method is more complex than that for residential sources described in Part A. First, when developing the method very little published literature was available for commercial activities (none for Canada in recent years) and therefore the research team had little a priori knowledge of expected values or variance to guide the design of an efficient sampling framework. Second, commercial activities are characterized by very high variance, relative to the residential sector. That variance is observed in waste generation both within and among the various retail and service sectors. There is also a wide range in store size (measured in level of sales or employment) within these sectors that must be taken into account. These variations mean that a much larger number of samples are required in order to provide the same degree of reliability obtained in the study on residential waste generation. Third, while detailed descriptions of household characteristics are provided by the Census of Canada, together with a variety of forecasts of growth and change provided by market research firms and government agencies, it is difficult to identify even the base population for a sample of commercial activities. It is not common for a single data source to provide counts or lists of the number of supermarkets or barber shops within a municipality. Sample locations must be identified in the field; extrapolations to obtain municipal or regional totals requires elaborate assumptions and indirect procedures.

Nonetheless, this manual describes a workable method to estimate overall waste generation and major components of the waste stream. While many more sample points than what was analyzed in the Waterloo Study will be required to increase the precision of estimates of waste streams for specific commercial activities, studies at the municipal level will benefit from the effect of aggregation in which hundreds or thousands of activities may be averaged together. This manual also provides a methodology for future studies that overcomes each of the difficulties identified earlier through future refinement of the method. Data on commercial waste generation and composition are now available to guide the design of waste sampling procedures (see Volume II for further information). The identification of high waste generation activities in Volume II permits agencies to target waste reduction and recycling programs on these activities. The difficulties, due to varying store size and unavailable data on the population of stores, have been overcome in the Waterloo Study by focusing on number of employees as the key measure that connects the sample observation to the overall data analysis and ultimately to the aggregate waste generation by the municipality. The number of employees in each SIC code is listed by Statistics Canada in their data base.

It would have been possible to restrict the Waterloo Study to just a few well chosen SIC groups in order to achieve greater confidence in the waste estimates. However, a broader study was chosen in order to assess the variances encountered in various SIC groups. This choice will benefit subsequent researchers who can target their efforts to develop and enhance a data base of waste generation for commercial activities in Ontario.

1.2 Literature Review

The results of the literature review as conducted in Volume II are presented in this manual as follows for convenience to the reader.

In the past, the Bird & Hale report (ref. 2) has been used as the baseline study for waste composition information on the municipal solid waste stream in Ontario. In the Bird & Hale study, the average annual composition of municipal solid waste entering landfill sites, transfer stations and incinerators, in Toronto, was derived from samples obtained during spring, summer, winter and fall. Twelve visits were made to six sites between October, 1976 and September, 1977, with two visits apiece at: Commissioners Street Incinerator, Ingram Incinerator, Dufferin Incinerator, Beare Road

Landfill Site, Bermondsey Transfer Station and Wellington Incinerator. Sample weights of municipal solid waste ranged up to 400 lbs. (180.7 kg).

Municipal solid waste has been traditionally defined as a combination of waste from residential and commercial sources, so the Bird & Hale study--which collected and reported on this combined municipal solid waste data--does not serve as a suitable baseline for the Waterloo Study which focused on the commercial activities that are related to residential consumption.

The earliest studies of the composition of commercial solid waste were reported by Peter Middleton & Associates (ref. 11). They briefly described three studies: Louisville (1970), Proctor & Redfern (1972) and Proctor & Redfern (1975), each based on questionnaires sent out to commercial businesses. The Louisville study reportedly divided the commercial sector into 18 different categories but regrettably this detail was not provided in the main report or appendix. The same is true of the two Proctor & Redfern reports. The questionnaires reportedly contained information on the categories of commercial businesses, but the information was reportedly lost (ref. 11).

Franke (ref. 5) described the general composition of the commercial waste stream in Cologne, Germany (1980/81 data) and Evans (ref. 4) reported the weight and volume of components in the waste streams from "retail", restaurants and office towers in Toronto (1984 data). More recently, Rhyner & Green (ref. 14) compared published literature data on per capita or per employee waste generation rates for residential, commercial, industrial and construction/demolition wastes with actual waste data that they were obtaining at county-owned landfill sites in Brown County, Wisconsin. Annual solid waste generation estimates were calculated for a number of SIC codes in the commercial sector. Rhyner & Green's estimates of the annual generation of commercial refuse, using a daily employee generation rate of 0.73-0.77 kg and county employment data, was within 15% of the "actual quantity". Table 1 summarizes the available information on the composition of commercial waste streams, from sources reported above.

A key paper that became the basis for the data gathering procedures developed in the Waterloo Study was published in 1971 by DeGeare & Ongerth (ref. 3). The

TABLE 1 COMPARISON OF WASTE COMPOSITION INFORMATION FOR THE COMMERCIAL SECTOR - PUBLISHED DATA[1] (PERCENT OF TOTAL)

Material	Proctor & Redfern (1972; 1975)	Evans (1985) Retail	Evans (1985) Restaurant	Evans (1985) Office Towers	Louisville (1970)	Liblit (1990) Retail Trade	Liblit (1990) Restaurant	Liblit (1990) Office	Liblit (1990) School	Liblit (1990) Government	Franke (1987)
Newsprint		6.2	2.7	6.3		2.9	2.5	3.6	3.3	6.7	27
Brown Paper		2.8	2.9	8.6							total
OCC	51 - 65	16.5	4.0	2.9		22.0	16.6	11.5	11.6	8.4	paper
Fine Paper	total paper	15.4	15.4	66.9		1.4		10.6	6.3	7.2	
Other Paper		24.3	22.5	10.6		15.2	18.5	38.5	26.6	31.5	10 organics
Food Waste		9.6	42.9	1.1		8.1	36.0	3.0	14.0	3.2	
Vegetation		0.0	0.0	0.0							9
Plastic	1 - 2	19.1	4.8	1.1	9.4	12.0	13.7	4.3	5.1	3.5	
Textile/Cloth		2.0	0.0	0.1							11
Wood		0.9	0.0	0.1		10.7	0.6	7.8	21.0	20.0	
Other Combustibles		1.1	0.6	0.8							
Ferrous Metals		1.05	1.7	0.4		19.7	4.2	2.4	3.9	9.0	3 metals &
Non-ferrous metals		0.1	0.3	0.1		0.8	0.7	0.5	1.9	0.8	glass
Glass	1 - 4	0.75	1.8	0.7	11.3	2.5	5.9	3.9	3.2	2.7	
Other non-combustibles		0.3	0.6	0.3							12
Inert Materials											12
Production Wastes (Rubber, rags etc)											15
Other ("household -like" wastes)											
Miscellaneous	1.1 - 17[2]					4.7	2.3	13.9	3.1	7.0	

1 Data are given as percentages of the commercial waste stream. Canadian studies: Proctor & Redfern (1972; 1975), Evans (1985); U.S.A. studies: Louisville (1970), Liblit (1990); Germany: Franke (1987).

2 Includes 12% construction wastes

authors explored the relationship between waste generation in clothing, drug, grocery, hardware stores, and restaurants as a function of a number of variables indicative of the physical and operational characteristics of commercial establishments. For example: (1) number of hours open per week; (2) number of business days open per week; (3) average annual gross receipts; (4) physical area of store, in square feet; (5) average inventory in dollars; (6) equipment value, in dollars; (7) number of delivery days per week; and (8) number of employees. Number of employees and store hours were the two variables that gave the best prediction of the waste generation rate for premises in the commercial sectors under study.

DeGeare and Ongerth, using "multiple stepwise regression analyses", demonstrated that the generation of commercial solid waste was found to be most closely related to the number of employees, hours open, and type of establishment involved. Graphs illustrating the correlation between actual and predicted waste quantities from the DeGeare and Ongerth study are reproduced in Appendix A.

DeGeare and Ongerth noted two points which clarify the relationship between waste generation and company employment. First, employment is a function of the intensity of retail activity; i.e., a small store with few customers will require a smaller sales staff than a larger store that serves a large clientele. Second, the items sold by stores are delivered in bulk, in packages, cartons, and other containers, with the individual items placed on shelves or otherwise displayed. Taken together, one can see that as the size of a store's staff increases to serve increasing numbers of customers (and sales), the quantity of goods delivered to the store will grow in response to customer demand and the amount of bulk packaging and related administrative wastes will also increase.

The focus on waste generation per employee that is evident in the literature fits well with another reference that examines consumer behaviour and commercial structure (Jones & Simmons, ref. 8). This reference demonstrates that the amount of commercial activity is highly predictable from information about the size and income level of the market. Given the number of households and average income level in any municipality, it is possible to project first, the patterns of consumer expenditure, from toothpaste to bank deposits, in great detail; and second, to calculate the level and composition of commercial activity. Furthermore, the different measures of commercial activity (i.e., number of stores, floor area, retail sales, number of employees) are all closely interrelated. Employment happens to be the most frequently measured and readily obtained. It provides the key link between the samples from the field work and the larger municipal waste system. When one determines the waste generation per employee for a SIC group, this generation rate can be extrapolated, via Statistics Canada data on total employment in the SIC sector to get the waste generation rate for the entire company. It is then possible to determine whether a reasonable amount of waste is being disposed at a given company as compared to an average waste generation rate for a company of similar size in the same SIC sector.

The authors would like to point out that they discovered a paucity of information pertaining to this subject and have made every attempt to locate and examine all relative material.

SECTION 2

OVERVIEW OF METHODOLOGY

2.0 OVERVIEW OF METHODOLOGY

The general approach used in the Waterloo Study included the following stages which are also summarized in Figure 1. This methodology is recommended for continued use and further refinement with growth of Ontario's waste generation and composition database:

1. Project Initiation and Selection of SIC Code Major Study Groups

   Review of procedures contained in this manual and any other relevant literature.

   Obtain and review census information on commercial businesses from Statistics Canada. Define specific commercial types. Review commercial business SIC codes with respect to retail/service activities to determine whether certain activities could be grouped together. Although the commodities or services provided by businesses may differ, similarities in the waste streams permit the aggregation of sectors thereby reducing the field work required.

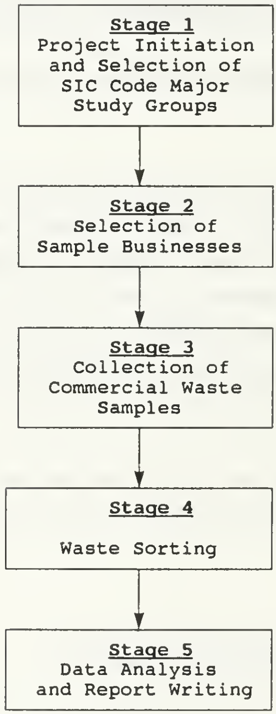
   Prior to finalizing a strategy, the current waste management practices in the municipality undergoing the waste composition study must be understood.

2. Selection of Commercial Businesses

   Determine a reasonable number of samples and the size of those samples that can be taken given the applicable monetary and time constraints for the study.

   Contact the chosen businesses to ensure that the locations meet the basic criteria as described in chapter 6. If necessary, arrange a site visit, to assist in deciding whether a particular location is suitable for sampling.

FIGURE 1
STAGES OF COMMERCIAL WASTE
COMPOSITION STUDY



3. Collection of Commercial Waste Samples

Arrangements and scheduling for collection of commercial waste samples should be made prior to the commencement of the field work. Commercial wastes should be weighed, collected and transported to a sorting area.

Collection of waste samples will vary depending upon whether the waste is loose or compacted. Once the waste sample is extracted from the refuse bin and weighed, the sample should be transported to a sorting area.

4. Waste Sorting

Before actual sorting takes place, it is necessary to set-up the necessary sorting equipment and develop a time efficient and accurate sorting strategy.

Obtain information on the composition of the waste stream from each SIC by sorting and weighing the various material types. An example of a waste composition data field sheet is provided in section 8. Whenever possible, recyclable material should be deposited at the local recycling depot.

5. Data Analysis and Report Writing

Estimate the average generation rate of total waste per employee for each of the commercial groups. In the Waterloo Study, waste was collected from a number of premises in each SIC group, attempting to cover a range of small and large companies. Assess the relationship between waste generation and employment by regression analyses when sample size permits.

Analyze both Statistics Canada employment data and the municipality's planning information to generate an estimate of the total number of people employed in the commercial groupings for which waste generation estimates are obtained.

Multiply the total municipal employment figure by the employee waste generation rate for each SIC group to estimate the quantity of waste generated by each of the commercial activities. The sum of the waste estimates for the groups gives an estimate of waste generation by a large segment of the commercial sector in the municipality.

SECTION 3

WASTE STUDY PARAMETERS AND CONSIDERATIONS

3.0 WASTE STUDY PARAMETERS AND CONSIDERATIONS

Conducting a waste composition and generation study requires careful planning with regard to the type of data required, and how the data will be collected.

3.1 Required Waste Generation Rate and Waste Composition Data

The data collected in a waste composition study fall into two categories:

1. per employee generation rate information; and
2. percent composition of the waste by component materials.

3.1.1 Waste Generation Rate

For the purposes of the Waterloo Study the commercial waste generation rate was defined as kilograms per employee per day (kg/employee/day). These units can easily be multiplied by constants to obtain weekly, monthly, or yearly generation rates in kilograms or tonnes. As well, a total tonnage of waste generated for the municipality can be calculated by multiplying by the total number of employees in the municipality by the per employee generation rate.

3.1.2 Waste Composition

The percent composition of waste by its material components is dependent on the waste stream studied, and on the definition of the categories of material used.

The waste component categories used in the Waterloo Study were based in part on the physical or chemical make-up of the component and in part on the form the waste material takes. As such there are several subcategories for most materials. The subcategories can be based on physical and chemical make-up, such as those for paper (fine paper, newspaper, corrugated cardboard etc.), or the sub-categories can be based on form and usage such as with ferrous metal (food containers, returnable beverage containers, non-food containers). A list of the waste component categories and sub categories used in the Waterloo Study is given in Table 2.

TABLE 2: WASTE COMPOSITION DATA FIELD SHEET

Town:
SIC:
Sample # :
Collection Dates:

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Category				
(1) Paper (a) Newsprint (b) Fine Paper / CPO / Ledger (c) Magazines / Flyers (d) Waxed / Plastic / Mixed (e) Boxboard (f) Kraft (g) Wallpaper (h) OCC (i) Tissues				
(2) Glass (a) Beer (i) refillable (ii) non-refillable (b) Liquor & Wine Containers (c) Food Containers (d) Soft Drink (i) refillable (ii) non-refillable (e) Other Containers (f) Plate (g) Other				
(3) Ferrous (a) Soft Drink Containers (b) Food Containers (c) Beer Cans (i) returnable (ii) non-returnable (d) Aerosol Cans (e) Other				
(4) Non-Ferrous (a) Beer Cans (i) returnable (ii) non-returnable (iii) American (b) Soft Drink Containers (c) Other Packaging (d) Aluminum (e) Other				
(5) Plastics (a) Polyolefins (b) PVC (c) Polystyrene (d) ABS (e) PET (f) Mixed Blend Plastic (g) Coated Plastic (i) Nylon (i) Vinyl				
(6) Organic (a) Food Waste / Rodent Bedding (b) Yard Waste				
(7) Wood				
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos				
(9) Diapers				
(10) Textiles/Leather/Rubber				
(11) Hazardous Wastes (a) Paints / Solvents (b) Waste Oils (c) Pesticides/Herbicides				
(12) Dry Cell Batteries				
(13) Kitty Litter				
(14) Miscellaneous				
	TOTAL kg		TOTAL kg	

Note that in Table 2 there are no categories for bulky items such as used appliances and furniture. These items are usually collected separately from regular waste.

3.2 Basis for Defining Commercial Waste Generation

A key paper that became the basis for the data gathering procedures developed in the Waterloo Study was published by DeGeare & Ongerth (ref. 3). The authors explored the relationship between waste generation in clothing, drug, grocery, hardware stores, and restaurants as a function of a number of variables indicative of the physical and operational characteristics of commercial establishments. Number of employees and store hours were the two variables that had the best prediction of the waste generation rate for premises in the commercial sectors under study.

Number of employees is the variable that is most readily available and hence was utilized in the Waterloo Study. First, Standard Industrial Classification (SIC) Codes, available from Canada Census, were used to describe business types. Canada Census data and local planning information were then used to determine the number of employees per SIC division and per business establishment. Finally, this information was used to select locations for the collection of waste samples.

SECTION 4

MANPOWER, EQUIPMENT AND COST

4.0 MANPOWER, EQUIPMENT AND COST

The following is a description of the manpower requirements, necessary equipment and costs associated with conducting a waste composition study. In the manpower section a dollar value of the wage for the workers is not specified as this must be determined by the municipality conducting the study. Instead, only an estimation of the number of work days and hours required to complete the study is given. Lists of required and optional equipment is provided, but no dollar amount for the purchase or rental of this equipment is given. These details should be carefully considered by any municipality undertaking a waste composition study.

4.1 Personnel

For the Waterloo study the field crew consisted of three people. When collecting waste, one person empties the bin, another weighs the refuse, and the third person fills out the data sheets (sample weight, waste stream description, any unique miscellaneous notes, etc.).

A basic background in science or engineering was deemed desirable because of the quantitative aspect of the work. A waste composition study is an exercise in quantitative analysis of commercial wastes conducted under field conditions, using skills learned in technical courses that are part of science and engineering education.

A "laboratory" work ethic should be emphasized in terms of accurate data acquisition/manipulation and maintaining as clean as possible work environment (ie. regularly rinsing garbage cans, cleaning waste bin area, sweeping back of truck, etc.). Further, individuals should have an avid concern for the environment and as such when recyclable materials are found in waste bins they should attempt to bring those materials to the recycling area whenever possible.

In addition to the field crew, a project manager is required. That person must have a technical background and a high level of respect and responsibility within the municipality's works and engineering department. The project leader (in absence of an outside consultant) will be responsible for performing the calculations necessary to define the sample ranges, determine the sample locations, contact and liaison with waste haulers, ensure good records are kept, and general project management. The project manager will also be responsible for generating a report presenting the results of the study.

It is imperative that the crew receive instructions in health and safety prior to commencing the field studies. All members must be alert for potential dangers, eg. traffic, explosive/acidic cans, etc. A similar health and safety program to those utilized to train waste collectors and landfill technicians could be adapted to suit the needs of the waste composition study.

The crew must also receive instructions on recognizing waste categories. Because the focus of the Waterloo Study was on method development, the crew was instructed to be critical of their procedures. The crew should be encouraged to set aside all materials that were difficult to categorize, describe them in writing and include them in a 'miscellaneous' category.

4.2 Equipment Used in the Waste Study

An equipment list similar to that used in the Waterloo Study is suggested for future waste composition studies, but should not be regarded as an exhaustive list. The following list of equipment includes a rented vehicle and purchased equipment utilized in the Waterloo Study:

one - 4.3 m. (14 ft.) cube van (for collection of bagged refuse);

one - electronic platform scale (150 kg capacity, Accu Weigh Model PAK-150 (electronic, battery operated scale with digital read-out), Exact Weight Scale Inc., Toronto, Ontario);

one -electronic bench scale (500 g capacity, Accurate, model 3670)

one - chicken wire "crib": 1.2 m. (4 ft.) x 1.2 m. (4 ft.) x 1.3 cm. (1/2 in.) plywood base; 0.6 m. (2 ft.) high chicken wire and 2.5 cm. (1 in.) x 5.1 cm.(2 in.) furring sides. Nailed to the underside of the crib floor was a square frame which permitted the crib to be centred on the bed of the platform scale; the crib was used for weighing the refuse as it was being collected from the firms;

40 - 30 litre polyethylene garbage cans; these were used as containers into which sorted refuse was placed;

one - broad-mouth aluminum shovel; used for cleaning up spills;

one - broom; used for cleaning up spills and sweeping out the vehicle;

one - staple gun and 0.95 cm. (3/8 in.) staples for construction and repair of chicken wire dividers and crib;

one - claw hammer; 5.1 cm. (2 in.) common nails: used in the construction of the crib.

Personal Safety Equipment:

a) Certified steel toe safety boots
b) Coveralls
c) Orange safety vests
d) Hard hats (at the landfill)
f) Rubber safety gloves
g) Particle filter masks (dust in garbage bins)
h) Complete first aid kit (in truck)
i) Tetanus/polio vaccination
(optional: diphtheria, Hepatitis A and B).

Health (including personal hygiene) and safety must be stressed at all times during the study. It is important to remember that within each bag/bin of garbage there may be disease carrying organisms, sharp objects including hypodermic needles, containers that may explode, combustibles, corrosive and caustic agents, harmful chemicals, and dust. Caution and common sense should be exercised.

4.2.1 Seasonal Effects on Equipment Requirements - Shelter and Clothing

The season of the year in which the study is conducted has a great bearing on the clothing and shelter requirements of the field crew, and general carrying out of the study.

For several reasons it may be advisable to conduct the study during the fall or winter months. The waste will have less odour and fewer maggots and flies at this time of year. In addition the cool or freezing temperatures will keep the organic fraction of the waste from rotting which will make the work more manageable from an objective and aesthetic standpoint. The cooler weather will also reduce the amount of moisture lost by the waste, due to evaporation, from the time the sample is collected to the time it is actually sorted (several days in some cases).

If the study is conducted in the autumn or winter months some form of shelter is required by the field crew while sorting the waste. Shelter is required to protect the field crew (and the waste samples!) from wind, rain, snow and cold. In the summer protection from the wind, rain, and direct sun will be required.

In addition to a sheltered work space, the sorting crew must be provided with a warm and dry break-room as well as washroom facilities.

4.3 Cost of Conducting a Typical Commercial Waste Study

The unique nature of each municipality's commercial structure precludes the development of a generic guideline budget of time requirements and costs for a commercial waste study. Formula for estimating costs are not provided in this manual, however some indication of time requirements will be made.

The municipality undertaking commercial waste study must determine the number of establishments required to adequately characterize the waste from that municipality's business community. The required number of samples for statistical reliability was not determined during the Ontario Waste Composition Study. The limiting factor for the number of establishments sampled in a municipality will be the time and monetary constraints of the study.

The following is an estimate of the cost associated with conducting a commercial waste composition study with a minimal number of samples.

4.3.1 Estimated Personnel Time and Disbursement/Equipment Requirements

STAGE 1: PROJECT INITIATION AND SELECTION OF SIC CODE MAJOR STUDY GROUPS

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Project Initiation	Project Manager[1]	4.0
Task: Obtaining/Reviewing Census and Local Commercial Employment Data	Project Manager Project Assistant[2]	2.0 2.0
Task: Review and Selection of SIC Code Major Study Groups	Project Manager	2.0
SUB-TOTAL	Project Manager Project Assistant	8.0 2.0
DISBURSEMENTS:	Statistics Canada Service Fee, Travel, Telephone, Office Supplies, and Computer time.	

continued.../

[1]The Project Manager will typically be a person from the Municipal engineering Department or some other member of the Municipal Staff familiar with Waste Management procedures.

[2]The Project Assistant would ideally be a member of the field crew and also a member of the municipal staff familiar with waste management procedures.

4.3.1 Estimated Personnel Time and Disbursement/Equipment Requirements

STAGE 2: SELECTION OF BUSINESSES

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Selection of Businesses within the Chosen SIC Groups	Project Manager Project Assistant	2.0 2.0
Task: Contact Businesses to Obtain Permission and Arrange Sample Collection	Project Manager Project Assistant	6.0 6.0
SUB-TOTAL:	Project Manager Project Assistant	8.0 8.0
DISBURSEMENTS:	Travel, Telephone, and Office Supplies	

Note: Stage 1 and Stage 2 can be carried out by the Project Manager, or in association with an outside consulting agency familiar with Census of Canada data and sampling procedures.

continued.../

4.3.1 Estimated Personnel Time and Disbursement Requirements

STAGE 3: COLLECTION OF COMMERCIAL WASTE SAMPLES

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Field Crew Training	Project Manager	2.0
	Field Crew[3] (of 4)	4.0
Task: Obtaining/Constructing All Required Equipment and Supplies	Project Manager	3.0
	Project Assistant	3.0
(A) Once per week commercial waste collection.	Project Manager	0.5
Task: Collection of Waste Sample	Field Crew (of 4)	2.0[4]
(B) More than once per week municipal waste collection	Project Manager	1.0
Task: Collection of Waste Sample	Field Crew (of 4)	4.0

SUB-TOTAL: (A) Once per week waste collection

Project Manager	5.5
Project Assistant	3.0
Field Crew	6.0

(B) Twice per week waste collection

Project Manager	6.0
Project Assistant	3.0
Field Crew	8.0

DISBURSEMENTS: Telephone, Travel Cost and Office Supplies.

EQUIPMENT: Equipment purchases and rentals including rental of vehicles, portable weigh scales and safety equipment.

continued.../

[3]The four (4) person field crew would ideally be composed of persons dedicated to the study and familiar with waste management procedures, and aware of the need for accurate waste management information. The field crew members should have some education in standard laboratory skills such as proper use of scales, accurate record keeping and the necessity of replication of study results. The 4 person field crew may include the project assistant, who could act as a supervisor in the absence of the project Manager.

[4]Two to three samples per half-day depending on size of business entity.

4.3.1 Estimated Personnel Time and Disbursement/Equipment Requirements

STAGE 4: WASTE SORTING AND ANALYSIS

PROJECT REQUIREMENTS		PERSONNEL	WORK DAYS
Task: Field Crew Training - Sorting and Classifying Waste and Data Recording		Project Manager	1.0
		Field Crew (of 4)	2.0
Task: Waste Sorting		Project Manager	0.25
		Field Crew (of 4)	2.0[5]
	SUB-TOTAL:	Project Manager	1.25
		Field Crew (of 4)	4.0
	DISBURSEMENTS:	Tipping/disposal fee for sorted waste after analysis, telephone, travel cost and office supplies.	
	EQUIPMENT:	Equipment purchases and rentals including obtaining shelter for the field crew, provision of safety equipment, and tetanus/polio/diphtheria immunization of field crew.	

continued.../

[5]Two to three samples per half-day depending upon the size of the business entity.

4.3.1 Estimated Personnel Time and Disbursement/Equipment Requirements

STAGE 5: DATA ANALYSIS AND REPORT WRITING

PROJECT REQUIREMENTS	PERSONNEL	WORK DAYS
Task: Data Entry to Spreadsheets	Project Assistant	1.0+[6]
Task: Data Analysis, Calculations, Report Writing and Typing	Project Manager	10.0
	Project Assistant	3.0
SUB-TOTAL:	Project Manager	10.0
	Project Assistant	4.0+

DISBURSEMENTS: Office supplies, and computer time

WORK DAYS TOTAL

Administrative:	Project Manager	32.75
	Project Assistant	17.0
	Project Crew	10.0

Note: For twice per week collection add 1.5 hours to project manager total and 2.0 hours to field crew total.

[6] Up to 10 samples per day.

SECTION 5

STAGE 1 - PROJECT INITIATION AND SELECTION OF SIC MAJOR STUDY GROUPS

5.0 STAGE 1 - PROJECT INITIATION AND SELECTION OF SIC MAJOR STUDY GROUPS

5.1 Obtaining Census Canada Information

Obtaining Canada Census data is the starting point for defining business activities. The Census of Canada gathers information about occupation, type of firm and place of work from a twenty percent sample of households. A special tabulation of these data provides information about the number of employees in 36 different commercial sectors for each CMA in Ontario. The basic tabulation is by place of residence, which is not a problem for a regional municipality as a whole, but other "journey-to-work" tabulations indicate how this employment is allocated by municipality within the Region. These data can be updated by reference to the monthly survey of "The Labour Force" which estimates employment for each CMA.

Census data is collected every five years and is available from Statistics Canada for a nominal service fee. In Ontario the Statistics Canada library has the following address:

Statistics Canada, Toronto
25 St. Clair Avenue East
Toronto, Ontario
M4T 1M4

Data can be obtained in printed format or on computer disk or tape. Larger municipalities may find the computer disk format to be more useful owing to the large volume of data required.

5.1.1 Defining Commercial Activity

When driving along a commercial strip, through a central business district (CBD), or past an industrial park, a casual observation creates a general mental picture of a wide variety of commercial establishments. Modern society reflects the entrenched selling and buying mentality in which people recognize the various commercial facilities that are available for their disposable incomes. However, in the context of developing a well structured waste composition sample program, a range of commercial establishments must be categorically defined in terms of specific socioeconomic function.

Statistics Canada, as part of its Standard Industrial Classification (SIC), is a main source for developing an organized sample pool that reflects existing commercial and industrial infrastructure (ref. 15). In its SIC catalogue Statistics Canada has disaggregated the universe of economic activity into 18 primary industrial divisions (Table 3) that contain major sub-divisions or specifically "Major Groups" (Table 4). These Major Groups are further delineated into areas of specific commercial functions. An example is as follows:

> Division J represents the retail trade industries. Within this division are numerous major groups, such as Major Group 60 - food, beverage, and drug industries (retail). This is further delineated into specific commercial establishments including SIC #6011 super markets and SIC #6012 grocery stores.

The hierarchial SIC category arrangement of business and industry provides a well organized sample framework to develop a diverse and accurate representative sample pool.

Thus, the classification provides the basis for the selection of commercial activities to be studied, and for the extrapolation of the sample results into municipal totals. The same classification is used for all of Statistics Canada's economic surveys. It enables us to apply data from the Census of Canada, or the monthly Labour Force Survey, to the task of estimating waste generation for aggregations of commercial activities.

5.1.2 Commercial Employment in the Regional Municipality of Waterloo

Within the universe of economic activity, the Waterloo Study focused on six divisions: J, K, L, M, Q, and R (as indicated with asterisks on Table 3). The activities in these divisions take place within the private sector and serve local residential communities. Thus they are located within the communities they serve, and the number and size of these activities are quite predictable from a knowledge

TABLE 3: LIST OF SIC DIVISIONS

Division A	Agricultural and Related Service Industries
Division B	Fishing and Trapping Industries
Division C	Logging and Forestry Industries
Division D	Mining (Including Milling), Quarrying and Oil Well Industries
Division E	Manufacturing Industries *
Division F	Construction Industries
Division G	Transportation and Storage Industries
Division H	Communication and Other Utility Industries *
Division I	Wholesale Trade Industries *
Division J	Retail Trade Industries **
Division K	Finance and Insurance Industries **
Division L	Real Estate Operator and Insurance Industries **
Division M	Business Service Industries **
Division N	Government Service Industries
Division O	Educational Service Industries
Division P	Health and Social Service Industries
Division Q	Accommodation, Food and Beverage Service ** Industries
Division R	Other Service Industries **

* Low emphasis in study

** High emphasis in study

TABLE 4: LIST OF THE 13 SIC CODE MAJOR STUDY GROUPS

Major Group	Description
17	- Leather and Allied Products Industries.
28	- Printing, Publishing and Allied Industries.
48	- Communications Industry.
56[1]	- Metals, Hardware Plumbing, Heating and Building Materials Industry, Wholesale
60	- Food, Beverage and Drug Industries, Retail.
61	- Shoe, Apparel, Fabric and Yarn Industries, Retail.
62	- Household Furniture, Appliances and Furnishings Industries, Retail.
63	- Automotive Vehicles, Parts and Accessories Industries, Sales and Service.
65	- Other Retail Store Industries (i.e. Florist Shops, Jewellery Stores etc.).
70	- Deposit Accepting Intermediary Industries (i.e. Banks, Trust Companies).
91	- Accommodation Service Industries.
92	- Food and Beverage Service Industries.
96	- Amusement and Recreational Service Industries.

[1]Retail hardware and building supplies are designated as wholesale activities in the SIC classification

of the size and characteristics of the residential population. Within these six divisions, Statistics Canada identifies hundreds of smaller groups of specialized activities each of which includes a large number of stores that provide similar goods and services and operate in the same fashion. Given a base population of activities, these stores can be sampled and extrapolated to provide overall estimates of waste generation.

In contrast, the primary manufacturing and wholesaling divisions are fewer in number and far more diverse in size and specialization. This is because they are not directly tied to or restricted by the size and requirements of <u>local</u> markets; i.e., those in close spatial proximity to the manufacturing or wholesaling activity. A factory may produce goods for markets across the continent using processes and materials that are quite different from a neighbouring plant--even if the plant has the same industrial classification. Some municipalities have many factories; others have virtually none. Waste generation by such activities must be studied on a site-by-site basis.

While many educational, health, and local governmental services serve local residents, some activities, such as universities or major hospitals, were excluded from the Waterloo Study. As well, the lawn and yard maintenance service sector was not sampled in the Waterloo Study.

The six divisions in the Waterloo Study included 32.8 percent of the total employment in the Regional Municipality of Waterloo. Divisions J and Q, which were sampled most thoroughly, included 18.1 percent of the total. Commercial activities are numerous and represent a significant component of the economic base of every community.

Statistics Canada further disaggregates these six divisions of commercial activity (which were included in the Waterloo Study) into 27, two-digit SIC codes, each representing a familiar group of retail or service activities. In order to get the most information from a limited number of samples, these two-digit groups should be further aggregated and disaggregated as in the Waterloo Study as shown in Table 4. The general principle is to aggregate those groups that appear to have similar waste generation patterns, and to disaggregate those that have varied rates of waste generation. For example, the automotive group (SIC 63) can be disaggregated to reflect fundamentally different kinds of operations in dealerships, garages and gas stations. One group can be used to estimate other groups; for example, in the Waterloo Study Group 64 was estimated from the results for groups 61 and 62. Among financial services, only banks were sampled in the Waterloo Study. Hotels and restaurants were each disaggregated in the Waterloo Study to determine if different waste generation patterns could be identified.

In addition, in the Waterloo Study a limited number of samples explored economic activities lying outside the targeted divisions. Building supply stores (SIC 56) were sampled within the framework, but are formally classified as wholesale activities within the SIC. They are excluded from the expansion of the sample for the municipal total. The printing and publishing manufacturing group (SIC 28) was also sampled in the Waterloo Study.

5.1.3 Extrapolation of Sample Data to a Municipality

The task of extrapolating the results from the waste generation samples to project the waste generation for an entire area or regional municipality is complicated by the lack of information that describes the overall magnitude of commercial activity. There is no Census of Retail and Service Activity, or its equivalent. Instead, data on commercial employment can be obtained from several different sources and must be adapted to the particular study. The procedures used for this extrapolation may vary from place to place, depending on the mix of information that is available.

The starting point is the Census of Canada, 1986 (soon to be superseded by the 1991 version) for the residential population. For a twenty percent sample of households, each person over 15 is asked about employment; e.g., what kind of firm? These data are coded to the SIC categories. For each Census Metropolitan Area (CMA) how many people work in which kinds of activities is known. Unfortunately people do not always work in the same municipality where they live. If the municipality is isolated from other places (e.g., Timmins) the assumption can be made that the residents work in the same municipality that they reside; if it is embedded within a larger economic region (e.g., the City of Toronto or the City of Waterloo) further adjustments must be made. One could shift the scale of analysis from the smaller area municipality to the region as a whole (e.g., the Greater Toronto Area, the Region of Waterloo) or one could turn to other sources of data on employment. The Ministry of Transportation has compiled journey-to-work data for the major urban regions in Ontario that indicates how many people work in one community (e.g., the City of Cambridge) and live in another (e.g., the City of Waterloo), but these data are not broken down by SIC. Or there may be regional employment surveys that indicate how many jobs of various kinds are found in each component municipality--although they do not always use the same breakdown of commercial activities as Statistics Canada's SIC. The problem, then, is complex; and may require local expertise.

In the Waterloo Study, the starting point was the Census of Canada material, augmented by the Region of Waterloo employment survey to provide more spatial data, and Statistics Canada's Labour Force survey, to provide a temporal update. The amount of spatial or temporal detail required will depend on the application of the information.

While in the Waterloo Study there was no alternative to the use of employment data to link the waste generation sample to the projections for the municipalities, the relationship between employment and the volume of commercial activity is very strong (ref. 8). Sales, floor area, and employment are consistently linked together very closely. In the present work, employment is simply the total number of workers, both part-time and full-time--as defined by Statistics Canada. The ratio of part-time to full-time employees is consistent across each SIC sector, and the number of each type of employees should vary through time with the level of sales. Both employment and sales vary slightly from season to season (depending on the type of commercial activity). Early summer data (as used in the Waterloo study) provide a reasonable proxy for the annual levels as indicated by indices of seasonality computed by Statistics Canada (see ref. 16). These indices allow us to calibrate the seasonal effects at other times of the year.

5.2 Regional Municipality of Waterloo Planning Information

A discussion of the Regional Municipality of Waterloo planning information which was used in the Waterloo Study has been included as follows for information purposes.

The Regional Municipality of Waterloo, encompassing the cities of Kitchener, Waterloo and Cambridge, and four smaller Townships of Woolwich, Wilmot, Wellesley and North Dumphries, is located about 110 kilometres west of Toronto and about 60 kilometres northwest of Hamilton. The population of the Region (1988 Municipal Directory information) was 342,030. Information from an employment survey conducted by the Region's Planning Department provided additional information about the number of firms and employment in commercial activity in each of the local municipalities within the Region in 1989. The sectoral categories differ slightly from those used by Statistics Canada so the data could not be used directly in the estimate of waste generation. Instead, the information was used to estimate the share of Regional waste that is generated by each municipality.

Specific establishments within the Region of Waterloo were chosen, based on the selected SIC groups, by referring to local municipal business directories of Kitchener, Waterloo, and Cambridge. These sources provided the type of business, name of business, address/phone number, and number of employees. When deciding on the specific establishment to be sampled, the sample size in terms of the number of employees is important since for each SIC code grouping a range of different establishment sizes is necessary (e.g. small, medium, and large). Such a sample range, based on number of employees, provides a more accurate data analysis for waste composition and per capita waste generation (kg/employee/day). For example, SIC Major Group 60, food, beverage and drug industries (retail), provides the SIC code sub-groups SIC #6011 - supermarket (large number of employees ranging from 40 to 200), SIC #6012 - mid-size grocery store (medium number of employees ranging from 10 to 40 people), and SIC #6019 - other food stores i.e. convenient/specialty stores (small number of employees ranging from 1 to 10). It is not always possible to define such a sample range since it does not exist for all commercial establishments.

In addition, the yellow pages of the Bell Canada phone directory also contains a valuable up-to-date source of potential sample candidates. Finally, "the casual observation" driving to work in the morning, creates a mental note of commercial and industrial business locations where specific SIC code establishments can be incorporated into the sample pool.

5.3 Knowing Your Community - Current Waste Management Practices

The next parameter that must be known before beginning the waste study is the current waste management practices in the municipality.

The following information should be assessed:

1. waste collection frequency: once per week, or twice or more times per week;
2. collection routes and schedules;
3. collection practices and scheduling during holidays etc.;
4. presence of Blue Box programs or other recycling activities and days on which recyclable materials are collected;
5. presence of special waste collection programs such as spring and fall clean-up collections, leaf and yard-waste collections, bulky item collection days, white metal collections, hazardous waste collections and so on.

This information is needed to coordinate the collection of waste samples with regular waste collection so that conflicts do not occur, and to ensure that data are collected regarding special waste collections.

5.3.1 Waste Composition Variability

Does one expect a large variation in the composition of the waste streams generated by commercial businesses throughout the year? Given the "predictable character" of retail activities carried on within each SIC group, there is no reason to expect a significant variation in the composition of the waste generated by business within a given sector.

It is expected, however, that there may be variations in the quantity of waste with increases occurring at certain times of the year, e.g. Christmas holidays, year-end inventories, etc. However, retail activity is dependent on consumer habits. Consumer waste generation is reportedly consistent, varying +/-10% of a yearly average over three quarters of the time (cf. Vesilind & Rimer, ref. 17). The implication of the consistency is that seasonal variations in residential refuse generation patterns will be mirrored in many of the commercial retail sectors. Financial institutions may also exhibit predictable fluctuations in waste composition and/or quantity, that may be correlated with cyclic business-related activities.

5.3.2 Bulk Item and Special Collection Days

The snap-shot approach (relatively small number of samples taken for numerous SIC groups) to waste characterization which was utilized in the Waterloo Study precludes taking of any waste that would not be generated on a daily or weekly basis.

A similar "snap-shot" approach would require that special care be taken to identify special wastes or wastes that may not normally be present in the commercial establishment's waste stream. Several waste generation practices and "one-time" waste disposal occurrences can bias a random sample, especially when only a limited number of samples are taken from any one SIC group. This is a consideration where bulky items are present in the commercial waste stream.

A sampled commercial establishment may have unusual waste disposal occurrences during the study period. Note should be taken of the following:

- Items which are rarely disposed such as appliances or other bulk items may be present in the sampled waste. Large, one-time disposal items will bias the sample and hence the aggregated sample for the entire SIC group if the number of samples is small. When dividing the materials into respective waste composition categories, the large or heavy "one-time" items will raise the relative proportion of that material while decreasing the relative proportion of the other materials. When the item is clearly a "one-time" disposal occurrence that item should be weighed but recorded separately.

- Some material may be segregated for future recycling and set along-side with refuse awaiting disposal. These items should also be clearly identified and their weights recorded under the "recycled" waste category. As more and more materials are recycled or reused from commercial establishments, including materials excluded from a "blue box" program, additional care must be taken to identify and record the weights of such waste separately.

- Hazardous wastes, such as crank-case oil, paints, and solvents, may show up in the general refuse bin of various commercial establishments. Such wastes should be weighed and noted in the appropriate categories under the heading "hazardous waste" on the data collection sheets.

SECTION 6

STAGE 2 - SELECTION OF BUSINESSES

6.0 STAGE 2 - SELECTION OF BUSINESSES

6.1 Size and Number of Samples Required

6.1.1 Size of Samples Required

The size, i.e. weight, of the sample that must be taken to maintain statistical reliability depends on the variability of both the waste composition and the waste generation rates. If an estimate of the approximate percentage that a particular component contributes to the overall composition of waste is known and an estimate of the population standard deviation is known then the size of sample required may be calculated using the optimal sample size within clusters (ref. 19, Vol. I, p. 244). Nomograms reflecting this relationship were used to determine the size and number of samples required in the residential waste composition study. However, this relationship is not clearly defined for commercial wastes which are by-products from a variety of commercial activity. In the future, the lack of sample data from which reasonable estimates of waste composition and population standard deviations can be made will likely be rectified and a statically valid sample size may be determined.

The Waterloo Study was a pioneering study and as such no attempt was made to define a sample size. Waste was sampled from one week's accumulation. When the waste was placed at the curbside or loose in a dumpster the entire contents of the container was taken. When the waste sample was obtained from large compactor bins only half of the contents of the bins was sampled due to time constraints. As a result the weights of the samples ranged from 2.4 kg to 5782 kg.

6.1.2 Number of Samples Required

The number of samples that must be taken from each SIC group depends on the population standard deviation, the probability distribution associated with the population, and the desired level of precision. Due to a lack of historical information, the number of samples taken during the Waterloo Study was based on the availability of time and man-power. In the future, when commercial waste composition estimates are more readily available, it may be possible to utilize a similar formula to that used in the residential study in Volume I.

6.2 Contacting Businesses

The Waterloo Study field crew had considerable familiarity with a variety of businesses in the Region and they were able to recommend many companies to contact for the study; the Yellow Pages in the phone directory were also consulted for the names of firms. The decision on how best to approach businesses was left up to the field crew, after considering two alternatives: (a) contact by telephone and (b) direct company visits.

The field crew quickly realized that the most practical and efficient method of obtaining permission from local businesses to participate in the study was from a personal visit from the crew members themselves. The approach of contacting the firms by telephone is very time consuming and was inherently very unsuccessful. In the direct approach, store owners or managers can see first hand, who they would be dealing with. The waste study can be discussed in detail and questions can be answered and the logistical problems at each location can be assessed. A business card legitimizes the crew's intentions and initiates a good rapport between the field crew team and the business. In fact, in the Waterloo Study more than 90% of the businesses directly approached agreed to participate in the study.

The basic criteria required for sample locations are as follows:

- The commercial waste bin cannot be shared with another establishment in order to obtain a pure sample representation of one specific establishment.

- The waste bin must not contain an internal compacter since it is potentially dangerous for sampling (never enter a closed bin) and it would be very difficult to obtain the total bin refuse weight due to the densely compacted waste. Exceptions are made for external compactor bins, but only if absolutely necessary. The waste is still difficult to remove, but it is an open bin and if the compactor is turned off and the start key is removed the hazard is lessened.

- The waste bin must be safely accessible, ie. located in an area free of traffic or other potential hazards to the field crew.

The provision of such information, and if necessary an arranged site visit, will help decide whether a particular location is suitable for sampling. This will prevent unnecessary use of time for both the business and the study team.

SECTION 7

STAGE 3 - COLLECTION OF WASTE SAMPLES

7.0 STAGE 3 - COLLECTION OF WASTE SAMPLES

7.1 Scheduling Waste Collection

One objective of the Waterloo Study was to obtain a "snap shot" of the composition of waste generated in a week by commercial businesses. Therefore, waste collections for the study must be tailored to the waste collection for each business. In the simplest case (i.e., once a week collection), the crew might consider visiting the company 12 to 18 hours before the bulk-lift refuse bin is scheduled for dumping and removing the accumulated waste. Whenever Monday is the collection day, the crew will have to make their collection on Sunday.

Many businesses may have to be visited 3 or more times in order to obtain a week's worth of waste. In some cases, it may be necessary to have businesses store their waste, especially if the putrescible content was low, in order to save the crew repeated trips.

Sample scheduling must also consider the proximity of establishments from one another. Generally, two or three establishments may be sampled per day. It is time effective to schedule establishments that are close together on the same sampling day.

Other factors should be considered when developing a field sample schedule. Irregular activities, eg. festivals, renovations, will generate larger amounts of waste. Another factor involves the concern of management's preference for schedule time. Finally, one may choose to avoid collecting and sorting food wastes during the hottest summer days to avoid encountering bugs and pungent odours.

7.2 Special Documentation

A letter must be obtained from the Ministry of the Environment authorizing the collection of the waste from commercial businesses for purposes of the composition study. The private waste hauler participating in the Waterloo Study requested and received a letter from the Region confirming the confidentiality of the waste information obtained in the study.

The procedure to obtain Ministry approval for solid waste sample collection by municipalities undertaking waste composition studies is as follows:

A letter requesting Ministry approval for temporary collection of solid waste samples shall be mailed by the interested municipality to:

Mr. Dave Crump
Operations Coordinator
Operations Division
Ministry of the Environment
14th Floor, 135 St. Clair Ave., West
Toronto, Ontario
M4V 1P5

The letter shall include, but not be limited to the following type of information:

- Background and reasons for undertaking the study.
- Study objectives.
- Study approach.
- Contractor's name.
- Collection area.
- Approximative number of samples to be collected.
- Approximative weight of each sample.
- Estimated duration of the project.

7.3 Waste Collection Methods for Waste Quantities and Composition

In the Regional Municipality of Waterloo as with most municipalities, private waste haulers are usually contracted to remove the waste from commercial businesses, except in the downtown core of Kitchener and Waterloo where waste collection was three times per week or daily, respectively. In the Waterloo Study, commercial haulers provided bulk-lift refuse containers of various sizes (2 to 8 cubic yards) in which a firm's waste was accumulated and picked up as required. In most cases, wastes are placed, loose, into the bulk bins; however, some businesses might be using compactor type bulk refuse containers.

Waste sampling procedures will vary depending on whether the waste is loose or compacted. In the former case, for the Waterloo Study the entire contents of the container were unloaded, weighed in a chicken wire/wood "crib" mounted on a scale (see Figures 2 and 3) and placed in 4′ x 4′ x 4′ heavy duty corrugated containers ("gaylords") in the back of a cube van and taken to the Waterloo landfill site (parking lot of the Recycling Office) for sorting (see Figure 4).

Unloading waste from a compacted entanglement of loose and bagged refuse in a 6 or 8 cubic yard bin during the Waterloo Study was found to be very difficult. It was decided that only half of the contents of the bin could be conveniently and efficiently unloaded and weighed, given the arduous task and the time requirement. The weight of the entire bin was estimated on a volume basis from the weight of the sample that was removed, i.e., usually several hundred kilograms. All loose waste was set aside for sorting; bags of refuse were randomly placed into two piles, with an equal number of bags in each pile. One pile was randomly selected for sorting, the other pile was returned to the bin.

7.4 Waste Collection Methods for Waste Quantities Only

Two sampling methods can be used to determine the quantity of waste generated at each firm. In the first method, the field crew must weigh the waste in the refuse containers before putting the waste in the cube van for transportation to their base for sorting. As noted above, the frequency of waste collection at each firm should be obtained from the owner or manager. The field crew can obtain the employment figure for each business at the time of the interview or by telephone.

When it is not possible to obtain the number of full- and part-time personnel from each firm, the figures for total employment can be used in the regressions of employment versus waste quantity. This is compatible with the data gathered by Statistics Canada.

FIGURE 2: WEIGHTING COMMERCIAL WASTE IN A CRIB MOUNTED ON AN ELECTRONIC DIGITAL SCALE

FIGURE 3: REMOVING WASTE FROM A COMMERCIAL WASTE BIN

FIGURE 4: SORTING A WASTE SAMPLE AT THE LANDFILL SITE

The first method enables one to get waste quantity information from small and medium size businesses. The method is very labour intensive and time consuming but works well for small loads of loose waste. The method is not satisfactory for refuse compacted in 6 to 8 cubic yards containers. The latter containers may be frequently encountered at some of the larger locations.

The second procedure is applicable to all bulk containers irrespective of bin size or degree of waste compaction. In the Waterloo Study, a scale initially developed to weigh loads of sand and gravel carried in the scoop of a front end loader had been adapted for use on overhead (front-end) loading garbage trucks. The scale worked off of the hydraulic lift system that raises and lowers the arms of the bin hoist. A Wray-Tech Model WT4000/6000 (obtained from Woolsey Equipment Sales Ltd., Ottawa) was installed on an overhead packer truck and calibrated with the assistance of the Toledo Scale Company, Hamilton, Ontario.

The bulk waste weighing procedure is a two-step process. First, the bin and waste contents are weighed. Then the contents of the bin are dumped into the truck and the empty bin is weighed. The weight of the bin contents is determined by subtracting the weight of the empty bin from the weight of the bin plus contents. Again, employment data is obtained for these firms, either by telephone or directly visiting these firms after the waste has been collected.

Participants in the waste composition study should be assured of confidentiality of the waste generation and composition information.

7.5 Information to be Obtained at the Time of Sample Collection

A field note book should be carried during the sample collection to note general information and any odd occurrences that may be encountered. General data which should be obtained from every establishment should include:

- company name,
- company address,
- number of employees,
- total weight of refuse,

- number of days refuse generated,
- frequency of refuse collections per week,
- refuse pick-up days,
- size of refuse bins, and
- percentage of bagged waste sampled (for composition).

7.6 Data Obtained for Per Employee Waste Generation Rates

As noted above, the frequency of waste collection at each firm should be obtained. The field crew must also obtain the employment figure for each business at the time of the interview or by telephone.

Bin collection frequency can be determined from the hauler's records and a daily generation rate (kg/day) of waste was determined for each firm. At the conclusion of the field work, the employment and waste generation data can be plotted on separate graphs for each of the commercial groupings. The length of the "work week" is different for different SIC groupings. Some businesses are open 7 days a week (e.g., restaurants, and hotels) and some are open for 6 days (e.g., supermarkets, banks, and automobile dealerships), while some are open for 5 days (e.g., printing shops).

When it was not possible to obtain the number of full- and part-time personnel from each firm, the figures for total employment can be used in the regressions of employment versus waste quantity. This is compatible with the data gathered by Statistics Canada.

SECTION 8

STAGE 4 - WASTE SORTING

8.0 STAGE 4 - WASTE SORTING

8.1 Equipment Set-Up and Sorting Commencement

Before actual sorting, it is necessary to develop a time efficient and accurate sorting strategy. In the Waterloo Study, a large sheet of plywood, 2.4 m by 1.2 m in size, was laid across two clamp-style work-horses to form a table. Four rows of six garbage cans were then aligned behind the table. Each sorter positioned themselves between two rows of cans, with an additional can in front of them (beneath the table), as well two cans are placed on the table. This positioning will optimize the amounts of material types that can be sorted in a timely fashion. This set-up will vary according to convenience depending upon the quantity of certain wastes and diversity of materials sampled. Each member of the field crew should sort one garbage bag/can at a time, tossing material to the defined waste composition cans. Such a system prevents confusion and time wasted in walking to various scattered cans.

8.2 Sample Sorting and Data Management

In the Waterloo Study, sorting occurred at the regional landfill site in order to avoid unnecessary interference and possible spillage of garbage on the commercial establishment's property. It may be possible to arrange for sorting to take place at similar site.

The commercial waste composition data sheets (Table 5) which were used for logging the weights of the various waste materials encountered in the samples in the Waterloo Study can be adapted to suit other waste composition studies. After sorting the waste into categories, each category should be weighed and its relative contribution to the total sample weight determined, i.e., percent of the waste composition. Waste materials that can not be easily categorized, should be separately identified (described and weighed) on a "miscellaneous" table, accompanying the main waste composition table for each sample. The total weight of materials in the "main" and "miscellaneous" lists should equal 100% of the sample weight.

TABLE 5: WASTE COMPOSITION DATA FIELD SHEET

Town:
SIC:
Sample # :
Collection Dates:

Ministry of the Environment
Waste Composition Study

GORE & STORRIE LIMITED

Category	Item				
(1) Paper	(a) Newsprint				
	(b) Fine Paper / CPO / Ledger				
	(c) Magazines / Flyers				
	(d) Waxed / Plastic / Mixed				
	(e) Boxboard				
	(f) Kraft				
	(g) Wallpaper				
	(h) OCC				
	(i) Tissues				
(2) Glass	(a) Beer (i) refillable				
	(ii) non-refillable				
	(b) Liquor & Wine Containers				
	(c) Food Containers				
	(d) Soft Drink (i) refillable				
	(ii) non-refillable				
	(e) Other Containers				
	(f) Plate				
	(g) Other				
(3) Ferrous	(a) Soft Drink Containers				
	(b) Food Containers				
	(c) Beer Cans (i) returnable				
	(ii) non-returnable				
	(d) Aerosol Cans				
	(e) Other				
(4) Non-Ferrous	(a) Beer Cans (i) returnable				
	(ii) non-returnable				
	(iii) American				
	(b) Soft Drink Containers				
	(c) Other Packaging				
	(d) Aluminum				
	(e) Other				
(5) Plastics	(a) Polyolefins				
	(b) PVC				
	(c) Polystyrene				
	(d) ABS				
	(e) PET				
	(f) Mixed Blend Plastic				
	(g) Coated Plastic				
	(i) Nylon				
	(i) Vinyl				
(6) Organic	(a) Food Waste / Rodent Bedding				
	(b) Yard Waste				
(7) Wood					
(8) Ceramics / Rubble / Fiberglass / Gypsum Board / Asbestos					
(9) Diapers					
(10) Textiles/Leather/Rubber					
(11) Hazardous Wastes	(a) Paints / Solvents				
	(b) Waste Oils				
	(c) Pesticides/Herbicides				
(12) Dry Cell Batteries					
(13) Kitty Litter					
(14) Miscellaneous					
		TOTAL kg		TOTAL kg	

SECTION 9

STAGE 5 - DATA ANALYSIS AND REPORT WRITING

9.0 STAGE 5 - DATA ANALYSIS AND REPORT WRITING

9.1 Estimates of Average Per Employee Waste Generation Rates

Each sample observation may provide information on the number of employees and the total weekly waste generation for the establishment. This permits two different kinds of statistical generalization. First, it is possible simply to divide the total waste by the number of employees to obtain an estimate of waste generation per employee. Several of these estimates can then be used to determine average values and standard deviations.

Second, more information can be extracted by plotting total waste against employment for each observation. This provides:

(1) a visual pattern of the overall variability in the results, an evaluation of the relation between waste generation per employee and size of store (e.g., are big stores more or less efficient with respect to waste generation?);

(2) a measure of the waste reduction efficiency of individual stores relative to the group; and

(3) an evaluation of the effectiveness of the sample selection in relation to store size.

By fitting a regression line to the graph one can obtain another measure of the regularity of waste generation, i.e., the regression coefficient r^2. Another estimate of the relation between waste generation and number of employees is the slope of the regression line (b).

In the next step in the analysis, estimates of waste generation per employee are used to estimate total waste generation within the study area. Either the mean value of waste per employee or the regression slope (b) can be selected. The regression slope should be used as long as it was adjudged reliable; otherwise the mean value should be used. The reliability depends on both the regression coefficient (over 0.5) and the scatter of observations on the graph. A sample with a wide variety of different stores sizes may be deemed acceptable. Those where the observations are clustered together around the same size store should be rejected. In the ideal case, where there is perfect correlation between waste generation and employment, the intercept (a) is expected to be zero and the mean value should equal the regression slope (b). For further discussion of regression analysis the reader may consult Modern Elementary Statistics (ref. 6).

9.1.1 Estimates From Average Waste Weight Per Employee Data

For each SIC group of commercial business, the daily waste weight generated at each firm can be divided by the number of employees to obtain the weight of waste per employee per day. An average estimated waste generation rate (± 1 Standard Error) can be calculated for the SIC sector from the sample data.

9.2 Estimation of Waste Generation by Commercial Sector in the Entire Municipality

The estimation of commercial waste generation for the entire municipality combines two kinds of information. First, various employment data can be used to estimate total commercial employment and employment for various types of commercial activity in the entire municipality. Second, the field work provides estimates of the amount of waste generated per employee by type of commercial activity. By combining these two kinds of information the final estimate of commercial waste generation is obtained for the entire municipality.

It is much more important to make accurate estimates for the larger places than for the smaller ones. (Note: Familiarity with the local economic structure is required to make minor adjustments to Statistic Canada employment information where needed).

For the Region as a whole, the share of commercial jobs was 32.8 percent in the 1986 Census and 38.7 percent in 1989 according to the Region's Planning Department--a difference that reflects variations in definitions in the two data sets. Despite these differences, the regional employment survey permitted an estimation of the share of regional commercial employment to be allocated to each municipality. This should assist in estimating the share of commercial waste generation.

9.3 Sources of Potential Error in Employee Waste Generation Estimates

Table 6 lists the kinds of errors that will affect the accuracy of the employee waste generation estimates presented herein. An estimate of the magnitude and "direction" of the error is also given.

Error in the estimates of waste generation for a municipality can occur in two ways. First, the labelled Waste Survey in Table 6 is derived from the evaluation of ratios of waste generation per employee. When the error occurs in the sampling procedure, due to store-to-store differences in the ratios this error can be reduced by increasing the sample size. Difficulty in identifying and clarifying the correct type of business SIC group can also contribute to that error and is more difficult to evaluate. The error depends on the significance of identifiable differences in subtype s of commercial activities, perhaps segmented by location or brand names or product mix. A store incorrectly identified could lead to a sizeable error in a small number of samples. In the Waterloo Study, local business directories provided the SIC type for the businesses. Measurement errors, e.g. weight of wastes, should be relatively minor.

The second form of error (possibly embodied in the remainder of Table 6) is related to the estimation of total commercial activity in various sectors, based on various data sources. Each data source has its own problems. These errors cannot be reduced by increasing the sample size. Census data are comprehensive, but begin with the undercounting bias that averages this percent across the population as a whole.

There may be other systematic errors in reporting the SIC types, such as, whether the person is actually working or the location of the work place. Most of the error in the Labour Force survey is derived directly from the sample size, since there is not detailed information on location of SIC groups. The regional employment survey provided greater spatial detail but carried a high level or error due to non-response and error in SIC or number of employees. Local governments are not professional data gathering agencies and employers are not required to respond to survey requests.

TABLE 6 ACCURACY IN WASTE ESTIMATION - SOURCES OF POTENTIAL ERROR

Type of Data	Type of Error	Magnitude of potential error (%)[1]	Bias	Level of Observation
Census Employment	Undercounting	2-5	negative	CMA, sector
	Misclassification	5 (?)	neutral	sector
	Employment Definition	5 (?)	positive	CMA, sector
	Location (JTW)[2]	5-10	small places	municipality
Labour Force Survey	Sampling Error	2-5	neutral	CMA
	(largely eliminated by tracking monthly estimates over time)			
Regional Employment Survey	Reporting & Tabulating	up to 10	neutral	municipality, sector
	Misclassification	up to 10	neutral	sector
	Employment Definition	minor		municipality, sector
Waste Survey	Sampling Error	standard deviation up to 15%	neutral	store
	Measurement	5 (?)	?	store
	Classification	10	10 (?)	store

[1]Best estimate based on professional judgement (J. Simmons)
[2]Journey-to-work

The Waterloo Study was thus an exploratory one, and the sampling errors in the waste survey predominate. As more information is integrated from additional work, and samples become larger and more precisely targeted, these waste survey errors can be reduced and made small relative to the problems of employment estimations and projections.

9.4 Per Employee Waste Generation Rates

As indicated earlier, for each company participating in the study, a daily, per employee waste generation rate can be determined (kg per employee per day). The weight of waste generated by a company during one "work week" is divided by the number of days in their "work week", either 5, 6 or 7. The weight per day is divided by the total number of employees in the firm. An estimate of the employee waste generation rate per day for each SIC group, or sub-grouping, is obtained by averaging the information for all companies in the same SIC group or sub-grouping. The following illustrates the above steps:

1. $\frac{\text{(kg/wk)}}{6}$ = weight per day

2. $\frac{\text{weight per day}}{\text{total no. of employees}}$ = employee generation rate per day

3. $\frac{\text{sum: employee generation rates}}{\text{n (no. of employees)}}$ = average employee generation rate per day

For each two-digit SIC group or sub-grouping, the daily waste generation rate for each firm can be plotted against the number of employees. Linear regressions can be calculated for the data and the resulting coefficients representing the employee waste generation rate (the coefficient b in the regression equation: $y = a + bx$) can be compared with the estimates of daily waste generation for the SIC sector, determined by the averaging method.

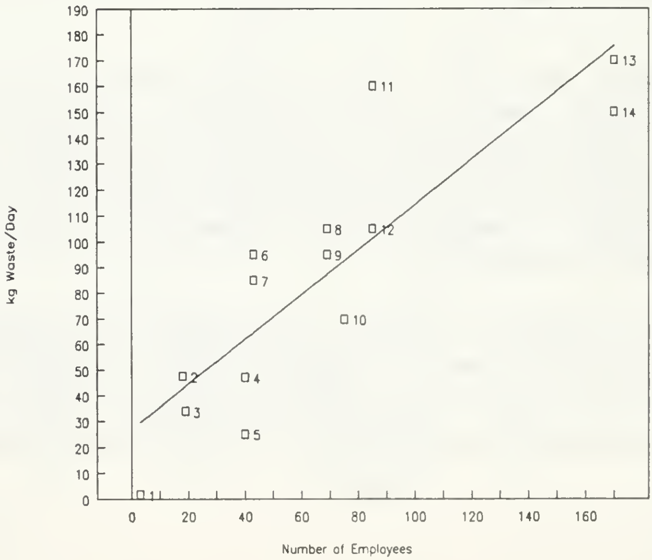
An example of the average per employee waste generation rate and the error standard for SIC group 631 sampled in the Waterloo Study is provided in Table 7. An example of a corresponding scatter graph which shows a strong correlation between waste generation and employment is provided as an example in Figure 5.

TABLE 7 *SIC GROUP 631, WASTE GENERATION DATA (KG/EMPLOYEE/DAY) FOR THE AUTOMOBILE DEALERS*

Sample #	Total # of Employees	kg Waste/Day	kg Waste/ Employee/Day
1	3	1.71	0.57
2	18	47.52	2.64
3	19	33.86	1.78
4	40	46.93	1.17
5	40	25.06	0.63
6	43	95.00	2.21
7	43	85.00	1.98
8	69	105.00	1.52
9	69	95.00	1.38
10	75	69.70	0.93
11	85	160.00	1.88
12	85	105.00	1.24
13	170	170.00	1.00
14	170	150.00	0.88
		AVERAGE	1.41
		+/- SE	0.165

FIGURE 5: SIC GROUP 631

GRAPH OF WASTE GENERATION DATA



9.5 Estimation of Commercial Waste Generation in the Regional Municipality of Waterloo

Table 8 has been included in this procedure manual for illustration purposes only. Table 8 disaggregates the various SIC categories from Statistics Canada to conform to the groups used in the Waterloo Study. The table also contains estimates of total municipal employment for each of the commercial sectors. To obtain an estimate of the municipality's employment from the Census Metropolitan Area (CMA) data in the Census simply multiply by 1 ± the percent difference in the spatial definition of the study area (i.e., the municipality's boundaries may be slightly larger than those of Statistic Canada for the municipality). To convert the 1986 employment to 1990 employment, multiply by the estimated commercial employment growth. The application of growth rates in this manner does not account for fluctuations occurring as a result of economic fluctuations, such as during a periods of recession. These employment estimates are multiplied by the waste generation per employee to estimate total commercial waste for the SIC group listed.

The data in the right hand column of Table 8 are estimates of weekly waste generation rates (kg/employee/week) for 13 commercial SIC Groups. The weekly per employee waste generation estimate for each SIC group is multiplied by the total municipal employment for the group to obtain the weekly waste contribution (kg/week) from the SIC group. Note that the kg/wk are presented in 1,000s, i.e., the actual values are 1,000 times higher than the number entered in the table, e.g., 342 x 1,000 = 342,000.

The total estimated weight generated by the commercial sector in the Region of Waterloo was also calculated (1,469,400 kg/wk, or approximately 1,469 tonnes/wk or 76,388 tonnes/year).

TABLE 8

AN EXAMPLE OF ESTIMATES OF COMMERCIAL WASTE GENERATION IN A MUNICIPALITY

Activity	Number of Employees[a] (1990)	Waste Generation kg./empl./wk.	Total Waste kg./wk. x 10^3
Retail			
Food (SIC 60)	6195	55.2	342.0
Clothes (61)	2215	3.6	8.0
Furniture (62)	1430	10.1	14.4
Auto (63)	5400	12.6	68.1
General (64)	3825	6.8[b]	26.0
Misc. Retail (65)	3455	29.6	102.3
Bldg. Suppl. (56)	1495	34.2	51.1
Non-store (69)	590	1.0[c]	0.6
Sub-total	24605	-----	612.5
Finance and Services			
Banks (70)	2900	1.0	2.9
Other Fin. (71-77)	18970	3.0[f]	575.8
Services (97-99)	9080	1.0[c]	9.1
Sub-total	30950	-----	587.8
Hotels (91)			
No Restaurant[d]	520	43.5	22.6
With Restaurant	1035	12.0	13.0
Sub-total	1555	-----	35.6
Restaurants (92)			
Licensed[e]	5520	21.1	116.5
Unlicensed	2760	21.1	58.2
Sub-total	8280	-----	174.7
Recreation (96)	1800	2.1	3.8
Total Commercial for SIC Groups Listed Above	**67190**		**1469.4**

[a] Figures derived from Canada Census data and local planning statistics reflecting an adjustment for spatial difference plus growth rate to bring dated information into current years.

[b] The average of categories 61 and 62.

[c] Because of the similarities in activities, the employee waste generation estimates for non-store and service commercial entities were estimated to be the same as banks.

[d] Estimated as one-third of hotel employment.

[e] Estimated as two-thirds of restaurant employment.

[f] Estimate from Ministry of Government Services (personal communications with M. Sidhwa; note that this estimate is tentative and awaiting confirmation).

SECTION 10

EVALUATION OF METHOD

10.0 EVALUATION OF METHOD

10.1 Timing of the Waterloo Study

It must be realized that the management of waste is dynamic and as such future waste composition studies should make use of additional information and circumstances which may develop with time.

The Waterloo Study did not attempt to quantify the amount of materials being diverted from a company's waste stream; the waste composition, therefore, does not include those materials which were being diverted (if any) through any outside agencies.

Because of the scope of the work, it was not possible to design a waste sampling program that would permit the collection of a sufficient number of samples so that statistical analyses could be applied to the waste composition data. It must be pointed out that the Waterloo Study was a prerequisite study; the level of variance between the estimated and actual waste composition is not known. More field work must now be done in other municipalities to augment the data contained in the Waterloo Study.

10.2 Graphical Presentation of Waste Generation Versus Employment--- Potential Method to Evaluate Company Waste Management Performance?

Graphs of the Waterloo Study data for waste generated by businesses, versus employment displayed the variance of "waste management performance" that had been encountered in the sample of businesses. In theory, the waste generated by businesses should be closely correlated with employment and the data should tend to fall about an imaginary linear projection line. If there are data that are greatly removed from the linear tendency of the majority of the sample points, those businesses may be targeted for investigation with respect to their waste management practices. For example, a business with exceptional waste minimization efforts will show up as a data point that is well below the general linear grouping of businesses; a business with poor waste management policies will show up as a data point that lies well above the linear grouping of businesses.

Therefore, municipalities are advised to plot the employment/waste generation ratios in order to "get a feel" for practical problems that they can address in specific companies. A simple average of employee waste generation rates would suffice if rates, alone, were important.

While the per employee waste generation rates are simply taken as the values of 'b' (slope), one may legitimately modify these rates, based on the number of employees in a given firm. In other words, one may divide the value for 'a' (kg/day) by the number of employees in a firm and add this quotient (in units of kg/employee/day) to the value of 'b'. As employment increases, the impact of the 'a' (employment) on the value of 'b' will decrease. No company-specific adjustments were made to waste generation estimates because we were interested only in an average estimate, representative of the SIC group as a whole, i.e., the value of 'b' alone.

10.3 Usefulness of Landfill Data in Estimating Commercial Refuse Quantity

Generally, there are three systems for the collection of waste from commercial sources and delivery to landfill sites: (1) residential garbage trucks (2) front end (or over-head) packer trucks and (3) "dedicated loads" from large supermarkets and large malls. Residential garbage trucks frequently make collections from commercial businesses as part of their daily routing through a municipality. The load is weighed at the scalehouse and the weight is normally recorded as "residential". The fraction of the waste collected from commercial businesses cannot be accurately determined under these circumstances.

Haulers using front end packer trucks frequently make between 25 and 50 refuse collections from customers before proceeding to a waste facility. A typical collection route for one of these trucks may include stops at: schools, senior citizen's homes, commercial businesses, industries, hospitals, condominiums, apartment houses, malls, etc. It is apparent that no matter what category is chosen to designate the "source" of the waste, when the load is weighed at a disposal facility, the choice will not reflect the heterogeneity of the waste in the truck. It is normal for these loads to be recorded as either "commercial" or "industrial".

Given the nature of the waste delivery systems from generator to transfer station or landfill site, most of the scalehouse data do not give a reliable picture of commercial and industrial waste generation, and to use that data in estimating waste composition would be misleading. Yet, scalehouse "records" are the basis for the widely held generalization that residential waste is "40%" of the total waste stream and commercial and industrial waste accounts for "60%". There is good reason to doubt the accuracy of this or any other percentages that rely on scalehouse weight data. The method that we have developed in the present study will enable municipalities to make a reasonable estimate of the waste generated by the commercial business sector. The method described in Volume I of the Waste Composition Study can be used to estimate the residential waste stream.

10.4 Verification of the Employee Waste Generation Estimates

In the absence of an alternative method to directly estimate the employee waste generation rates, one must defer to a comparison of the data with published literature values. Such a comparison is given in Table 9.

The following verification method is suggested in future studies. Using small "strip malls", estimate the total waste generation rate for each business, using the SIC per employee waste generation rate estimates (from this study) and the employment figure for each business. Compare the estimated sum of waste generated for the entire sample mall with the actual weight of waste produced by the mall.

10.5 "Light Industry"

The Standard Industrial Classification system uses the term "industry" throughout (e.g., "Retail Trade Industries"), but no categorical distinction or definition is given to the term "light", with respect to any kind of industry. Commercial businesses are

TABLE 9

COMPARISON OF PER EMPLOYEE WASTE GENERATION RATES: RHYNER & GREEN (REF. 14) AND PRESENT STUDY[1]

SIC[2]	Description	Rhyner & Green (ref. 14) tonnes/emp /yr	Rhyner & Green (ref. 14) kg/emp /day[3]	Present study kg/emp /day
50-51	Wholesale trade	1.70	6.5[4]	
52	Retail building materials	1.44	4.6[5]	5.7
53	Retail general merchandise	0.25	0.8[5]	1.1
54	Retail Food	1.97	6.3[5]	9.2
55	Auto sales, service	0.41	1.3[5]	0.9-4.6
56	Retail apparel	0.41	1.3[5]	0.6
57	Furniture	1.06	3.4[5]	1.7
58	Eating & drinking place	2.07	5.7[6]	3.0
59	Miscellaneous retail trade	0.89	2.0[5]	4.9
60-67	Financial operation	1.18	4.5[4]	0.2-0.6
70	Hotels	1.95	5.4[6]	1.7-6.2
72	Personal services	0.38	1.5[4]	
73	Business services	0.68	2.6[4]	
76	Miscellaneous repair	1.51	4.8[5]	
79	Amusement recreation	0.66	1.8[6]	2.1
89	Miscellaneous services	0.68	2.2[5]	
90	Government[7]	0.68	2.6[4]	

---

[1] data from Table 7 of Volume II of the Ontario Waste Composition Study.

[2] numbering for the U.S. SIC code differs from the Canadian code.

[3] calculated from Rhyner & Green data for tonnes/emp/yr.

[4] five day work week (260 days/yr): tonnes/emp/yr ÷ 260 work days/yr x 1000 kg/tonne = kg/emp/day.

[5] six day work week (312 days/yr): tonnes/emp/yr ÷ 312 work days/yr x 1000 kg/tonne = kg/emp/day.

[6] seven day work week (365 days/yr): tonnes/emp/yr ÷ 365 work days/yr x 1000 kg/tonne = kg/emp/day.

[7] value not reported; Miscellaneous Services value used.

also called industries, so one cannot look to the SIC code to assist in distinguishing "light" industry from "heavy" industry.

Semantic arguments and clear problems of nomenclature aside, an arbitrary decision was made to call the shoe manufacturing industry (SIC 17) and the printing industry (SIC 28) "light industry". No special methods were applied to the data gathering procedures for these businesses and therefore the data are considered tentative. This study describes sampling procedures for commercial activities that closely serve the residential sector. Longer term sampling procedures are needed to assess industrial waste stream characteristics.

SECTION 11

RECOMMENDATIONS FOR FURTHER REFINEMENT

11.0 RECOMMENDATIONS FOR FURTHER REFINEMENT

The methods employed in the commercial portion of the Ontario Waste Composition Study have been demonstrated on a selection of commercial businesses in the Regional Municipality of Waterloo. Within the commercial sectors in the Region there is a relatively high awareness of waste diversion options that will reduce waste disposal costs and encourage recycling. Therefore, we cautiously regard the qualitative and quantitative data presented in the Waterloo Study as a best estimate under constantly changing circumstances.

The Waterloo Study has developed a procedure for estimating the amount of waste generated by commercial activities within Ontario urban areas and began with the process of integrating the complex data inputs required. What are the next steps?

The Waterloo Study has employed a two-stage estimation process: (1) the development of ratios of waste generation per employee; and (2) the estimation of commercial employment composition for the municipality as a whole. Each step poses different problems. The following recommendations are submitted for further refinement of the methodology:

1. The waste generation and composition data base will require many more samples than what were taken in the Waterloo Study in order to cover the full range of commercial activities. No one study will have the resources to undertake a complete evaluation; the research results must be accumulated over many studies and evaluated over time. Fortunately, there is no inherent reason that a business in any part of the province cannot be used to estimate waste generated elsewhere--unless local waste management policies differ significantly.

   This means that each study should use the same SIC identification to code commercial activity and the same methodology for measuring waste output and composition. A central agency (e.g., the Ministry of Environment) may have to take the responsibility for organizing and evaluating the data.

2. It will also be necessary to monitor any changes over time in waste generation that may reflect innovations in policy, technology or corporate behaviour. The date of each sample must be retained and/or it may be necessary to identify sample locations that can be restudied over time in order to minimize sampling error.

3. To better understand the effect of recycling behaviour on the data gathered, it is recommended that employees/management of participating firms be asked to describe the nature and extent of any source separation recycling activities.

4. The immediate priorities for sampling can be identified from the results of this study. Those commercial activities that employ large numbers of people must be further investigated in order to improve sample size and reveal any significant variation within the SIC groups; this includes the diverse set of office and financial activities. Conversely, those activities with a high rate of waste generation per employee, such as food stores and restaurants, must be sampled repeatedly because of their importance to the overall waste generation. Those sectors where the observed sample variance (standard deviation) is high require larger samples to improve overall accuracy, possibly by isolating subgroups within the SIC. Activities that generate policy-relevant waste materials should be given special attention.

5. The future development of employment estimates requires two divergent approaches. First, substantial savings may result from a centralized standardized analysis of employment that applies the same set of data, techniques and projections to all urban areas--much as the Ontario Statistical Centre has developed a common set of population forecasts.

   At the same time, municipalities have better information about local peculiarities and exceptions to the employment structure. These special cases, e.g., community colleges, tourist attractions, shopping concentrations, as well as manufacturing activities, may require special attention by a local agency.

6. During the course of the Waterloo Study, insights were noted regarding the effectiveness of waste management practices of some firms. For example, for automotive repair businesses, it appears that employee's tend to use the general refuse bin for discarding metal waste materials, despite the fact that a scrap metal bin has been made available.

Such insights, when communicated to the management of the firm provide an immediate opportunity to help that firm improve the efficiency of their recycling efforts.

There was also an indication in the Waterloo Study that differences exist in per employee waste generation rates in small grocery stores and in larger supermarkets.

The demonstrated method for estimating the rate of employee waste generation has the potential to be used as a waste management tool by municipalities. The distribution of the daily waste generation rates versus employment data, exhibited in the graphs for each SIC sector, could enable municipal waste management personnel to prioritize their "remedial" waste reduction efforts by planning to visit those companies whose waste generation rates seem out of line with the general waste-to-employee relationship.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

Gore & Storrie Limited wish to acknowledge the assistance provided by the Regional Municipality of Waterloo for the commercial portion of the Ontario Waste Composition Study. Mr. Dick Buggeln of the Region co-ordinated the field work and wrote significant portions of the text.

The concept for the field study was developed following the advice of Dr. Virginia Maclaren that led to extensive discussions with Dr. Jim Simmons (both faculty members in the Geography Department, University of Toronto). Dr. Simmons worked with the Canada Census employment information and accessed other employment data bases in order to develop a picture of employment in the retail commercial businesses in the Regional Municipality of Waterloo. Dr. Simmons also assisted in evaluating the field data and writing portions of the text. The project clearly benefitted from Dr. Simmons' many crucial contributions.

The field crew: David Fox (Gore & Storrie Limited), Richard Stevenson and Lisa Morgan (both from the Region of Waterloo) were responsible for contacting the companies, organizing an often complicated waste collection schedule and sorting the waste. They were a dedicated crew and their efforts are gratefully acknowledged.

A considerable portion of the field work was conducted with the participation of Big Bear Services, Waterloo, Ontario, and the cooperation of Messrs. Bob Knarr, Gary Bell and Bruce Storrer.

Report preparation assistance was provided by David Fox, Brock Harrington, Rob Flindall, Debra Hayes and Chris Taylor of Gore & Storrie Limited, with additional support from Adam Buggeln and Barbara St. Hill.

The Project Managers for Gore & Storrie Limited were Les MacMillan and Jeff Flewelling.

We gratefully acknowledge the strong ongoing support and assistance of Messrs. Neal Ahlberg, Brendan Killackey and Dan Ionescu, Waste Management Branch, Ministry of the Environment.

REFERENCES

REFERENCES

1. AMS (1973) Applied Management Sciences Inc. The private sector in solid waste management: a profile of its resources and contribution to collection and disposal. Environmental Protection Agency Publication SW - 51d.1, U. S. Government Printing Office, Washington, D.C. (Cited by Rhyner & Green, 1988).

2. Bird & Hale. 1978. Municipal Refuse Statistics for Canadian Communities of over 100,000 (1976-1977). 37 pp. (EPS File No. 4672-1).

3. DeGeare, T. V. & J. E. Ongerth. 1971. Empirical analysis of commercial solid waste generation. Jour. Sanitary Engineering Division. Proc. Amer. Soc. Civil Engineering. 97(SA 6): 843 - 850.

4. Evans, B. W. 1985. How garbage analysis can reduce collection costs. Biocycle. March: 30 - 33.

5. Franke, B. 1987. Comparing solid waste management options: a case study. Unpublished manuscript. Institute for Energy and Environmental Research. Takoma Park, MD 20912. 15 pp + 6 figures.

6. Freund, John E. 1984. Modern elementary Statistics. 6th Edition. Prentice-Hall, Englewood Cliffs, N.J. xii + 561 pp.

7. Golueke, C. G. 1971. Comprehensive studies of solid waste management, third annual report. NTIS Report PB 213 576, National Technical Information Service, U. S. Department of Commerce, Washington, D. C. (Cited by Rhyner & Green, 1988).

8. Jones, K. & J. Simmons. 1987. Location, Location, Location. Methuen Publications, Agincourt, Ontario. Canada. xix + 438 pp.

9. Liblit, E. R. 1990. Commercial recycling in Babylon, New York: how the other half operates. Resource Recycling 9(11): 48-52.

10. Louisville. 1970. (Cited by Peter Middleton & Associates but not referenced in their report).

11. Peter Middleton & Associates Limited. 1975. Composition and quantity: a critical evaluation of existing data. A Municipal Solid Waste Management Study by the Pollution Probe Foundation. 86 pp.

12. Proctor & Redfern Ltd. 1972. Hamilton-Wentworth Waste Management Study. First and Second Interim Report, May and October. (Cited by Peter Middleton & Associates).

13. Proctor & Redfern Ltd. 1975. (Cited by Peter Middleton & Associates but not referenced in their report).

14. Rhyner, C. R. & B. D. Green. 1988. The predictive accuracy of published solid waste generation factors. Waste Management & Research 6: 329 - 338. Smith, F. A. 1975. A solid waste estimation procedure: materials flows approach. Environmental Protection Publication SW - 147, U. S. Environmental Protection Agency, Washington, D. C. (Cited by Rhyner & Green, 1988).

15. Statistics Canada. 1980. Standard Industrial Classification. Ottawa

16. Statistics Canada. 1985. Seasonal Variation in the Canadian Economy: Retail Trade. Categories 16-502.

17. Vesilind, P. A. & A. E. Rimer. 1981. Unit Operations in Resource Recovery Engineering. Prentice-Hall, Inc., Englewood Cliffs, N. J. x + 452 pp.

APPENDIX A

APPENDIX A

Results of an Empirical Analysis of Commercial Solid Waste Generation Undertaken by T.V. DeGeare and J. E. Ongerth (1971) (ref. 3)

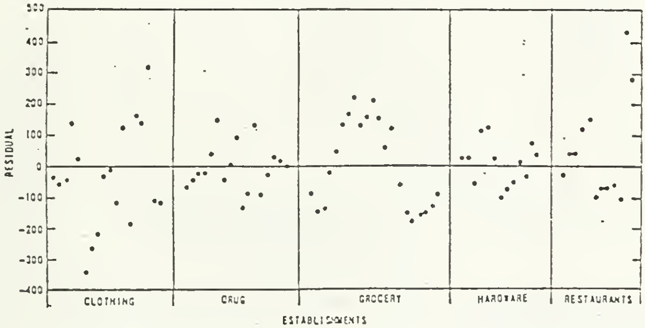


FIG. 1.—REGRESSION EQUATION RESIDUALS (See Table 1 for Data Information)

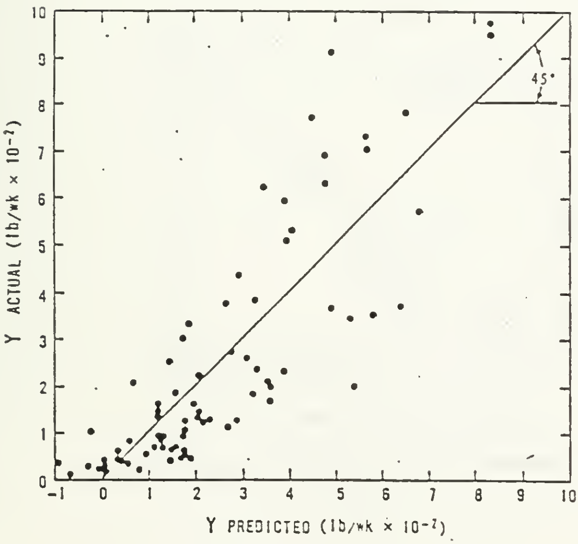


FIG. 2.—ACTUAL VERSUS PREDICTED SOLID WASTE QUANTITIES (All Stores)

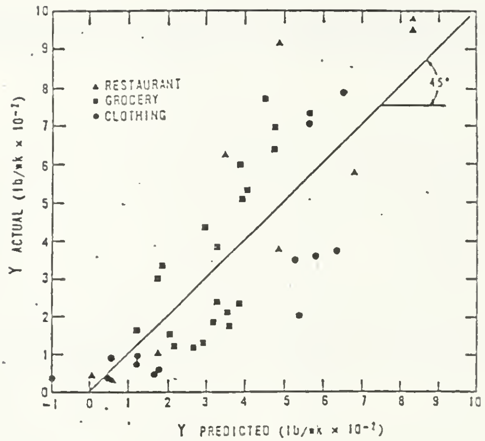


FIG. 3.—ACTUAL VERSUS PREDICTED SOLID WASTE QUANTITIES (Restaurant, Grocery, and Clothing Stores)

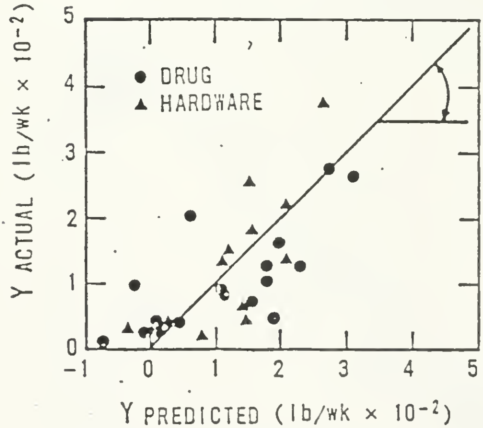


FIG. 4.—ACTUAL VERSUS PREDICTED SOLID WASTE QUANTITIES (Drug and Hardware Stores)

GLOSSARY OF TERMS

GLOSSARY OF TERMS

ABS	Acrylonitrile butadiene styrene; a dense plastic found in computer housings, telephone casings, pipe.
accuracy	In a statistical sense, the term gives an indication of the closeness of the results, estimates, etc. to the "true" value.
commercial wastes	Discarded materials generated by commercial businesses as a result of normal activities in the workplace.
correlation of determination	A numerical measure specifying the proportion of variation in Y, the dependent variable, that is explained by the regression line; i.e., by Y's relationship with the independent variable.
dependent variable	The variable we are trying to predict in regression analysis.
ferrous	A metal object containing elemental iron, giving a 'positive' or attractive response to a magnet (Note: other ferromagnetic materials such as nickel would also give a positive response).
mean	The mean or arithmetic mean of a set of values is the sum of the values divided by their number; average.
MSW	Municipal solid waste, usually defined as the sum of residential and commercial solid wastes, and excluding industrial wastes.
non-ferrous	A metal object which does not give a 'positive' or attractive response to a magnet, e.g., brass, lead, aluminum, etc. (Note: other ferromagnetic materials such as nickel are non-ferrous but would give positive response to a magnet).
OCC	Old corrugated containers; variously called, old corrugated cardboard.
PET	Polyethylene terephthalate; the plastic used to manufacture the common 2 litre pop bottles.
polyolefin	In the sense used here, a grouping of chemically related plastics whose chemical building blocks are either ethylene or propylene.
precision	In a statistical sense, the term gives an indication of the repeatability of a series of observations, estimates, etc. The Standard Error is one kind of estimate of the precision or repeatability or "tightness" of the grouping of the observations (=data).

putrescible	A material which is biodegradable; usually a term reserved for animal or vegetable matter.
PVC	Polyvinyl chloride; a plastic containing chlorine; well known as siding, plastic window sashes and frames, pipe and a few rigid containers.
random number table	These tables (which are found in many statistical textbooks) consist of blocks of numbers that meet certain properties of "randomness", including that numbers in the range 0 to 9 are equally likely to occur; and that the numbers are not serially ordered in any way. Starting at any point on the Table, the user moves systematically through the Table taking the required number of digits.
regression	The general process of predicting one variable from another by statistical means.
regression line	A line fitted to a set of data points to estimate the relationship between two variables, ie. line of best fit.
residential waste	Discarded materials generated by individuals in the course of their daily activities at their place of residence; in this case, exclusive of yard wastes and leaves.
scatter diagram	A graph of points on a grid; the X- and Y-coordinates of each point correspond to the two measurements made on some particular sample element, and the pattern of points illustrates the relationship between the two variables.
slope	A constant for any given straight line, the value of which represents how much each unit change of the independent variable changes the dependent variable.
standard deviation	A measure of the variation or difference of sample measurements from the mean of all measurements taken.
standard error	A measure of how much sample means can be expected to fluctuate (±) from the true mean due to chance.
tare weight	The weight of an empty container.
Y-intercept	A constant for any given straight line, whose value represents the predicted value of the Y-variable when the X-variable has a value of 0.

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OPERATIONS IMPROVEMENT

Blue Box Program Enhancement and Best Practices Assessment Project

Final Report

Volume I – July 31, 2007

ADVISORY SERVICES

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RECYCLE

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Use of This Report

This report is intended solely for the use of the MIPC Steering Committee of the Recycling Program Enhancement and Best Practices Project (2006/2007) and Ontario municipalities with respect to this specific matter and is not intended for other general use, circulation or publication. Neither KPMG LLP, its affiliates, employees of advisors assume any responsibility or liability for any claims, costs, damages, losses, liabilities or expenses incurred by anyone as a result of the circulation, publication, reproduction, use of or reliance upon our report contrary to the provisions of this paragraph. The comments in this report are not intended, nor should they be interpreted to be, legal advice or opinion.

As with any planning assignment, the role of this document is to estimate future events based on information available and/or provided to us at the time of our report, primarily interview results, field observations, consultation with industry representatives and available published information. There are, however, a number of uncontrollable political, social and internal factors that may affect the findings outlined in this document. As a result, this document should be viewed in the context of being an estimate based on information, which may or may not be influenced by unforeseen or uncontrollable events. We caution the reader that the ultimate success any Blue Box Program Enhancement initiatives can vary significantly from the projections outlined in this report due to economic or regulatory changes, cost escalations, decisions of communities, the emergence of new competitors, changes in government funding programs and/or priorities, or the inability of the program improvement process to achieve certain key milestones.

Executive Summary

*Project Team visited 32 programs to understand causes of good and poor performance and to glean **Best Practices.***

*Best Practices needed to be **measurable**, **comparable**, **transferable**, and **replicable**.*

*Best Practices also needed to result in **minimized unit cost**, while **maintaining or improving diversion**, and producing net positive effects, related to cost and diversion.*

*Programs were observed to have a wide variety of attributes. They varied in **geography**, **size**, **household density**, **maturity**, **governance**, **demographics**, and **materials accepted in the Blue Box**, among other factors.*

In September 2006, the Municipal-Industry Programs Committee (MIPC) of Waste Diversion Ontario (WDO) directed a KPMG-led consortium to identify Best Practices in Ontario municipal Blue Box recycling and to determine 2006 Net System Cost under Best Practices. Identification of opportunities for improvement among a number of recycling programs was also sought by MIPC.

The Project Team was comprised of KPMG LLP, a recognized Canadian advisory services firm, R. W. Beck Inc., a leading US-based recycling and solid waste management consulting organization, and Entec Consulting Ltd., a local recycling services consultancy; municipal and industry secondees augmented the consulting team.

Working collaboratively, the Team developed a project definition of Best Practices in the context of Ontario Blue Box recycling. Best Practices were defined as **waste system practices that affect Blue Box recycling programs and that result in the attainment of provincial and municipal Blue Box material diversion goals in the most cost-effective way possible**.

In order to glean Best Practices and identify opportunities for improvement among the province's recycling programs, detailed questionnaires were completed by program staff and the Project Team then conducted site visits at 32 Ontario municipal recycling programs. Programs were selected on the basis of cost and recovery performance, size, geography, program type, and contract structure.

On site visits, team members interviewed key program staff, observed collection routes, and toured transfer stations and processing facilities. Interviews and visit observations were thoroughly documented and shared across the team using web-based collaboration tools. Over 1,000 photographs and videos were collected as part of the field evidence. Site visits were augmented by secondary research of Best Practices from Canadian and International sources. Previous Best Practice studies by Ontario provincial, municipal, and industry entities were also leveraged.

Information gathered from site visits and industry research was subsequently used to formulate Best Practices, analyze issues and barriers, and identify opportunities for improvement.

Following a significant analytical exercise and a consensus building process among the team members, preliminary Best Practices were identified. A fact-based approach, rooted in site visit evidence, expert contributions, and statistical analysis, was used to finalize a set of Best Practices for municipal Blue Box programs.

Fundamental Best Practices – Best Practices as defined above that apply to all Ontario programs – are presented below:

- Development and implementation of an up-to-date plan for recycling, as part of an integrated Waste Management system

- Multi-municipal planning approach to collection and processing of recyclables
- Establishing defined performance measures, including diversion targets, monitoring and a continuous improvement program
- Optimization of operations in collections and processing
- Training of key program staff in core competencies
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded Promotion and Education program
- Established and enforced policies that induce waste diversion

A set of Best Practice Spotlights – descriptions of leading practices in specific program components – was developed to help recycling coordinators address commonly encountered challenges and issues. These program areas include:

- Multi-Family Recycling
- Recycling of Challenging Plastic Materials
- Curbside Collection of Materials
- Depot Collection of Materials
- Processing of Materials
- Marketing of Materials

Decision Tree Factors

*The basis for geographic delineation is the **Blue Box Program Plan** legislation, which defines physical boundaries of Northern and Southern parts of the province.*

*Program size is defined by the annual Blue Box material **tonnes marketed** by the program.*

*Household density is defined by the number of **households per kilometre** of road in served by the program.*

Conditional Best Practices, which apply only to programs with specific characteristics and under certain conditions, were delineated for specific program types using a Decision Tree approach. The Decision Tree takes into consideration three main factors in program variability: geography, size, and density. Based on the combination of these three factors, 12 program types were identified. Conditional Best Practices, along with other helpful guidance, are detailed in Program Profile documents, customized for each program type.

Individualized reports on opportunities for improvement were developed for 23 of the visited municipalities. These customized reports contain an overview of the current state, the future state under Best Practices, and provide specific action items to be implemented by the municipality to improve the performance of its Blue Box program. These documents were distributed directly to the respective municipalities, and are not included in this report. Reports to communities that have agreed to make them public can be found on the WDO website.

In addition to identifying Best Practice activities in municipal recycling, the Project Team developed an estimate of 2006 Blue Box Program Net System Costs under Best Practices for the purposes of setting 2008 Stewards' fees. This cost estimate ranges from $134.1M to $144.9M, depending on the method of calculation.

Volume I of this document provides information related to Best Practice activities. Volume II provides information on the cost model and determination of 2006 Net System Cost under Best Practices.

Introduction

The Ontario Blue Box Recycling Program Effectiveness and Best Practices Assessment Project is driven by the need to identify Best Practices in municipal recycling and determine the 2006 Net System Cost under Best Practices.

Project Overview

Key Drivers

In September 2006, the Municipal-Industry Program Committee (MIPC) of Waste Diversion Ontario (WDO) engaged KPMG and its associates to review current practices across a number of Ontario municipal recycling programs, identify and document Best Practices, formulate opportunities for implementing and diffusing Best Practices, and quantify the effects of province-wide Best Practice adoption. The key drivers for this project are as follows:

- The Minister of the Environment has determined that Stewards' obligation will be confined to 50% of Best Practice system costs by 2008
- Stewards' fees for 2008 are to be based on 2006 Net System Cost under Best Practices
- There is lack of understanding and consensus among stakeholders on what constitutes Best Practices in municipal recycling
- Municipalities are seeking guidance on how to employ Best Practices in order to increase diversion and lower program costs

Project Objectives and Expected Outcomes

To address the Minister's direction and help municipalities to implement Best Practices, MIPC defined several key project objectives. Two primary objectives are as follows:

- To identify Ontario Blue Box Recycling Program Best Practice activities, opportunities, and associated costs
- To determine the 2006 Ontario Net System Cost under Best Practices for the purpose of defining Stewards' contributions

A secondary objective, aimed at diffusing project deliverables and implementing Best Practices is:

- To identify and assess options for the use of the Effectiveness and Efficiency (E&E) Fund in promoting the adoption of Best Practices

The attainment of these objectives relates directly to expected outcomes for the project. MIPC's expectations for project outcomes are as follows:

- List of Best Practice activities
- Individual plans on how to adopt Best Practices for selected participant municipalities
- Total 2006 Net System Cost under Best Practices for the purpose of setting of 2008 Steward Fees
- Options for the use of the E&E Fund to promote Best Practice diffusion

Success Criteria

In order to define what constitutes success for this project, KPMG interviewed several MIPC members and received feedback on their vision for a successful outcome. While a number of factors were articulated, the main criteria for success were documented as follows:

- Consensus is reached on Best Practice Net System Cost figure for 2006
- Deliverables are developed in a transparent, inclusive, collaborative manner
- Recommendations made by the KPMG Team are accepted by MIPC
- Recommendations institutionalize a continuous improvement approach within municipalities

MIPC, as the Steering Committee for the project, is the governing body that decides whether the above criteria have been met and the project deemed to be successful. Upon being accepted and signed off by MIPC, project deliverables are to be presented to the WDO Board, Stewardship Ontario Board, and Association of Municipalities of Ontario (AMO) Board.

Approach and Methodology

To effectively execute this engagement, the Project Team employed a rigorous, fact-based, collaborative approach in gathering and analyzing data, engaging stakeholders, and producing project deliverables.

__KPMG LLP__ is the Canadian member firm of KPMG International, the coordinating entity for a global network of professional services firms that aim to turn knowledge into value for the benefit of their clients, people and the capital markets.

With nearly __94,000 people__ worldwide, and more than __3,500 people__ in __35 offices__ across Canada, KPMG provides a range of management advisory, audit and tax services.

__R.W. Beck Inc.__ is an employee-owned corporation, founded in 1942, with __25 offices__ in the US and project experience in over __50 countries__.

With a portfolio of more than __500 recycling studies__ in the United State and abroad, R.W. Beck is widely regarded as the __leading recycling consulting__ firm in the United States.

Team Structure

Consortium of KPMG, R.W. Beck, and Entec

Project scope and objectives required a multifaceted consulting team, with the ability to bring experience in identifying best management practices, adopting leading recycling processes, and leveraging the knowledge of Ontario Blue Box programs. A consortium of firms was established that included KPMG, R.W. Beck, and Entec Consulting.

KPMG team members are professionals in the firm's large and rapidly-growing Advisory Services practice, focusing mainly on business improvement and strategic cost management. They have worked across the broader public sector, and in a diverse range of industries, including financial services, manufacturing, healthcare, and retail. On previous projects they have helped organizations to reduce operational costs, streamline processes, determine strategic direction, manage change, and review or implement new programs or services.

R.W. Beck professionals have completed major strategic planning and recycling policy and program development projects for multiple US municipalities, state governments and the US EPA, as well as trade associations representing nearly all of the major recycling commodities. Additionally, R. W. Beck has collaborated with numerous Fortune 500 companies, including Wal-Mart, Weyerhaeuser, Dow Chemical, Coca Cola and Procter & Gamble, to develop corporate sustainability and recycling program initiatives.

Entec's main principal has been actively involved in providing consulting services to Ontario municipalities for over 30 years. During that time, he has worked both directly with individual municipal clients, as well as indirectly through clients such as OMMRI, CSR, WDO and more recently Stewardship Ontario, on a wide variety of solid waste system design and evaluation projects for collection systems, MRFs, and transfer stations. He has also worked on a number of International recycling and solid waste projects.

A number of industry and functional advisors were relied on at key points in the project to bring subject matter expertise and analyze, validate, and review the Team's findings. Specifically, guidance was provided in the following areas:

- Cost management
- Statistical analysis
- Industry insight
- Emerging and existing recycling technologies
- Promotion and advertising
- Procurement and supply chain management
- Stakeholder engagement
- Change management

Municipal and Steward Secondees

To augment the consulting team and bring first-hand knowledge of Ontario recycling programs, nine municipal and steward employees were deployed to this project on a secondment basis. Municipal secondees represented large, small and mid sized programs across the province. Steward representatives had extensive municipal recycling work experience and specialized expertise relevant to the project. Collectively, the secondees' expertise and experience spanned virtually all elements of a recycling program, including:

- Program coordination and management
- Promotion and education
- Policy development
- Procurement and contract management
- Collections
- Processing
- Marketing

Project Approach

KPMG Methodology

On this project The KPMG Team employed a robust Project Management methodology that has been used effectively on numerous previous large scale assignments. This methodology enabled the Project Team to meet the objectives of the engagement and complete the project in the allotted timeframe.

To develop the project work plan, the Team leveraged KPMG's Business Transformation Methodology, which is designed to help organizations transition from current state to a desired future state. All project phases, activities, and tasks were aligned along the main components of this methodology, as depicted below:

Collaboration

All major deliverables produced in this project were developed through a collaborative and iterative process that involved consultants, secondees, and key stakeholders. By employing communication and workflow tools, all members of the Team were able to write, revise, review, and/or comment on work products at various stages of their completion. To communicate, share documents, schedule events, and store data, the Team used KClient – a proprietary web-based project management and collaboration tool.

Weekly team meetings contributed to heightened levels of engagement, awareness, participation, and responsibility by all members of the Team.

Program site visits and interviews were conducted jointly by consultants and secondees, with at least one member of KPMG or R. W. Beck participating in each visit.

Stakeholder Involvement

To understand and incorporate perspectives of various stakeholders affected by this project, the Team developed and executed a Stakeholder Engagement Plan. Key stakeholders of this project were identified as:

- MIPC
- Stewardship Ontario
- Municipal programs and their representatives
- WDO
- Ministry of the Environment
- Private sector service companies
- Municipal leaders in recycling
- Secondees

Regular meetings with MIPC were held to report on project progress, make decisions in the direction of the work, and review and comment on interim and final deliverables. Also, a MIPC-appointed Project Coordinator liaised with the team on a regular basis. Furthermore, all MIPC members were interviewed individually as part of the initial stakeholder engagement strategy.

Stewardship Ontario was involved in providing insight into current industry issues and opportunities, conveying International leading practices, obtaining program data, and coordinating the secondment of municipal and steward resources. Also, several presentations were made to the Stewardship Ontario Projects Committee. Individual interviews were also conducted with selected steward representatives.

Municipal programs coordinators and staff were involved in site visit interviews and facility tours. They were also primary reviewers and recipients of individual program reports on opportunities for improvement. Presentations on project work scope and progress were made to municipal entities, such as AMO, Association of Municipal Recycling Coordinators (AMRC), and at the Ontario Recyclers' Workshop (ORW).

Individual interviews on project expectations and desired outcomes were conducted with members of the WDO Cost Effectiveness Committee and with senior personnel within the Ontario Ministry of Environment.

To gain insights and seek answers to specific technical questions, interviews were conducted with selected recycling equipment manufacturers, private operators, and recycling industry consultants.

Workshops focusing on project expectations, interim deliverables, and input for implementation of work products were held with representatives of large and influential Ontario municipal recycling programs.

Municipal and steward secondees were integrated into the Project Team and worked jointly with consultants on all major work products. Professional development training sessions were held at regular intervals to enhance skills in the areas of teamwork, project planning, meeting effectiveness, and negotiations, among others.

Blue Box Program Visits

Program Selection Process

In order to glean Best Practices and identify opportunities for improvement among province's recycling programs, the Project Team conducted site visits of several Ontario municipalities.

Selection of municipalities to be visited was based on the following Project Charter criteria:

- Eight to ten programs regarded as high performing, based on having low Effectiveness and Efficiency (E&E) ratios, were to be visited for the purpose of identifying Best Practices and determining factors that lead to high performance. (The definition and components of the E&E ratio are discussed in the "Key Observations" section of this report.)
- Twenty to thirty programs, believed to be moderately to poorly performing, (having high E&E ratios), were to be visited for the purpose of identifying opportunities for improvement and determining factors that lead to moderate or poor performance. Best Practices and factors that lead to high performance were also to be observed and documented within these programs.
- Largest programs, as measured by tonnage of marketed materials were to be visited due to the potential magnitude of impact on cost and tonnage of diverted materials.

Within these, to be selected were: five to ten programs with contracts expiring in the next 24 months, five to ten programs expiring after 24 months, and five to ten municipally-operated programs. In order to identify individual communities that fall within the parameters of the Project Charter criteria, additional selection criteria were developed. These criteria, aimed at maximizing the value of the project, are as follows:

- Municipal Groupings (clusters of programs, based on size, density, geography, and collection type) – within municipal groupings, at least one high performing program and one or more moderate to poor performing programs were to be selected. In depot collection groups, only the high performing programs were to be selected
- Geography – while representation of geography is facilitated by the Municipal Groupings criterion, the final sample of programs was to contain a mix of Southern and Northern municipalities to ensure balanced representation
- Transferable – the aim of Best Practice analysis was to identify those practices and circumstances that can duplicated across a large number of communities
- Clustered programs – programs were to be selected that are located close to each other, thereby presenting opportunities for project efficiency and the potential to identify multi-municipal cooperation structures
- Learning value – programs that are known in the industry to exhibit leading practices were to be considered

Programs meeting the above criteria were invited to participate in this study. Upon receipt of the responses, a list of 32 programs to be visited was finalized and approved by MIPC. The list of participating municipalities is presented in Appendix A. Nine of these municipalities were selected as well performing programs as measured by the E&E factor, while 23 were selected as poorer performing programs as measured by the E&E factor. Individual program reports on opportunities for improvement were to be developed and distributed only to the latter set of municipalities. Due to the program-specific information outlined in the community reports and the confidentiality agreement between the Project Team and municipalities, these work products are not presented as part of this final report. A table of contents for a sample program is presented in Appendix B. Reports for communities that have agreed to make them public will be posted on the WDO website.

The site visit questionnaire was designed to gather information on numerous program areas, including: ***general program management, promotion and education, collection, processing marketing, tendering and contracts,*** *and* ***monitoring and evaluation.***

Questionnaire Development

In order to obtain reliable and comprehensive information from visited programs, a consistent and repeatable process of gathering data was required. The Project Team worked collaboratively to define the objectives of the site visit, assess the means of facilitating the interview, and determine the options for site visit documentation.

A significant element of the interview protocol was the administration of a questionnaire to learn details about each program. The questionnaire was developed through an iterative process involving the consulting team, secondees, and MIPC members. Stakeholder suggestions and amendments were integrated into the questionnaire to ensure that information on key aspects of the program was captured. The final questionnaire contained 121 questions split into two sections: pre-visit and site-visit.

The resulting questionnaire was used as an interview guide that enabled the Team to ask the same set of questions in each community, leading to greater comparability and consistency of documented program information.

Site Visits

Members of the Project Team visited 32 Ontario municipal recycling programs to glean Best Practices and identify opportunities for improvement. For smaller programs, a site visit lasted one day. For larger programs, time spent on site typically consisted of two to three days to gather program data and information. A typical visit consisted of an interview with key program staff, observations of a collection route, and a tour of a processing facility and/or a depot/transfer station.

The interview was usually conducted with the program coordinator; in larger programs, specialized staff were also present to answer questions on specific questionnaire topics. Promotional materials used by the program were collected for further study and analysis.

Tours were usually facilitated by a municipal staff member or a contractor representative. Collection vehicles, curbside set outs, depot areas, and loading processes, were photographed or videotaped. Where allowed by the contractor/municipality, processing facilities were also photographed or videotaped. Over 1,000 photographs and videos were collected as part of the field evidence.

Information gathered from site visits was subsequently used to define Best Practices, analyze issues and barriers, and formulate opportunities for improvement.

Documentation

Use of KClient

To facilitate capturing, storing, and sharing of information, the Team utilized KClient as a dynamic document and record repository. A mix of databases, shared directories, and calendars was used.

All pertinent documents that were identified and reviewed as part of the primary and secondary research were filed in KClient. All site visit information, including completed questionnaires, background reports, WDO audits, photographs and videos, electronic versions of promotional materials, and other relevant program documents were stored on KClient for team access and review.

All quantitative and qualitative analyses conducted on available and acquired data were stored on KClient for Team access and review. All interim and final deliverables, including Project Charter, presentations to stakeholders, and status reports were filed on KClient for full access by the Team.

Collectively, these supporting documents act as a foundation of the fact-based analysis conducted by the Team. They comprise a set of working papers that can be used to trace the source, rationale, and basis for the Team's findings. Due to its importance to project's final results, all electronic documentation from KClient has been made available to MIPC to support the information contained in this report.

Analysis and Assessment

Regression analysis *examines the relation of a dependent variable (response variable) to specified independent variables (predictors). In this project it was used to determine how and to what degree a change in process/activity/practice has the ability to influence program performance.*

Correlation *indicates the strength and direction of a linear relationship between two random variables. In this project it was used to determine factors that correlate to good and poor performance by programs.*

Frequency distribution *is an assessment of values that a variable takes in a given sample. In this project it was used to assess the probability of a performance outcome based on a change in one or more parameters.*

Range of Analytical Tools

A combination of quantitative and qualitative analyses was used to support or reject hypotheses, validate findings, and confirm our recommendations. Quantitatively, the following methods were used:

- Regression analysis
- Correlation analysis
- Frequency distribution analysis
- Mean and median calculations

The Team also relied on an evidence framework in analyzing qualitative elements of programs and identifying Best Practices. This framework included considerations of the following:

- Best Practices definition and criteria, agreed to by MIPC
- Site visit evidence
- Best Practice reports on other communities and jurisdictions
- Industry expert opinion and other previous Best Practices studies (AMRC, Ontario Waste Management Association, Ontario Centre for Municipal Best Practices, R.W. Beck studies, and other data sources)

Further details on the methodology utilized are provided in the following sections describing specific project work steps.

Secondary Research

Document Research and Review

Members of the Best Practices Project Team performed a search and review of literature, available in print and on line, related to residential recycling practices. Team members were asked to research information on assigned topics, so they could become team "experts" in their assigned topic areas on behalf of the Team as a whole. These individuals were later called upon to do subsequent project tasks related to their areas of expertise and to serve as technical resources to other team members as needed.

The literature that was reviewed encompassed over 100 documents, available from numerous Ontario, Canadian, and international sources. Local research sources included:

- Stewardship Ontario and the Stewardship Ontario Knowledge Network
- Waste Diversion Ontario
- AMO
- AMRC
- Federation of Canadian Municipalities
- Ontario Center for Municipal Best Practices
- Selected Ontario local government websites
- Other Canada province websites, including Nova Scotia and New Brunswick
- Selected recycling industry trade associations
- Municipal programs
- Documents and information from Project Team member files and reference libraries

International Best Practices research focused on leading global recycling jurisdictions, including the following:

- U.S. Environmental Protection Agency
- Selected U.S. states, including Minnesota, California, Pennsylvania, New York, and Massachusetts
- Selected U.S cities and counties, including Alameda County, CA; Kansas City, MO; New York City, NY
- The United Kingdom
- Australia
- Sweden
- Japan
- Scotland
- Germany

Many of the reviewed documents or their associated web links were uploaded to KClient so they could be accessed by the Team for reference throughout the project. To aid other team members in accessing information pertinent to their work, significant documents were catalogued in the Team's Documents Review Database on KClient, with notations made regarding topics covered, key insights, and relevance.

Other Research

In addition to reviewing recycling industry literature and reference materials, information on specific topics was also obtained through e-mail communications and interviews with selected recycling professionals and industry experts. Among these were processing equipment manufacturers, MRF operators, trade association technical staff, and recycling program managers in Canada, the US, and abroad. For the most part, such communications served to validate Project Team assumptions regarding Best Practices or to obtain specific information (e.g., leading International Best Practices information) not available through other sources.

Best Practices Definition and Assessment Criteria

A definition and assessment criteria for Best Practices allow for determination of what constitutes a Best Practice and provides direction on how to differentiate practices that are "Good" from those that are "Best"

Definition of Best Practices

The Project Team worked collaboratively to determine a working definition of the term "Best Practice", as it applies to the recycling industry. Team members' proposals and suggestions were evaluated based on the need to maintain a balance of municipalities' and stewards' objectives, respect municipal autonomy, adhere to Blue Box Program Plan guidelines, and to be clear and easy to understand.

As an outcome of this process, the following definition was formulated and approved by MIPC:

"Best Practices are defined as waste system practices that affect Blue Box recycling programs and that result in the attainment of provincial and municipal Blue Box material diversion goals in the most cost-effective way possible"

Best Practices Attributes

To help identify and qualify observed practices as "Best Practices", the Team developed a set of criteria and attributes that further augment the formulated definition. Thus, Best Practices in municipal Blue Box recycling are:

- Measurable
- Comparable
- Transferable
- Replicable
- Result in minimized unit cost, while maintaining or improving diversion
- Result in net positive effect, as it relates to cost and diversion
- Temporal in nature – continuous improvement and evolution of technology will yield new Best Practices

Best Practices are not confined to any specific area of the Blue Box program. They could be operational, promotional, administrative, or legislative.

Key Observations

Team's observations from site visits, research, and analysis are presented in this section. Collectively, they serve as a foundation for project findings and recommendations.

Use of E&E Factor as a Performance Measure

E&E Factor Definition

The Effectiveness and Efficiency Factor (E&E Factor) was developed as part of the WDO Cost Containment plan requested by the Minister of the Environment, and takes into consideration two fundamental program metrics – recovery rate and net cost per tonne. It is derived by dividing net cost per tonne by the recovery rate percentage for a given program. Lower E&E Factor figures are meant to convey better performance, as programs strive to minimize unit costs (numerator) and maximize recovery rates (denominator).

Net cost per tonne is determined by deducting program revenues from gross program costs and dividing the resulting net program cost by the tonnage of materials marketed.

The recovery rate portion of the Factor, measured in percent, conveys the relationship between kilograms per household per year recovered and kilograms per household per year available for a given community. The available kilograms are assigned to a program based on a number of factors, chief of which is extrapolation of results of material audits across the province.

Examples of feedback received on the use of the E&E ratio:

"…it has some merit when used with proper data and in context."

" …(a) performance measure is a good idea and (E&E Ratio) ties two key performance factors together – costs/tonne and recovery – to give a quick comparative snapshot."

"…the recovery rate is an artificial number based upon extrapolation of a study."

"… (E&E Ratio) works well for (a program in which) MRF is fully amortized."

Observations on the use of the E&E Factor

The Factor serves as a good overall metric to assess program performance at a high level. Programs with low unit costs and high recovery rates do demonstrate better E&E Factor numbers than those with high unit costs and poor recovery rates. However, there are a number of inherent issues with the E&E Factor.

First, as municipal program operators have pointed out, the recovery rate percentage is a calculated number, based on the availability of recyclable materials assigned by WDO. If the availability of materials does not accurately represent a community's retailing landscape, demographic profile, or residents' purchasing patterns, the recovery rate figures will be skewed.

Second, the net cost per tonne does not adequately allocate program capital costs to current tonnes if the employed capital is fully depreciated. Therefore, if a program with an older, amortized MRF opts to replace it with a new facility, its net cost will most likely rise, and so will the E&E Factor. In this situation, program performance

Examples of feedback received on the use of the E&E ratio (cont):

"…It appears to try to consider too much, and if you slightly fall outside different steps, your program is considered ineffective."

"…it does not take into account that programs are in different developmental stages."

may not have changed (or may have even improved), while the E&E Factor would indicate lower levels of performance. Thus, as an observation, programs with fully amortized MRFs tend to exhibit lower E&E Factor metrics.

Third, the Factor is designed to assign equal importance to unit costs and recovery levels. This may not account for the differences in municipal goals and perspectives, as some municipalities place priority on maximizing diversion and are prepared to incur higher costs because of it, while others may pursue opposite objectives. Thus, from a municipal point of view, if a program is recovering 80% of recyclables at $160/tonne, it may be considered to perform significantly better than a program that recovers 50% of recyclables at $100/tonne (both programs would have the same E&E Factor of 2).

Finally, the Factor tends to penalize municipalities with recently introduced programs and reward communities with established, mature programs. Newer programs tend to exhibit higher costs and lower recovery levels due to start up activities and low initial resident participation rates. There is a dual effect on the E&E Factor: low tonnages of recyclables recovered significantly reduce the calculated recovery rate, and fixed and variable program costs are spread out over a smaller number of tonnes, leading to higher unit costs. Consequently, programs within the same municipal group (similar size, geography, collection method) will exhibit different E&E Factors due to variance in their maturity.

As a result of these shortcomings, the use of the E&E Factor alone to evaluate program performance may not be optimal, as perceived by municipal program coordinators and operators. It is important to understand other factors in assessing a program's performance.

Program Diversity

The challenge of identifying Best Practices becomes more difficult when one considers the sheer variety of municipal Blue Box programs that exist in Ontario. While some of the differences are captured by the use of Municipal Groupings, which aim to categorize programs based on size, geography, density, and collection process, other variations that appear to have significant program implications still exist.

One of the major differences among programs is size, as measured by population and tonnage. Larger cities and municipalities, even within municipal groups, tend to generate greater economies of scale. They have more staff dedicated to waste management and recycling. Their fixed costs are distributed over a larger number of tonnes and/or households, thereby reducing unit costs. Larger cities also tend to have more pressing landfill issues, leading to increased emphasis on recycling.

Geography is an important differentiator of programs. Northern Ontario municipalities tend to deal with issues that are not prevalent in the southern parts of the province. These include distance to markets and equipment suppliers, lack of competition, lack of diversion drivers (greater landfill capacities), large distances between programs, weather complexities, and conflict with the natural resource-based economy of the North, among others. Southern Ontario municipalities exhibit differences in their proximity to the Golden Horseshoe region (and the associated markets, equipment suppliers, and contractors), proximity to highways, topography, seasonal and transient population, and labour availability.

Household density is an essential component of program design and operation, and even within municipal groupings, it varies substantially. Moreover, some municipalities have uniform distribution of households, while others have pockets of density, requiring different collection methods. The percentage of multi-family households, which is a function of household density, also varies across programs, adding further complexity to program operations.

Program maturity varies significantly among municipalities in the same group. Recently established Blue Box programs tend operate in an investment mode, which requires substantial emphasis and effort on optimizing program components and increasing residents' participation and recovery rates. Mature programs tend to concentrate on maintaining or tweaking existing processes, seeking to gain incremental improvements in costs or recovery rates. The Project Team visited communities with Blue Box history ranging from three years to several decades.

A variety of governance structures was also observed in site visits. In some municipalities, decisions on all strategic, tactical, and operational issues need to be escalated to full council level. In others, a council sub-committee has the authority to make final decisions. In some, only strategic issues are dealt with by the council, whereas operational decisions are made at the staff level. In some regional programs, a Board, comprised of representatives from participating municipalities, makes the majority of decisions. There also exist instances, where a non-profit municipal entity operates the regional Blue Box program, with only periodic guidance from its constituent municipalities.

Demographic characteristics of community residents are varied across and within programs. Some municipalities have homogenous demographic traits, while others exhibit high diversity in resident ethnicity, language, age, and economic status. The degree of attention afforded by the recycling program to address these demographic differences also varies greatly among municipalities.

The range of materials accepted by Blue Box programs varied widely across the province. While the basic five materials legislated by Regulation 101 under the Environmental Protection Act were accepted by all programs, the combination of additional recyclable materials was unique in almost every program. Some municipalities, in an effort to maximize diversion, include all major plastic, paper, and metal recyclables in their program. Others include only those products that are economically viable to collect and process, and have developed mature markets.

Other program differentiators, observed through site visits and data analysis, include, but not limited to:

- Synergies between waste streams
- Economic conditions of the region
- Degree of contractor competition available
- Environmental focus in the community
- Pool of available labour

Challenges of Comparability

Challenges of Identifying and Quantifying Best Practices

The large degree of variability makes the identification of Best Practices extremely challenging. The main barrier to determining what constitutes a Best Practice is that some of the observed practices employed by municipalities may have yielded good performance results only due to the specific nature of a given community, and, thus, they are not transferable to other programs.

Even when a practice is deemed to result in net positive effects in a broad range of municipalities, quantifying the effect of employing that practice poses insurmountable difficulties. For example, if a recently established program were to begin employing a good practice and experience a positive outcome of a certain magnitude, the outcome of the same magnitude cannot be realistically expected from a mature, well-established program.

Another factor that complicates comparability and quantification of Best Practice is the method in which municipalities make changes to their programs. In most cases, when introducing a new process or employing a new practice, municipalities tend to make multiple other program amendments at the same time. As a consequence, when program performance is evaluated to measure the impact of implemented modifications, it is difficult to attribute the resulting outcome to any one specific practice.

Additionally, Blue Box recycling programs are usually one of many components of a community's waste management system, and operations often have interdependent aspects. As an example, one contractor might be hired to provide both Blue Box recycling and waste collection services, and certain communities perform co-collection of recyclable materials and waste items.

These observations and realizations precluded the Project Team from determining costs of or assigning "prices" to individual Blue Box program Best Practices. Furthermore, the Team concluded that extrapolating financial or operational results of individual Best Practices to other programs is neither practically feasible nor defensible in the context of Ontario municipal Blue Box recycling. Consequently, it was not deemed feasible to aggregate the effect of all individual Best Practices in order to quantify the "Best Practice Program Cost".

As an alternative approach, the Team utilized a holistic, system-wide approach to identifying the effects of Best Practices adoption. Components of well-performing programs were analyzed with respect to their collective implications to determine whether a program was operating at Best Practice level. Descriptions of programs that were observed to utilize a large number of Best Practices are presented in Volume II of this report.

Factors Contributing to Good and Poor Performance

The Project Team utilized various approaches for determining specific factors that contribute to good and poor Blue Box program performance. Initial attempts were focused on identifying the correlation between distinct program attributes and the program's E&E ratio. However, as described in the "Key Observations" section of this report, the Project Team found that the E&E ratio was influenced by a number of elements that are not representative of program performance, such as location, geography, and population demographics.

The project team attempted to analyze the 2005 WDO Datacall data to see if good and poor performance could be correlated to certain program items, despite understanding that non-programmatic factors contribute to performance. However, it was often found that correlation analysis was not meaningful due to lack of data points and multiple contributing factors. The following example may help to illustrate this. The number of program options exponentially affects the number of possible permutations – a set of only ten options with two choices each results in 2^{10} or 1,024 possible program configurations. In fact, combinations of more than seven program options exceed the available number of data points (189 total programs in 2005).

Because of data limitations, the Project Team sought to identify which attributes appeared to contribute positively or negatively to program performance as defined by a variety of other performance measures and did not rely on the E&E ratio alone as the measure of performance.

Methods used in this modified approach to the analysis were as follows:

- Documenting specific factors and program attributes identified through site visits that appeared to influence program performance
- Interviewing program representatives to gain their insights and opinions regarding program attributes that they believe affected program performance
- Reviewing and assessing program data and interview records to glean information indicating potential contributors to good or poor program performance
- Comparing the results across visited communities to look for patterns indicating common contributing factors
- Performing limited sets of statistical analyses on WDO Datacall data regarding very specific factors to assess the extent to which the presence or absence of these factors appeared to affect program results

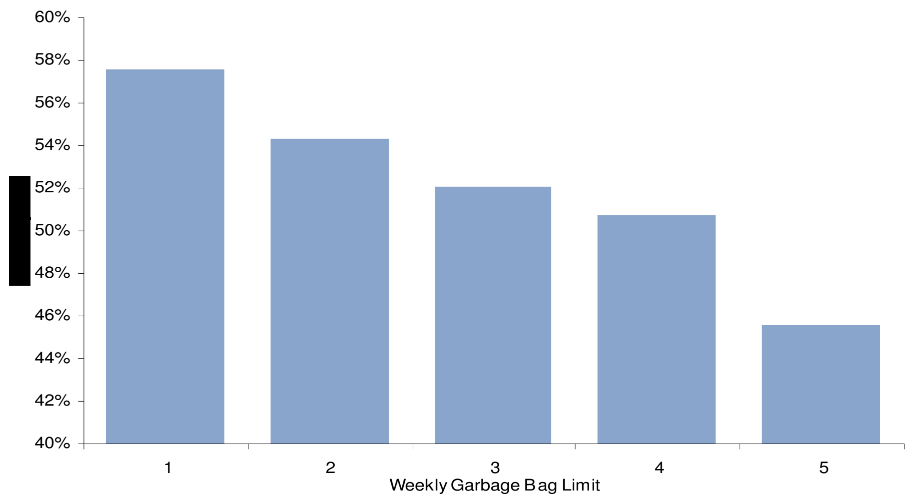
- Holding field team and full team meetings to discuss the results of the activities described above and to develop a common list of factors and program attributes for reference purposes in determining Best Practices

A list of potential contributors to program performance identified through qualitative analysis and as reported to the Project Team by community representatives interviewed was compiled. Although regression analysis could not provide confidence in correlation of many specific program factors to performance, a quantitative and qualitative analysis (e.g., including support from other studies, field work and expert opinion) of certain data sets provided strong support that certain factors contribute to good or poor performance. Conclusions that were derived from these analyses are as follows:

- Reducing solid waste services (e.g., two-bag limit, reduced frequency of solid waste collection) supported by diversion alternatives was found to result in higher recovery rates for Blue Box materials. This is illustrated in the following figure, which shows the relationship between recovery rate and the garbage bag limit imposed on residents.

Bag Limit Effect on the Recovery Rate

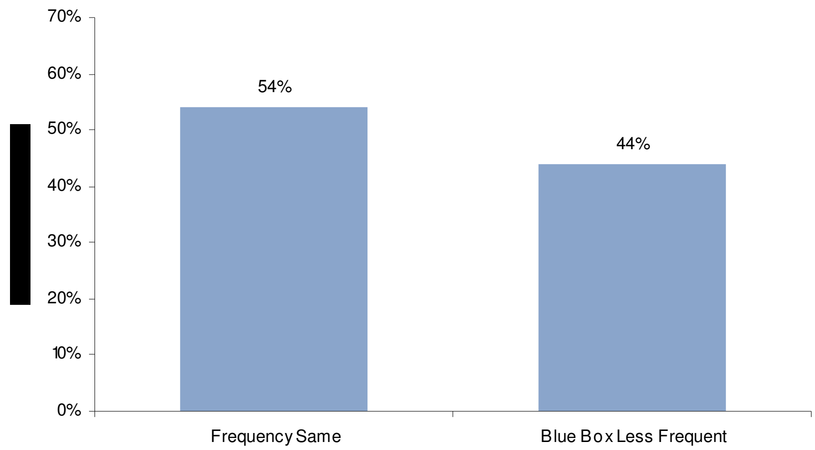
Municipalities with lower weekly garbage bag limits tend to exhibit higher recovery rates.



- Collecting an expanded list of Blue Box materials above that required by Ontario Regulation 101 was found to result in higher recovery rates for Blue Box materials.
- Reducing the frequency of garbage collection and/or increasing the frequency of Blue Box collection was found to have a positive effect on recovery rate, as illustrated in the figure below.

Frequency of Garbage and Blue Box Collection

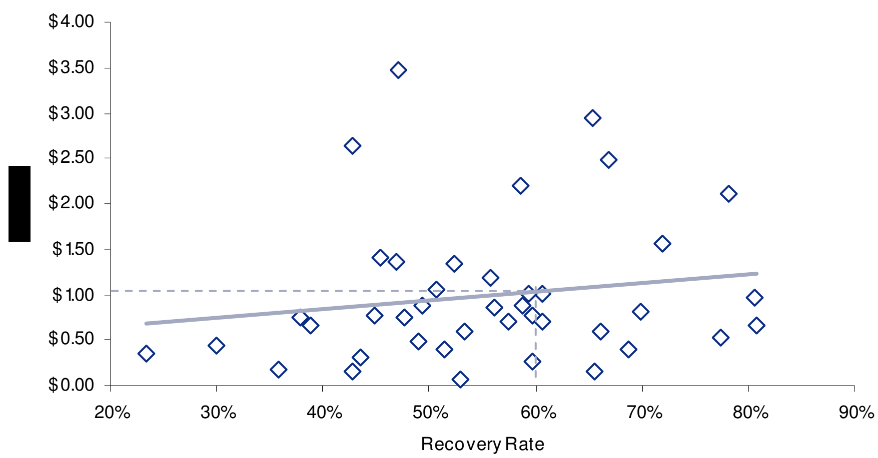
Municipalities that collect recyclables less frequently than garbage tend to exhibit lower recovery rates, as compared to municipalities where collection frequency of garbage and recyclables is equal.



- While the correlation between P&E expenditures and corresponding recovery rates was low, on average, programs that obtain 60% recovery tend to spend approximately $1 on Promotion and Education. This is illustrated in the following figure.

Promotion and Education Expenditures among Medium and Large Municipalities

Municipalities achieving 60% recovery levels, on average, tend to spend approximately $1 on Promotion and Education.



- Distinct processing efficiency differences were observed between facilities that process more than 10,000 tonnes per year of Blue Box recyclables and those that process less.

A number of other factors were reported to the Project Team on site visits as potential factors influencing performance.

Factors that appeared to **positively** affect program performance:

- Promotion of environmental awareness as community focus - comprehensive menu of environmental programs that develops/reinforces a broad environmental ethic
- Existence of an integrated Waste Management Plan
- Regional cooperation
- Established relationships with and knowledge of end markets
- At least one depot for Blue Box overflow, additional materials, or to serve multi-family who otherwise don't have Blue Box service
- Programs that forego revenue for low cost collection/processing from a local MRF can be very efficient
- Short distance to MRFs and markets
- Clear instructions to residents, operators, collectors, etc.
- Consistent enforcement of rules and limits
- Staff consistency, especially on collection
- Collaborative P&E, with schools/civic organizations/young persons groups, etc.
- High availability of P&E, such as local phonebooks, visible on trucks, calendars, etc.
- High tipping fees at landfills

Factors that appeared to **negatively** affect program performance:

- Long distance to MRFs and markets
- Contracts not fully understood, e.g., fuel surcharge amounts
- High residue rates – may be poor setout, collection, processing, or "high-grading" at MRF
- Poor baling – not dense enough
- Inconsistent collection or enforcement of rules
- Poor education of municipal/contractor employees
- No provision of Blue boxes
- High degree of seasonal residents
- High degree of private, narrow, roads
- Dispersed population
- Poor location of MRF within municipality (not centralized)
- Lack of Audits of materials
- Low importance by management
- Lack of skills and resources
- Recently established recycling program

Other Observations

The Project Team documented a number of other observations, drawn from site visits, research, and data analysis. These are presented in this document as perceived issues; further review, analysis, and validation is required to substantiate these observations.

- The system appears to be under-capitalized, as many programs continue to operate processing facilities that are old, rudimentary, and fully depreciated for accounting purposes. A wave of new MRFs is expected to be constructed or retrofitted (or have recently been constructed or retrofitted) in the next several years to address this issue. This will likely cause reported capital costs to escalate.
- Program variance, detailed above, may have been caused by factors that were within municipality's span of control, rather than by inherent, unchangeable factors. This implies that some programs are different due to historic elements and program decisions that have been made in the past.
- Generally, municipal program staff are trying to be efficient and seeking cost effective methods of operating the Blue Box program. In some isolated cases, neglect and lack of priority of recycling within other competing municipal programs, causes program inefficiencies and inhibits improvement.
- Transportation practices, specifically in transferring materials from the curb to a processing facility, appear to be non-standardized in rural remote communities. Where no major urban center exists in the area, rural programs face challenges in finding effective transportation methods for hauling materials to the closest MRF (which is often situated very far from the rural community).
- Pricing for processing of commingled (unsorted single stream or two-stream) material appears to vary significantly across Ontario MRFs that receive recyclables from other communities. The same MRF may be paying a fee, receiving materials free of charge, or charging a tipping fee for seemingly similar material compositions from varying communities.
- Inter-municipal cooperation has reportedly not been widely practiced across Ontario programs. Some rivalries between neighbouring municipalities exist, and some political figures or program staff don't like working together with their neighbours for historical reasons.
- There is a perceived lack of communications between MIPC/WDO and Ontario municipalities (this may be due to the fact that municipal MIPC members have few full-time MIPC-dedicated resources). Furthermore, there is a perceived lack of transparency in MIPC's decision-making process.

Best Practices for Ontario Blue Box Programs

Best Practices were formulated as a result of a fact-based analysis, incorporating site visit evidence, multi-jurisdictional research, contribution of industry experts, and use of advanced statistical tools.

Introduction to Best Practices

As previously stated, "Best Practices" for the purpose of this project are defined as "*waste system practices that affect Blue Box recycling programs and that result in the attainment of provincial and municipal Blue Box material diversion goals in the most cost-effective way possible*".

To distinguish practices that are "best" from those that may be good, poor, or irrelevant, the Project Team used an evidence framework built on a combination of research findings, analytical assessments, and defined screening criteria.

First, the original definition and criteria, presented earlier in this report, were expanded upon to further clarify what is and is not a Best Practice. These criteria helped team members to identify and document candidate Best Practices.

Next, a Best Practices Database was established for collective team use on KClient. Team members identified and posted candidate Best Practices pertaining to specific recycling program components, along with supporting information. In addition to Best Practice description and its applicability, the database provided for capture of the following information for each record:

- Potential impact resulting from use of the practice
- Ontario municipalities demonstrating use of the practice
- International/other Canada locations demonstrating use of the practice
- Expert comment/stakeholder consensus (AMRC, OWMA, consulting teams, etc.) regarding the practice as a best practice
- Proof of concept/validation (documentation that the practice is a best practice)
- Quantified costs/benefits
- Community type that the practice is suited for
- Resource requirements for implementing the practice
- Constraining variables limiting applicability of the practice

Through this documentation process, the Best Practices Database served as a common repository for all candidate Best Practices information derived from the field work, literature review, interviews, and other means of gathering Best Practices information in this project.

Finally, candidate Best Practices were subjected to a screening process, which took into account the degree of fact-based evidence available to support them. Main evidence categories included:

- Site visit evidence suggesting a Best Practice
- Canadian and International sources citing the Best Practice
- Documented expert opinion and published reports citing the Best Practice
- Quantitative analysis suggesting correlation of performance and use of Best Practice

***Fundamental** Best Practices apply to all Municipal Programs*

***Conditional** Best Practices apply to programs with certain characteristics or are included as alternative methods or "toolsets" for achieving Fundamental Best Practices*

***Other** Practices have not been substantiated by fact-based analysis; they may, however, produce positive results in isolated cases*

This analytical framework served as the foundation for identifying a preliminary list of **"Fundamental Best Practices"** that apply to all Ontario Blue Box recycling programs and **"Conditional Best Practices"** that appeared to apply to some but not all programs depending on prevailing circumstances. In some cases these conditional practices were identified as alternative methods or "toolsets" for achieving the Fundamental Best Practices. Certain other candidate practices, reported to the Team by staff of visited municipalities or documented through research, were deemed as **"Other Practices Meriting Consideration"** if some or all evidentiary criteria were not met. Several workshops aimed at validating the preliminary Best Practices and gaining consensus on their applicability were held with the entire team. Subsequent to that process, a set of narrative descriptions of each Fundamental Best Practice was developed. Furthermore, at the request of MIPC, the Project Team developed description Best Practices applications in several key program areas. These are presented in this report as **"Best Practice Spotlights"**.

Fundamental Best Practices

The Project Team identified eight Fundamental Best Practices that apply to all municipal recycling programs in Ontario. These are as follows:

- Development and implementation of an up-to-date plan for recycling, as part of an integrated Waste Management system
- Multi-municipal planning approach to collection and processing recyclables
- Establishing defined performance measures, including diversion targets and monitoring and a continuous improvement program
- Optimization of operations in collections and processing
- Training of key program staff in core competencies
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded Promotion and Education program
- Established and enforced policies that induce waste diversion

Each of these Fundamental Best Practices is described in detail in this section.

It is important to note that all of the Best Practices discussed herein were based on research, field observations, and careful deliberation and consensus building among members of the Project Team. When information was conflicting or team member opinions differed, additional research was performed to make a decision. If inadequate information was found to resolve conflicting positions, the disputed practice was omitted. The reader should keep in mind, however, that in discussing Best Practices at the profile or program component level, the information presented is inherently general in nature. Furthermore, the more detailed and specific the information presented, the less supporting documentation is available to substantiate that a particular practice is indeed Best Practice.

The Project Team has worked to balance stakeholder desires for detailed guidance with the need for "proof" with respect to Best Practices. This is not a perfect science; consequently neither are the results. However the guidance provided herein is the result of extensive scrutiny and fine tuning which adds confidence to its validity. Future projects will be needed to develop more-detailed guidance and technical assistance tools such as worksheets, checklists, training modules, to help ensure that the practices identified herein are implemented in a best practices fashion by communities seeking to do so.

Fundamental Best Practice

Development and Implementation of an Up-to-date Plan for Recycling, as Part of an Integrated Waste Management System

Overview

A recycling program plan that results from a thorough planning process is a strategic and practical guide for the design, management, operation, and optimization of a community's Blue Box program. To be effective, it should reflect careful examination of all program components, and direct goal setting, action steps, and resource allocation to achieve meaningful results over time. Implementation of a well-conceived plan is facilitated by an overarching vision, purpose, and direction, allowing synergies to be realized across operational, geographical, and political boundaries. The recycling plan may be a stand alone document or may be incorporated into a larger integrated waste management plan.

On June 12, 2007 the Ministry of the Environment issued a policy statement on planning that "articulates the province's expectations for waste management in Ontario, outlines a framework and principles for decision-making by all waste managers and provides specific direction to guide the development of long-term municipal waste management plans. It is intended to achieve more consistent and timely waste management planning across the province and to make the decision-making process more transparent. This Policy Statement sets out best management practices for the management of waste and creation of waste management plans, and the Province encourages all waste managers to face the challenge of waste management and follow this policy."

This 28-page policy statement should also be referenced as a source of best practice guidance for Blue Box program planning as one component of integrated waste management planning.

Key Benefits and Outcomes

Program planning is a long-term investment that will result in the following benefits:

- A clear vision to guide program development
- Defined program goals and objectives against which progress can be measured
- Focused use of staff and monetary resources aimed at achieving cost-effective results
- Clarification of what is needed to proactively bring about change rather than just react to change
- Provision of a "roadmap" on how to meet program needs and objectives
- Enhanced operational and political decision-making process
- Integration of solid waste services, leading to lower system costs
- Overall improved program effectiveness and efficiency

Description of Best Practice

Integrated waste management is defined as a combination of techniques and programs to manage all municipal waste streams in a manner that is appropriate based on local needs and circumstances and considerate of potential economic, environmental, and social implications of the choices made. Critical to the success of any Blue Box recycling program is up-front planning of how the program will be developed and implemented, with the recognition that Blue Box recycling is an integral part of the overall waste management system.

The value of recycling program planning comes not just with the development of a document, but is realized during the process of planning itself. While the nature and extent of the planning process will vary, depending on the level of resources available for planning and the complexity of programs being planned for, planning is fundamental to all programs.

Regardless of the size or complexity of the planning document, a recycling plan should ask and provide answers to four basic questions:

1 Where do we want to be?

2 Where are we now?

3 How do we get from Current State to Future State?

4 How do we measure/track our progress?

The kind of information that can be presented to answer each of these questions is provided below. The amount of information and the degree of its detail will vary with program size and resources available for planning.

1. Where do we want to be (Future State)?

This component of the plan establishes a long-range vision for how the recycling program would look, if fully and successfully implemented, and sets the goals and objectives of the program to be achieved during the planning timeframe. Typical planning horizon is around three to five years; however, program planning can have a longer time frame – five to ten years – depending on the extent to which infrastructure is needed. An important part of this planning step is to engage community stakeholders in the visioning process, so that the resultant vision is shared by all.

Equally important is recognizing that recycling as just one component of an overall waste management system. The entire system should be aimed at minimizing waste generation and capturing valuable energy and material resources from waste prior to disposing of materials that cannot be technically and/or economically recovered for further use. Establishing an integrated waste management system and determining the appropriate role for recycling within that vision serves as a guide to further recycling planning and decision-making. In addition, recycling and waste management planning should be integrated with other broad municipal planning activities, such as planning for growth, economic development, or sustainability and would benefit from being part of a comprehensive environmental management system providing a systematic approach to addressing institutional and operating program objectives.

2. Where are we now (Current State)?

Developing an answer to this question will entail a review and assessment of the current recycling and related waste management programs, operations, and activities including:

- Population and recyclable materials tonnage projections for the planning period, estimates of current diversion levels
- A description of the strengths and weaknesses of all aspects of the recycling program and related policies, procedures, facilities, and operations. This review should include an assessment of the current and projected capacity of the recyclable materials handling infrastructure, an assessment of recyclable materials market conditions, and market trends, and any circumstances or conditions that may affect the program over the course of the planning period
- Documenting current costs for programs
- Identifying how the current recycling program works in conjunction with other waste management programs
- Identifying remaining needs and gaps to be addressed

3. How do we get from Current State to Future State?

With respect to answering this question, plans should describe the strategies and action steps to be used in order to address the identified needs and gaps and meet the Blue Box program's goals and objectives. Topics to be addressed in the development of these plan strategies could include:

- Potential program and policy options
- Opportunities for cooperation (both internal and external, with respect to neighbouring jurisdictions)
- Opportunities for coordination and integration of recycling programs and operations with other components of the resource/waste management system
- Opportunities for public/private partnerships
- Clarification of the roles and responsibilities of various stakeholders
- Costing/budget estimates and financing approach
- Continuous improvements measures
- An implementation timetable reflecting short, mid and long term planning milestones

4. How do we measure/track progress?

To address this planning question, plans should outline the methods to be used to measure the Blue Box program's progress and performance results. Having performance measures and tracking performance against these measures will ensure that continuous improvement will be an integral part of the system. This will include:

- Adoption of the plan by the appropriate decision-making bodies
- Identifying the means by which data and information can be captured to measure progress toward defined program targets
- Timelines for review of the program and the recycling plan itself

Program plans should include specific diversion targets against which program effectiveness can be measured (see Best Practice on Performance Measurement).

Implementation

Any municipality should be able to develop a basic recycling plan and will benefit from doing so. The key aspect in developing a plan is to match the plan to the program needs, size and complexity. There is no "one size fits all" solution for a plan, but a good planning process will have the following common characteristics:

- Is flexible, applicable to the program and user friendly
- Is participatory -- has the involvement of all the key "stakeholders" in the planning process and, ultimately, their support
- Is practical and realistic with respect to goals, objectives, resources and outcomes
- Accounts for budget and resource allocations and limitations
- Provides for realistic and achievable recommendations for the program
- Establishes and ensures accountability for results
- Leads to resource decisions and acknowledges the reality of the limitations of financial and other resources
- Is not static – the process and plan have to be reviewed and revised on a regular basis
- Is not done in isolation of other planning processes, such as for other waste management system components, as well as for broader municipal planning, such as community master planning

Lastly, a recycling plan should address and incorporate elements from other defined Best Practices.

Source and Links

"Preparing a Waste Management Plan – A methodological guidance note"
http://www.eukn.org/eukn/themes/Urban_Policy/Transport_and_infrastructure/Technical_infrastructure/Waste_collection/Waste-management-plan_1002.html

"Guidelines for Strategic Planning", US Department of Energy
http://www.orau.gov/pbm/links/sp-guide.pdf

"Guide to the Preparation of Regional Solid Waste Management Plans by Regional Districts," Ministry of the Environment Environmental Protection Division, British Columbia: http://www.env.gov.bc.ca/epd/epdpa/mpp/gprswmp1.html#s17

European Topic Centre on Resource and Waste Management
http://waste.eionet.europa.eu

Ontario Centre for Municipal Best Practices
http://www.amo.on.ca/Content/ocmbp/PolicyIssues/WasteManagement/default.htm

Policy Statement on Waste Management Planning: Best Practices for Waste Managers, Ministry of the Environment, Published on: June 12, 2007

Fundamental Best Practice

Multi-Municipal Planning Approach to Collection and Processing Recyclables

Overview

A widely-recognized principle of business is that significant efficiencies and economies can be obtained from larger scale activities. The same principle applies to recycling programs. Therefore, it is considered a fundamental Best Practice for municipalities to explore a multi-municipal approach to planning recycling activities. Considerable amount of industry research and data analysis indicates that nearly all municipalities can benefit from a co-operative approach to planning and/or providing recycling services.

Key Benefits and Outcomes

Many communities have found it advantageous to work co-operatively in providing solid waste management services. Working jointly, municipalities can increase bargaining power with private service providers for collection and processing of recyclables. Pooling resources, such as processing equipment, collection equipment, or facilities, can result in increasing equipment, labour, and/or facility utilization, thereby realizing financial and operational efficiencies.

Co-operation between two or more municipalities is becoming more common as municipalities face increasing budgetary constraints. Co-operative planning can lead to improved performance across virtually all recycling program components, enhancing effectiveness and efficiency in the following areas:

- Economies of scale
- Increased resident participation/satisfaction
- Optimized program funding
- Shared staff/time/costs/skills/equipment
- Improved supplier/contractor relations
- Reduced need for management supervision
- Reduced need for council time and attention
- Increased capacity to adopt new technologies and methods
- Material markets and pricing advantages, yielding higher revenues
- Increased innovation in strategies, services and products
- Shared risk management
- Shared capital requirements

Description of Best Practice

While multi-municipal cooperation can yield positive results in all circumstances, its applicability is highest when:

- Municipalities within the region are in need of the same set of services
- Jurisdictions have worked together successfully in the past
- Responsibilities and roles are clearly defined
- There are clear advantages to working cooperatively
- Entry and exit protocols for contractual relationships are clearly defined

A successful multi-municipal planning approach will focus on supporting municipal objectives, including;

Cost Containment

Economies of scale can result in dramatic savings for municipalities due to volume discounts; standardized equipment size, features, and specifications; standardized service levels; and promotion and education synergies. For example, a 2006, cooperative collection contract among six municipalities in York Region reportedly resulted in annual Blue Box and waste cost savings of over $900,000.

Improved Quality and Productivity

Municipalities that share some of the workload across a multitude of components of a recycling program can lower their unit cost and develop staff expertise through common resources. This often results in improved quality and consistency of the services delivered and increased staff productivity. A desirable bonus obtained from interaction with knowledgeable staff is an increase in resident satisfaction with the program, which, in turn, results in increased participation and diversion.

Transferability

Multi-municipal cooperation can result in greater resident participation and smoother operation of the recycling program. As residents commute and relocate from one community to another, common messages through co-operative promotion and education and common service levels/procedures make it easy for residents to maintain their participation and diversion levels.

Over time, cost reductions will be realized through staff time and promotional savings obtained from less re-education and reduced collection rejections. Contamination levels often decrease and diversion is maintained or increased as a result of the diminished need to educate residents.

Competitiveness

Many municipalities struggle to attract bidders for recycling RFP's or tenders. One obvious benefit of multi-municipal planning is to take advantage of the larger tonnage offered under co-operative contracts to attract more bidders, as well as non-local bidders. WDO Datacall statistics confirm that recycling costs are steeply reduced when greater quantities of materials are collected and processed above a 10,000 tonnes per year threshold level. Clearly, the more tonnage that can be combined under a single contract, the more contractors are willing to participate and to pass on savings to municipalities.

The inverse also holds true. A contract that requires half a truck per week to collect is much less likely to attract multiple bidders than a contract that requires five trucks per week.

Market Revenue

Revenues for larger amounts of recyclables often increase because of shipping, storage and handling economies.

Recyclable markets are usually willing to pay better prices for a larger, continuous supply of good quality material. A multi-municipal approach to planning/marketing material may provide some of these benefits.

Implementation

In order to implement this Best Practice, municipalities are advised to follow a seven-step approach outlined below:

1. Identify service needs of each potential co-operating jurisdiction
2. Identify and communicate advantages to working co-operatively
3. Identify and implement communication and working protocols among potential cooperating municipalities (a steering committee or a task group may be required)
4. Determine and document clearly how the multi-municipal program will be funded, using financial projections and a business plan
5. Identify the governance strategies for providing for accountability, monitoring, and decision-making authority to participating jurisdictions. These may include a utility-type board, a sub-committee of municipal representatives, a municipal corporation, or a combination of the above.
6. Identify costs (and cost savings) associated with the co-operative program, using financial projections and business plan from Step 4.
7. Test multi-municipal strategies in low-risk circumstances, such as a joint advertising, container purchasing, promotion & education, etc., and build on successes of such efforts

Co-operative recycling activities, more often than not, simply entail establishing good contracts that align with activities and services municipal neighbours are already providing. Communication is the key to engaging in the co-operative planning process.

For example, it is possible to begin a co-operative planning process by synchronizing the expiry date of neighbouring municipal contracts, so that when the next tender is issued, contractors may bid on multiple contracts simultaneously. Municipalities may or may not have different service levels and features under each contract. Such minimal multi-municipal planning may result in considerable economies of scale for a supplier who is often willing to share a portion of savings with the municipalities in order to win the bid.

Another example is the co-operative purchasing of blue boxes. Since suppliers will almost always offer volume discounts, savings can be obtained simply by coordinating annual blue box (or any other program consumable) purchase requirements.

No cross governance structures, utility boards or joint ventures are required to participate in these or many other types of recycling activities.

Potential Challenges and Suggested Solutions

Municipalities often have reservations about planning activities and services with communities outside their own boundaries. Concerns frequently center on loss of autonomy. Staff and council may be concerned that they do not want to lose control of their program. Suggested solutions to overcome these issues are:

- Explore opportunities for shared decision-making and management authority; and
- Clearly document roles and responsibilities, such that control is not lost, but economies are gained.

Another frequent concern is that services provided are often different in surrounding jurisdictions. Suggested solutions to overcome these issues are:

- Consider some programs that you could work together on. Share educational items, for example, or share model contracts or communication literature that can be adjusted to suit individual programs;
- Consider why programs are different, and if it might be mutually beneficial to join forces, even if it means altering a program; and
- Design contracts and RFP's to provide for different services in different locations.

Sources and Links

There are numerous sources of online information that will offer help with multi-municipal planning activities. Below are some identified source documentation/links for additional information:

Blue Box Assistance Team (A-Team)
http://www.vubiz.com/V5/Stewardship/bluebox.htm

Association of Municipal Recycling Coordinators http://www.amrc.ca

Stewardship Ontario http://www.stewardshipontario.ca

Recyclers' Knowledge Network http://www.vubiz.com/stewardship/Welcome.asp

Fundamental Best Practice

Establishing Defined Performance Measures, Including Diversion Targets, Monitoring, and a Continuous Improvement Program

Overview

Proper management of a recycling program includes the monitoring and measurement of the program goals through the establishment of diversion targets and performance objectives. Targets and objectives must be realistic, measurable and relevant. Furthermore, targets and objectives are needed for the individual program components to be evaluated (e.g., curbside collection, depots, processing, promotion and education, etc.) Evaluation facilitates continuous improvement within the recycling program.

Key Benefits and Outcomes

Effective monitoring and evaluation allows program managers to continuously improve their municipal recycling programs and track progress through the use of targets and performance measures. Specifically, program staff are able to:

- Set objectives and targets for recycling programs that are implemented and evaluated within a defined time period
- Collect specific program data to evaluate the effectiveness of recycling programs before and after implementation
- Make decisions on recycling programs based on a detailed analysis of diversion rates and associated costs
- Evaluate program objectives against the pre-defined targets
- Tailor data collected to match the specific goal, avoiding the collection of data that are not pertinent

Description and Implementation of Best Practice

The monitoring and evaluation program should be developed with appropriate resources to gather and evaluate the required information. The collected data must be relevant to the recycling program and the target set must be measurable. The effectiveness of the recycling program should be evaluated and goals should be set for continuous improvement. Specific steps for implementation are detailed below.

Step 1: Establishing Program Objectives

Objectives and targets must be reasonably established by the municipality to meet the requirements of the specific program to which they will apply. The desired outcomes and the associated benefits to the program should be defined. The targets must be measurable and achievable, but challenging, and lead to increased benefits. An example of setting program objectives and targets would be the setting of a diversion target, establishing steps to meet the target, and then monitoring the diversion rate to evaluate if the target is being met. Ongoing assessments of the targets and objectives must be made to ensure that the recycling program goals are being met.

Step 2: Baseline Measurements and Waste Audits

In evaluating program performance, it is often desirable to first establish a baseline. This baseline will be specific to the program under consideration and can be used to compare the future performance of the program. Data collected as part of the baseline must be appropriately suited to accomplish the objectives. Understanding the specific waste stream that the program is targeting is a critical first step. This is generally accomplished through the completion of waste audits. Waste audits determine the composition of waste being generated, can measure the effectiveness of existing programs and can identify opportunities for improvements in the waste management program. Please refer to the Step by Step: Waste Audits link in the source documentation reference section for this fundamental leading practice.

Step 3: Defining Data Requirements

Best practices associated with program evaluation are aimed at tracking program effectiveness (how successful has the program been in achieving its target goals and objectives) as well as efficiency (the extent to which the program accomplished its objectives with minimal use of resources).

In defining data requirements, the following questions should be answered:

- Will the measure track program outcomes as opposed to just outputs and inputs?
- Is the measure for absolute impacts or relative impacts?
- Can information pertaining to the measure be gathered systematically, consistently, and objectively?
- Is there sufficient time and resources to gather, organize and interpret that information in order to tell a meaningful story to the evaluation audience?
- Will the intended audiences perceive the measure as credible?
- Will the knowledge gained through use of the measure be useful (e.g., for program improvement, adjustment in funding)?

Types of data collected can consist of set-out rate, capture rate, participation rate, residue rate, material tonnages, cost allocation, recyclable market statistics, MRF residue audits, MRF productivity statistics, staff requirements, facility requirements, supplies (i.e., blue boxes), and equipment. Selected definitions are provided in the last section of this Best Practice narrative.

Step 4: Data Collection and Management

Next determine how the data will be gathered and stored. Different data collection methods include mechanical (scales), surveys, focus groups, visually, etc. If appropriate develop a database to store the data in a secure location. Throughout the monitoring phase evaluate the data being collected to ensure that they are relevant to measuring the desired outcome, and accurate. Monitor the steps as part of the target and if required, adjust the steps and target as data is evaluated.

Step 5: Assessment and Reporting

Compile the data and analyze it by comparing to the baseline information. Assess the monitoring and evaluation program against the desired and measurable outcome. Report on the outcome of the objectives and targets. Identify and analyze the factors that influence your program's ability to meet established goals. Overall, use the findings to identify barriers to recycling, assess program performance relative to the objectives, assess MRF performance, and improve the effectiveness of the recycling program. Once a goal is met, continuously build and improve on future goals for the program.

Step 6: Reviewing Goals and Objectives

Evaluation for continuous improvement is an ongoing activity. Program performance must be monitored at appropriate intervals, often determined by the needs of individual program components. The effectiveness of prior evaluation methods should also be evaluated, so that this program component, too, can be improved upon.

Select Definitions

Capture Rate – The capture rate is the amount of recyclables set out for recycling divided by the total amount of recyclables set out for recycling plus recyclables left in the garbage. Capture rates can also be compared for each material type.

Participation Rate – The participation rate is typically defined as the percentage of households on a curbside collection route who set out recyclables at least once in a consecutive four week period. It is different from Set-Out Rate (see below), as it measures the percentage of residents participating in the program in general, not necessarily on every given collection day (some households may not generate enough recyclables to set-out the Blue Box on every collection day).

Residue Rate – The percent of material in a recycling stream that is rejected during processing.

Set-Out Rate – Percentage of households on a curbside collection route setting out recyclables on the day of collection. As a percent the set-out rate is the # of households setting out recycling on collection day divided by the total number of households available to set out material.

Waste Audit – A formal, structured process used to quantify the amount and type of waste including recyclables being generated.

Source and Links

Stewardship Ontario's Plan Your Own Waste Audit webpage:
http://www.stewardshipontario.ca/eefund/projects/audits/waste_audit_own.htm

E&E Project #105 – Protocol for MRF Residual Sampling April, 2006:
http://www.stewardshipontario.ca/pdf/eefund/reports/105/105_tech_memo_2.pdf

E&E Project #164 – Markets Help Desk (see Appendix C: Protocols and Procedures for Conducting Audits at the PIWMF)
http://www.stewardshipontario.ca/pdf/eefund/reports/164/164_final_report.pdf

California Division of Recycling Project Evaluation Tips:
http://www.consrv.ca.gov/DOR/grants/grant_seekers/ProEval.htm

Evaluation of Recycling Programs, East Central Iowa Council of Governments:
http://www.iowadnr.com/waste/pubs/files/ecicogfinal.pdf

EPA Measuring Recycling A Guide for State and Local Governments:
http://www.epa.gov/recyclable.measure/download.htm

Step by Step: Waste Audits
http://www.wme.com.au/magazine/downloads/WasteAudit_dec2002.pdf

Fundamental Best Practice

Optimization of Operations in Collections and Processing

Overview

Optimization of operations is a process of critically assessing collection and processing functions and making changes that have a net positive effect on recovery rates and/or cost. A combination of data-driven, expertise-driven, and heuristic approaches can be used to optimize operations. Where collection and/or processing are outsourced, close collaboration with the contractor, sufficient flexibility in the use of contractor labour and assets, and thorough understanding of cost drivers contribute to optimization of the system.

Key Benefits and Outcomes

- Collection efficiency means getting more for less—picking up more recyclables using fewer trucks, fewer staff and/or less time. Optimized curbside collection operations maximize the quantity of target materials set out at each stop on collection day and minimize the amount of time required to collect that material, thereby minimizing the unit costs involved.
- Optimized processing operations make full use of the available processing capacity, minimize the amount of manual and mechanical sorting required to produce recyclable products that meet target market specifications, and maximize the quantities of these materials from the incoming feed, while minimizing the amount of out throws, residue and prohibitives associated with the captured material.

Description and Implementation of Best Practice

Optimization entails evaluation and implementation steps aimed at improving the performance and efficiency of those operations being evaluated. There are basic principles associated with optimization that apply to both collection and processing. Key principles are as follows:

- Have an integrated approach to design and management of operations so as to take advantage of opportunities to share facilities and other resources, such as those associated with P&E program design and implementation, and reduce the costs of the system as a whole
- Pursue the "low hanging fruit" first: options that provide the greatest return on investment with respect to meeting operational performance and efficiency targets set by the jurisdiction (see Best Practice on Monitoring and Evaluation)
- Use existing infrastructure as appropriate prior to establishing additional infrastructure that may duplicate or compete with that already in existence
- Provide for a reasonable degree of redundancy to minimize down time, while avoiding unnecessary duplication of infrastructure. An example of this is to have

spare collection vehicles or arrange for a neighbouring processing facility to accept material in the event of processing facility down time

- Match the scale and nature of operational infrastructure to the task at hand and use appropriate technology – the right tool for the job
- Balance the use of mechanization with use of labour
- Avoid double handling of materials (e.g., moving materials from place to place within a MRF when conveyors could do the job more cost-effectively)
- Provide incentives to workers and contractors for spawning innovation and continuous improvement. One means of doing this is to offer spot bonuses for ideas that generate significant cost savings
- Use ergonomic, worker friendly equipment and systems, such as sorting conveyors of proper height and width, comfortable safety equipment, and good lighting and air conditioning
- Maintain a flexible design and operational approach to respond to changing needs and circumstances
- Make an appropriate level of capital investment to maximize benefits over the long term at a reasonable payback level
- Utilize a preventative maintenance program by servicing equipment prior to breakdowns instead of fixing it upon breakage, thus reducing downtime
- Address operational issues when they arise by understanding the underlying causes, developing potential solutions, and minimizing adverse impact. An example is to introduce compaction-enabled collection trucks when low material density has been identified as an issue
- Provide appropriate levels of management and supervisory personnel who are trained on optimization techniques and use of Best Practices
- Plan and provide for emergencies, contingencies, and growth

In working to optimize operations, it is important to recognize that other objectives beyond optimization merit focus and attention, such as providing for worker safety and acceptable working conditions, and protecting public health and welfare. Consequently, optimization must be performed in a manner consistent with meeting other such important community objectives.

Additional optimization best practices and considerations specific to curbside collection and processing are provided in separate sections on these topics. Best practices for depot and multi-family recycling programs are also discussed in separate sections so titled.

Sources and Links

E&E Fund Project Number 207. York Collection and Processing Optimization Study, 2006
http://www.stewardshipontario.ca/eefund/projects/benchmark.htm#207

Efficient Recycling Collection Routing in Pictou County, 2001
http://www.cogs.ns.ca/planning/projects/plt20014/images/research.pdf

US Environmental Protection Agency. Getting More for Less: Improving Collection Efficiency, 1999
www.epa.gov/garbage/coll-eff/r99038.pdf

Single Stream Best Practices Manual and Implementation Guide, Susan Kinsella, Conservatree, 2007
http://conservatree.com/learn/SolidWaste/bestpractices.shtml

Fundamental Best Practice

Training of Key Program Staff in Core Competencies

Overview

Municipalities need to ensure that management program personnel are adequately trained on position-related competencies and responsibilities. Training provides the skills needed to develop, manage, monitor, document and promote the numerous and complex components of a successful recycling program. Regardless of the size or type of municipal program, training acts as an enabler of performance, facilitating the achievement of objectives in a cost-effective manner. Equally important to training is ensuring that structure, authority and responsibility are well established and understood.

Key Benefits and Outcomes

Proper staffing and training leads to improved performance in all key program components, including both effectiveness and efficiency in the following areas:

- Resident participation and satisfaction
- Optimized program funding
- Staff time/costs
- Supplier/contractor relations
- Reduced need for management supervision
- Reduced need for council time and attention
- Job satisfaction, motivation and morale among employees
- Process efficiencies
- Capacity to adopt new technologies and methods
- Knowledge of material markets and pricing, yielding higher revenues
- Innovation in business strategies and products
- Reduced employee turnover
- Enhanced municipal image
- Risk management
- Increased ability to attract/promote staff

Description of Best Practice

Municipalities that take on the responsibility of providing recycling services also assume the duty to provide adequate amounts of time from knowledgeable management and operations staff to deliver those services. It is assumed that all municipalities and private contractors train operations staff to levels that ensure the safety and efficiency of the program.

Additionally, municipalities need to recognize the importance of having appropriately trained management staff to effectively perform the assigned responsibilities. Providing adequate staff time may be a challenge to smaller municipalities, however, all effective and efficient recycling programs depend on the availability of enough time from knowledgeable people. Therefore, all municipalities are encouraged to strive for the appropriate staffing and management training levels.

Knowledgeable staff routinely achieve higher levels of success within their local recycling program, as measured by greater resident participation and satisfaction, along with increased diversion and optimized program funding. Business research shows that productivity increases while training takes place (see end of this section for references). Staff who receive formal training can be significantly more productive than untrained colleagues who are working in the same role. As a result, most businesses provide on-the-job training, which generally yields a positive return on investment.

While rationale and objectives for training vary across organizations, municipalities seeking to improve program performance should consider focusing on the following goals:

Improved Quality and Productivity

Training that meets both staff and employer needs can increase the quality and flexibility of municipal recycling services by encouraging:

- accuracy and efficiency
- strong work safety practices
- better customer service

Enhanced Transferability

The benefits of training in one area can flow through to all levels of an organization. Over time, training will reduce costs by decreasing:

- wasted time and materials
- redundant work
- workplace accidents
- recruitment costs through the internal promotion of skilled staff
- absenteeism

Increased Competitiveness

Municipalities must continually change their work practices and infrastructure to improve diversion and contain recycling costs. Training staff to manage the implementation of new technology, work practices and business strategies can also act as a benchmark for future recruitment and quality assurance practices.

In addition to impacting municipal costs, training can improve:

- staff morale and satisfaction
- inter-staff/department communication and leadership
- time management
- customer satisfaction

Effective Recruiting

Training aids the recruiting process. If a municipality is committed to training, it may be more willing to hire a desirable candidate who lacks a specific skill. Training also makes a municipality more attractive in the eyes of potential employees because it shows them that they have room to grow and accept new challenges. Additionally, training existing employees often reduces the need to hire new staff.

Training rewards long-time employees. Municipalities are more willing to promote existing employees who have learned new skills and are ready to take on new challenges.

Training reduces the need for supervision. Not only does skill-based training teach employees how to do their jobs better, but it also helps them work more independently and develop a can-do attitude.

Perhaps the most important benefit of a healthy training culture is that the skills of your staff are formally recognized and their contribution to the municipality and the recycling program is openly valued.

Staff Retention

Training increases staff retention, resulting in significant cost savings. The loss of one competent person can equal the equivalent of one year's pay and benefits. In some companies, training programs have reduced staff turnover by 70 per cent and led to substantial returns on investment.

Implementation

Ontario recycling program coordinators and senior staff need the skills and expertise to effectively employ all of the fundamental best practices described in this report. Such skills include:

- Recycling program planning, development, evaluation, and continuous improvement
- Recycling services procurement and contract administration
- Use of policy mechanisms to promote waste diversion and recycling, and promotion and education
- Operations planning and management (where the municipality provides that function)

It is important to ensure this training is ongoing – i.e., refresher training to ensure staff are kept current and cross-training of departmental staff that rotate positions. The competency of staff should be monitored via annual performance reviews.

Numerous organizations offer opportunities to acquire training, information and networking.

- The Association of Municipal Recycling Coordinators (AMRC) offers several recycling conferences and workshops each year:
- Waste Diversion Ontario (WDO) offers many guides and informational packages to assist with municipal Datacall completion, funding and CAN/OCNA in kind advertising.
- Association of Municipalities of Ontario (AMO) is a non-profit organization representing the municipal order of government and provides a variety of services and products to members and non-members.
- Stewardship Ontario, WDO, and AMO regularly host "Ontario Recycler Workshops" (ORWs) for Ontario municipal waste management staff and private sector service providers, as well as for municipal councillors and interested stewards of Blue Box recyclables. These workshops and web casts provide information about how to optimize WDO funding to support municipal residential Blue Box recycling programs. Project studies and reports commissioned under the Effectiveness and Efficiency Fund are available, along with tendering tools and information from the Recyclers' Knowledge Network.
- The Solid Waste Association of North America (SWANA) has been a leading source of information and training programs for solid waste professionals for over 40 years. SWANA offers training and certification as a Recycling Systems Professional.

Although all of the above organizations offer some training and information services, there is no coordinated recycling management training system currently available in Ontario.

Broader and more comprehensive training resources and tools may be implemented in the near future to equip municipal recycling staff with adequate skills to effectively manage and operate Blue Box programs.

For example, in the United Kingdom, WRAP (the Waste & Resources Action Programme) has announced phase four of its free training courses for recycling managers. The training program, developed to support recycling managers in improving existing recycling schemes and introducing new collection initiatives, has proved very popular. In the first year of operation, 25 courses have been run and 400 delegates from across the UK have received training.

The three-day residential courses are aimed at people from local authorities, the community and private sectors who manage or develop and promote collections of recyclable or compostable materials. The content focuses on equipping delegates with the knowledge, skills and tools to develop cost-effective systems with high participation and recovery rates for the collection and sorting of materials that meet end market requirements.

Based on this and other examples, the Team estimated that annual costs for recycling program management training would amount to approximately $412,000. This assumes that two staff members from the largest 40 programs and one staff member from the remaining 150 programs need to be trained. Training-related expenses range from $1,600 to $2,150 per delegate.

Source and Links

There are numerous sources of online information about training and development. Below are some identified source documentation/links for additional information:

Association of Municipalities of Ontario http://www.amo.on.ca

Association of Municipal Recycling Coordinators http://www.amrc.ca

Waste Diversion Ontario http://www.wdo.ca

Stewardship Ontario http://www.stewardshipontario.ca

Recyclers' Knowledge Network http://www.vubiz.com/stewardship/Welcome.asp

Ontario Recycler Workshops
http://www.stewardshipontario.ca/eefund/orw/orw_main.htm

Solid Waste Association of North America http://www.swana.org

Research on training in the workplace: Smith A., 2001, Return on Investment in Training: Research Readings http://www.ncver.edu.au/research/proj/nr1002.pdf 2001, Australian National Training Authority.

WRAP launches phase 4 of its recycling manager training programs
http://www.wrap.org.uk/wrap_corporate/news/wrap_launches_6.html

Fundamental Best Practice

Following Generally Accepted Principles for Effective Procurement and Contract Management

Overview

A vast majority of Ontario Blue Box municipal programs involve the use of contractors for collection and/or processing of recyclables. Since contractor selection and performance in these municipalities has a substantial impact on program design, service delivery, cost, and sustainability, effective practices in procurement and contract management need to be employed.

Key Benefits and Outcomes

Well designed and executed procurement and contract management processes can yield a number of effectiveness benefits. Specifically, it

- Ensures high quality service to specified requirements
- Offers flexibility to address changing needs
- Provides incentives to maximize participation, tonnage and material revenues
- Provides a proper system (or system component) design that increases diversion at a lower cost
- Opens the door to innovation

Efficiencies that can be gained include:

- Cost savings due to increased competition
- Cost savings due to economies of scale
- Cost savings due to properly structured contract terms

Description and Implementation of Best Practice

The majority of Ontario Blue Box programs involve some element of contracting of services. It is, therefore, essential to employ effective procurement and contract management processes within these programs to yield positive province-wide diversion and fiscal results.

The goals of good procurement and contract management are to:

- Secure the desired level of services from competent contractors at the lowest possible cost, and
- Create an effective working partnership between contracting parties that continues through the duration of the contract.

Accepted leading practices for effective procurement and contract management to extract the best value for municipal Blue Box contract needs include:

- Planning procurements well in advance of service requirements. Useful life of existing equipment, lead times for replacing this equipment, and lead times for the execution of the procurement process itself all require careful consideration. Failure to plan properly may mean costly maintenance and breakdowns and sub-optimal contracting.
- Investigating and understanding suppliers' markets to understand the players, dynamics, cost drivers, and innovators in order to maximize value when setting procurement strategy. This results in municipal staff becoming informed buyers.
- Involving suppliers (in pre-procurement consultations) to help refine requirements, where own experience is limited, and to leverage innovation and capabilities of experienced suppliers. This results in municipal staff becoming smart buyers.
- Developing a clear definition of services and performance requirements
- Using the appropriate procurement instrument, such as a Tender or an RFP
- Using a competitive procurement process and working to encourage multiple proponents/bidders
- Using a two-envelope bid process (when a Request for Proposal process is appropriate)
- Using a pre-defined (transparent & fair) bid evaluation process
- Using knowledgeable evaluators. This may include a cross-functional team, supplemented with independent experts, as required.
- A partnership-oriented approach to monitoring and managing the contract and contractor to achieve objectives and take mutual advantage of opportunities for improvement

Implementation of an effective procurement and contract management involves a series of sequential steps. These steps are presented below:

Step 1: Precisely define services to be contracted

This involves developing answers to questions such as:

- Who is the service recipient? Is it one or more municipalities?
- What services are to be provided? What is the nature and type of service (e.g., collection, processing, transportation, marketing of materials, communication and education, program administration and operation)?
- What is the length of contract? For contracts involving the supply of equipment, the best contracts match the lifecycle of the equipment being supplied. If the contract is too short, the contractor must capitalize the equipment over the period of the contract, resulting in less than optimal unit pricing and overall cost. If the contract exceeds the equipment life by a year or more, the contractor will incur new equipment or expensive maintenance costs that must be built in to the price. Current lifecycle expectations for new collection trucks are about 7 years; new materials recovery facility (MRF) equipment 10 -15 years.

Municipalities should also evaluate options prior to proposal/bid process through informal dialogue with potential service providers and other stakeholders. Municipalities should clearly and specifically:

- Examine weaknesses in past agreements and any issues with service
- Review agreements from other communities
- Identify both short- and long-term needs
- Identify where flexibility can be incorporated without leaving too much open to interpretation

Program managers and procurement personnel should provide adequate data and technical specifications for accurate pricing of services. A typical collection contract may include: services to be provided, collection frequency, stream separation and number of streams, volume tonnage and types of material (from recent audited mix), future materials contemplated, number of households/stops per kilometre for collection; areas to be collected/route maps. A processing contract may include: tonnes per hour, product mix, quality measures (e.g., bailed material composition thresholds), uptime as a percentage of operating hours, and acceptable residue rate, among other factors.

Staff should also prepare a cost estimate of services requested to inform the procurement process – benchmark to other recent municipal procurement processes for similar services, whenever possible.

Step 2: Determine contractor pool and your market position

Good results are more likely to come from a minimum of 3 bidders. In rural areas, bargaining power may be improved by bundling services or partnering with other communities to increase attractiveness of potential business. On the other hand, if the service area is too large, as may be the case in urban areas, this can also limit contractors. In this event, it may be desirable to de-bundle services or break-up the contract to allow more, smaller bidders the opportunity to bid on selection or entire system.

The level of financial investment expected may determine the market of suppliers. A high capital investment typically requires a longer contract and implies more risk. Fewer contractors may be capable of bidding.

With respect to recycling collection and processing, the leading practice is to structure the procurement process to allow for separate contracting for collection and processing when feasible. This stimulates competition by encouraging collection contractors, who may not be able to bid on a MRF, to provide good service at competitive prices on the collection process. With this approach, it is most desirable to handle the procurement process for processing in advance of collection, or to specify a MRF location, so that collection service providers will know where the MRF will be located and can structure their proposals/bids accordingly. Quality control concerns when two contractors are involved can be managed contractually with appropriate monitoring, penalties and incentives.

Municipalities need to develop contract payment terms that align with incentives and desired performance levels. It should be clear and unambiguous how adherence to contact terms and achievement of performance thresholds will be tied to payments for services.

Additionally, it is desirable to obtain separate prices for collection and processing even if under one contract, and to request pricing for the handling of any materials that might be added at some point during the term of the contract.

Finally, a self-assessment process is needed to determine whether your municipal organization is fair and equitable when dealing with contractors. Investing in and protecting your reputation for open, transparent and fair procurement practices will positively influence the pool of available bidders on future contracts.

Example: Components of a good RFP and Contract

- Clearly defined terms
- Detailed description of service(s) to be provided
- Adequate background information and data
- Expectations regarding qualifications and experience
- Detailed performance specifications that address the following:
  - Location of service
  - Regulatory compliance
  - Recyclables (initial & provisions for future)
  - Markets for processed materials
  - Capacity/throughput
  - Vehicle access, operating hours, weighing
  - Residue management and limits
  - Start up schedule
  - Handling of complaints
  - Record keeping and reporting
  - Equipment requirements
  - Public education requirements
- Payment terms
- Incentives/penalties to support increasing performance
- Opportunities for amending scope to address changing circumstances
- Avenues for resolving disagreements - mandatory 3rd party mediation clause
- Clear financial/cost proposal instructions
- Proposal submission instructions
- Description of selection process and evaluation criteria

Step 3: Prepare a detailed, unambiguous RFP or Tender

Programs staff should select the appropriate procurement mechanism. A tender works best when:

- Services can be definitively specified
- All bidders are qualified
- Price is sole deciding factor

A Request for Proposals (RFP) – Works best when:

- Local government is receptive to different approaches to delivering service. This may often yield additional value opportunity
- Price is not sole determining factor in contractor selection

Step 4: Employ a fair and transparent contractor selection process

A healthy competitive market is critical to availability of service choice and better value in procurement. Local service markets become diminished if fair and transparent processes are not used. Service choice, therefore, becomes more limited in the future. Municipalities can influence and encourage competition and more robust supplier markets by employing the following activities:

- Use supplier mailing lists and widespread advertising to solicit interest in your service needs
- Co-operate with nearby municipalities to create joint opportunities that could increase the number of suppliers
- Learn about capabilities/interests of potential contractors in advance by meeting with them
- Consider pre-qualifying bidders
- Hold pre-proposal/bid meeting
- Provide adequate opportunities for questions/answers during proposal/bid development

- Determine detailed evaluation criteria and scoring system to be used
- Clearly describe evaluation criteria in bid documents
- Require and verify references

Potential contractor selection and evaluation criteria include:

- Responsiveness to RFP or Tender
- Qualifications & experience (organization, management), including facility/operational capacity, financial stability, and references
- Technical soundness of response
- Cost
- Innovation

Each criterion must be clearly defined and explained in the documentation. Mandatory and preferred requirements should also be specified.

Evaluate proposals with a qualified team, which may include business unit & technical personnel (or qualified and independent consultants, if necessary), purchasing, and legal representatives. First, evaluate compliance with mandatory requirements on a pass/fail basis. Then, evaluate compliant technical responses on a point scale or on a pass/fail basis. Finally, open the price envelope to evaluate price and value according to the pre-specified evaluation criteria. Document evaluations and final rationale for selection.

Through a well-executed procurement process, the contract will be awarded to the best overall scored proposal (according to the predetermined bid criteria and scoring process). However, if actions or circumstances did not result in proper procurement (such as improper sequence of response component evaluations, failure to come to terms with the winning bidder, failed due diligence processes), the process may need to be redone.

Communicate results to all bidders, including strengths and weaknesses of their proposals. For the winners, this sets the stage for any final negotiations on services. For the losers, it helps them to improve their bids for the next competition, which benefits all parties.

Step 5: Negotiate a partnership-oriented contract

The final contract negotiation process with the winner (and if not successful, the runner-up) should go smoothly if the procurement was well-managed. Well-prepared RFPs include a comprehensive draft contract and require the supplier to comment on the draft contract in their proposal. The focus should now turn to setting the stage for building a successful business relationship, positioning both parties for success. Specifically, the municipality should:

- Build upon RFP terms and conditions
- Finalize the structure of incentives for improving performance

- Allow flexibility for amending scope to address changing circumstances, including technical or process innovation, means of addressing extraordinary circumstances, such as changes in law, index-based monthly fuel adjustments, index-based annual payment adjustment for inflation (e.g., CPI or PPI with fuel component removed), adjustments for growth, etc.
- Provide avenues for resolving disagreements
- Build in ongoing communication and feedback

Step 6: Maintain partnership approach in contract administration and monitoring through entire contract term

Successful relationships require attention and effort in regular maintenance and communication by trained/skilled contract management personnel. To maintain and build on the partnership, municipal staff should:

- Become knowledgeable about factors affecting recovered materials movement and value
- Monitor recycling market prices and trends
- Monitor markets used and revenues received
- Continuously monitor contractor compliance with performance specifications and contract terms. Apply pre-agreed incentives and penalties for performance
- Live up to your side of the relationship, including the flexibility arrangements, to help your contractor be successful in providing your service
- Communicate regularly on pre-agreed schedule and frequency
- Address problems as soon as they arise
- Have a back up plan if the relationship deteriorates or services are jeopardized

Common pitfalls to avoid

By avoiding pitfalls, municipalities increase the likelihood of selecting a qualified supplier at a low price and building a lasting relationship with them. The following list includes some of the most common pitfalls in recycling related procurement:

- Not using a competitive process
- Over- or under-specification
- Prescribing the "How of operations" versus focusing on the business, legal & performance requirements
- Micromanaging the contractors operations beyond ensuring business, legal and performance requirements are being met
- Not managing the contractor due to infrequent communication and performance discussions
- Not providing for operational flexibility or for innovation

- Poorly matching equipment life-cycle and maintenance provision to contract length
- Poor procurement planning, including insufficient lead time for procurements and insufficient knowledge of the marketplace
- Poorly defined service requirements and performance standards
- Prohibitive bonds and letters of credit, which unnecessarily reduce competition and add directly to cost
- No service exit strategy or contract language
- Lack of transparency and fair competition
- Allowing a poor procurement to proceed

Sources and Links

Recycling Contracting Tips and Tools training materials developed for State of Pennsylvania, R.W. Beck, February 2006

Best Practices Review – Contracting and Procurement in the Public Sector, Minnesota Deputy State Auditor, November 2005

Model collection contracts available under "Tools for Recycling Coordinators." http://www.mass.gov/dep/recycle/reduce/assistan1.htm

Blue Box Residential Recycling Best Practices – A Private Sector Perspective, A Joint Project of Stewardship Ontario and the Waste Management Association, Guilford and Associates, February 2007

Stewardship Ontario Model Tender Tool

Fundamental Best Practice

Appropriately Planned, Designed, and Funded Promotion and Education Program

Overview

To be effective, a municipal Blue Box program needs to be supported by a Promotion and Education (P&E) component that is appropriately designed and funded, and incorporates specific audiences, defined messages & media, planned frequency of communication, and monitoring of results. A well-designed and implemented P&E program can have effects on virtually all other elements of the Blue Box system, including planning, collection, processing, marketing, and policy development.

Key Benefits and Outcomes

The impacts of effective P&E propagate throughout the recycling program. Most significant benefits include

- Potentially higher revenues for marketed materials due to the lower degree of contamination
- Higher waste diversion and recyclables recovery rates overall
- Establishment of new recycling behaviours and reinforcement of emerging or existing positive patterns among residents
- Increased community involvement in the program
- Set out of only those materials that are accepted by the program
- Proper set out of recyclables at the curb, leading to increased collection efficiencies and decreased operator safety issues
- Lower residue rates at processing facilities, resulting in higher recovery and lower costs

Description and Implementation of Best Practice

Planning and implementing targeted P&E programs that support recycling and waste diversion are vital to municipal Blue Box programs. Experts in the field agree that P&E is one of the cornerstones of an effective program. Most recently, an OWMA report stated that a "unanimous conclusion (of a group of private sector companies) is that effective promotion and education programs are significant contributors to the success of the blue box program." Another recent E&E Fund study, aimed at enhancing Blue Box recovery in the Golden Horseshoe area, determined that effective communication and education is required to "increase cost-effectively the number of recyclables recovered…." Furthermore, a study titled "Best Practice P&E Review" defines and articulates a number attributes that lead to a successful P&E program. Some content from the above studies is used throughout this document.

The key to effective P&E lies in the concept of "appropriateness" – considering what level of planning, research, deployment, and measurement is appropriate for different communities across the province. Each community's ability to design and deploy P&E is affected by community size, geography, resources (financial, skills-based and time) and many other factors.

The description that follows attempts to provide useful direction to communities, as they consider what may determine the appropriate P&E for their programs, taking into account four key factors that include:

- Design
- Funding
- Deployment
- Monitoring and Evaluation

Design

P&E programs that contribute to best practices in recycling are based on a current (and regularly updated) communications plan, with identified goals and measurable objectives.

Ideally, recycling P&E programs and targeted campaigns will be rooted in a communications plan, based on targeted community research, or if resources are unavailable, on reliable existing research that highlights common factors that are broadly applicable.

Communications plans include a statement of goals and objectives, target audiences, key messages, tactics (including planned media and distribution), timing, and plans for monitoring and evaluation. While the majority of Ontario recycling programs do not have in place detailed or current communications, in the course of this study, project team members were told by various communities that they intend to develop these plans in the near future.

The Best Practice P&E Review report, previously mentioned, indicates that most of Ontario communities conduct some form of research to identify their audiences, themes, targeted messages, images and branding before rolling out new communications efforts. For communities that lack the resources to carry out targeted research, several research documents are currently available that may provide insights from which they may extrapolate. See Sources and Links section for more information on these and other resources.

Funding

As a rule of thumb, communities will determine the level of financial resources they have available, whether they are adequate to cover full program costs, and, if necessary, identify other sources of funding or modify tactics to achieve P&E program goals. The best plan cannot be implemented if adequate financing is not in place. Furthermore, having a sizable P&E budget will not be helpful without knowing how to effectively utilize these funds to achieve specified P&E program objectives.

A recent study of eight programs that are considered to be among the P&E leaders, as well as of other well-performing communities, revealed that their P&E costs, as reported in the 2005 WDO Datacall, range from approximately $0.83 to $1.18 per household, with recovery rate at or exceeding 60%. Statistical analysis showed a positive, albeit weak, correlation between increased P&E spending and increased recovery in Ontario recycling programs.

Supporting this conclusion is that the US Curbside Value Partnership used $1/per household as a general spending guide for existing recycling programs, but recommends spending levels of up to $3 or $4 per household when implementing new programs or major program changes. Also in the U.S., research by Skumatz Economic Research Associates (SERA) in 2002 found that urban communities generally spend about $1.00 per household per year on P&E, suburban communities spend about $1.30 per household per year, and rural communities spend about $0.90 per household per year (in U.S. dollars). All programs with diversion rates greater than 30 percent spent more than $1.00 per household per year. The same study also found that increasing the P&E expenditure by $1.00 per household per year could yield an increase of 1 percent in the recycling rate for communities with already high P&E expenditures, while it could yield up to 3 percent additional diversion in communities with relatively low current P&E expenditures (Skumatz & Green, "Evaluation the Impacts of Recycling/Diversion Education Programs – Effective Methods and Optimizing Expenditures," for Iowa DNR, 2002).

In applying the above conclusions, one needs to take into consideration that P&E funding may and should vary significantly from one year to the next, based on the introduction of new services, new materials, additional programming and several other factors.

More details on the cost analysis are provided in the Key Observations section of this report. Promotion and education funding considerations, as they relate to the Net System Cost under Best Practices, are outlined in Volume II of this report.

Deployment

P&E initiatives that contribute the success of a recycling program employ a mix of media (e.g., calendars, brochures, radio spots and others) over a sustained period of time. These vary according to the audience, available budget, and resources.

Mix of Media

The use of media reported by P&E leaders may be grouped in five broad categories:

- Print (paid ads, brochures, calendars, newsletters)
- Broadcast (TV, radio ads, Public Service Announcements)
- Electronic (websites, emails)
- Outreach (special events, in-school education, community education centres, door to door campaigns, landfill/depot contact, etc.)

- Icons & incentives (Blue Boxes or other collection containers, magnets and other 'gifts', community mascots etc).

The strongest and most effective P&E campaigns strategically combine media and tactics. The Blue Box Program P&E Review report suggests that wherever possible, communities should try to implement a multi-tiered approach, with appropriate tactics selected from each of three tiers:

- Tier 1 - Radio components or, if possible, TV (vs. print ads)
- Tier 2 - householder drop of calendars or user-friendly tools showcasing website offerings; complemented by
- Tier 3 - public relations or word-of-mouth strategies to animate communities – highly visible events and activities, community and corporate partnerships, role model identification, personal testimonials

Communities that use this approach benefit from the mass media impact that helps build awareness and shift attitudes, combined with outreach that helps engage residents and contributes to skill-building. Where limited budgets and media outlets constrain P&E program choices, the Best Practice P&E Review suggests focusing on a limited range of Tier 2 activities, deployed with greater frequency to achieve greater impact.

Sustained & sustainable deployment: Campaigns that include a program for ongoing and sustained contact with targeted audiences generally have greater impact than a one-time "blitz." Year-round exposure is the target.

Communities that look for and implement innovative and cost effective strategies to deploy their messaging expand the reach of their messaging and get a better 'bang for their buck.' There are many ways to maximize deployment or delivery mechanisms including:

- Partnering with other communities with similar messaging to design/deliver tactics
- Sharing with community partners to deliver messaging (e.g., sending print materials with utility bills, inserting messaging into politicians' newsletters, working with community groups)
- Enlisting a known community spokesperson to 'carry the message'
- Combining public relations (earned media coverage) with other 'cost-based' tactics (calendars, newsletters etc.)
- Working with appropriate community partners to design and or deliver P&E messaging

Messaging: Recycling P&E campaigns that target those who are receptive to recycling and skew toward the female head of the household show greater success.

Most community residents are aware of recycling and what to recycle, particularly with materials that have been recycled for several years now. They continue to need information to support the addition of new materials to recycling collection programs. They also need to be motivated to take action.

Recent focus group findings in several Greater Toronto Area municipalities indicate that despite efforts to provide information about recycling, many multi-family residents remain unaware. Efforts to reach out to multi-family residents require continued persistence and creativity, with rewards (e.g., with indications that their efforts pay off, and by providing clean, safe recycling sites for their use) and attention to ethnic/cultural issues that are often pervasive in multi-family buildings.

In many communities, the need for traditional informational messaging is becoming secondary to inspirational approaches. Most residents are aware of at least the 'first generation' materials that may be recycled.

The most compelling messages also speak to the emotions (again, rather than simply providing information).

Linguistic issues are a vital component: to be successful and engaging, P&E must be produced in the languages spoken in the community.

The foundation for the messaging lies in targeted community research or, where resources are unavailable, consideration of the wealth of information that exists in available reference documents.

Allocation of financial resources: For most, if not all Ontario communities, P&E for recycling programs is constrained by limited financial (and staff) resources. The majority of respondents in the P&E Review survey reported that they thought they would need to double their budgets to be able to accomplish the full range of tasks to ensure "successful P&E."

Despite that, communities across the province are developing and sustaining P&E programs that are contributing to program effectiveness with, in some cases, very limited resources. To achieve Best Practices, communities should consider planning their P&E strategies to include some of the low cost/high impact components (and others) identified above.

Opportunity to increase efficiency: For some elements of their programs, communities are already sharing resources either with other communities or with other programs within their communities or existing P&E vehicles.

Other shared resources for P&E that exist or are in development include:

- the WDO Ad bank
- a new web-based resource about all Ontario recycling programs (www.blueboxmore.ca)
- P&E module coming to "Recyclers' Knowledge Network" (expected in May 2007)
- Project reports from all E&E Fund Communication and Education studies

Communities that seek out new opportunities to share resources (information, graphics, activities and others) will increase the cost-effective impact of their P&E

programs and in some cases, be able to employ tactics that would otherwise be cost-prohibitive.

Monitoring and Evaluation

P&E programs that contribute to best practices contain a monitoring and evaluation component that is budgeted and mapped out in the planning phase.

For many communities, the ability to implement formal qualitative and quantitative research will be constrained by budgetary limitations.

In a more informal way, evaluation may also be monitored by changes in amounts/quality of materials marketed over a year. Because there are so many factors that influence program performance, this is a less precise means of evaluating a P&E campaign or program, but it does provide an indicator. In the Blue Box Program P&E Program Survey, London, Durham and Toronto indicated that they look to 'spikes' in recovery or overall annual tonnages in their consideration of P&E effectiveness.

Communities that use these measures as indicators of P&E effectiveness may link their findings with existing (and growing) research about the impact of specific tools and campaigns in Ontario and beyond.

Source and Links

Reports

AMRC, County of Oxford et al; *"Research Report: Identifying Best Practices in Municipal Blue Box Promotion and Education"*, 2005

City of Hamilton: *"Blue Box Recycling Public Opinion Survey (March 2006)"*

City of Barrie & CSR: *"Master Recycler Program Report"*, 2000 & *"Phase II Report"*, 2001

Coffman: *"Public Communication Campaign Evaluation"*, 2002

Informa Research for McConnell Weaver Communication Management: *"Communication & Benchmark Survey, Enhanced Blue Box Recovery Program, Focus Group Report"*; 2006

McConnell Weaver Communication Management: Enhanced Blue Box Recovery *"Benchmark Survey & Focus Groups"*; 2006

McConnell Weaver Communication Management: *"Enhanced Blue Box Recovery Strategic Communication Plan"*, 2006

"Blue Box Residential Recycling Best practices – A Private Sector Perspective", A Joint Project of Stewardship Ontario and the Waste Management Association, Guilford and Associates, February 2007

Praxis PR: *"Best Practice P&E Review Final Report"*, 2007

Skumatz: "*Policy and Program Options that Increase Recycling*", 2004

Skumatz & Green, "*Evaluation the Impacts of Recycling/Diversion Education Programs – Effective Methods and Optimizing Expenditures*," for Iowa DNR, 2002

Presentations

AMRC: "*2005 Promotion & Education Awards*", 2006AMRC Policy & Programs Committee: "*2006 Municipal P&E Awards*", February 2007

"*Industry Experts Speak about Advertising: Research Perspectives*": A presentation at AMRC's Spring Workshop by Informa Research, Praxis PR and McConnell Weaver Communications Research; February, 2007

Resources

Stewardship Ontario's Efficiency and Effectiveness Fund Communication & Education projects

Fundamental Best Practice

Established and Enforced Policies that Induce Waste Diversion

Overview

Municipalities need to utilize a combination of policy mechanisms and incentives to stimulate recycling and discourage excessive generation of garbage. Most of these policies are aimed toward causing a permanent shift in residents' behaviour through the use of economic and non-monetary levers. Economic incentives work by assigning a tangible value to the recyclable portion of the refuse stream. Non-monetary incentives, on the other hand, force residents to limit undesired behaviours and stimulate desired ones, using punitive and rewarding policy tools, respectively. Each type of incentive is described in further detail in this section, with pragmatic application guidance.

Key Benefits and Outcomes

By using a mix of economic and non-monetary incentives, municipalities can change residents' behaviours and generate program revenues. Specific effectiveness benefits include:

- Higher participation rates
- Increase in materials diverted to recycling
- Reduction in recyclable materials loss
- Improved quality of materials
- Realized synergies between policies and Promotion and Education

Efficiency benefits include:

- Decrease in garbage collection costs
- Increase in program revenues
- High return on investment
- Low capital requirements

Description of Best Practice

Economic incentives

Economic incentives are as diverse and varied as the municipalities and waste authorities that employ them. The basic objective of incentives, as relates to recycling programs, is to place a cost on disposing of waste at the curbside, which will cause system users to divert appropriate material to diversion programs. The intended result is a decrease in waste disposed and an increase in recycling volumes.

There are a number of approaches employed, the names for which are often used interchangeably: Pay-as-you-throw (PAYT), unit pricing, and variable rate structures are often cited. Generically, these are often referred to as "user pay" systems. Incentive programs can employ variable fee structures, and simple but effective forms use bags or stickers. Other approaches require subscription by container volume, or may be weight-based. Bag tags and sticker programs are consistent with approaches used in many Ontario communities, in which system users pay for bags or tags that qualify for curb side garbage collection. In some cases, partial systems are used in conjunction with bag limits (see discussion on non-monetary policies), allowing users a maximum number of bags at the curb (often 2 or 3), after which user paid bags or tags are required to qualify for garbage collection.

In general, the "user pay" concept has the potential to recover part or all of waste management costs from system users. Utility-based or self-financing systems recover all of their costs, while the user pay systems recover part or all costs. Potential increases in net recycling costs may result in lower unit costs, while other aspects of the waste management system may benefit from reduced garbage collection costs, reduced disposal costs and increased landfill life expectancy. Well-conceived incentive programs may also improve material quality, resulting in increased program revenues and reduced sorting costs. However, some programs may experience an increase in total per-household program costs depending on how the program is administered, and as a result of changes in customer waste generation behaviour as a result of the economic incentive.

Non-monetary Incentives

Bag limits are a common practice of limiting how much waste, and specifically the number of garbage bags full of waste, will be accepted for collection. They are often employed with "user pay" systems, which will assign a cost per bag for collection for bags over the limit. Bag limits are a relatively simple means of encouraging residents to become more conscious of the amount and type of waste they generate to initiate a change in attitude and behaviour about their waste generation habits.

Typical bag limit designs include:

- Strict bag limit is imposed with no other options provided for placing additional waste at the curb. Once the bag limit set out is reached, any additional units of garbage are left at the curb by the collection crew
- Partial Bag Limit allows residents to purchase special tags or bags for excess garbage (also referred as a partial user pay system). Because residents are given an alternative approach to deal with excess garbage, it is not as critical to provide convenient waste diversion alternatives. However, residents will expect some level of waste diversion services to enable them to divert their waste and reduce the financial burden of paying for excess garbage. This approach is much more common among communities imposing bag limits of three bags or less

- Hybrid System combines features of the strict bag limit and with features of the partial bag limit. Typically, in a hybrid system, a community will impose a strict bag limit but will distribute a set of “free” tags for use by residents to augment the bag limit

Bag limit programs send a clear message to residents that it is no longer acceptable to produce unlimited amounts of garbage. However, they are usually coupled with significant convenient opportunities to divert waste.

Communities that impose bag limits of less than three per week, in general, experience a noticeable reduction in the amount of waste sent for disposal and an increase in recycling rates. There tends to be an inverse relationship between the number of bags permitted at the curb and the diversion and recycling rates achieved. The lower the bag limit the higher the diversion rate of waste from landfill and the recycling rate, as long as residents have access to convenient and comprehensive waste diversion opportunities. Curb side recycling is generally considered essential if a bag limit of three or less is to be contemplated. Introduction of additional diversion opportunities, such as curb side collection of kitchen organics, further enhances bag limit impacts.

Bag limits can generally be administered without capital expense to the waste authority, and thus are generally regarded as a low-cost initiative.

Provision of blue boxes entails the provision to households of free blue boxes in order to ensure ample household recycling capacity. This is usually done when programs are initiated and when materials are added and/or the program is re-promoted. Additional blue boxes require an initial capital outlay, however, the added capacity may not only increase capture and potentially lower unit operating costs, but the minimization of home-made curb side containers may yield longer-term ergonomic benefits to collection crews.

Disposal bans can be implemented by the disposal authority, which determines what materials it will accept for disposal. This forces the collection authority to redirect banned materials from the waste stream to appropriate receivers. This policy is often applied to broader material types and industrial wastes, and not specifically a blue box strategy.

Curb side material bans entails banning of material from garbage collection, forcing the household to dispose of the material through the proper program channels, such as recycling, source separated organics, household special waste depot, or any other appropriate collection or depot system. This is enforced at the curb, and disposal service can be withdrawn if users refuse to divert banned materials to the proper streams.

Mandatory recycling is institution of a by-law that directs households to use the recycling program for recyclable material. This can be enforced at the curb, and disposal service can be withdrawn when users continually place recyclables in the garbage. This approach is also commonly used to direct managers and property owners of multi-family residences to promote recycling, and is enforced by making public garbage collection programs available on condition that the complex provides a recycling program.

Reduction in garbage collection frequency is a strategy made possible when diversion programs are able to divert large amounts of material, such as recycling and source separated organics programs. With significant diversion, a minor portion of material left for the garbage stream makes weekly collection obsolete, and the conversion to less frequent garbage collection, in turn, makes diversion programs more attractive even to program hold-outs. Reduction in garbage collection frequency has the added benefit of reducing garbage collection costs.

Drop-off depots for overflow materials make recycling available at locations and facilities where public traffic is present. Recycling receptacles are an opportunity to collect material without curb side collection costs, adding material to the revenue stream without the same level of cost for collection.

Careful program planning is essential to the success of economic and non-monetary policies. A number of critical considerations are cited within the body of literature, studies and experience associated with these practices.

Implementation of Best Practice

Economic Incentives

Implementation of economic incentives requires thorough analysis and planning. User pay incentives work best:

- In conjunction with clear, well-considered goals
- When there is a strong sense of what barriers to recycling are being targeted through the incentives
- Where there is adequate infrastructure to obtain the desired results, including strong program elements, such as accessible recycling programs, a commitment to educational/promotional support, active enforcement (it should be noted that in some literature, fines are considered to be a form of economic incentive), and provision of adequate recycling capacity
- Where there is careful determination as to what type of program is suitable for the community (bag tag, variable pricing, weight or volume based)
- As part of a waste management strategy

Through proper planning, minor concerns can be anticipated and mitigated. With respect to litter and illegal dumping, experience shows that implementation issues may arise. Diminished quality of recyclables, for example, may result from placement of over-the-limit garbage in recycling bins by residents in order to avoid garbage cost. Roadside garbage dumping may take place in isolated cases. However, these issues can be addressed by stepping up enforcement in the early post-implementation stages and developing targeted educational campaigns.

Administration and capital requirements will depend on the type of program selected. Weight-based systems require a capital outlay with increased operational expenditures, and, therefore, may be more expensive to operate. Bag-tag systems are considered to be less expensive to operate, with some programs looking to retail outlets to manage distribution of bags, tags or stickers.

Some programs offer variable rate plans based on either weight or volume, allowing subscribers to select containers or bins that match their waste production needs and encourage a "downsizing" of household waste generation. This provides additional incentive to reduce waste and increase recycling by placing a value on the behaviour through additional savings. Consideration of such approaches are systemic in nature, accompanied by assessment of weight or volume-based subscription plans, automated collection systems for carts or bins, and impacts on system cost.

Non-monetary Incentives

As previously noted, benefits attributed to any of these strategies are dependent on the amount of associated public education, promotion, and enforcement support.

In the case of those strategies that "direct" waste to the recycling stream, care must be taken to avoid negative impacts to the quality of the collected material. When instituting bans, bag limits, or garbage collection frequency reduction, recycling collectors need to be diligent with respect to quality control. It is possible that non-recyclables will be placed in the blue box as a reaction to reduced garbage service or capacity.

Reduction in garbage collection frequency is one of the final implementation steps in a successful integrated waste management diversion program, and is a companion strategy to the effective diversion of household organics and blue box recycling. The need for weekly garbage collection is effectively eliminated. This particular strategy requires a revision of collection logistics that may result in co-collection scenarios for waste, recycling and organics, in a manner that can lead to efficient use of collection vehicles.

The implementation of a bag limit program (featuring three bags or less) requires a planned phase-in to address communication with residents (citizens need to know why the municipality is doing this) and the infrastructure required to support it. The following is suggested as effective bag limit levels for various Blue Box recycling programs:

Recycling System	Collection Frequency	Garbage	Suggested Bag Limit	Add Kitchen Organics	Suggested Bag Limit
Multi sort	weekly	weekly	3	weekly	2
	bi-weekly	weekly	4	weekly	3
Two stream	weekly	weekly	3	weekly	2
	bi-weekly	weekly	4	weekly	2
	alternating weeks	weekly	3	weekly	2

Single stream	weekly	weekly	3	weekly	2
	bi-weekly	weekly	4	weekly	2

In most communities, where a recycling curbside program is in place, the average householder sets out three bags or less of garbage per week and only has excess garbage a few times a year, typically after the holiday season and spring clean up. These special times can be effectively accommodated with amnesty days.

Sources and Links

AMRC *"User Pay Implementation Guide" E&E Fund Project 126 (2005)"* http://www.stewardshipontario.ca/eefund/projects/innovative.htm#126

AMRC "Analysis of User Pay System Costs**"** *E&E Fund Project 191 (2006)* http://www.stewardshipontario.ca/eefund/projects/innovative.htm#191

User Pay learning modules on the Knowledge Network – accessible via www.vubiz.com/stewardship

Implementation of a Waste Management Utility in Ontario Municipalities (PN 160) - Six Draft Discussion Papers are available on the Knowledge Network

AMRC Best Practice Consultation Sessions: *"User Pay and combined user pay systems (bag tags)"* www.amrc.ca

"The Waste Diversion Impacts of Bag Limits and PAYT Systems in North America" April 2001, ENVIROS RIS for the City of Toronto www.ris.ltd.com

US EPA PAYT: http://www.epa.gov/epaoswer/non-hw/payt/index.htm.

"Nationwide Diversion Rate Study: Quantitative Effects of Program Choices on Recycling and Green Waste Diversion, Beyond Case Studies." Skumatz & Associates (SERA), Seattle, USA, 1996.

US EPA, MSW Management journal article *"The Rise and...the rise of Pay-As-You-Throw"* citing more than 6,000 communities in US.

"Measuring Source Reduction: Pay as you Throw/Variable Rates as an Example." Skumatz Economic Research Associates (SERA), Seattle, WA USA, 2000.

UK Defra (Dept for Environment, Food and Rural Affairs) *"Evaluation of the Household Waste Incentives Pilot Scheme"* www.defra.gov.uk

Conditional Best Practices

Unlike Fundamental Best Practices that apply to all Blue Box programs, Conditional Best Practices apply only to those programs that exhibit a certain set of characteristics. A Decision Tree method, discussed in a subsequent section of this report, has been used to define major program characteristics. Program Profiles that were produced by the Decision Tree reference the Fundamental Best Practices and identify applicable Conditional Best Practices and the circumstances under which they apply. Conditional Best Practices were integrated into Program Profiles due to the fact that they are not meaningful without the context of the community characteristics in which they apply. This is consistent with the holistic approach to program design, management, and operations that was used to originally identify and formulate Best Practices. There are two types of Conditional Best Practices: 1) those that apply to every community in a specified program profile group as defined by the Decision Tree; 2) those that apply to programs within a specific profile but only under specific circumstances or conditions, as discussed in the Profile description.

Best Practice Spotlights

In addition to delineating Fundamental and Conditional Best Practices for Blue Box programs, the Project Team prepared more-detailed Best Practices guidance pertaining to specific program areas. These "spotlighted" areas include:

- Curbside Collection of Materials
- Processing of Materials
- Marketing of Materials
- Multi-Family Recycling
- Depot Collection of Materials
- Recycling of Challenging Plastic Materials

Described below are these Best Practice Spotlights.

Best Practice Spotlight

Best Practices in Curbside Collection

Overview

In a typical Blue Box recycling program, the curbside collection function is the most expensive program component. It is, therefore, essential to understand and properly manage cost drivers and operational intricacies associated with collecting recyclables at the curb. This section provides guidance for municipal program operators on the availability of choices and resulting cost and recovery implications of adopting or changing curbside collection methods and parameters.

Key Benefits and Outcomes

By effectively structuring and optimizing their collection functions, Blue Box programs can obtain the following effectiveness benefits:

- Increased recovery of materials and diversion from landfill
- Improved separation of materials in vehicles and MRFs
- Increased participation in recycling
- Enhanced aesthetic appeal of containers at the curb
- Improved operator safety and ergonomics
- Improved customer satisfaction levels

Programs can become more efficient due to the following factors:

- Lower collection and processing costs
- Increased revenues from sale of recyclables captured
- Improved utilization of capital (trucks and processing equipment)

Description and Implementation of Best Practice

Relationship to Processing

The appropriateness of any specific curbside collection practice is directly related to the processing capabilities of the MRF that will be receiving the collected material. Some collection methods listed may not be appropriate for all municipalities for this reason, as well as others. All collection methods should be reviewed with consideration of processing capabilities and further feasibility analysis may be required.

Set Out Containers

It is good practice for municipal programs to complete set out studies, waste audits, and capacity studies to evaluate the current program's recovery effectiveness, remaining recovery potential, and set out container capacity needs. If sufficient container capacity is not provided to match the set out volume and frequency of collection, then there is the potential that additional recyclables might be placed into the garbage. Often, additional collection can help solve the bin capacity issue.

As a program continues to grow, additional or larger containers may become increasingly advantageous. Some programs allow residents to add blue boxes or allow residents to include the additional materials in clear plastic or clear blue bags. Single stream collection programs using carts do not usually have container capacity problems, provided that residents follow instructions on how to prepare material (e.g., flattening cardboard so that it will fit into the cart, etc.). The size and number of recycling bins or carts should be selected to match the collection frequency and the projected volume of recyclables. Container options typically include:

- **Recycling box:** may be suitable for most small programs collecting only the "mandatory" recyclables weekly (18-68 litre)
- **Multiple boxes:** as programs grow in the number of designated recyclables collected and in the recovery of those materials, they usually move to providing multiple boxes to residents, often one for fibres and one for loose containers
- **Roll-out cart:** used by programs with a wide range of materials with reduced collection frequency (bi-weekly or monthly) to enable the use of semi- and/or fully- automated collection vehicles (120 – 360 litre).
- **Translucent bags:** provide flexible capacity, similar to carts, but increase sorting problems at the MRF. Allow identification of gross contamination, but not the opportunity to provide curbside contamination sort

Degree of Sorting

Programs generating less than 10,000 tonnes per year can benefit from curbside sort collections when no two-stream or single-stream MRF is located within a reasonable driving distance. Smaller programs typically do not recover sufficient tonnage to justify establishing their own MRF: however, such programs may find it cost effective to implement a low-tech bulking facility where densification of curbside sorted materials takes place. Often materials recovered through curbside sort systems have very low contamination, thus resulting in a very high quality product. Only a few Ontario communities utilize this approach, however. It must be stressed that this is an option used by, and suitable for, only the smallest communities that provide blue box recycling where there is no MRF available for more efficient sorting. In the absence of a MRF or a system of regional cooperation, a low tech non-sorting facility may be the most appropriate method of densifying materials for markets.

As programs grow in size and tonnage, there is more pressure to consider additional commingling of recyclables. Typically, programs previously providing a multi-sort curbside scheme evolve into providing a dual sort collection system, i.e., separation of fibre and containers in two vehicle compartments. Another variation of the dual sort system is separation of glass into a third compartment.

Sorting glass at the curb can add incremental costs to collection, and these costs are borne by the entity that funds the collection program. Costs arise both in the extra time for sorting and in the extra compartment required on the truck. The sorted glass is usually kept out of the processing stream at the MRF – deposited in an outside bunker, for example, before the truck dumps the remaining commingled materials on the tipping floor inside. Three fairly significant benefits then accrue to the processing entity – the reduction in sorting equipment needed for glass (and associated reduced maintenance of other equipment that may be affected by broken glass), the possible increased market value of the glass itself, since it has not been commingled with other materials, and the possible increased market value of all other materials that have not been in contact with glass and thus are not subject to potential downgrades due to glass contamination.

If the same entity operates and funds both the collection and processing systems, these costs and savings may balance positively, leading to reduced overall costs for the program. However, if the collection entity and processing entity are different, these costs and potential savings must be balanced in the tender and contracting process to ensure that they are shared in a manner that does not benefit one entity at the expense of the other. However, few communities in Ontario continue to rely on this approach. As the new LCBO return system becomes fully integrated into the public's behaviour, the amount of glass in Blue Box programs may decline, making the curb sort option even less desirable.

Two-stream collection (fibres and containers) is generally the preferred collection method for programs that process between about 10K to 40k tonnes of material per year, again, depending on the processing capabilities at the MRF. This tonnage throughput can support two-stream processing; but if a single-stream MRF is located within an hour's driving distance, single stream collection should be considered as a potential collection option. Two-stream collections capitalize on the initial labour provided from the residents at the curb. Often, programs with high participation can benefit from this type of collection as materials are collected fairly easily by collection staff. In addition, if boxes are used to set out recyclables (as opposed to bags or carts), collection staff have an opportunity to perform a degree of contamination screening at the curb to improve the quality of the product delivered to the MRF.

As program tonnages approach and exceed 40,000 tonnes per year, single stream collection and processing may become more feasible. Single stream recycling offers the potential for increased collection savings and increased recovery of recyclables, but also results in increased processing costs and, depending on the container type used, increased contamination. In simple terms, the larger the program tonnage, the greater the potential for collection cost savings and, hence, the greater the potential to offset the additional cost of single stream processing. In addition, the use of fully or semi-automated collection vehicles to tip carts into a vehicle results in fewer injury-related strains, thereby increasing worker safety and lowering operating costs associated with injuries.

It should be noted that if a two box set out is maintained in a single stream program, most of the potential savings in urban areas will be lost, since there will be little reduction in stop times. A more-detailed discussion of single stream recycling is provided in the "Processing" section.

Opportunities for increasing recyclables collection efficiencies and reducing costs grow with increased commingling. Collecting materials single stream allows for controlled compaction, which makes collection more efficient because trucks can stay on route longer before filling. Compaction can also be used in two stream collection; however, the per-household cost for collection in single stream systems is typically less than comparable two stream systems because materials can be loaded into a single stream truck in less time. For either two-stream or single stream collection, the compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers.

Collection Frequency

Municipalities need to assess their program performance to identify the type of collection that is best suited to their own circumstances. Selection of collection frequency needs to be made with consideration to the variety and volume of recyclables recovered, the type, number, and volume of household containers supplied to the resident, the type of collection equipment available for use, and how recyclables collection is integrated with other solid waste collection services (e.g., household organics, garbage, etc.). Team's analysis indicates that programs that collect recyclables at least as frequently as garbage exhibit higher recovery rates. This practice sends an important message to residents that recycling is equally as important and as convenient as setting out garbage, thereby boosting the tonnage of materials diverted.

The most effective programs in the province with respect to tonnage diversion provide weekly collection of recyclables and household organics, with bi-weekly collection of garbage (and an effective refuse bag limit). However, bi-weekly collection of recyclables on its own can be more cost-effective than weekly collection, provided there is no appreciable loss of tonnage, and provided that householders are given sufficient container capacity to meet or exceed their two-week material storage requirements. Another option, used primarily by programs that do not have specialized collection vehicles or are co-collecting recyclables with other waste materials (with recyclables taken to a two-stream MRF), is the collection of fibres and containers on alternating weeks. While not a best practice, in certain situations, where efficiency must be weighed against diversion benefits, such programs may be justifiable.

Collection frequency for recyclables should be reassessed when planning for collection of kitchen organics. Co-collection opportunities should be evaluated and utilized, when feasible. This entails using the same vehicle for two or more different waste streams or fitting a vehicle with appropriate equipment (in low-density, rural areas), so that a single pass can be made to collect multiple types of materials. Co-

collection is typically only appropriate when materials can be unloaded at the same or adjacent facilities.

Co-collection allows for a reduction in total system cost by not needing to have two trucks drive down the same road on the same day. The essence of the cost savings lies in reducing non-productive time, such as time spent driving from stop to stop. In order to successfully implement this practice, the two materials that are co-collected need to be delivered to one location, such as a transfer station or to two nearby facilities. This practice works well with single stream recycling but it can be adapted with two stream programs with an alternating week collection schedule, where waste and fibres may be collected one week, and waste and containers are collected the next week. Collecting on an alternating week basis does not mean that the MRF only processes paper products one week and containers the other week; rather it means that half the routes collect one material and the other half of routes collect the other material on any given day. This allows the MRF to be optimally sized.

Regardless of the number of streams collected and the type of vehicles used, other collection practices may be a Best Practice under certain conditions. An example is extended collection days, where the normal working day for collection crews is lengthened, allowing operators to get in their weekly hours in four days per week instead of five. The advantage of longer collection days is that fewer routes need to be operated to collect from the program because trucks stay on route longer and collect from more homes before ending the day. There is a certain amount of non-productive time with each route (i.e., daily preventative maintenance, fuelling, fluid checks, breaks, etc.). Fewer routes mean less non-productive time and cost savings. Drawbacks to extended collection days include declining productivity near the end of the day and increasing potential for injury or accidents. Considering extended collection days is conditional on trucks having payload capacity for the additional homes to be collected (usually because of compaction). If trucks are usually full at the end of the normal work day, it will not likely be cost effective to go back out on route. Extended collection days should normally seek to employ the equipment on the same number of working days per week (five or six) compared to regular collection days through effective use of labour and equipment allocation.

Regardless of the collection frequency, but particularly in programs with waste bag limits or lower frequency of collection, it is beneficial to provide convenient and consistent options for capturing overflow materials. Some communities have depots for this purpose, while others provide clear plastic bags for the collection of overflow materials.

Routing

Regardless of the type of collection procedure used, it is a Best Practice that collection methods are designed to ensure that the routes are shortest in distance and reach all the residential locations. Route design should also maximize collection vehicle time spent on route and minimize collection vehicle time spent off route. One means of doing this is to use large-capacity collection vehicles. Set out instructions can also be prepared to increase collection efficiency. For example, when street layouts permit and safety is not an issue (and particularly in low-density areas), households can be directed to set out material on one side of the street only. Another option is to encourage "twinning" of recycling containers at the curbside (residents place their bins beside their neighbour's bins) to maximize set outs per stop. This can be particularly beneficial when street side parking can interfere in servicing set outs, or when houses are on large lots. This technique is more commonly used for solid waste collection programs using roll-out carts, but the same technique works for recyclables collection as well.

For larger programs in particular, and for private collection service providers, the use of route optimization tools and methods to balance routes and payloads, can be very effective in reducing time per stop, time between stops, off-route time, and miles driven. Optimized routes provide efficient service to residents, reducing collection time, which can translate into lower collection costs. Some municipal staff have produced in-house route optimization methods and there are a number of route optimization software applications available for municipal staff to purchase. Whether a purchased program or an in house methodology is used, optimizing routes on a regular basis will result in some beneficial change.

Transfer

Transfer is an option that should be considered for programs with tonnages of recyclables considered too small to support their own MRF, or for larger programs without their own MRF with direct haul time to a MRF of greater than about one hour. How recyclables will be transferred will depend on the destination MRF. The degree of commingling, receiving hours, and possibly the type of transfer vehicle that can be used are typically items that the MRF will dictate. Transfer of single stream recyclables using light compaction will likely be simpler and more economical than transfer of two stream recyclables.

The design of a transfer station can vary from a very simple split-elevation, direct unload operation into an open top transfer trailer (for small tonnages) to more sophisticated enclosed structures with several loading bays. A recent WDO report provides more detailed information about transfer systems. The cost of providing a transfer option must be weighed against that of direct haul. To assist in this, an Excel model has been developed to assess different transfer options on a site specific basis (check with WDO on how to access model).

Sources and Links

E&E Fund Project Number 207. *York Collection and Processing Optimization Study*, 2006
http://www.stewardshipontario.ca/eefund/projects/benchmark.htm#207

Efficient Recycling Collection Routing in Pictou County, 2001
http://www.cogs.ns.ca/planning/projects/plt20014/images/research.pdf

US Environmental Protection Agency. *Getting More for Less: Improving Collection Efficiency*, 1999
www.epa.gov/garbage/coll-eff/r99038.pdf

Single Stream Best Practices Manual and Implementation Guide, Susan Kinsella, Conservatree, 2007
http://conservatree.com/learn/SolidWaste/bestpractices.shtml

"Assessment of Ontario Transfer Capabilities of Residential Blue Box Materials and Opportunities for Cost Savings"; Jacques Whitford for WDO; December, 2006

Waste Diversion Ontario
www.wdo.ca

Best Practice Spotlight

Best Practices in Processing of Recyclable Materials

Overview

Processing of Blue Box recyclables at a MRF is an intermediate step between the collection of the recyclables and the marketing of those materials to selected material markets. The role of a MRF is to receive, sort and prepare the recyclables to meet material specifications dictated by the selected markets. Discussed herein are selected design and operational Best Practices and associated considerations. Please refer to the Fundamental Best Practice on Operation Optimization, as well as the description of Curbside Recycling Best Practices for additional relevant information.

Key Benefits and Outcomes

By improving and optimizing processing functions, municipalities can obtain the following effectiveness benefits:

- Increased recovery of materials and diversion from landfill
- Improved separation of materials
- Lower residue levels
- Consistent material quality
- Improved relationships with end-markets

Programs can become more efficient due to the following factors:

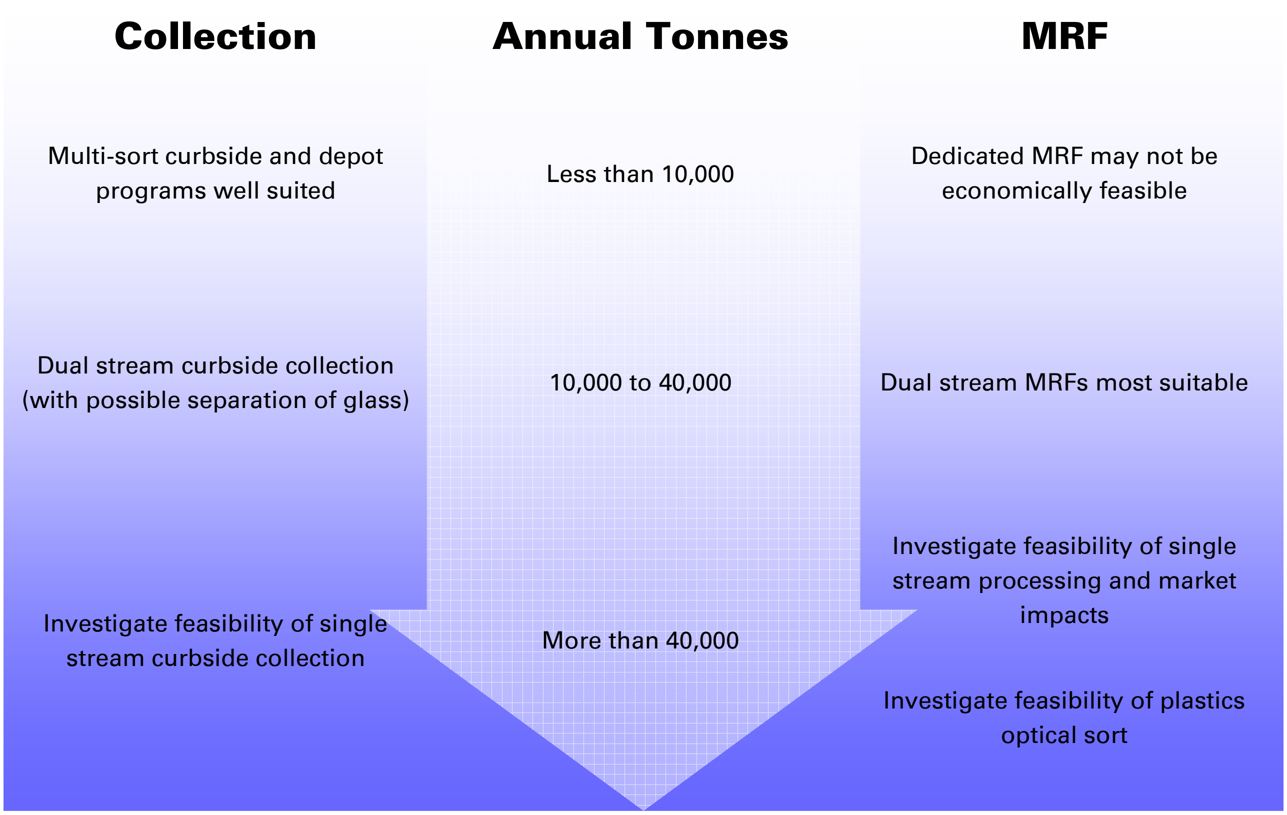
- Reduced need for staff, reduced downtime, reduced maintenance
- Increased revenues from sale of recyclables captured
- Improved employee safety and ergonomics
- Improved utilization of capital

Description and Implementation of Best Practice

The design of a MRF is dependent on the materials delivered, the composition of those materials, the degree of commingling, the annual tonnages delivered, and the proposed grades and specifications of materials to be produced and marketed.

As previously mentioned, smaller communities that employ curbside material sorting may rely on low-tech bulking facilities to densify materials for shipping. These facilities generally have no sorting capability, or feature a rudimentary sorting system (i.e. sorting directly from the pile of material deposited on the floor by the truck) that is not recommended for safety and health reasons. Medium-sized programs featuring dual-stream collection may use processing facilities that rely heavily on manual sorting because the material flow-through does not justify the capital expense on automated sorting equipment. The operation of efficient manual (labour-based) sorting systems has been refined over many years, and such systems are available on the market by MRF technology companies. Although labour costs can be high, these systems have a place in MRF design and will continue to be used. For many programs, they can be a cost-effective way of sorting materials if managed properly. Larger programs with higher tonnages and an expanded degree of commingling of recyclables are able to support more sophisticated mechanical sorting at the MRF. It is a best practice to consider opportunities for regional cooperation with respect to collection and processing, to enhance economies of scale and program efficiency. Similarly, consideration should also be given to handling recyclables captured through institutional, commercial and industrial (ICI) recycling programs as a means to increase throughput and improve processing facility economies of scale.

The schematic below illustrates how collection and processing systems change with increased tonnage recovered.



Regardless of the type of MRF, there are a number of conditional Best Practices that should be considered by any program looking to improve processing effectiveness, efficiency and costs. These include:

- Provide at least 2 day's storage capacity for incoming recyclables. This permits a second shift operation and provides a storage buffer during unscheduled equipment down time. Consider planning for a second shift, to maximize the use of processing equipment and to allow for processing of additional materials

- Build in as much flexibility as possible into the design and operational approach; this allows responding to changing needs and circumstances (e.g., changes in material mix, additional materials, improved technology, optical sorting, changes in market specifications, seasonal surges in tonnage, etc.)
- Balance the use of mechanization and labour. Evaluate the benefits and cost of labour and capital in each processing step to identify the optimum balance
- Use appropriate technology – the right tool for the job. These may include use of balers sized and designed to match the nature of material to be processed, ergonomically designed sorting lines, appropriately-sized and designed loaders to handle incoming materials, etc
- Provide adequate pre-sort capability. This practice provides the ability to remove oversize and problem materials such as large cardboard, wire, plastic film, etc. before reaching mechanical sorting equipment, where they may interfere or cause damage or interfere with subsequent processing. Removal of these materials improves the efficiency of subsequent sorting operations. Pre-sort capacity also offers an opportunity for sorting future add-on materials, such as bagged film plastic, textiles or oversized plastic bottles. Length of pre-sort conveyor required is dependent on the quantity and type of contamination present and the width of storage bunkers or cages required below the sorting conveyor
- Use fluffers (at the baler in-feed) or perforators with single ram balers, as some plastic bottles are difficult to bale (especially bottles with the lids still on). While single ram balers are suitable for smaller MRFs, they typically do not have the ability of larger 2-ram balers to produce dense plastic bales. The use of fluffers or perforators results in improved bale density of up to 20%.
- Investigate the feasibility of optical sorting of plastics if MRF throughput tonnage is >40,000 tonnes, or alternatively, if 3 or more sorters are required for sorting plastic containers. PET bottles are the most economical target for automatic sorting, as the number of bottles per kilogram is significantly higher than for HDPE and the absolute number of PET bottles is higher in Canada as well. It should also be noted that automated systems are primarily designed for sorting plastic bottles only and the addition of tubs/lids, clamshells, and polystyrene may limit the applicability of this technology in Canada, compared to other regions, such as the United States where collection and processing of these other plastic containers and components is not widespread. The shape of tubs and lids is not well suited to the capabilities of the automated sorting equipment. However, if the program handles a large volume of plastics, it might be desirable to leave space for optical sorting in a new MRF design, in the event that this will be added later. Retrofitting a MRF with an automated plastic sorting system requires a source of compressed air for the ejection mechanism, which most MRFs will not install as a matter of course.

- Make an appropriate level of capital investment to maximize benefits over the long term at a reasonable payback level (a detailed feasibility analysis is required).
- Pursue the "low hanging fruit" first – meaning those options that provide the greatest return on investment with respect to meeting specified operational performance and efficiency targets
- Build into contracts a clear understanding of preventive maintenance and equipment replacement requirements to maximize equipment life and ensure good equipment performance

In addition to the above, the following is a list of "toolbox" items that might be considered in MRF design and operation. Many of these were observed during MRF site visits in this project:

- Municipal ownership of MRFs – increasingly more municipalities are electing to own their own MRF and contract the operation. This gives them more control of their processing operations (e.g., ability to test and add materials, ability to retrofit as necessary to accommodate new technologies and processing systems, etc.). While private sector-owned MRFs ease the capital financing requirements of municipalities, they may offer less flexibility to the municipality (e.g., in what materials they can process, operating hours, number of streams processed, willingness to invest in additional equipment or equipment maintenance to further reduce operating costs, etc.). Contracts for operation of publicly-owned MRFs by private contractors should not exceed ten years in length.
- Provide frequent training of sorters to identify recyclables, improve sorting efficiency, reduce turnover
- Use variable speed conveyors wherever possible to adjust for material changes and staff sorting variability
- Incorporate ergonomic considerations in design with adherence to the ANSI Z245.41-2004 Facilities for the Processing of Commingled Recyclable Materials – Safety Requirements
- Incorporate methods to encourage a uniform flow of material through the process (even flow at reduced burden depth) (e.g., levelling drums, variable speed conveyors, provide 2 to 3-foot drop at fibre conveyor transitions, etc.)
- To the extent possible, remove large and bulky material (such as OCC and items that can be mechanically sorted) first on sort lines to get these materials out of the sorters' way
- Use negative sorting in the appropriate circumstances to sort commodities to minimize handling, especially when markets for such a commodity are more forgiving. This practice is mostly applicable when the material is predominant on the conveyor, and positively sorting the residue as opposed to the material is a better use of the sorters' skills. For example, if a community has a market for newspaper with a significant allowance for other fibre materials (i.e. #6 ONP), this material may be a large percentage of the fibre stream on the conveyor and thus best left to negative sort at the end. In the absence of such circumstances,

residue should be removed by negative sort to minimize labour requirements and maximize material quality

- Use technology (screens, air classifier, magnets, etc.) early in the process to reduce the volume to be sorted and leave an opportunity for supplementary recovery (i.e., quality control) after the technology has been applied to maximize the recovery of valuable commodities
- To the extent possible, use gravity and free fall to move materials from processing to storage and further processing to simplify the operation, reduce maintenance, reduce floor space, requirements, and reduce operating costs. One example of this is to use vertical storage hoppers that release sorted materials when they are scheduled to be fed into the baler
- Optimize traffic flow control to reduce unloading time and congestion; and minimize double handling where possible for example by using conveyors to move materials as opposed to repeated loading and unloading
- Provide workers with environmentally comfortable and safe working conditions in accordance to ANSI Z245.41-2004 Standard (heat/cool, ventilation, lighting, safety and protective equipment, etc.) Ensure knowledge of health and safety requirements, including Pre-Start Health and Safety Review, the provision of safety training in accordance to ANSI Z245.41-2004, minimization of noise and air contamination, and the safe use of equipment, personal protection equipment (PPE).
- Provide a quality control station at the baler pre-feed, in place of several quality control stations for individual materials
- Consider compacting, or possibly baling residue, to minimize shipping costs to landfill
- Monitor residue rates and work to improve both incoming and outgoing product quality
- Conduct periodic efficiency/optimization studies and provide structured opportunities for employee input to provide for continuous improvement

Single Stream Recycling

While the discussion above relates to all MRFs, there exists particular interest in the development of single stream recycling. The term "Single Stream Recycling" refers to a process in which Blue Box recyclables, container and fibre materials, are collected from residences and/or businesses in a single, fully commingled form and subsequently separated and processed into marketable secondary materials at a materials recovery facility. The following discussion reviews a number of key issues related to single stream recycling, with particular emphasis on single stream MRFs. The reader is also directed to the Best Practice Spotlight on Curbside Collection discussion for more detail on related single stream collection issues.

As the definition implies, there are two parts of a single stream recycling system that are generally implemented in tandem:

- **Single stream** Collection of Recyclables – To facilitate efficient collection residents are told that there is no need to segregate recyclables into separate streams (e.g., fibre, containers). The recyclables can then be collected using standard single compartment collection vehicles, in some instances, with semi-automated or automated loading capabilities. The use of larger capacity containers (carts, bags) encourages consideration of a reduction in collection frequency (from weekly to every other week) with resulting cost savings. The use of a large container allows for the collection of additional recyclable materials (such as a full range of fibres and rigid plastic containers), as well as the reduction in collection frequency due to the additional storage capacity provided by the container. It also provides convenience and ease of use to the resident and/or business. In some programs, residents use plastic bags, rather than rigid containers, to set out the commingled recyclables
- **Single stream Processing of Recyclables –** The implementation of a single stream recycling system also requires the availability of a materials recovery facility (MRF) that is able to accept and process recyclables that are collected in a single stream form.

There has been a tremendous growth in the implementation of the single stream recycling approach in the last decade. In 1995, there were five single stream MRFs in the United States. In 2000, there were 64 single stream MRFs. These facilities represented more than 20% of the MRF processing capacity in the U.S. in the year 2000. According to Governmental Advisory Associates, a Westport, Conn., consulting firm that maintains a database on MRFs, there are presently about 100 municipal and regional single stream programs located in 22 states serving about 27 million residents.

While single stream recycling may not be appropriate for every community, there is a definite trend regarding the implementation of this approach for residential recycling systems. It is noteworthy that a number of the most aggressive and dedicated U.S. recycling communities have converted to single stream recyclables collection programs. Among the converts are:

- Seattle, Washington
- Portland, Oregon
- San Jose, California
- Los Angeles, California
- Denver, Colorado
- Plano, Texas.

The Canadian experience is similar, especially in Ontario. In 2004, approximately 20% of Blue Box tonnage was processed through single stream MRFs. In 2006, this had increased to approximately 40%. Programs such as the City of Toronto, York Region, Peel Region, and Sudbury have introduced single stream recycling over the past two years.

The following factors have contributed to the rapid growth of single stream systems in the last ten years:

- **Desire to Increase Number and Quantity of Recyclables –** The adoption of higher recycling goals has caused communities to target more materials for collection, exacerbating the problems associated with curb-sort collection systems (e.g., limited number and size of compartments, limited bin capacity, etc.)
- **Householder Desire for Convenience and Ease of Use –** The increase in the number of materials targeted for recycling increased the difficulty of the resident's participation in source-separated recyclables collection systems, leading first to the development of the dual-stream concept and later to the single stream approach. Single stream recycling has shown to be successful in increasing both participation and capture rates even in communities that previously had good two-stream recovery rates
- **Improvements in MRF Processing Technologies –** The heavy reliance of early MRFs on manual labour led to the development and/or refinement of materials handling technologies to the point where screening systems can now reliably and effectively sort out containers and fibrous materials. In the last ten years or so, improvements have been made in MRF processing equipment - specifically, disc screens and optical sorting equipment (for larger facilities) - that have enabled MRFs to cost effectively process single stream recyclables
- **Improvements in Automated Collection Technologies –** In the last 20 years, there has been significant growth in the utilization of automated refuse collection vehicles for both refuse and recyclables collection, particularly in the U.S. This trend has not occurred in Ontario, although it may become more prevalent in future years where weather permits. The growth of this market has resulted in design improvements that have increased the reliability and reduced the maintenance costs of automated collection equipment, as well as lowered equipment prices
- **Pressure to Reduce Overall System Costs and Minimize Cost Increases Resulting from Addition of New Materials –** In many parts of Canada and the U.S., different governments are responsible for the collection and processing elements of curbside recycling systems (i.e., cities and towns assumed or were given responsibility for recyclables collection, while counties or states implemented MRFs). For this reason, there was little opportunity or incentive to look at system-wide efficiencies. It took large municipal and private sector organizations with major responsibilities for both recyclables collection and processing service, such as the Peel Region, the City of Toronto, City of Phoenix, Waste Management, Inc., etc., to recognize the potential system efficiencies associated with the single stream approach. These efficiencies are primarily associated with the curbside collection of recyclables in a single stream form. Very often, single stream recycling has been implemented to accommodate other waste management practices (e.g., co-collection, addition of household organics collection, etc.)

- **Consolidation in the Waste and Recycling Industries –** With fewer companies handling greater quantities of materials from larger geographic areas, larger, more automated regional MRFs have become increasingly feasible. Capital investment in processing systems has increased, and with it the use of single stream systems

According to its promoters, single stream recycling is reported to have the following benefits:

- Easier and more convenient for residents
- Increased recyclable capture rates due to the ability to collect more types and volumes of materials
- Reduction in scavenging (materials are usually set out in one larger container)
- Less wind scatter and litter
- Protection of paper from rain if carts or bags are used
- Ability to use high capacity collection vehicles, including automated collection vehicles in some areas
- Improved collection efficiencies (reduced seconds per stop, more materials per stop)
- Reduced fatigue and risks to workers, especially when the system is fully or semi-automated

Reported disadvantages include the following:

- Less quality control at curb
- Low recovery of glass by colour due to more glass breakage
- Recovered materials contamination, especially paper with glass shards and plastic film
- Loss of collected materials due to cross over contamination (e.g., plastic bottles ending up in paper bales)
- Potentially lower value of recovered materials
- Contamination of fibre caused by food and liquids originating from the containers;
- Increase in MRF residuals
- Higher MRF capital and processing costs
- Higher vehicle maintenance costs (for automated vehicles)
- Increased marketing of minimally sorted paper as mixed paper – much of it shipped overseas – rather than sorting paper into grades used by domestic mills, thereby creating supply concerns. (Also results in low grading, as opposed to highest and best use, and ultimate deterioration of material quality)

Single stream recycling is a complex issue that impacts virtually all of the major components of a solid waste management system. Specifically, single stream recycling program components are listed below.

Collection – Although collection efficiencies can be achieved with single stream recycling, this is not a certainty. Municipalities considering single stream recycling need to take a system-wide approach because collection savings will only be achieved under certain circumstances. If fully automated waste collection is franchised or contracted for the entire municipality, there is a strong incentive to investigate single stream recycling because existing trucks can be used to collect both waste and recyclables on separate routes. However, if most waste collection is performed via rear-load manual trucks, single stream recycling will require an entirely new collection fleet, and will impose a cart-based system on residents who may be accustomed to setting out bags, bins, or bundles or recyclables. Similarly, if a municipality decides to maintain a two box collection system, potential savings in stop times at the curb will not be fully realized.

Single-stream collection systems typically use collection equipment with on board compaction that is also used for waste collection for simplicity of operations and maintenance. Although waste benefits from maximum compaction, single stream recycling collection can only accept some compaction before its impact will seriously affect the performance of the processing system. The processing system is based on the separation of "flats and rounds" or two-dimensional objects from three-dimensional objects. Excessive compaction during collection can compromise this property differential.

Reduction of the collection frequency from weekly to every-other-week collection can lead to significant cost savings in single stream systems. While this option has been identified by as a promising strategy to ensure the long-term economic viability of residential curbside recycling systems, there appears to be no documentation in the literature of its combined economic impacts.

Public Education – For the past two decades, most residential customers who live in areas with curbside recycling have been asked to carefully prepare and often separate fibre from containers. Single stream recycling is a significant change in behaviour for residents – they are now told that there is no need to segregate recyclables into separate containers and a distinctive recycling truck is replaced by a "garbage truck". This can create significant scepticism among them about whether the materials are actually recycled.

Processing – There is no question that processing single stream material is more costly, requires more capital investment, and requires a significant throughput to assure financial success. Additionally, residuals are known to be significantly higher for single stream MRFs. These high residue rates partially offset the higher capture rates of the single stream program, so any evaluation of single stream should take into account both impacts.

Some materials are not compatible with single stream systems because of their physical properties. For instance, plastic film and telephone directories affect the disc screen performance. Polystyrene pieces and shredded paper tend to flow through the screens and contaminate mixed broken glass. Larger plastic containers (over 8 litres) have the potential to be mechanically separated into the cardboard stream, if the pre sort is inadequate and a post screen quality control on cardboard is not implemented.

Marketing – Prior to converting to a single stream program, it will be extremely important to understand the availability of markets for single stream material, and to evaluate the potential to achieve target specifications for sorted materials. The acceptability of materials collected through single stream systems depends on the specific products to be made. The fact that some paper mills are able to accept single stream materials does not mean that all will be able to do so. Many mills requiring high quality recovered paper feedstock have growing concerns about the ongoing availability of suitable supply.

Although single stream equipment manufacturers insist that their configurations can produce #8 ONP if needed, there has been mixed feedback from paper mills. Some indicate that single stream material is highly contaminated and increases potential to damage mill equipment, while others point to examples of single stream feedstock that is far better quality than that of dual stream customers. Clearly, blanket statements regarding the quality of fibre coming from single stream MRFs should be avoided. The MRF operator plays a key role in product quality. There have been exceptionally clean loads produced from single stream MRFs and very dirty loads from dual stream MRFs.

While the issue of fibre contamination is a market concern for single stream systems, other market concerns also exist. The issue of glass breakage in the collection and processing steps and the resulting reduction in glass recovery is an issue faced in both dual-stream, as well as single stream systems, but is a greater issue in certain single stream systems – particularly in communities without access to glass beneficiation facilities with optical sorting technology.

Cost – Despite the recent growth in single stream systems, it would be a mistake to assume that the single stream recycling approach represents the most economical alternative for all communities. In some cases, other approaches, such as the dual-stream, two-bin recycling approach, may prove to be more economical. This conclusion underscores the importance of using local economic and market data in assessing the economic feasibility of single stream recycling for a local community.

Sources and Links

Berenyi, Eileen B.; *"Single stream Ahead;"* Resource Recycling, August 2002. pp 31-33.

Entec Consulting Ltd.; *"Report on Ontario Blue Box Material Recovery Facilities"*; for WDO; March 2007

Tim Goodman & Associates; *"Single-Stream and Dual Stream Recycling: Comparative Impacts of Commingled Recyclables Processing"*; for Minnesota pollution control Agency; January, 2006

Stewardship Ontario Knowledge Network

E&E Fund Project Number 207. York Collection and Processing Optimization Study, 2006
http://www.stewardshipontario.ca/eefund/projects/benchmark.htm#207

Single Stream Best Practices Manual and Implementation Guide, Susan Kinsella, Conservatree, 2007
http://conservatree.com/learn/SolidWaste/bestpractices.shtml

Best Practice Spotlight

Successful Marketing Strategy for Processed Recyclables

Overview

Marketing of processed recyclable materials is the last step in the value chain of municipal Blue Box recycling. As a result, the effective execution of this process is largely influenced not only by the end-market demands and relationships, but also by virtually all other value chain elements that precede it. This section describes a range of factors that lead to improved material quality and higher revenues and provides guidance on how to structure a successful marketing strategy

Key Benefits and Outcomes

A successful marketing strategy, when properly designed and executed, has the ability to improve program effectiveness by:

- Ensuring high quality service to specified requirements
- Improving end-market relationships
- Improving contractor relationships
- Allowing for flexibility and innovation to address changing conditions
- Positively affecting system-wide program strategies
- Allowing processor to properly manage inventory
- Aiding market development
- Raising municipal profile
- Engaging staff
- Maintaining focus on continuous improvement

It can improve program efficiency by:

- Positively affecting the net cost of the overall recycling program
- Resulting in higher, more predictable revenue
- Potentially optimizing funding
- Potential mitigating municipal risk, if desired
- Improving risk management by way of due diligence
- Identifying potential revenue enhancements through modified processing

Description of Marketing Practices

The marketing of recovered materials is one of the most critical factors in the success of any municipal recycling program, as the revenue realized from the sale of materials directly affects the net cost of the overall recycling program. Municipal marketing strategies are widely diverse and varied (as a consequence, analysis of WDO data did not conclusively identify a leading practice in this realm). The range of strategies includes:

- Marketing done by municipality who retains revenue
- Marketing done by contractor who retains revenue
- Marketing done by contractor who rebates most of the revenue to municipality
- Marketing done by contractor who shares revenue with municipality (e.g., 50/50)
- Marketing done by municipality who shares revenue with contractor
- Municipality sells commodities to contractor based on a formula (contractor then markets and attempts to receive a premium)
- The use of service agreements or spot markets (or a combination)
- The use of tenders or other bidding system of varying terms
- Pricing based on established indexes such as the Official Board Markets (OBM), Yellow Sheet Price
- The exclusive use of brokers or end markets (or combination)
- Collection contract that does not include control of material once collected (collection contractor responsible for processing and marketing)
- Cooperative marketing (marketing recyclables from different, usually smaller, programs)
- Other combinations of the above strategies

Many of the contractor-controlled marketing strategies listed above are designed to mitigate municipal risk. A recent report, titled "*Blue Box Residential Recycling Best Practices – A Private Sector Perspective*", jointly prepared by Stewardship Ontario and the Ontario Waste Management Association (OWMA), suggests that market risks should not be assigned to the contractor without fully considering the options and potential implications. If contractors accept risks they cannot control, they will make appropriate provisions in pricing, forcing municipalities to pay a premium. By doing this, contractors protect the bottom line when market revenues decline, and make excessive profits if revenues meet or exceed expectations. Because contractor-controlled marketing strategies are often tied to varied contractual terms and pricing (e.g., processing or collection fees), it is considered best practice, in cases where a potential decision may be to assign all revenues to the contractor, to structure a tender that permits the municipality to assess what exactly is being charged by the contractor to assume market risks. This can be done, for instance, by requesting pricing options that include revenue sharing scenarios.

The OWMA report suggests that the private sector preferred practice is for the contractor to retain responsibility for marketing the materials in exchange for a small percentage of revenue (5-10%). These revenue sharing arrangements usually serve to benefit both parties, as the objectives of revenue maximization and appropriate risk management are aligned. It should be noted that in these contractor marketing scenarios, municipalities need to employ knowledgeable staff to manage the contract, as there is little incentive to the contactor to realize the best revenues.

Marketing by municipal staff, whose municipalities retain the revenue, can also be a successful strategy. This strategy can be employed in municipally-operated Material Recovery Facilities (MRFs), as well as those that are operated on behalf of municipalities by contractors.

Successful marketing is inherently tied to all aspects of a recycling program. For example, materials are often targeted for recycling by municipalities for a variety of reasons not related to their marketability (e.g., waste audit information, regulations, political mandate). If materials included in the program do not have established markets with consistent revenue, or cannot be used to displace another material (e.g., glass as an aggregate substitute), net revenue per tonne is negatively affected. If Promotion and Education (P&E) is not effective and collection crews do not deliver quality feedstock to the MRF, then there is pressure on the MRF to meet recyclable material recovery and quality targets. Because of this, the marketer needs to communicate with those responsible for Program Planning, P&E and Collections.

The marketer's relationship to other program elements is particularly relevant when it comes to processing. In order to successfully market processed commodities at the highest possible revenue, a marketer requires a consistent supply of quality material (i.e., meets market specifications and payload minimums). As markets for recyclable commodities are generally well established, fluctuation in revenue is primarily the result of individual product quality and current market conditions. Even if staff responsible for marketing is not the same as for processing (or managing the processing contract), it is important that the marketer has a keen understanding of MRF operations, contracts, and opportunities (e.g., alternative plastic sorts, densification options, etc.) that determine the quality and composition of the material that is being sold. Conducting routine audits helps to ensure that opportunities that improve revenue through tonnage increase or mitigation of quality concerns are fully acted upon. Equally, the marketer needs to understand and establish relationships with markets (all end-users), and mutual understanding of the composition of the marketed material is important to this relationship. The markets, to which recyclable materials are sold for revenue, are critically important to understand, as they specify types, quantities, and quality of materials that will be purchased. These requirements fundamentally influence processing, collection and other aspects of a recycling program's operation.

Implementation of a Good Marketing Strategy

There are a number of leading practices, based on the marketing experience of developed programs that can be employed by municipal program operators. These include:

- An understanding of basic market requirements
- The performance of marketing-related audits

- The provision of quality feedstock to end markets
- A systematic approach to finding and selecting end market options

These practices and their benefits are described below in greater detail.

Planning and Operating According to General Principles that Promote Service, Integrity and Sound Decision-making

Whereas a waste manager is a service provider, with a responsibility to collect waste and keep citizens satisfied with service, a recycling manager must also provide quality feedstock to an industrial process, ensuring clean, consistent volumes of useable material.

Some industry experts indicate that there is currently a gap in quality, consistency, and reliability between materials produced by the municipal recycling process and the expectations of buyers of these materials. Higher degree of communications and interactions between producers (recyclers) and buyers (end-markets) may be needed to close this gap. Progress in this area may shift the relationship from a punitive one that causes loss of revenues (reduction in prices paid, downgrades, etc.) to a collaborative one that results in higher revenues from buyer expectations being met (customized material compositions, special bailing methods, convenient delivery schedule, etc.).

General principles to apply to recyclable materials markets:

- Markets should be as secure as possible, either by having multiple outlets or by establishing purchase agreements
- Market requirements and location influence program collection and processing. Material with low market value generally benefit with nearby outlets, whereas products with high value may be economically transported in truckload or railcar quantities to more distant markets
- Markets may need varying quality, consistency and quantity. Materials need to be processed to meet the specific market specifications of the buying entity.
- Market fluctuations must be considered in program planning. This can be gauged by reviewing historical pricing trends available through trade associations and publications, monitoring of the trade press, personal communication with end markets, brokers and municipal marketers, and by tracking key market indicators (refer to the Sources and Links section below)
- There must be one or more markets for materials made from recycled products

Traditional revenue generating markets require the following:

- High and predictable quality feedstock (i.e., uncontaminated recyclables)
- Sufficient volumes to be cost effective
- A consistent supply

These market requirements dictate the appropriate recovery technique, equipment and recyclable material revenues.

Program managers need to recognize that a variety of micro and macroeconomic factors influence the revenues received from marketing processed recyclable materials. Some of these include:

- Business cycle - the periodic up and down movements in economic activity (i.e., expansion, contraction, recession etc.)
- Energy prices
- Transportation costs
- Export and imports
- Currency exchange
- Size and proximity to market
- Supply and demand of a particular material
- Competition
- Labour issues
- A development/change in end use
- Supply and demand of virgin materials
- Innovations in raw material supply
- Regulations, institutional, and government issues (domestic and international)
- Quality/quantity and consistency of supply of material
- Landfill costs (indirectly)

Conducting Marketing-Related Audits

Material audits are instrumental in identifying issues, deducing causes of problems, and making program changes. They allow program managers to reinforce and leverage positive elements of the program and reduce or eliminate problem areas.

Inbound audits serve to:

- Identify quality of feedstock to the MRF
- Identify changes in composition
- Draw attention to new packaging
- Aid in planning process changes
- Assist in targeting P&E
- Monitor collection crew diligence
- Aid in effectively managing collections and processing contracts

Residue audits serve to:

- Determine the amount of recyclable material that is lost to residue
- Further analyze effectiveness of P&E
- Further determine collection consistency as it relates to accepted material

- Identify potential sorting opportunities (e.g., Tubs and Lids vs. 3-7)
- Identify potential mechanical (or manual) deficiencies in the system
- Determine marketing options for residue (alternate processing)
- Aids in effectively managing collection and processing contracts

Commodity audits (bale audit) serve to:

- Determine if processing is meeting market specifications
- Communicate data to end markets
- Defend against downgrades
- Determine if revenue is being lost (e.g., aluminium in Fibre)
- Identify sorting opportunities (e.g., natural vs. pigmented HDPE)
- Identify potential mechanical (or manual) deficiencies in the system
- Train sorters
- Aid in effectively managing processing contracts

Finding and Selecting Markets

Municipal marketers need to continuously evaluate end-market options for transportation and material handling. Delivery options of processed materials to end markets are as follows:

- Haul recyclable material directly to material consumer (the mill) where it is processed and used in an industrial process
- Haul to an intermediary (a broker or dealer) who processes it to specification and hauls it to the mill
- Have an intermediary pick up recyclable material
- Adopt a regional approach with smaller feeder programs decontaminating and storing materials to feed into larger regional processing centres that process materials and haul to market. More information on cooperative marketing experience is available from AMRC and Cooperative Marketing project report (E&E Fund Project #86)

Factors to consider in choosing a recyclable materials market:

- **Distance to market:** the greater the distance, the higher the haulage costs and the greater the need to maximize payload
- **Required specifications for material preparation:** in general, select the market with the minimum specifications and the highest price. For a stable situation, it is important to balance the two elements, and look at patterns and history (such as downgrades)
- **Tonnages:** programs with larger tonnages can often sell directly to a market, ensuring a higher price. Smaller programs may require a broker/merchant or cooperative agreement to obtain favourable pricing

- **Revenue/cost ratio:** maximum revenue implies a higher processing cost, therefore there is a need to select the optimum revenue/cost ratio. It is important to find a balance between the two

Determining the best market for a material requires four steps: identifying, contacting, selecting and negotiating and/or contracting with buyers. To be executed properly, this process usually requires dedicated time and resources. Even small programs should dedicate resources to this task, even if it is temporary/periodic for the purpose of setting up and monitoring a longer-term strategy. It should be noted that it may be advisable to use more than one buyer, if possible, and to sell material using a combination of agreements and spot markets.

- **Step 1 - Identify potential buyers:** Contact information can often be found from talking to other recycling program operators, or by contacting national and provincial recycling and/or industry organizations. Numerous trade publications and websites also exist. Marketers also often receive unsolicited calls from potential buyers.
- **Step 2 – Contact potential buyers:** This step involves requesting information regarding the market. Some questions might include:
  - Price paid for material
  - Material specifications (degree of contamination acceptable, densification required)
  - Transportation options and costs
  - Minimum/maximum loads
  - References
  - Payment terms
- **Step 3 – Select a buyer:** This step may involve interviewing potential buyers and assessing them based on a set of criteria.
- **Step 4 – Contract with a buyer:** A written agreement protects a relationship with a buyer as competition for markets escalates. Contracts can be useful when markets take a downturn because buyers may only service customers with written agreements. Written agreements may include letters of intent to purchase material as well as formal contracts. Provisions in a written agreement may include tonnage and volume requirements, material quality specifications, and provisions for delivery or pickup, termination provisions, length of commitment, and the pricing basis that may include a relevant index.

Knowledgeable marketers continually research pricing trends to ensure they receive fair value for material. Marketers should monitor performance by analyzing relevant industry publications (e.g., CSR Price Sheet) and communicating with other municipal marketers, markets, brokers and organizations (e.g., Association of Municipal Recycling Coordinators, Markets and Operations Committee).

Sources and Links

Ontario Waste Management Association: *"Blue Box Residential Recycling Best practices – A Private Sector Perspective,"* Guilford and Associates (February 2007)
http://www.owma.org/home.asp

Federation of Canadian Municipalities: "*Solid Waste as a resource – Guide for Sustainable Communities"* (March 2004)
http://www.fcm.ca/

Minnesota Office of Environmental Assistance: *"Single-Stream and Dual-Stream Recycling – Comparative impacts of Commingled Recyclables Processing*" (January 2006)
http://www.pca.state.mn.us/oea/lc/commingled.cfm

Official Board Markets Yellow Sheet Pricing (OBM):
http://www.packaging-online.com/paperboardpackaging/

CSR Price Sheet:
http://csr.org/pricesheet/pricesheet.htm

Association of Municipal Recycling Coordinators (AMRC):
http://www.amrc.ca/

Stewardship Ontario E&E Fund Approved Projects:

" #86, Pre-Feasibility Study of Co-operative Marketing Programs for Blue Box Materials in Ontario" (April 2006)

*"#164, Markets Help Desk Report" (*January 2007)

http://www.stewardshipontario.ca/eefund/projects.htm

Best Practice Spotlight

Best Practices in Multi-Family Recycling

Overview

Statistics Canada 2001 Census reported that approximately 26% of Ontario's residents currently live in multi-family buildings and the number is continuing to grow. Since the collection of recyclable materials from multi-family households has historically been a challenging process, a new approach that incorporates Best Practices is needed. This section is designed to provide guidance to municipalities that seek to enhance participation levels, recovery levels, and material quality levels, while yielding operational efficiencies in multi-family collection.

Key Benefits and Outcomes

By employing Best Practices in multi-family recycling, municipalities can obtain the following effectiveness benefits:

- Increased diversion from landfill
- Decreased contamination of materials
- Increased capture rates
- Increased participation in recycling

Programs can become more efficient due to the following factors:

- Collection of front-load bins or side-load carts at a single collection point are more cost-effective methods when compared to individual stops at each household for the equivalent number of units
- Front-load bins are more cost efficient than carts, carts more efficient than boxes
- Increased revenues from sale of recyclables captured
- Optimization of collection and processing systems due to increased tonnage

Description and Implementation of Best Practice

Ontario Regulation 103/94 requires the owner of a building that contains six or more dwelling units and is located within a municipality that has a population of at least 5,000 to implement a source separation program for the waste generated at the building.

Municipalities are required to collect recyclable materials from multi-family buildings only if the properties are receiving garbage collection services from the municipality. However, if garbage service is not provided by the municipality, all qualifying multi-family buildings are still required to recycle aluminium food or beverage cans, glass bottles and jars for food or beverages, newsprint, polyethylene terephthalate (PET) bottles for food or beverages, steel food or beverage cans, and any other categories of waste that are collected or accepted in the blue box program of the municipality where the building is located. Despite this law being in place for over a decade, a recent E&E-funded Focus Group (see Sources and Links section) study revealed that most property managers were not aware of this Ontario government regulation.

Municipalities often regard multi-family buildings as being part of the commercial sector. Therefore, financial and operation information may not be reported under the WDO Datacall for the municipal Blue Box program. Municipalities who do not service the commercial sector may be unaware of the potential to include the multi-family sector in their residential Blue Box program as a possible cost-effective method of capturing large amounts of recyclables. Assuming the challenges associated with multi-family recycling are understood and addressed, the benefits of adding this sector to the municipal Blue Box program include increased diversion of materials from landfill, increased recycling tonnage, optimization of collection and processing systems, and increased revenues from the sale of the additional recycling materials captured.

It is recommended that municipalities identify all existing serviced and un-serviced multi-family buildings within their boundaries. For those currently not serviced, investigate the possibility of incorporating this sector with those residents served through the municipal Blue Box program. Factors to consider include whether some or all of the multi-family buildings could be absorbed into the existing curbside program or if a defined multi-family program would be warranted. The rationale will be affected by such things as the number, size, and location of the buildings, as well as the impact on the overall system to collect, process, and market the expected increased tonnage. For complexes that are currently being serviced under the municipal Blue Box program, it is important that the performance be measured and monitored.

Waste Composition Audits

It is recommended that periodic waste composition audits be conducted to assist with program planning, to determine generation rates and capture rates, and to obtain benchmark data used to compare performance over time. Stewardship Ontario has developed multi family waste audit worksheets, tips and, guidelines for waste sorting.

Generation and Capture Rates

Each multi-family household in a large urban area generates approximately 264 kg of recyclables per year (approximately 92 kg less than single family households), but less than 32% of this is captured. In comparison, approximately 60% of the available recyclables generated by single-family households are captured.

A contributing factor to the lower generation rate for both garbage and recyclable materials is that there are usually fewer occupants in each household. On average, there are 2 people per apartment unit, as opposed to 2.9 in a single family home.

Factors that adversely affect recycling at multi-family buildings include:

- Recycling is almost always less convenient than garbage disposal
- Insufficient recycling bin capacity
- Residents' sense of disconnect from recycling program, leading to sense of direct responsibility
- Anonymity limits repercussions for not recycling properly or at all
- Transience issues - apartments may be considered temporary accommodation
- Multi-cultural and socio-economic factors may affect recycling behaviour
- Multi-lingual issues may hinder understanding of the recycling program
- Opinion that maintenance fees cover waste management services
- Insufficient promotion and education of the program

Multi-family buildings exist in a variety of sizes, heights, and designs. Since the majority of multi-family recycling programs have been added to existing apartment developments that were not designed for recycling programs, there are often challenges with insufficient space, location, or collection system for recycling bins. In addition, multi-family buildings generally share common bins and have their garbage and recycling collected at a central collection point. Unless closely monitored, sharing common bins can contribute to the potential for misuse, causing contamination and premature topping out. However, given the high concentration of residents using common bins, there is a potential to cost-effectively capture large amounts of recyclables.

Design Requirements for New Developments and Re-Developments

Although some existing buildings may have less than optimal layouts for recycling programs, there is an opportunity to ensure that any new developments are designed to meet the individual municipality's recycling system requirements prior to approval. It is recommended that municipalities develop mandatory requirements for new or re-developed multi-family buildings to be designed to allow for integrated waste management practices.

The standards for these developments should work in harmony with each municipality's Waste Management Master Plan, and suit the collection system and processing operations accordingly. The design plans submitted by the developer should be reviewed by competent staff with the Solid Waste knowledge to assess the drawings to determine if the design requirements for garbage and recycling collection have been met.

If developers propose a change in collection points, method of collection, change of use, or an existing building being expanded by more than 1/3 its original size, the plans should also be reviewed by Solid Waste staff. Each site and building should be inspected prior to approval to ensure that the development has complied with all requirements for solid waste and recycling programs.

In order for multi-family buildings to qualify for the municipal garbage and recyclables collection services, it is recommended that municipalities only approve those new developments or redevelopments that adhere to the appropriate design requirements. Requirements may stipulate an appropriate type, quantity, and location of the garbage and recycling bins to accommodate the volume of material expected to be generated by the number of residential units at the complex, assuming full participation in the municipal recycling program.

The application submitted to the municipality should include details regarding the number of dwelling units in the development, the total ground floor area, the number of stories, access routes, loading facilities, garbage rooms, recycling rooms, size and quantity of garbage and recycling containers to be used, and, if designed for a chute disposal system, the type and quantity of chutes for garbage and recycling.

The new or re-development should be designed to ensure that the recycling system is as convenient a system for the residents to use as the garbage system. For example, a chute system on each floor would have to receive both garbage and recyclables, either as one chute with mechanical baffles for residents to control the direction of the appropriate stream, or with individual chutes for garbage and each steam of recyclables. If no chute is provided, then there should be a central garbage and recycling facility on the ground floor.

Set a minimum recovery threshold for recycling. It is recommended that sites fully participate in the municipal recycling program in order to be eligible to receive municipal garbage collection. It will be necessary to determine what quantity of recyclables should be used as a benchmark in order to be considered fully participating in the recycling program. This will depend largely on the frequency of collection, the amount of materials accepted in the program, and the collection system in which to base the measurement. For example, the City of Toronto has used the following benchmark: for every 100 units at a complex, a volume of 6 cubic yards (or 1212 US gallons) of recyclables should be captured per week as a minimum. The management and residents are informed of this minimum requirement. In many cases, once appropriate promotion and education activities are executed, the capture rate exceeds the minimum requirements.

Many programs require multi-family buildings to purchase the recycling bins at full or subsidized cost. A recent focus group study revealed that although superintendents identified the need and repeatedly requested that their property management supply more recycling bins, this minimal investment request was refused. Unless the building was going to incur additional garbage charges for excess quantities, they did not see the financial benefit to their business. If there were maximum garbage limits and minimum recycling limits, they would be more likely to comply with obtaining the appropriate number of bins.

The feedback from the collector is crucial regarding compliance at the multi-family buildings. Buildings that are not meeting their minimum should be notified regarding their performance and offered guidance toward achieving a better capture rate in order to be eligible to receive municipal garbage collection.

There should not be a maximum limit placed on recycling. In some programs, a limit has been placed on the quantity of cardboard set out in the recycling carts. The operational problems created by big quantities of cardboard can be resolved by changing collection method, bin type, or increasing frequency rather than limiting the quantity accepted as recycling. On the first of the month, buildings are likely to have an increase in the amount of cardboard due to new residents unpacking. This should be taken into consideration when assessing the collection system and bin types. Setting a limit on recyclables will only resulting in the disposal of the material as garbage. If the quantity of recyclables is unmanageable within the current system, it may be necessary to reassess the bin size and type used at the site, and/or consider increasing the collection frequency to meet the need.

Type of Collection Bin

The type of collection bins is dependent on current operational practices for each municipal program, as well as the location and design of the multi-family building. The method of garbage collection may determine the method of recycling collection. For example, multi-family buildings receiving front-end bulk garbage would be an appropriate candidate to consider bulk recycling, as the layout is already conducive to this type of bins and collection vehicles.

Very small complexes that have less than 6 units, may distribute individual blue boxes for their residents to set at the curb for collection with the single family homes. However, depending on each program’s recycling sort streams, and the extent of recycling materials accepted by the program, combined with the collection frequency offered through the municipal programs, each unit may require more than one box to sufficiently contain the recyclables between collections. This can create storage issues within the units, potential problems at the set out point, and an inefficient collection method at the complex.

Multi-family buildings or infill townhouse complexes that have a common collection point for up to 30 units should consider using 90 or 95 gallon (340-360 litre) roll-out carts that are compatible with the collection vehicles. Each recycling cart offers the equivalent volume of 6 to 8 curbside recycling boxes. The residents will not have the negative aspects associated with storing the material in their own units between collections, and the cart can be mechanically lifted and emptied more efficiently. The carts should be stored in a location that is convenient for the residents to use (inside or sheltered from rain and snow), and, if different than the collection point, moved out for the day of collection only.

For complexes between 30 and 100 units either carts or front-end bulk bins can be effective, depending on the number of recycling streams in the program and the design of the complex. Programs offering single stream recycling may see a benefit by using front load recycling bins in this mid-size multi-family building category, as several carts can be replaced by one bulk bin, thereby reducing the number of carts and lifts required. For example, one 4-cubic yard (3-cubic m) bin could replace 9 carts containing the same materials. However, if the existing design is a sprawling infill townhouse complex, it may be more appropriate to have several recycling stations to enhance convenience, and have the carts brought to one or more central location points on collection day.

For complexes with 100 units or greater, front-load bulk bins should be considered the preferred choice to maximize both efficiency and effectiveness. If the bins are to be accessed directly by residents, it is recommended that the bins be modified to limit the opening to contain only the desired materials and thereby minimize opportunity for contamination. The top lid should be kept padlocked between collections, with only the building's maintenance staff responsible to open it daily to remove any contaminating items. On collection day, the top lid should be unlocked, contaminating items should have been removed, and the bin placed in position for collection.

Determine Suitable Recycling Bin Capacity

Bin capacity should be considered in relation to the number of residential units sharing the recycling containers, the number of sort streams required under the municipal program, and the degree of automation by the collection system.

As a guideline, the City of Toronto has used the bin capacity formula of a minimum of 6 cubic yards (4.6 cu m) recycling capacity for every 100 units collected weekly. This same volume converts to 1211.84 US gallons (4587 litres). Multi-family buildings using 90 or 95 US gallon recycling carts would, therefore, require a minimum of 13 carts for every 100 units.

Capacity considerations for individual communities, however, will be highly affected by the recycling program in place. For example, some semi-automated programs require the cardboard to be flattened and tied in bundles of specified dimensions beside the recycling carts. In this case, the collector could manually set the bundled cardboard in the hopper as he/she must get out of the truck anyway to connect the carts to be mechanically lifted. This method may reduce the number of carts required.

Automated systems are designed for all recycling materials to be contained in the carts, as the driver controls the lifting of the carts from inside of the vehicle. Although this is a convenient method of collection, considerably more carts may be required. This is particularly the case with excess cardboard generated by new residents unpacking.

Frequency of Collection

Recyclables from multi-family buildings with 6 or more units, and that have a common collection point, should be collected weekly. In cases of existing structures that can demonstrate there is insufficient storage space to provide recycling bin capacity for weekly collection, more frequent collection of recyclables may be required to ensure maximum capture of recycling materials.

Storage and Collection Area

Recycling bins should be stored inside, where possible, provided that all building and fire codes are followed. This ensures better control over the proper use of the bins and minimizes opportunity for public contamination. The recycling room should be large enough to contain all the recycling bins to be used, be safe and clean for residents to access, permit easy movement of the bins, and allow for additional space for future program expansion.

In-unit Storage and/or Transfer Containers

A mini Blue Box, basket or a reusable Blue Bag may contribute to a higher recovery rate, particularly when the box or bag has printed graphics to reinforce the items that are accepted in the recycling program. However, research has shown inconclusive results as to the long-term effects of these tools, partly due to the ongoing turnover of new residents.

Depending on an individual's recycling habits, such tools can be seen as a convenience or as a nuisance. Surveys have shown that often residents take their recycling to the bins on their way out to work, shopping, etc. They do not want to take the empty container with them nor have to come back to their unit with it. However, even if the mini Blue Box or Blue Bag is used only as storage within the unit, and not for transferring purposes, it can serve as an effective reminder that a program exists for the complex, and that certain items should be separated from the garbage.

Some programs recommend that residents transport the recyclables from their units to the bins in plastic bags and deposit the material loose into the appropriate bin. Although this can be promoted as the second "R" (Reuse), this method can pose a contamination problem in the recycling bin if residents do not understand the importance of depositing the material loose into the appropriate category. If plastic bags are not included in the municipal recycling program, it is imperative that there be a small clearly labelled waste receptacle beside the recycling bin instructing residents to deposit their empty plastic bags there.

Promotion and Education

Owners, Property Managers, and Superintendents: According to a recent focus group study, "superintendents in most of the study areas reported that they are working mainly in isolation and without the help of the municipal waste management experts". (E&E Fund Project #199, pg 7)

Building staff need to be fully trained with regards to the responsibilities and requirements of the recycling program. Several programs have developed a "Handbook for Owners, Property Managers and Superintendents" to educate them regarding the responsibilities and to trouble-shoot problems with suggestions of how to resolve the issues. In addition, it also may be beneficial to offer a link to a website that allows owners and property managers to download literature regarding the program, as well as graphics or translated educational material for posting and distribution to the residents. A list of resources, including contact names and numbers, should be made available to the multi-family buildings to assist with concerns that may arise.

Written literature, however, cannot eliminate the need for face-to-face contact with the site staff. Site visits will be required to check on the bin contents, replace missing or outdated educational materials and faded bin labels, and offer guidance and support to the site staff. Depending on the specific building, there can be considerable rotation of site superintendents and property managers. Staff changes are usually not reported to the municipality and the new staff may not understand the program requirements that were explained to the previous staff.

Residents: As reported in focus groups and interviews "Residents are operating on the basis of habit, imitation and partial information". (E&E Fund Project #199, pg 3)

Appropriate literature is required in order to convey program information to residents. The most critical information that needs to be understood by residents is:

- What items are to be included in the recycling bins
- How the items are to be sorted or prepared (flatten cardboard, rinse out bottles)
- Where the recycling bins are located to deposit the items (if required to take the material to a designated location)

It is recommended that new residents be given a recycling package, shown the recycling location, and have the recycling program explained as part of their lease or agreement to live in the complex. Having a clause in the lease or agreement that states that recycling is mandatory can help to stimulate residents' participation in recycling.

It is important to know the demographics within the building to ensure the promotion and education materials and methods are applied appropriately.

Multi-lingual, multi-cultural, and socio-economic factors can affect the success of the recycling program if challenges are not acknowledged and addressed. If additional languages are required, it is recommended that recycling literature be translated as appropriate. These can be posted on a website for site staff to download and post or distribute as necessary.

In addition to distributing literature to each unit, it is recommended that recycling literature be posted in a common area(s) of the building in English, as well as in the other appropriate languages identified for the building. For durability, the postings can be contained in a protective case, or covered with plexi-glass or laminated. Common areas that may be suitable for the posting board include the lobby, mailbox room, laundry room, chute rooms, and recycling rooms. Having the recycling literature posted ensures that new residents have an opportunity to see the information, and offers repeated promotion and reinforcement of the program each time residents (or visitors) are exposed to the information. The use of pictures and other graphics to illustrate what can and cannot be recycled is recommended, particularly when residents speak multiple languages.

Collectors: It is important that the collectors, whether municipal forces or contracted, are adequately trained and fully understand their role in the multi-family recycling program. This includes understanding the acceptable recycling items, what constitutes contamination, the minimum amount of recycling material required at each site, and proper documentation.

It is recommended that collectors have a "problem sheet" for each collection day on which to record any issues with the site that would require follow up prior to the next collection day. These issues may include concerns such as contamination, bins not in the proper position for collection, bins not out, not meeting the minimum quantity to be considered fully participating, bin needing repair, etc. It should also state whether the recycling bin was emptied by the collector or not. The completed problem sheet should be submitted to Solid Waste staff for follow up at the end of each collection day.

Feedback

Site staff and residents need to hear how they are doing to stay motivated. Periodic communication with the site is recommended to update contact information, replenish resource materials, and offer guidance and support.

Training

To move beyond the feeling of disconnect and lack of responsibility for the recycling programs at multi-family buildings, it is imperative that key players that are directly involved with the recycling program (Property Managers, Superintendents, residents, and collectors) be adequately trained in all aspects of the program.

In the past, the City of Barrie offered an 8-hour Master Recycler course targeted at Property Managers, Superintendents and apartment residents who were committed to act as recycling champions within their buildings. The Master Recycler course was organized into four sessions:

- Day One: Introduction to Recycling
- Day Two: The MRF and Markets
- Day Three: Communications
- Day Four: Preparing to be Master Recyclers

The Master Recycler course participants were provided with information about the municipal recycling program as a whole, and how to communicate with multi-family residents to promote effective waste diversion through recycling. Upon successful completion of the 4 classes and a test, the participants were issued a Master Recycler Certificate. They became the on-site recycling contacts, educating new and existing residents, while promoting the program within their buildings. Subsequently, there were substantial improvements in the quality and quantity of the materials captured, and long-term benefits stemming from the Master Recycler course have been seen several years later. It is recommended that municipalities consider offering similar comprehensive training for key participants in the multi-family recycling program.

Sources and Links

"Multi-Residential Recycling System Improvements, Residents, Superintendents & Property Managers Focus Groups & Interviews", E&E Fund Project #199, January 2007
http://www.stewardshipontario.ca/eefund/projects/mfamily.htm#199

"City of Toronto Requirements for Garbage and Recycling Collection from New Developments and Redevelopments", City of Toronto, last Revised November 2006.
http://www.toronto.ca/garbage/pdf/requirements_all.pdf

"Ontario Annual Generation of Blue Box Materials by Demographic Type (Based on Waste Composition Study Results)", Stewardship Ontario, 2006

"Best Practice Guidelines for Curbside Recycling at Multi-Occupancy Residential Developments, Draft Guidelines", Sustainability Victoria, June 2006.

"Enhanced Waste Diversion in Multi-Unit Residential Dwellings in the City of Toronto, Ontario", Katherine Whitfield. August 2005.

"Best Practices in Multifamily (Apartment) Recycling", Eureka Recycling. June 2004.

"Excerpts from Presentation to Toronto Waste Expo Featuring Master Recycler". Margot Beverley, To The Point Communications. December 2, 2004.

Stewardship Ontario multi family waste audit worksheets, tips, and guidelines for waste sorting.
http://www.stewardshipontario.ca/eefund/projects/audits/waste_audit_own.htm

"Report on Master Recycler: Phase II", City of Barrie, in conjunction with Corporations Supporting Recycling, April 2001

"Multifamily Recycling: A National Study", United States Environmental Protection Agency. November 2001.

"Multi-Residential Multilingual Pilot Project", WDO OPT-R3-06, The Regional Municipality of Peel in Partnership with WDO, October 2001.

"Multi-Family Recycling Initiative", WDO Project OPT-R2-12, City of Greater Sudbury, April 2001.

"Waste Diversion Concept Testing: Qualitative & Quantitative Findings", Northstar Research Partners Prepared for The City of Toronto, February 2001

"Toronto Apartment Blue Bag Recycling Pilot", Enviros RIS McConnell Weaver, March 2001.

"City of Barrie Multi-Family Fibre Bag Project", City of Barrie, March 2001.

"Report on Master Recycler: A Multi-family Recycling Initiative", City of Barrie, in conjuction with Corporations Supporting Recycling, July 2000

"Assessment of Multi-Unit Recycling in Ontario", Recycling Council of Ontario, *August 2000.*

"Focus on Residential Multi-Unit Housing: Structural Building Factors and Recycling Success", NYC Residential Waste Characterization Study. Prepared for New York City Department of Sanitation's Bureau of Waste Prevention, Reuse and Recycling by R.W. Beck, Inc., November, 2006.

"Private Households by Structural Type of Dwelling, by Province and Territory (2001 Census"), Statistics Canada, Census of Population.
http://www40.statcan.ca/l01/cst01/famil55b.htm

"Enhanced Diversion From Apartments Pilot Project", Metro Works, October 1997.

Environmental Protection Act. Ontario Regulation 103/94

http://www.e-laws.gov.on.ca/DBLaws/Regs/English/940103_e.htm

"Sector Compliance Branch: Inspections Industrial, Commercial & Institutional – Recycling in Multi-unit Residential Buildings", Government of Ontario Ministry of the Environment
http://www.ene.gov.on.ca/envision/scb/work/recycling.htm#results

"Recycling Handbook for Owners, Property Managers and Superintendents", City of Toronto.
http://www.toronto.ca/garbage/multi/pdf/recycling_handbook.pdf

"Toronto Recycles, Apartment Version", City of Toronto
http://www.toronto.ca/garbage/multi/pdf/461apartment.pdf

Markham website apartment recycling
http://www.markham.ca/Markham/Channels/wastemgmt/aptrecycle/recycle_tools.htm

Best Practice Spotlight

Best Practices in the Use of Recycling Depots

Overview

Recycling depots offer a cost-effective alternative to curbside collection in small municipalities and serve as a supplemental channel for material overflow in larger communities. While this collection method is simpler to manage and operate than curbside collection, there are a number of challenges and barriers that prevent programs from achieving optimal performance. This section provides guidance on Best Practices that need to be employed across depot systems if performance improvements are to be achieved.

Key Benefits and Outcomes

By employing Best Practices in depot collection programs, municipalities can obtain the following effectiveness benefits:

- Improved diversion rates for communities that do not collect recyclables curbside, or smaller rural programs with lower volumes
- Increased tonnage of recyclables due to an available overflow channel for residents that have limited storage capacity
- Increased tonnage of recyclable materials not accepted at the curb, such as expanded polystyrene packing materials and film

Programs can become more efficient due to the following factors:

- Collection cost savings - communities that are large in area but sparsely populated can achieve cost savings by utilizing depots as an alternative to curbside collection
- Transportation cost savings - deposited material can be transferred with large roll off or other bulk carrier vehicles from fewer locations than if collected from every household in a municipality

Description and Implementation of Best Practice

Recycling Depots (depots) constitute an effective channel for municipalities to offer residents a location to bring their recyclables and help capture recyclable materials that would otherwise end up in the landfill. They are primarily used in small rural municipalities, where no curbside collection program exists.

Depots are also used in communities with high participation rates as an alternate option for residents. In these communities, the rationale for having a depot is to provide capacity for overflow materials between or in addition to curbside collections. Furthermore, depots are effective in municipalities with a high seasonal household percentage and in areas with small private roads where collection is difficult and costly. Depots in high participation municipalities can also provide for collection of items not accepted at the curb, such as expanded polystyrene packing materials and film. Some materials that are too light or bulky make curbside collection difficult, as they are easily wind blown or take too much room in recycling containers. Designated drop off bins in recycling depots give residents an option to recycle these items. Large bulky or light materials separated at the recycling depot may sometimes be sent directly to end markets without any processing, provided quality control enforcement is available at the depot; however, transportation costs may be prohibitive if un-baled shipping weights are low.

Depots are a common tool for rural communities that are large in area but sparsely populated. They offer residents a place to bring recyclables where collection services would be very expensive compared to the amount of materials collected and where potential revenues generated from marketing recycling materials are low.

Depots are generally inexpensive to initiate, relative to curbside collection. The primary costs are the containers and transfer costs. Often municipalities contract out the rental of containers, complete with the delivery service to empty the containers at a processing facility or end markets. The other major costs are the labour to maintain the site, assist participating residents, and offer recycling program information. To contain costs, often municipalities use an existing municipally-owned location, such as a Transportation Works facility or a recycling depot set up at the municipally-owned landfill. Municipalities sometimes choose to open a depot without staff, however, this practice is not preferred as site maintenance and contamination control are made more difficult.

Key attributes of effective and efficient depot systems are:

- Situated in a safe and accessible location
- Convenient to use, ensuring smooth traffic flow
- Designed to limit the potential for contamination and illegal dumping by
  - employing trained and knowledgeable personnel
  - transferring/removing materials with adequate frequency
- Attractive and well-maintained
- Appropriate signage with clear instructions to residents
- Adequate promotion and education to enhance awareness of residents
- Robust record keeping processes
- Optimized container design and transportation system

Situated in a safe and accessible location

Proper planning is crucial in selecting a depot location. Depots situated on municipally-owned property constitute a good practice, as such arrangements facilitate proper oversight, regular maintenance, and improved risk management with respect to liabilities and hazardous materials. Accessibility to depots is high in locations visited frequently and regularly by area residents. These may include municipal community centres, sports arenas, or landfills.

Municipalities should determine the list of items that will be included in the recycling program by referring to Ontario Regulation 101 and by market availability. Materials beyond the regulated list should have sufficient and stable markets. Otherwise, excess items often become residue, thereby lowering the efficiency of the program.

Convenient to use, ensuring smooth traffic flow

In those municipalities where no curbside garbage collection is provided (residents bring household garbage to a municipal landfill), depots set up at landfills make it more convenient for residents to participate in the recycling program. (Those municipalities that do have a curbside garbage and recycling programs should also consider providing drop-off depots at the landfill or other strategic locations in the community to ensure sufficient capacity for overflow materials.) Depots located at landfills also help promote recycling of materials that could have ended up in the landfill. Most municipally-owned landfills are staffed; consequently, the addition of a recycling depot may be manageable utilizing the existing landfill staff. The staff are necessary to help encourage recycling and to reduce the potential for illegal dumping and contamination. Depots are best located where staff are available to oversee the site and report when bins are full.

Depots should be set up with an adequate number of containers, oriented in such a way as to minimize the effort associated with transferring materials from the car to the bin. This may be achieved by using a ramp or a higher platform for vehicular traffic. The number and capacity of containers will depend on the amount of materials collected at the depots and observed/desired resident participation rates (an estimate can be obtained through waste audits, which should be done at various times of the year to capture seasonal fluctuations). Depots should enable residents to drop off recyclables quickly and enhance their willingness to repeat the process in the future.

The site should be designed for safe operations by residents and employees. It should be of adequate size, allowing for good traffic flow. Effective flow of vehicular traffic is important, as convenience is diminished if residents need to wait in queue in order to reach the bins. Vehicles should generally drive in one direction, minimizing the need to back up. Ramp areas should have railing or other safety precautions as required.

Designed to limit the potential for contamination and illegal dumping

Depots that have been designed to limit the potential for contamination and illegal dumping contribute to the success of the program. Bins equipped with size-restricted openings help deter contamination. An example is an opening that allows flattened cardboard materials only. Flattening cardboard increases bin capacity and helps ensure boxes are emptied out prior to the transfer. Illegal dumping signs should be posted in the depot area citing municipal by-laws.

Illegal dumping is common at depots, but is often eliminated when depots are staffed and serviced with trained personnel. Employees can assist residents in placing recyclables into proper containers and provide general information about the recycling program. Furthermore, employee dedication and program buy-in is critical to reducing contamination and illegal dumping issues. As a consequence, staff working at the depot should be fully trained and knowledgeable about the details of the entire municipal waste management program.

Depots without staff tend to have higher contamination and more illegal dumping of materials at gates, in front of, or around recycling bins. In some communities, un-staffed depots became so expensive and time-consuming to operate and maintain, that program managers chose to close the depot and start a curbside collection service. Thus, programs with un-staffed depots should develop a maintenance plan for the sites to ensure aesthetic and functional appeal. The assistance of enforcement staff may help educate and deter offenders.

Bins need to be emptied before overflowing. Overflowing bins create an impression that the municipality does not care to properly maintain the recycling program, which can negatively affect the attitude of the residents and their willingness to participate. Front-loader bins can be emptied on an appropriate schedule, driven by the required capacity. Carts and roll off bins are usually used when the depot is close to a processing facility and pick ups can be done more frequently. Appropriate front end containers, roll off bins with compaction or even highway transfer are used when the haul distances are substantial.

Attractive and well maintained

A depot that appears clean and orderly gives a positive perception to residents that the program is operating successfully. Paved areas that can be maintained during winter months help ensure that the site can be accessed by residents all year. If a depot is not paved, it should be graded to ensure water does not pond in the area and deter participation. Depot areas should be cleared of snow and sanded and/or salted, as required, in winter months; this practice also helps to minimize potential liabilities.

Any debris or non-recyclables should be removed promptly to keep the site appearance neat and tidy. If depots are not cleaned regularly they develop a poor reputation and residents may stop using the facility, often resulting in increased illegal dumping.

Appropriate signage with clear instructions to residents

Provisions should be made to display information in a manner that is understandable and heavily biased toward universally understood graphics, photos or displays of acceptable and unacceptable items. Depot signage should have large lettering that is clear and visible from a reasonable distance. The colours should be bright and complement the depot appearance. Standard graphics and symbols that are informative and easy to interpret should be used. The graphics and symbols should be consistent with the recycling program logos and font styles. Each bin should be clearly labelled to define the type of materials it can receive.

Large signs mounted near the depot entrance should indicate acceptable and unacceptable materials. Illegal dumping signs should also be posted at depots at various locations as required. For centres that are not visible from main roads, directional signs should be used to aid users in finding the depot.

The Knowledge Network contains a number of depot graphics and signage examples for download.

Provide adequate promotion and education to enhance awareness of residents

Residents need to become aware of the depot location and receive frequent reminders about the recycling program. A weather-proof information area at the site, with pamphlets available for residents to take away, can help in the promotion of the program.

Communities with high percentage of seasonal residents need to time their educational and promotional campaigns with the arrival of these seasonal residents. Some programs may choose to give a free blue box to residents for storing materials between depot drop-off trips.

Robust record keeping processes

It is important to accurately measure and record weights of materials collected at the depot. Regardless of the haul system used, materials should be weighed prior to tipping at the processing facility. These volumetrics allow for accurate Datacall submission and provide means to manage, evaluate, and fine-tune the program. Different materials should be weighed separately if materials are sorted into separate bins at the depot.

Optimized container design and transportation system

Municipal recycling program coordinators need to select an effective system of transporting recyclables to processing facilities or end-markets. Often waste audits and/or participation studies are needed to determine approximate material volumes on weekly, monthly, and seasonal basis. Once an expected material amount has been determined, container and transportation selections need to be considered.

Containers can range from 95-gallon carts, four- or six-yard closed bins that are material specific and require specialized haul trucks, four- or six-yard front loader bins, or roll-off containers ranging in size from 12 yard to 40 yards. Caution should be used before committing to the use of specialized haul trucks for non-standard bins, as there are limited options available in case of truck breakdown or other equipment failure. Specialized trucks are also likely to be unusable for other municipal operations, which will tend to increase overall waste management and recycling costs. For some municipalities, contracting the transportation of containers can help offset the capital investment start-up costs for purchasing the required vehicles.

Container selection will depend largely on processing capabilities (whether materials can be co-mingled for two-stream processing or single stream processing, or materials must be completely sorted). It will also depend on capital investment funds available. Small programs may consider renting containers or contracting transportation services that include the provision of containers. Contractor availability and distance to processing facilities will also dictate the type of containers used. If a processing facility is nearby, smaller and/or standard containers, such as carts or roll off containers, may be more economical. In cases where long distance hauls are needed it is critical to incorporate compaction within the system to minimize transportation costs. This may be accomplished with the use of standard front end container that utilizes the truck compaction system where services are not available at the depot site. When services are available, roll off compactors with a ramp can be used. Where large volumes justify it, transfer trailers with or without compaction may be the best option.

Program managers should strive to maximize the use of containers to help ensure only full loads are picked up. Hauling full and densely packed containers will reduce transportation costs on a per unit basis. Depot staff should try to move materials around in the bin to help ensure all corners and other space is utilized. Staff can use loaders or hand tools to facilitate this process. It is not recommended, however, to ask residents or employees to enter the bins or try to move materials by hand due to the risk of injury.

Sources and Links

http://www.stewardshipontario.ca/eefund/projects/benchmark.htm#45

http://www.vubiz.com/stewardship/Welcome.asp Use login and password to access the Knowledge Network, where an entire module is dedicated to depots

http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/tech_rpts/Schuylkill.htm

http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/tech_rpts/Blairsville.htm

http://www.markham.ca/Markham/Channels/wastemgmt/recycledepots.htm

http://www.region.peel.on.ca/pw/waste/crc/

http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/tech_rpts/McKean.htm

http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/tech_rpts/Cambria.htm

http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/tech_rpts/Carbon.htm

http://www.uog.edu/cals/PEOPLE/Pubs/WASTE/F-888.PDF

Best Practice Spotlight

Best Practices in Collection and Processing of Challenging Plastics

Overview

In an effort to increase waste diversion rates and remove non-biodegradable materials from the landfill, some Ontario municipalities are choosing to include auxiliary plastic materials in their Blue Box programs. Chief among these materials are Polyethylene (PE) film bags, polystyrene foam and containers, and oversized Polyethylene Terephthalate (PET) bottles. However, due to their physical properties, these plastics present a variety of challenges in collection and processing, hindering operational efficiencies and driving up the costs.

Differences of opinion remain about whether the collection of these challenging plastic materials is itself a best practice for municipal programs to implement to increase diversion, or which practices are best to use in collection, processing and marketing of these materials. There is currently little data on the costs and associated recovery levels specifically attributable to these materials in Ontario programs that include them. There are few model programs, as each community treats these materials differently (except for oversize PET bottles, which are all either excluded from collection or discarded early in the processing step). However, some Ontario programs are already collecting film and polystyrene materials and others have expressed interest in doing so. Obtaining the costs of recycling film and PS from Ontario communities currently collecting these materials would be a start at defining best practices for these materials, but the objectives of this particular project did not provide for separate detailed consideration of these materials within the original framework. We do recommend research focused on these communities to gather the important data that could then be used to model the effectiveness and efficiency of such collection programs. The practices presented here provide a hierarchy of options for communities that wish to implement collection of these materials. The information presented in this report is the most current and most detailed to be found in the existing literature, in listings of resources available, and in conversations with plastic industry representatives.

This section is designed to provide guidance in making the choice to include these materials into the program and developing methods to recycle them in an effective and efficient manner. The handling of each material is described in detail below.

Key Benefits and Outcomes

By including challenging plastics to a recycling program, municipalities may experience the following benefits:

- Increased diversion from landfill
- Enhanced customer satisfaction levels

However, there are a number of drawbacks associated with collecting and processing these plastics:

- Extremely high cost per tonne
- Decreased operational efficiencies of trucks and processing facility
- Increased incidence of maintenance issues at the MRF
- Decreased storage space at the MRF
- Low marketing revenues due to limited markets

Section A: Best Practices in Handling PE Film

Up to 85 percent of the PE film generated by households is readily marketable, including grocery bags, retail shopping bags, newspaper sleeves, dry cleaning bags, and any other clean, dry bag marked with a #2 (HDPE) or #4 (LDPE) resin code. In Canada, rinsed HDPE milk pouches and outer bags, bread bags, sandwich bags and bulk food bags, diaper outer bags, frozen food bags, and over-wrap for toilet tissue and paper towels are defined as recyclable under market specifications. The films are mostly made of Low-Density Polyethylene (LDPE, #4), Linear Low Density Polyethylene (LLDPE, #4), and High-Density Polyethylene (HDPE, #2).

Other PE film pertinent facts include:

- Recyclable films in the residential waste stream comprise approximately 13% of the plastics. Recyclable PE household film comprises 85 percent of all household films, offering an opportunity for increased recovery of household materials.
- Even in programs that don’t ask for film and bags, this material has been known to approach four percent by weight of material at the MRF.
- Theoretical calculations have shown that one sorter can positively sort 28 kg per hour of household PE bags at a MRF, based on 70 bags per lb (4,325 bags per hour)
- A material recovery facility in California with an overall capacity of 200 tonnes per day reports a throughput of 30-40 tonnes per month of film, with 8 sorters spending at least some of their time picking bags.
- The value of the California facility’s recovered film is low, at US $20 per ton, due to low quality. The California facility also reports that even with sorters handling the material, at least one hour per day is spent removing bags and film that have accumulated on the star screens.
- In Ontario, according to the CSR Online price sheet, PE film sells at $47 per tonne in March, 2007. The average price per tonne in 2006 was $137 per tonne and in 2005 reached a high of $148 per tonne averaged over the year.
- Collection of household bags and film is a challenge, with its high volume to weight ratio and potential to instantly become offensive litter if wind-borne.

- One study estimates the incremental gross cost of collecting and processing film at $900/tonne.

Collection

There are three mainstream methods of collecting PE film. Each of these is described in greater detail below:

- Retail drop-off collection
- Curbside collection, including single stream, two-stream, and blue bag
- Depot collection

Retail drop-off collection

Retail drop-off collection residents bringing plastic bags back to the point of purchase. The trend is toward this collection practice in the United States. The California Integrated Waste Management Board (CIWMB) and the Progressive Bag Alliance (PBA) launched a retail take-back recycling program in California in response to California's AB 2449 legislation. AB 2449, effective July 1, 2007, requires most large grocery stores and drug stores to offer in-store plastic bag recycling programs. Initial advertising place on June 11th was sponsored by additional program partners – the California Retailers Association, California Grocers Association, and Keep California Beautiful. Consumers will be educated to bring bags back to retail locations, where the retailers will bale or otherwise package the material for markets. The role of the PBA is to work with stores to find markets for the material. The PBA intends to connect the stores with markets that will pay the stores for the material. In the U.S., recycling trends often begin in California and spread to other areas of the country.

With retail bag collection the costs are borne by the store and not the public recycling agency. However, frequently local recycling coordinators are not partners in establishing or operating these programs, leading to a lack of communication, gaps in public education, and no accountability for the materials collected. The following attributes can make a drop-off collection option a success:

- The recycling bin(s) provided must be accessible, clean, attractive, and serviced regularly
- Public education must be a priority, with various media as well as in-store displays used to communicate instructions on what and how to recycle at the store
- The material collected must be properly handled, processed and marketed to a reliable end use, and the public must be notified of this as part of the educational program.

The local community could provide collection bins and P&E, while the store covers the handling, processing and transportation costs to a processing center, either their own distribution center and facility or the local MRF.

Curbside collection: Two-stream scenario

In this scenario (mainly employed in US), residents deposit their various household bags and acceptable plastic films into one large plastic bag, and place it between the containers blue box and the fibres blue box or bundle. The lightweight bag must be wedged firmly in place to avoid being dislodged and windblown. The collection vehicle operator picks up this large bag, simultaneously registering that it is feather-light and squeezing it to ensure that no rigid objects are enclosed. If contamination seems evident, the bag is left.

These bags of bags are then placed in yet another plastic bag of a large size, approximately 60 gallons (227 litres), hanging in a convenient place on the truck body. Full bags are tied off and deposited in the newspaper or cardboard compartment of the truck.

Curbside collection: Single-stream scenario

In single-stream systems, aggressive public education campaigns are needed to ensure that residents again bag all their small bags and film products into one larger bag, and place this bag in their blue box or collection bag.

In programs that use an enclosed cart for single-stream collection, a practice not yet common in Ontario, residents should be educated not to deposit individual bags that can fall or blow out of the cart during the collection tip. Because of the commingling with all other materials, bags collected through single-stream programs may be more costly to retrieve and of lesser quality.

Curbside collection: Blue or clear bag scenario

The larger collection bag for the smaller bags could be a separate blue or clear bag, or another bag of bags could be stuffed into one blue/clear bag with the other materials. This separate blue/clear bag is then picked up and thrown in the truck with the rest of the bags, and possibly compacted. Again, the collection operator would check for light weight and the presence of rigid objects.

Depot collection

Several containers, such as 90-gallon roll carts, can be set up with PE liners for depot users to deposit bags and film. Large display signs can be set up adjacent to these containers illustrating the acceptable and non-acceptable materials for immediate, on-site instruction and reinforcement.

As needed, the site attendant can visit the collection containers and use a tool to compact the bags as much as possible in order to contain the largest number of bags before tying off and replacing the liner bag. These large, stuffed bags may then be stored in a covered dumpster or a compactor for later removal to the MRF.

Processing

The first point of capture for bags is the tip floor or a pre-sort station, before there is any potential for the bags to open and scatter individual bags. Sorters on each subsequent line should be trained to capture, bag, and then deposit any bags missed in the pre-sort into a storage bunker. Sorters may also be trained to de-bag any containers and fibres from plastic bags, but the recovery for recycling of these bags which may contain residual products is questionable.

The most efficient way of moving bags from both the tip floor and the sort lines into the storage bunker may be with a vacuum system. The vacuum system could load an overhead storage bin to save space, due to the light weight of the material. The vacuum system, or gravity, could also potentially load the material into the baler.

Automatic de-baggers that may be used in blue bag processing facilities could potentially also open the smaller bag inside that contains the accumulated household bags and scatter the smaller bags. Additionally, any blue bags that are stuffed full of smaller bags only must be directed away from the de-bagger and directly to the baler. Blue bags that held other recyclables may or may not be recyclable, depending on the market specification for blue film and the degree of moisture and contamination in these bags.

Baling film may be made easier and more frequent by adopting the "Sandwich Bale ™" pioneered by Wal-Mart stores. This is a bale with layers of film plastic alternating with layers of cardboard. When the bale is broken open, the film and OCC layers naturally and easily separate. However, a market must be found that will accept this type of bale, and then separate the materials for further processing (Ontario market availability for this products is unknown at this time).

Promotion and Education

Residents must be properly trained about the correct types of bags and films to include for recycling, the types that are prohibited, and the acceptable way to package the bags and film. Consistent and repetitive messages designed to motivate change toward specific behaviours and habits must be applied rigorously using any and all appropriate media channels.

The most important message is to "Bag the Bags". Additionally residents can be educated about "Tying the Knot" before stuffing bags into the larger bags.

Markets

The American Chemistry Council's recycled plastics markets database lists six companies in Ontario as buyers of post-consumer residential retail bags and other films. Additionally fourteen companies are listed as buyers of "post-consumer, industrial, commercial, institutional" bags and film, which may indicate that they would purchase material collected in retail stores but not from MRFs. The largest end-use for this material is composite plastic lumber products. Large amounts of blue bags may reduce the quality and price of the material.

Ontario Communities Recycling Bags and Film

Fourteen communities in Ontario collect bags and film in their curbside programs (some of these at their depots as well). Ten of these municipalities instruct residents to place their bags and film inside one bag and tie it, then place this bag either in, or beside, their blue box (or equivalent) for containers (one community is single-stream but still uses blue boxes). Two communities instruct residents to place their bag in a second, gray box with fibre products. One single stream community instructs residents to place their bag inside their cart, and one blue bag community instructs residents to use a separate blue or clear bag for household bags and film.

Eight communities that collect bags and film allow the most of the materials in the complete EPIC list of grocery bags, retail shopping bags, newspaper sleeves, dry cleaning bags, rinsed HDPE milk pouches and outer bags, bread bags, sandwich bags and bulk food bags, diaper outer bags, frozen food bags, and over-wrap for toilet tissue and paper towels. Five communities restrict the list to grocery bags and/or shopping bags only.

Implementing PE film handling Best Practices

Retail drop-off collection is the desired approach for film recycling, because costs are shared by the retailer. Merchants have a business interest in providing recycling services on-site for their store brand bags, as well as competitors' bags, and residents would not have to make a special trip to recycle their bags. Active partnership by the municipal recycling coordinator is necessary to promote the program, build participation, and educate users. The preferred handling method is back-haul of the material to a retailer's distribution facility for baling. If a MRF must be used, the local recycling coordinator would be required to work with the facility to minimize material handling issues.

For communities that decline to use retail collection, or wish to supplement it with another method, depot collection is the next preferred method. Depots take advantage of the "free" labour and energy expended by residents in bringing this lightweight material to the location, as opposed to capture at every individual household. Site attendants, where they are used, can monitor for contamination and provide additional packaging and even compaction of the bags prior to delivery to the MRF. Adding bags to an existing depot would add very little incremental cost in terms of land, labour, and other factors.

For those communities that prefer to collect bags and films at curbside, the following practices should be followed:

- Emphasize public education, specifically the "Bag Your Bags" message
- Use a set-out method that minimizes opportunities for bags to become windblown litter
- Utilize vehicle operators to check for contamination and leave bags that are contaminated as an educational tool
- Combine large full bags with the fibre portion of the load in the truck to facilitate separation and removal at the MRF and to minimize bag breakage and contamination due to contact with broken, sharp-edged or wet recyclable containers.

For MRF processing of bags, effort should be made to remove bagged bags immediately after tipping or at a pre-sort station, before the bags can encounter MRF equipment. Handling of bags and contact with other recyclables should be minimized. In blue bag systems, care should be used with automatic bag breakers. Vacuum equipment may be an effective way of moving the material.

The highest value markets should be sought for the bags and film. To obtain these markets, producing high quality material must be a priority that begins with public education and continues throughout the handling and sorting process. Residents must be taught what to include and what is prohibited; operators must leave behind contaminated bags; contact with other materials at the MRF should be minimized. Markets should be consulted about the impact of recycling plastic bags in which other recyclables were mistakenly packaged by the residents and of recycling blue or clear collection bags (specifically, the impact of the blue bags should be assessed).

Ontario communities are already recycling bags and films through curbside and drop-off systems. If such programs are to be considered for widespread implementation in the province, more data should be gathered from these communities about the costs and operational impacts of such programs in order to accurately document best practices and to encourage continual improvement. Program costs should be justified in the overall recycling program budget, taking into consideration the community's waste reduction and recycling goals and how bag and film recycling helps them meet those goals.

Section B: Best Practices in Handling Polystyrene

Polystyrene resin is both effective and efficient in its original use – as packaging material. It is inexpensive to manufacture; therefore the costs of its original production and transportation are considered a reasonable trade-off for its many benefits. However, a cost-effective scheme for its post-use management is elusive because:

- It diffuses into society in its many uses, and bringing it back together in quantities large enough to process and market is challenging
- Its many shapes and forms render it difficult to efficiently package for transport, post-use
- The costs become larger as the product's quality is degraded; these costs can no longer be covered in the price

While polystyrene accounts for less than one percent of the municipal waste stream, at certain times of year, such as the holidays or consumer goods sales events, it becomes a significant and challenging component of the household-generated waste. In handling it, municipalities face a number of obstacles. Chief among them are:

- Polystyrene foam exhibits a very high volume to weight ratio, making economical transportation a challenge

- Polystyrene foam breaks easily when processed through MRF equipment, leading to contamination of marketed materials and affecting the cleanliness of the facility
- Polystyrene foam does not compress in the baling process, and may break into smaller pieces
- Foamed PS meat and produce trays have high potential of food contamination, possibly leading to sanitation issues at MRFs

Current Collection and Processing

According to the Canadian Polystyrene Recycling Association (CPRA), 11 Canadian municipalities are collecting polystyrene in their curbside programs, and another three are collecting through depot or special collection events only. However, some of these municipalities are located in other provinces, and at least six Ontario programs, which the CPRA does not list, are known to collect polystyrene. These communities all prohibit loose-fill polystyrene packaging ("popcorn" or "peanuts") in their programs.

Since the CPRA standards require baling, it is assumed that most of the foamed PS is baled. Some material from depot collection, if close to the CPRA plant, may be delivered loose.

Promotion and Education

There is no model for P&E for polystyrene products because each municipality's program reflects their unique collection and processing constraints, as shown by the following examples:

- The City of Kingston allows "Plastic/Styrofoam" containers in the blue box. Rigid and foamed plastic containers are allowed, but not loose fill packaging and protective foam must measure less than 36"x24"x8"
- The City of Peterborough allows rigid PS baked goods trays "marked #6 only" and foamed PS food containers (meat trays, egg cartons) in the blue box; however, foamed packing material is accepted only at drop-off
- The County of Wellington presumably allows rigid polystyrene packages in the blue box, as their guidelines are broad and do not use the resin identification code. However, Styrofoam is specifically prohibited
- Northumberland County collects foamed polystyrene "cushion" packaging at special collection events after the holiday season. Food packaging is prohibited. The material is accumulated in roll-off containers at drop-off depots. The County also accepts PS food containers in its curbside program as a component of "Plastic Jars, Bottles and Containers #1-7"

Markets

A polystyrene market currently exists in Ontario. CPRA, an 82,000 square-foot facility located in Peel Region (Mississauga), is designed specifically to recycle and sell polystyrene from the industrial, commercial and consumer waste streams. The plant capacity is about 5,000 tonnes per year. Polystyrene is recycled into office desktop accessories, nursery trays, automotive and hardware accessories, audio and video cassette cases, vacuum cleaner attachments and building products.

CPRA purchases two grades of polystyrene bales: Type A contains both rigid and foam PS and Type B contains only foam PS. Type A bales allow 10 percent contamination while Type B bales allow 15 percent contamination. The CSR Price Sheet shows that CPRA is currently paying 75 CDN$/tonne for material delivered to their facility. This price has not changed since 2001.

Implementation

Ontario is fortunate to have a major end-use processor for polystyrene accepting both foamed and rigid grades, either separated or mixed. For polystyrene, the constraints to recycling are issues related to handling and transportation, not markets.

Some municipalities in Ontario are recycling polystyrene, both the rigid and the foamed, at depots, at special collection events, and through curbside. However, a "model" program has not been identified, and very little is known about the handling issues, processing issues and costs of such programs

Communities that wish to add polystyrene to their recycling programs should begin with special collection events limited to foamed PS, tied to the holidays or periodic sales on consumer goods such as appliances and electronics. These events can be held at existing recycling depots, or, if arrangements can be made, in partnership with retailers selling these goods and possibly held at malls and shopping centres (similar to one method for collecting end-of-life electronics and possibly in tandem with such an event). The benefits of holding these events are:

- The public will provide the "free" transportation and sorting labour
- A container is not dedicated full-time at a depot while a sufficient quantity to process and ship is accumulated, with associated weather, storage space and contamination issues
- It may offer an opportunity for increased public awareness of the community recycling program. This is a way to keep costs under control yet still offer a service that many residents deem valuable.

Communities that wish to provide an ongoing polystyrene collection program for citizens should look first to depot collection. A separate collection container for foamed polystyrene would add only incremental costs to the depot operation; however, it would most likely need to be a covered container. Ongoing storage space would also be needed. The rigid polystyrene containers could be added to a "non-bottle rigid" plastic collection stream. Several marketing options exist for this material, including baling with the other rigid containers for export, or sorting to separate the HDPE, PET and PP then baling with the foamed PS. The advantage of collecting non-bottle rigid PS at depots is that the public could be trained to sort these from the plastic bottles by placing them in separate containers.

The next level of collection, if a community strongly desired to provide this service or if the collection at special events and depots proved impractical, would be curbside collection of polystyrene. Again, collecting the PS rigid containers mixed with other plastics would not be difficult at the curb, but market research would need to be conducted to determine the degree of MRF sorting needed. The foamed polystyrene would pose challenges in the areas of potential blowing litter, space in the collection truck, and then MRF storage and baling. Foamed loose-fill packaging, called "peanuts" or "popcorn" should be excluded due to serious litter concerns.

Regardless of the collection method chosen, communities need to calculate the transportation costs to the CPRA and determine if a polystyrene recycling program can fit into their overall budget, given the impact polystyrene has on their recovery rates and waste reduction goals.

Transportation and material storage will be the most costly elements of a polystyrene collection program. Food contamination could be costly in terms of downgrading marketed loads, and public education materials should stress that food containers must be rinsed before recycling.

Additional research is needed into the practices of communities currently collecting and processing polystyrene, to determine more specific details on operational issues, costs, and opportunities for improvement.

Section C: Best Practices in Handling Oversized PET Bottles

Large size PET water bottles, from 8 to 15 litres, are being marketed in Canada by at least two bottled water companies. These bottles, designed for home dispensing units, are displacing the 15 to 18 litre polycarbonate, multi-use water bottles captured by a deposit-return system. They are increasingly being found in the blue box program as residents correctly interpret them as being recyclable. These bottles are mandated to be recycled by Part 1 of Schedule 1 of Ontario Regulation 101/94 by virtue of the non-size specific definition of the PET beverage bottle.

Recycling oversized PET bottles is facilitated by:

- Their larger size. PET water bottles weigh up to 50 grams, capturing a significant amount of material in each handling step
- Packaging contents. Since they only package water, bottles are not contaminated by contents

However, these materials present some issues for program operators. These include:

- The large size of the bottles makes them a challenge to collect in traditional blue boxes, as they take up more space in the box and on the collection truck
- MRFs must remove these bottles early in the sorting process in the same step as removal of buckets and large contaminants
- Some MRFs may not have storage space for the additional bottle stream

Collection

These large size PET bottles take up one-third of the volume of a typical blue box, and a correspondingly large ratio of space in a single-stream or blue bag program. They also take up more space in the collection trucks. While scenarios about trucks making extra trips to MRFs solely because the large PET bottles have filled the compartments have been imagined, no evidence exists that this is a risk with the current market penetration. The impact of bottle size is less significant at depots, where containers are larger. For communities desiring to recover these bottles, an additional bin dedicated to these larger size containers could be provided. Distinguishing of these bottles by the public should be relatively easy.

Processing

The first point of capture for the large PET bottles is the tip floor, where they are pulled from the incoming container stream, much as buckets and large contaminants are removed. Virtually all of the PET bottles separated on the tip floor at Ontario MRFs are currently being discarded.

If the bottles are allowed to continue up the in-feed conveyor, in MRFs that have shaker screens for separating containers from fibre, these PET bottles end up in the fibre stream due to their size, weight and shape, and they are discarded there. In MRFs without screens, the bottles still may be too large to fit in the sorting chutes for the smaller PET bottles. Furthermore, most balers are capable of compressing these bottles, either in a mixed PET bale or as a specialty bale.

Installing a dedicated, PET bottle-only grinder at the point of first removal may be the most efficient processing method for these bottles. This alternative would require capital investment, operator training, Gaylord boxes for material storage, and a willing market.

Promotion and Education

It is unknown how many communities in Ontario are prohibiting these bottles and clearly stating the prohibition in their promotion/education material. Motivating residents to recycle these bottles, if such action is desirable, would most likely be relatively easy, as the bottles are unique and easily identified.

Markets

PET re-claimers may refuse to accept any large PET water bottles mixed with the other PET because their size makes them problematic. They are simply too big for the clearance between the high-speed conveyors and the automated bottle sorting units that most re-claimers utilize. The bottles have enough "memory" to spring back into a larger shape when de-baled. Even a few of these bottles can cause pile-ups on the sorting lines, which can happen very quickly and require line shut-down to clear.

If markets are willing to accept these bottles, most would prefer these bottles to be baled separately, but may accept these bales on the same truck with the other PET bales. Markets for ground material exist, but would have to agree to purchase material ground in a MRF.

If the bottles are made from a standard bottle resin with an intrinsic viscosity (I.V.) in the 8.4 range, and are made in a two-stage, injection-stretch blow moulded process, they are fully compatible with existing PET markets. Some bottles may be made from a higher-I.V. material in a one-stage process. There is concern that these bottles are not compatible in existing PET bottle markets.

Implementation

Virtually all communities in Ontario that receive these bottles for recycling are currently discarding them. Given the uncertainties, and the currently small market penetration of this product, the impact of disposal by the MRFs on the solid waste stream is not yet significant.

Currently much is unknown about the market penetration, recycling market demand, or resin composition of these 8 to 15-litre PET water bottles. PET markets have indicated publicly a desire for more recovered post-consumer PET of the current, typical composition; it is not known to what extent they would accept the larger bottles due to equipment constraints.

Communities wishing to recover these bottles, either through depot or curbside collection, should first find out whether the bottles sold in their region were all of the same resin composition. If they were, and the likelihood of this changing was small, the community would then seek markets for the material, either baled separately or ground. If markets were found, a system of handling the material to facilitate recovery at the appropriate point would be needed.

A retail store take-back program could be explored for these bottles, with the recovered bottles delivered to the MRF in large loads and handled, baled and marketed separately. For communities that choose to recycle these bottles curbside, a second blue box could be provided for residents.

Sources and Links

PE Film

Recycled Products and Markets Databases, American Chemistry Council: http://www.plasticsresource.com/s_plasticsresource/sec.asp?TRACKID=&CID=86&DID=127

The Online Resource for Film Recovery in California: http://www.plasticbagrecycling.info/coord.php

California Integrated Waste Management Board, AB 2449 – Recycling Plastic Carryout Bags

www.ciwmb.ca.gov/lgcentral/basics/plasticbag.htm

Canadian Plastics Industry Association (CPIA), Environment and Plastics Industry Council (EPIC): *"Best Practices Guide for the Collection and Handling of Polyethylene Plastic Bags and Film in Municipal Curbside Recycling Programs"*.

CSR Online: "The Price Sheet", http://www.csr.org/pricesheet/pricesheet.htm

"It's in the Bag: The Direction of Residential Film Recycling", Patty Moore, Moore Recycling Associates and Kim Holmes, Plastics Recycling Update; *Plastics Recycling 2007*, February 13-14, Dallas, Texas.

"Blue Box Residential Recycling Best Practices – A Private Sector Perspective", Guilford and Associates for Stewardship Ontario and the Ontario Waste Management Association, February 1, 2007.

"County of Santa Cruz – Film Plastic Recycling", Dan DeGrassi, Santa Cruz County; *Plastics Recycling 2007*, February 13-14, Dallas, Texas.

Polystyrene

EPIC Polystyrene Fact Sheet:
http://www.cpia.ca/files/files/files_Fact_Sheet_on_Polystyrene.doc

CSR Online: The Price Sheet: http://www.csr.org/pdf/pricesheet/2007/03_2007ps.pdf

Fact Sheet: *"Polystyrene and the Environment"*, American Chemistry Council's Plastics Foodservice Packaging Group:
http://www.polystyrene.org/environment/environment.html

Oversized PET Bottles

"Improving the Efficiency of the Blue Box Program", an AMO/AMRC Position Paper, July 2006: http://www.amrc.ca/policy/Improving

Other Practices Meriting Consideration

Other practices that could not be validated through the use of the fact-based evidence framework or which evoked disagreement among project team members that could not be resolved are listed in this section. These should not be construed as guidance; instead, municipalities can use this list as pool of ideas that may be of benefit to the local Blue Box program. In fact, due to the isolated circumstances under which they are employed, some practice polar opposites of each other. Therefore, additional analysis and feasibility studies need to be conducted in order to determine the applicability of these practices to any given program. Most of these were not discussed in this report. However, the Project Team did elect to discuss the pros and cons of various collection frequency options, including co-collection, given the variety of collection patterns prevalent in Ontario today. It is important to note that the reason why these various options are listed below is that we could not document any of them as being "best."

Practice	Benefits	Municipalities Observed Employing the Practice
General		
Governance structure where the entity that serves as program coordinator is empowered to act on behalf of jurisdictions in the region to provide Blue Box services	Ability to make decisions that are best for the program Coordinated P&E, policies and incentives More agile, responsive program Political influence is reduced	Bluewater, Peel, Wellington County, Cochrane Temiskaming Waste Management Board, OVWRC, Muskoka, Simcoe, County of Peterborough
Shifting capital expenses such as collection vehicles onto contractors	Program doesn't have to compete with other municipal services for capital funds Contractor makes capital decisions that are best for its operation No need to accumulate and manage capital reserve funds	Halton, Orillia, Russell, Muskoka, Carling, Simcoe, Ottawa, Cornwall, OVWRC, Waterloo
Promotion of other waste reduction, diversion, and environmental quality programs	Improves environmental ethic resulting in increased Blue Box participation and diversion	Hamilton, City of Peterborough, Russell, Muskoka, Carling, Simcoe, Ottawa, Cornwall, OVWRC, Waterloo, York,
Collection		
Bag-based collection	Reduced collection cost Ability to compact recyclables and minimize glass breakage Surge capacity for bin overflow	Thunder Bay, Northumberland County, Peel (bin overflow)

Weekly collection	Higher tonnes recovered (SERA study found that weekly collection increases recycling rate by 2 to 4 percentage points).	Russell, Cornwall, Waterloo, York, Simcoe, Muskoka, County of Peterborough
Alternating weekly collection of fibres and containers (two boxes)	20 percent contractor bid savings Less seconds per stop Cube out collection vehicles Items are pre-sorted, saving on collection and processing Sufficient capacity in recycling containers needed	Kingston, OVWRC, Ottawa
Bi-weekly collection	Reduce collection time and transportation costs Requires provision of sufficient Blue Box capacity Positive impacts noted in rural areas and single stream programs with carts (Toronto found that carts allow recycling frequency at once every two weeks/ improves recycling capture by at least 10%/ facilitates automated collection)	Windsor, Southgate, Halton, Timmins, Toronto
Co-collection of recyclables with other waste streams	Reduce transportation costs Need to travel down the road less frequently	Toronto, Southgate, Bluewater, Peel
Collection on one side of the street in a rural setting	Reduce collection time Reduce transportation costs Increase safety liability Difficult in winter conditions May result in safety issues May not be compatible with PAYT	Quinte, Bluewater
Front end containers for depot service	Lower collection costs, but limited to programs with several depot locations	Bluewater
Development of incentives / penalties for collectors based on contamination rates	Provides incentive for collectors to be more discriminate in including items obviously not recyclable	Ottawa, Waterloo, OVWRC, York
Processing		
Municipally owned MRF facility and equipment	Flexibility on adjusting recovery of materials/grades/residue levels Preservation of capital investment	Northumberland, Kingston (MRF maintenance), Quinte, Essex Windsor, Toronto (Dufferin MRF), Waterloo, Simcoe (Only some processed there), York, Cornwall, OVWRC

Use of technology and early in the process.	Greater recovery of valuable commodities Less dependency on labour force Cleaner commodities Less rejections	Bluewater, Cornwall
Compaction of residue for disposal	Reduced disposal costs Potential to market residue for resorting Some programs have found baling residue to be cost-effective	Kingston Peel Northumberland County
Use negative sorting technique whenever possible	Maximize workforce usage Lower labour cost	Quinte, Windsor, Bluewater, Simcoe,
Knowledge and application of ANSI Z245.41-2004 Standard	Less injury More productive and happier employees Cleaner commodities	York, Peel, Toronto, Bluewater, OVWRC,
Ergonomically designed equipment	Less injury More productive and happier employees Cleaner commodities	Bluewater, OVWRC, York, Peel,
Strongly Enforced Safety rules	Increased safety Increased productivity and morale	OVWRC, York,
Central MRF Location	Reduced transit time More productive time on route	Northumberland, City of Peterborough, Timmins, Muskoka, Waterloo, Simcoe
Use of conveyor time delay devices	Accommodates variable contamination levels without stopping Cleaner commodities	Windsor, Peel, Bluewater, York
Quality control at the pre-baler	Higher revenues and decreased number of downgrades due to higher quality of material	Essex-Windsor, Bluewater, York, Simcoe, Waterloo,
Development of incentives / penalties for processors based on capture rates	Minimizes residue rates	Toronto, Peel
Marketing		
Marketing done by municipality	Municipalities keep revenues Municipalities manage market risk instead of pay contractors to take on risk	Durham Kingston Peel (containers) Toronto (containers), Waterloo, OVWRC

Marketing done by contractor	Better knowledge of markets Large volume pricing if a large contractor with multiple locations Revenue sharing needed for contractor incentives	Timmins, Peel (fibres) Toronto (fibres), Simcoe, Muskoka, Carling, York, Ottawa, Cornwall, Russell
Contractor keeps predominant portion of market revenues	Less risk and uncertainty for the program	Orillia, Amaranth, Timmins, Wellington, Carling, Russell,
Municipality keeps predominant portion of market revenues	More net revenue Less risk for contractor Budget is less predictable	Most, York, Ottawa, Simcoe, Cornwall, OVWRC, Waterloo
Established Relationships with end markets	Consistent movement of materials Better pricing overall	Quinte, Niagara, Bluewater, Ottawa, Simcoe, Muskoka, Cornwall, OVWRC, Waterloo
Use of more than one buyer for marketed commodities	Keeps prices competitive More net revenue Options during difficult periods	Bluewater, Windsor, Ottawa, Simcoe, Cornwall, OVWRC, Waterloo,
Market natural HDPE bottles	$200 per tonne price premium generally outweighs additional sorting cost	Peel, Timmins
Where large volumes exist, split sales between fixed contracts and spot marketing	Consistent movement of materials Better pricing overall Distribution of risk	Toronto, Windsor, Simcoe, Waterloo, York, Ottawa, Cornwall, OVWRC
Knowledge of the marketplace and price indexes	Keeps prices competitive More net revenue Options during difficult periods	Quinte, Simcoe , Waterloo, York, Muskoka, Ottawa, Cornwall, OVWRC
Administration and Tendering		
Pay collection on per household basis	Pay contractor for level of service, not risk	Durham, Wellington County, Orillia
Municipality-owned weight scales	Ensures transparency and accountability on the part of the contractor and staff	Windsor, Niagara, Quinte, Toronto (Dufferin MRF), Waterloo, Cornwall, Simcoe, York, OVWRC
Reasonable, not overburdening bonding (e.g., up to 50 percent of annual contract value)	Lower cost due for contractors More competitive pricing due to greater number of bidders	

Customer service line, with database of customer complaints with follow-up	Answers customer questions Increases customer satisfaction and participation/recovery Reduces contamination	Hamilton, Waterloo, Simcoe, Ottawa
Promotion and Education		
Provide direct mail promotional material, i.e., calendars, newsletter, etc. by bulk mail (Canada Post)	Increases diversion Raise community awareness	Windsor, Halton, Simcoe, Waterloo, Muskoka, Cornwall, Ottawa, OVWRC, Russell, Carling, County of Peterborough
Community outreach and education through seminars and demonstrations at schools and community events	Increases program awareness Pressure on the parents to recycle from kids Consistent message on program details	Halton, Essex-Windsor, Bluewater, City of Peterborough, Peel, Simcoe, Waterloo, Muskoka, York, Ottawa, Cornwall, OVWRC, County of Peterborough
Photo-Based Materials	Reliance on Brands, rather than packaging More appealing to residents Clearer message to residents Increases recovery	Windsor, Bluewater, Ottawa, OVWRC, Waterloo, York, Peel
Use of multiple channels, i.e., special events, website, home shows, truck sales, print, TV, radio, etc.	Consistent and continuous messaging reinforcing the program Ability to reach multiple segments through diversification of media	Windsor-Essex, Quinte, Toronto, Waterloo, OVWRC, Ottawa, Muskoka, York, Peel
Use of vehicles that are likely to be retained, such as useful calendars, or phone book printed information	Residents have a guide to set out items and dates Increases diversion	Waterloo, Muskoka, Ottawa, Cornwall, Simcoe, York, OVWRC, Russell, Peterborough County
P & E available at depots and depots well signed	Reduces contamination Increases diversion	OVWRC, Simcoe, Waterloo, Cornwall
Lottery, giveaways, and rewards for participation	Increases program awareness	Hamilton
Policies and Incentives		
Provision of free Blue Boxes only to new residents or as a replacement for a broken one	Increased diversion Lower likelihood of misuse and abuse	Essex Windsor, London, Russell, Ottawa, Toronto, Peel, Simcoe, York
New multi-family construction must provide space for recycling containers.	Eliminates facilities issues as a disincentive to recycle	Peel, Toronto

In order to be eligible for municipal garbage collection, the multi-family building must be fully participating in the municipal recycling program.	Increases diversion Raise community awareness	Toronto, Orillia
Set a maximum amount of garbage allowed at multi-family buildings based on unit count	Increases diversion Raise community awareness	Toronto
Set a minimum amount of recycling that must be collected from each multi-family building on collection day in order to be considered fully participating in recycling.	Increases diversion Raise community awareness	Toronto
Waste Management bylaws	Increases diversion Raise community awareness	Hamilton, Toronto, Muskoka, Simcoe, Waterloo, York, Ottawa, Cornwall, OVWRC, Russell, Carling, County of Peterborough

Decision Tree for Conditional Best Practices

Not all Best Practices apply universally to all Blue Box programs. A Decision Tree accounts for three major factors of program variability and allows for alignment of Conditional Best Practices with specific program characteristics.

Overview of Decision Tree

Purpose

The purpose of the Decision Tree is to guide Blue Box program managers interested in enhancing their programs through a series of choices that characterize their programs and that narrow the list of Best Practices pertaining to each of their Blue Box programs. The decision tree methodology was chosen because:

- Few Best Practices are universally applicable
- It allows for defining under what conditions certain practices are "best"
- It provides a holistic, systems approach involving combinations of practices that collectively result in optimal recycling program under specified conditions

A working group of the Project Team was convened to structure the Decision Tree. Several Tree iterations were developed each having various advantages and disadvantages. The final version of the Tree was refined by the full Project Team.

Intended Use

The Decision Tree and its outputs have been created with a very narrow and specific purpose – to provide initial guidance to municipal program operators in designing, managing, and operating their municipal Blue Box program. The Tree intends to describe, in general terms, the desired state for a given program type, which may or may not be different from the current state of operations. The gap, if one exists, may be attributed to a number of factors, including, but not limited to:

- Inherent community characteristics that are not captured by the Decision Tree
- Conditions that are not within municipality's span of control
- Historical barriers affecting program evolution
- Lack of skills, knowledge, and management focus

Regardless of the cause of the gap, municipal program coordinators are advised to become familiar with the Fundamental and Conditional Best Practices applicable to their community profile and evaluate the feasibility and appropriateness of adopting these practices to enhance their program efficiency and effectiveness. In addition, each community will need to determine the specific means by which each practice should be implemented based on its own unique conditions and circumstances. It is only through such careful design and implementation that that the practices identified in this report will truly be employed in a best practices fashion. The Project Team envisions that Stewardship Ontario and other stakeholder organizations will be developing more detailed guidance and offering technical assistance to aid communities in making this transition.

Geography Breakpoints:

*The basis for delineation between Northern and Southern communities is **Blue Box Program Plan** legislation, which defines physical boundaries of Northern and Southern parts of the province.*

Program Size Breakpoints:

Program size is defined by the annual Blue Box material tonnes marketed by the program.

***Small:** less than 10,000 tonnes*
***Medium:** 10,000 - 40,000 tonnes*
***Large:** more than 40,000 tonnes*

Household Density Breakpoints:

Household density is defined by the number of households per kilometre of road in the municipalities:

***Rural:** less than 10 households/km*
***Suburban:** 10-70 households/km*
***Urban:** more than 70 households/km*

Decision Tree Structure

Foundational "Roots"

The Decision Tree is founded upon the Best Practices definition and principles, with the understanding that Fundamental Best Practices apply to all programs, regardless of community characteristics.

In addition, the Tree is rooted in the Blue Box program legislation, which defines geography and population thresholds for operating a municipal recycling program in Ontario. It also takes into consideration the provincial guidance aimed at achieving 60% diversion of Blue Box materials.

Also considered foundational is that all programs need to provide for worker and public safety with respect to facility design and program operations.

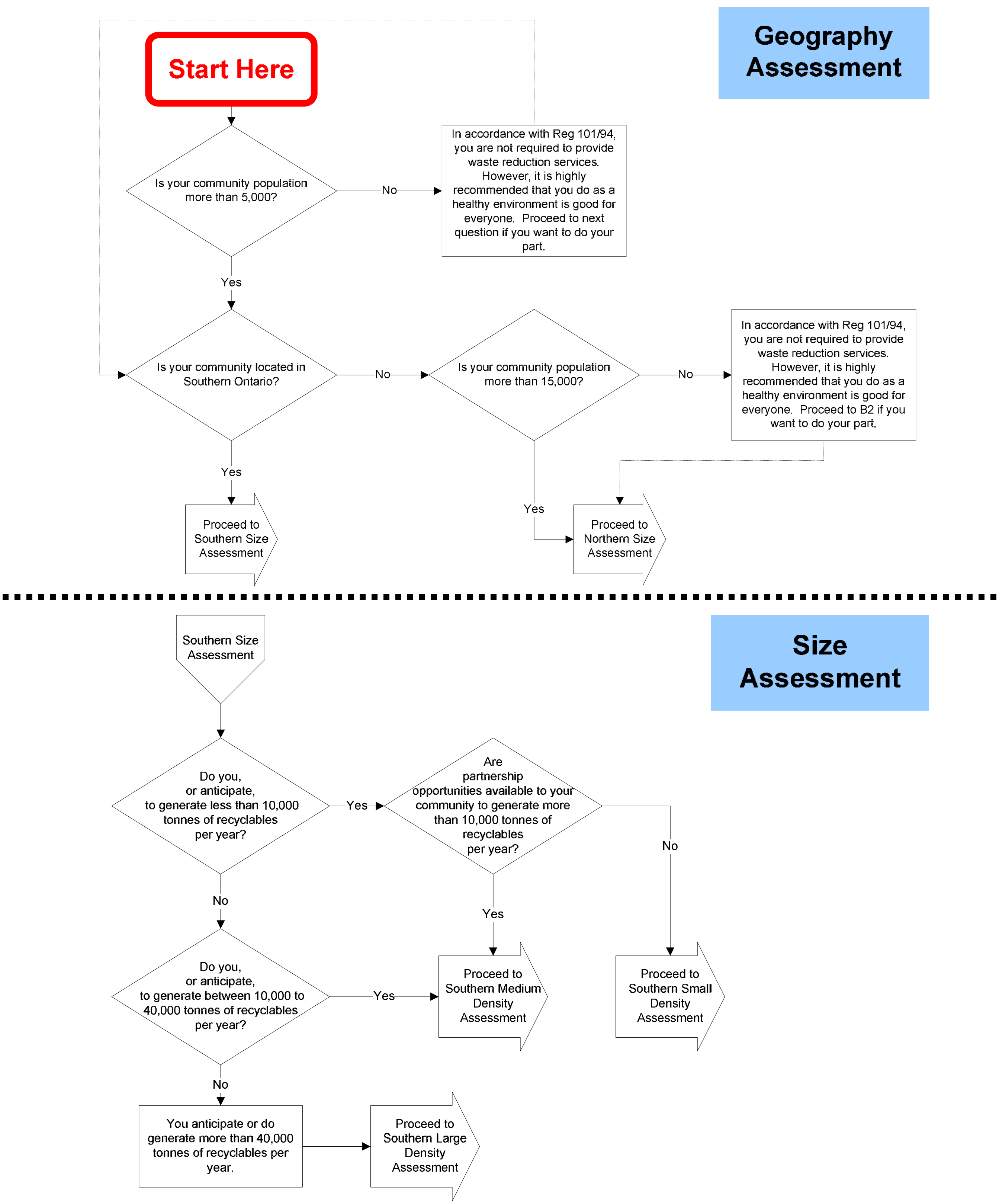
Nodes or "Branches"

The degree of program variance, described earlier in this report, necessitates a framework to logically group and cluster programs that exhibit similar characteristics. However, by accounting for a large number of observed program variations, the number of potential groups can become extremely large and nonsensical. For example, a set of only ten variations with two choices each will produce 1024 possible combinations (2^{10}), far exceeding the number of existing Ontario programs (less than 200). Therefore, the Team chose to account for three main program variables considered to have significant impact on program design and operations. As a result, the Decision Tree has three nodes or "branches", delineated as follows and illustrated in the three figures below.

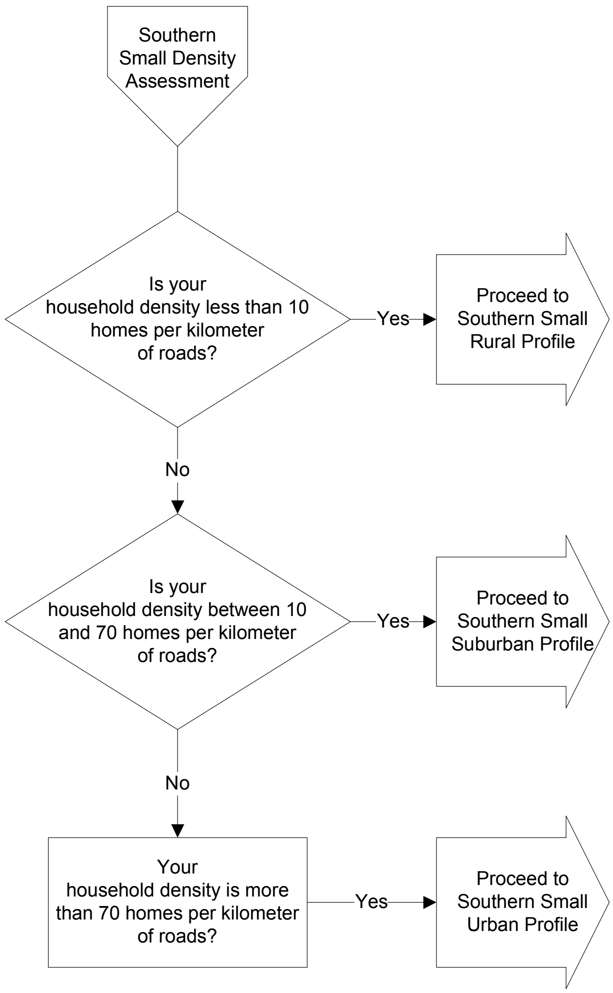
- **Geography:** North or South (2 choices)
- **Program size:** defined by annual tonnage handled through the program: Small, Medium, Large (3 choices)
- **Household density:** defined by number of households per kilometre: Rural, Suburban, Urban (3 choices)

The implication of this framework is that depending on the community's geographic location, size, and density, a different set of Best Practices will apply. Conditional Best Practices take into account these program differences.

Illustrative Example of the Decision Tree Structure



Density Assessment



A Different Approach

The questions on this page require you to know how many kilometers of roads within the service area exist to calculate the number of households per kilometer of road. You should be able to get the kilometers from your roads or planning department as they are used to report your performance under the Municipal Performance Measures Program managed by Municipal Affairs.

Nevertheless, if you are unsure of the number of kilometers of roads in your community or how to proceed before you have the data, you can use the following rule of thumb approach.
1) If you are a predominantly rural community (at least 80% of households are rural) then you are likely classified as having less than 10 households per kilometer of road.
2) If you are a predominantly urban community (at least 80% of households are urban) with at least 20% of your households in multi residential dwellings then you are likely classified as having more than 70 households per kilometer of road.
3) If you fall in either previous category and are mostly suburban then you are likely classified as having between 10 and 70 households per kilometer of roads.

Program Profiles

The Decision Tree framework produces a total of 18 theoretical program types, of which 12 actually exist in Ontario. The Project Team prepared descriptions of the Best Practices use for each of these 12 program types. Termed "Program Profiles", these descriptions provide guidance on the desired state of municipal recycling programs for a given program type. Conditional Best Practices are discussed in each Program Profile, augmented by references to Fundamental Best Practices and relevant Best Practice Spotlights. Please refer to the Table of Contents at the beginning of this document for the page number of the appropriate Program Profile for your community. For the programs visited in this project, Appendix A lists the applicable program profiles.

Program Profile

Small Rural Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating less than 10,000 tonnes per year
- Residential Density: Less than 10 homes per kilometre of road (more than 80% rural)

Programs in this profile are rural in nature, with only a small portion of households located in urban areas. These programs may be managed by a Township or a County, with very little urban development. The challenge in this group is to achieve diversion goals and provide efficient, cost-effective curbside and depot service to rural households.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
❑ Optimization of operations in collections and processing
❑ Training of key program staff in core competencies required
❑ Following generally accepted principles for effective procurement and contract management
❑ Appropriately planned, designed, and funded promotion and education program
❑ Established and enforced policies that induce waste diversion
CONDITIONAL BEST PRACTICES – applicable to programs fitting this profile
❑ Expanded list of Blue Box materials accepted

Program Planning and Design

Limited resources, lack of landfill space, and the need to focus on priorities and be resourceful are the main reasons for **maintaining and implementing an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

This profile group offers considerable potential for multi-municipal cooperation. A **multi-municipal planning approach** enables participating jurisdictions to evaluate opportunities to work together in making the most efficient use of limited personnel and equipment resources, to generate economies of scale, and to improve market leverage when contracting and moving recyclable materials into the marketplace. In addition, communities can work together in a region to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. Aggregation of blue box tonnage through shared use of processing facilities will result in higher throughput, thereby lowering per-tonne net costs for all participating communities. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no **defined diversion targets and performance measures, supported by data collection and analysis that measure the effectiveness of the plan and its implementation**. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile and in the corresponding Fundamental Best Practices section.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would need to **collect the five mandatory Blue Box materials as well as some of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling. For programs within this grouping that do not presently have their own MRF, choices regarding designated materials to be included in collection and the degree of commingling of these materials will be determined by the characteristics of the MRF where their materials are currently, or potentially, processed.

Collection

Use of **drop-off depots for recovering recyclables is a Best Practice in low-density rural areas**, where curbside recycling is cost prohibitive. It is more cost-effective to employ the use of depots in areas where curbside collection costs exceed $50 per household per year. **This is almost always the case for rural communities generating less than 2000 tonnes per year**. (See the text box at the end of the document for specific information on collection and processing best practices for programs of this size.)

Even when curbside collection is provided, **drop-off depots** are the Best Practice **to collect overflow Blue Box materials and additional recyclable materials, for which curbside collection is not practical or cost-effective**. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight**. Where feasible, if anywhere, curbside collection of recyclables should be used to service all available curbside-eligible households in the community**. Best Practices for curbside recycling in jurisdictions of this profile type are discussed in the Collection section below, with more information on curbside collection provided in the corresponding Best Practice Spotlight.

Communities of this profile will likely have a minimal multi-family population. **Multi-family recyclables collection, if performed, should be incorporated into curbside collection service routes wherever possible to minimize collection costs.** Because of the unique challenges of multi-family recycling, associated Best Practices are further discussed in the corresponding Best Practice Spotlight.

To increase the economic feasibility of curbside recycling, it is a Best Practice to **employ measures that increase the amount of material collected per stop and maximize collection efficiency**. This is particularly important in areas of low-density population, as it is more challenging to perform curbside recycling at an annual per-household cost below $50.

For curbside programs, providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **When curbside collection service is provided, collection of Blue Box materials should be at least as frequent as waste collection.**

The number of streams collected will be dictated by the processing options available to the program, as discussed in the next section. Single stream collection can benefit small rural programs because of the reduced collection and transfer costs when a single stream MRF is located within a one-hour's drive. Furthermore, because transfer of recyclables may be cost-effective for transporting materials, handling Blue Box materials in a single stream can minimize glass breakage due to the cushioning properties of paper and plastic products as materials are tipped, loaded into a transfer trailer, and tipped again.

Other opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the use of increased commingling and controlled compaction, where applicable and reducing non-productive operator time.. These and other Best Practices are expanded upon in the corresponding Best Practice Spotlight.

Processing

Our research and various studies have come to the same conclusion with respect to operating a material recovery facility (MRF) with less than 10,000 tonnes per year. The results show that it is extremely difficult to justify the capital expense to build the facility and keep it operated on a full-time basis, typically resulting in operating costs in excess of $100 per tonne processed.

Whenever possible, all programs with this profile should **explore partnership opportunities and/or use larger MRFs available in neighbouring jurisdictions,**

located within an hour's drive. Such arrangements can provide for efficient processing of recyclables and usually offer a broader range of materials.

If a neighbouring larger MRF is not available within reach, partnership opportunities should be explored for all programs, especially those in the lower tonnage range. The aggregation of blue box tonnage will result in a larger MRF's requirement of higher throughput, thereby lowering per-tonne processing costs for all participating communities. With enough cooperation, it may be possible to break through the 10,000 tonnes "barrier" and/or $100 per tonne threshold and maximize economies of scale.

In the absence of multi-municipal cooperation, the program's next best option may be to transfer and ship materials to a more distant MRF. Any community with more than a one hour haul distance to a MRF should consider the use of transfer facilities to potentially reduce system costs. **Preference should be given to MRFs that can handle single stream materials** to maximize collection and transfer savings.

As a last option, some programs have been successful at keeping costs low by sorting most or all the materials at the curb and performing rudimentary processing, usually limited to monitoring for contaminants and baling for material shipment. This typically results in higher collection costs and a somewhat limited target material range. One additional alternative is to provide alternating week collection, combined with a basic manual sorting line that can be used for both fibres and containers, as needed. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Spotlight: Rural Communities with less than 10 homes per km of roads (80% Rural) where curbside collection is cost prohibitive

Collection

For some rural communities in Ontario, curbside recycling service is cost prohibitive, meaning it is likely to exceed $50 per household per year. It is often logistically impractical, given the limited resources of communities of that size. The Best Practice for collection of recyclables in these small communities is **use of drop-off depots to collect Blue Box materials**.

Whenever possible (meaning if there is a suitable MRF within a reasonable haul distance), **collection should be conducted with the greatest degree of commingling in order to result in significant savings in transfer costs**. Furthermore, **controlled compaction** can be used to maximize payloads. Compaction at a depot can take place in the form of a roll-off compactor unit, where power and a ramp is available or with the use of front-end containers and its associated collection vehicle to collect one or more streams compacted. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Supporting Best Practices related to establishment and operation of drop-off depots are discussed further in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should be explored for such small rural programs. Operating a material recovery facility in this volume range is not feasible. Whenever possible, programs handling less than 2,000 tonnes should **use a larger MRF available in neighbouring jurisdictions**.

In the absence of a neighbouring MRF, the program's next best option is to transfer and ship to a more distant MRF. Any community with more than a one hour haul distance to a MRF should consider the use of transfer facilities to potentially reduce system costs. **Preference should be given to MRFs that can handle single stream materials** to minimize transfer costs. Supporting Best Practices related to transfer of recyclable materials are discussed further in the corresponding Best Practice Spotlight.

Program Profile

Small Suburban Southern Blue Box Program

Use of Program Profile

It is important to note that this document is intended to provide general guidance, not detailed, prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating less than 10,000 tonnes per year
- Residential Density: Between 10 and 70 homes per kilometre of roads (mixed urban and rural, or suburban)

Programs having this profile may have a mix of rural and urban areas, with a reasonable portion of households located in urban settings (between 20% and 80%). These programs may be better known as a small Village or Town, or perhaps even a relatively rural County. Landfill space is either exceptionally costly or is already lost to development. The challenge in this group is to achieve diversion goals and provide efficient, cost effective recycling services to potentially both rural and urban residents with limited multi-family units.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system

- ❑ Multi-municipal planning approach to collection and processing recyclables
- ❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
- ❑ Optimization of operations in collections and processing
- ❑ Training of key program staff in core competencies required
- ❑ Following generally accepted principles for effective procurement and contract management
- ❑ Appropriately planned, designed, and funded promotion and education program
- ❑ Established and enforced policies that induce waste diversion

CONDITIONAL BEST PRACTICES – applicable to all programs fitting this profile

- ❑ Expanded list of Blue Box materials accepted

Program Planning and Design

It is important to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling, as part of an integrated waste management system, can be found in the corresponding Fundamental Best Practices section.

A **multi-municipal planning approach** enables participating jurisdictions the opportunity to evaluate opportunities to work together in making the most efficient use of limited personnel and equipment resources, to generate economies of scale, and to improve market leverage when contracting and moving recyclable materials into the marketplace. In addition, communities can work together in a region to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. This is particularly important, as residents often relocate between neighbouring jurisdictions. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. This community group also offers considerable potential for multi-municipal cooperation beyond planning for collection, processing, and marketing. Aggregation of blue box tonnage will result in higher throughput, thereby lowering per-tonne net costs for all participating communities. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures**, **supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would need to **collect the five mandatory Blue Box materials as well as some of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling. For programs within this grouping that do not presently have their own MRF, choices regarding designated materials to be included in collection and the degree of commingling of these materials will be determined by the characteristics of the MRF where their materials are currently, or potentially, are processed.

Collection

Having a mix of rural and urban areas, as is the case for programs having this profile, results in **curbside recycling being cost-justified in some areas and drop-off depots being more cost-effective in others**. In areas where curbside collection costs exceed $50 per household per year, it is more cost-effective to provide recycling service using residential drop-off depots. Even when curbside collection is provided, **drop-off depots** are the Best Practice **to collect overflow Blue Box materials and additional types of recyclable materials, for which curbside collection is not practical or cost-effective**. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight. **Where feasible, curbside collection of recyclables should be used to service all available curbside-eligible households.** Best Practices for curbside recycling in jurisdictions of this profile type are discussed in the Collection section below, with more information on curbside recycling provided in the corresponding Best Practice Spotlight.

Programs of this profile are likely to have some, but not a large number of multi-family housing units. **Multi-family recyclables collection should be incorporated into curbside collection service routes wherever possible to minimize collection costs**. Because of the unique challenges of multi-family recycling, associated Best Practices are further discussed in the corresponding Best Practice Spotlight.

To increase the economic feasibility of curbside recycling, it is a Best Practice to **employ measures that increase the amount of material collected per stop and maximize collection efficiency**.

For curbside collection programs, providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection when curbside collection service is provided.**

The number of streams collected will be dictated by the processing options available to the program as discussed in the next section. Single stream collection can benefit the remote portions of the region due to reduced collection costs when a single stream MRF is located within a one-hour's drive. Furthermore, because transfer of recyclables may be cost-effective for transporting materials, handling Blue Box materials in a single stream can minimize glass breakage due to the cushioning properties of paper and plastic products as materials are tipped, loaded into a transfer trailer, and tipped again.

Furthermore, because transfer of recyclables may be cost-effective for transporting materials from remote parts of the region, handling Blue Box materials in a single stream can minimize glass breakage due to the cushioning properties of paper and plastic products as materials are tipped, loaded into a transfer trailer, and tipped again.

Collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers. Compaction can also be used in two stream collection; however, the per-household cost for collection in single stream systems is typically less than comparable two stream systems because materials can be loaded into a single stream truck in less time.

Other opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include: the **use of route optimization software** and **providing carts or dumpsters at multi-family buildings.** These and other collection optimization practices are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Our research and various studies have come to the same conclusion with respect to operating a material recovery facility (MRF) with less than 10,000 tonnes per year. The results show that it is extremely difficult to justify the capital expense to build the facility and keep it operated on a full-time basis, typically resulting in operating costs in excess of $100 per tonne processed.

Whenever possible, all programs with this profile should **explore partnership opportunities and/or use larger MRFs available in neighbouring jurisdictions, located within an hour's drive**. Such arrangements can provide for efficient processing of recyclables and usually offer a broader range of materials.

If a neighbouring larger MRF is not available within reach, partnership opportunities should be explored for all programs, especially those in the lower tonnage range. The aggregation of blue box tonnage will result in a larger MRF's requirement of higher throughput, thereby lowering per-tonne processing costs for all participating communities. With enough cooperation, it may be possible to break through the 10,000 tonnes "barrier" and/or $100 per tonne threshold and maximize economies of scale.

In the absence of multi-municipal cooperation, the program's next best option may be to transfer and ship materials to a more distant MRF. Any community with more than a one hour haul distance to a MRF should consider the use of transfer facilities to potentially reduce system costs. **Preference should be given to MRFs that can handle single stream materials to maximize collection and transfer savings**.

As a last option, some programs have been successful at keeping costs low by sorting most or all the materials at the curb and performing rudimentary processing, usually limited to monitoring for contaminants and baling for material shipment. This typically results in higher collection costs and a somewhat limited target material range. One additional alternative is to provide alternating week collection, combined with a basic manual sorting line that can be used for both fibres and containers, as needed. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Small Urban Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating less than 10,000 tonnes per year
- Residential Density: More than 70 homes per km of roads (80% Urban)

Programs having this profile are urban in nature. These municipalities may be better known as a large Town or a small or medium City, and are likely to be a significant population center of their area. Landfill space is either exceptionally costly or is already lost to development. The challenge in this group is to achieve diversion goals and maximize efficient, cost-effective recycling services to all urban residents with a number of multi-family units.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system

❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
❑ Optimization of operations in collections and processing
❑ Training of key program staff in core competencies required
❑ Following generally accepted principles for effective procurement and contract management
❑ Appropriately planned, designed, and funded promotion and education program
❑ Established and enforced policies that induce waste diversion
CONDITIONAL BEST PRACTICES – applicable to all programs fitting this profile
❑ Expanded list of Blue Box materials accepted

Program Planning and Design

It is important to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling, as part of an integrated waste management system, can be found in the corresponding Fundamental Best Practices section.

A **multi-municipal planning approach** enables participating jurisdictions the opportunity to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. This is particularly important, as residents often relocate between neighbouring jurisdictions. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. This community group also offers considerable potential for multi-municipal cooperation beyond planning for collection, processing, and marketing. Aggregation of blue box tonnage will result in higher throughput, thereby lowering per-tonne net costs for all participating communities. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures

and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would need to **collect the five mandatory Blue Box materials, as well as some of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling. For programs within this grouping that do not presently have their own MRF, choices regarding designated materials to be included in collection and the degree of commingling of these materials will be determined by the characteristics of the MRF where their materials are currently, or potentially, are processed.

Collection

Given the high-density nature of housing in communities of this profile, **curbside recycling is likely to be cost-effective and the primary means by which Blue Box materials should be collected**. Curbside collection is discussed further below, as well as in the corresponding Best Practice Spotlight. **Drop-off depots should be utilized to collect overflow Blue Box materials and additional recyclable materials for which curbside collection is not practical or cost-effective**. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

Programs in this profile will likely have a sizable multi-family population. **Multi-family recyclables collection needs to be a substantial part of this program, and should be integrated with curbside collection service wherever possible** in order to ensure program success. Because of the unique challenges of multi-family recycling, associated Best Practices are further discussed in the corresponding Best Practice Spotlight.

To minimize curbside recycling costs, it is a Best Practice to employ measures that increase the amount of material collected per stop and maximize collection efficiency.

Providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection.**

For programs in this profile, the number of streams collected will be dictated by the processing options available to the program, as discussed in the next section. Single stream collection can benefit the program due to reduced collection costs when a single stream MRF is located within a one-hour's drive. Furthermore, because transfer of recyclables may be cost-effective for transporting materials, handling Blue Box materials in a single stream can minimize glass breakage due to the cushioning properties of paper and plastic products as materials are tipped, loaded into a transfer trailer, and tipped again.

Other opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software** and **providing carts or dumpsters at multi-family complexes**. These and other collection optimization practices are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Our research and various studies have come to the same conclusion with respect to operating a material recovery facility (MRF) with less than 10,000 tonnes per year. The results show that it is extremely difficult to justify the capital expense to build the facility and keep it operated on a full-time basis, typically resulting in operating costs in excess of $100 per tonne processed.

Whenever possible, all programs with this profile should **explore partnership opportunities and/or use larger MRFs available in neighbouring jurisdictions, located within an hour's drive.** Such arrangements can provide for efficient processing of recyclables and usually offer a broader range of materials.

If a neighbouring larger MRF is not available within reach, partnership opportunities should be explored for all programs, especially those in the lower tonnage range. The aggregation of blue box tonnage will result in a larger MRF's requirement of higher throughput, thereby lowering per-tonne processing costs for all participating communities. With enough cooperation, it may be possible to break through the 10,000 tonnes "barrier" and/or $100 per tonne threshold and maximize economies of scale.

In the absence of multi-municipal cooperation, the program's next best option may be to transfer and ship materials to a more distant MRF. Any community with more than a one hour haul distance to a MRF should consider the use of transfer facilities to potentially reduce system costs. Preferences should be given to MRFs that can handle single stream materials to maximize collection and transfer savings.

As a last option, some programs have been successful at keeping costs low by sorting most or all the materials at the curb and performing rudimentary processing, usually limited to monitoring for contaminants and baling for material shipment. This typically results in higher collection costs and a somewhat limited target material range. One additional alternative is to provide alternating week collection, combined with a basic manual sorting line that can be used for both fibres and containers, as needed. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Medium Rural Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating between 10,000 and 40,000 tonnes per year
- Residential Density: Less than 10 homes per km of roads (more than 80% rural)

Programs having this profile are rural and regional in nature, comprised of a number of small cities, towns, and townships, with only a small portion of households located in urban areas. The challenge in this group is to achieve diversion goals and provide efficient, cost-effective curbside service and to transport recyclables to a MRF.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables

- Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
- Optimization of operations in collections and processing
- Training of key program staff in core competencies required
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded promotion and education program
- Established and enforced policies that induce waste diversion

CONDITIONAL BEST PRACTICES – applicable to all programs fitting this profile

- Expanded list of Blue Box materials accepted
- Two stream collection and processing of Blue Box materials

Program Planning and Design

It is important to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus, that, when combined with complementary waste reduction, organics, reuse, and waste diversion incentives (bag limits, user pay); will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Although a program within this grouping will be able to support its own MRF, some program decisions will have a direct impact on the programs in surrounding counties, towns, and townships. A **multi-municipal planning approach** will allow surrounding jurisdictions to work together to make the most efficient use of limited personnel, improve economies of scale, and improve market leverage when contracting for services and marketing recovered materials. A multi-municipal planning approach also offers participating jurisdictions the opportunity to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures

and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Due to the size of programs in this group there are opportunities to invest in capital equipment to automate the recycling process and increase the rate at which Blue Box materials are collected and processed. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would need to **collect the five mandatory Blue Box materials, as well as some of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling.

Collection

Curbside collection of recyclables should be used to service all available curbside-eligible households in the community, supported by drop-off depots to provide access to recycling for residents in areas where density may not support curbside and/or to collect additional recyclable materials that are not collected curbside. It is more cost-effective to employ the use of depots in areas where curbside collection costs exceed $50 per household per year. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

Multi-family householders will likely comprise a very small portion of the population. If offered, **multi-residential recyclables collection should be integrated with curbside collection service wherever possible**.

Providing sufficient **rigid collection containers free of charge** to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated setout volume of recyclables, based on the frequency of collection**.** Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection**.

Programs within this profile should be collecting recyclables in two streams (i.e., fibres and containers), with the possible exception of keeping glass separate as a third stream. Single-stream recycling is likely not warranted for programs of this profile, unless a regional single stream MRF exists or can be constructed that would process tonnages near or above 40,000 tonnes per year (otherwise capital costs could negatively impact cost-effectiveness). The cost of additional curbside sorting beyond a 2 stream recyclables system should be weighed against the merits of any reduced processing required and the potential of additional revenue.

Opportunities for increasing recyclables collection efficiencies and reducing costs grow with increased commingling. Two-stream collection enables the implementation of practices, such as **controlled compaction**. Compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, resulting in more productive time spend on route, without resulting in excessive glass breakage.

Transfer of recyclables should be considered if the direct haul time of collection vehicles to a MRF exceeds one hour. Transfer may also provide more MRF alternatives to programs than available locally.

Other opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software, and providing carts or dumpsters at multi-family complexes.** These and other collection optimization practices are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should be seriously explored for all programs with this profile in order to maximize processing efficiencies and allow surrounding jurisdictions the benefits of delivering materials to the program's MRF. Two-stream processing (fibres and containers) is most appropriate in this tonnage range. The cost of single stream processing is greater than that of two stream processing at the same capacity, and anticipated savings in collection are able to offset these processing costs only at high throughput tonnages. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include **following generally accepted principles for effective procurement and contract management**. This is discussed, in detail in the corresponding Fundamental Best Practices section.

Another Best Practice that specifically applies to this profile is the **alignment of service contract lengths with equipment depreciation terms**. This practice is conditional on the program: (1) contracting with a service provider rather than using municipal staff; and (2) specifying that the service provider provide new collection equipment or design and build a new MRF. The reason for aligning the contract lengths with equipment depreciation terms is to ensure that the program doesn't fully pay for equipment that may have additional life at the end of the contract. In the case of MRFs, the term should be aligned with the first scheduled major overhaul of the plant's equipment. A suitably long term also ensures that equipment is installed that has a life cycle cost advantage that may not be realized by the contractor over a shorter operating period.

When contracting for private sector collection and processing services, consideration should be given to the advantages and disadvantages of separate versus combined contracts and, in both cases, it is important to identify separate costs for collection and processing. When contracting with a private sector MRF operator, the municipality should keep the predominant proportion of material sales revenue.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program on waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Medium Suburban Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating between 10,000 and 40,000 tonnes per year
- Residential Density: Between 10 and 70 homes per km of roads (mixed urban and rural, or suburban)

Programs having this profile are regional, with a mix of urban and rural areas, including cities, towns, and townships. The challenge in this group is to achieve diversion goals and provide efficient, cost-effective recycling services to all residents, including those living in multi-family units.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program

- Optimization of operations in collections and processing
- Training of key program staff in core competencies required
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded promotion and education program
- Established and enforced policies that induce waste diversion

CONDITIONAL BEST PRACTICES – applicable to all programs fitting this profile

- Expanded list of Blue Box materials accepted
- Two-stream collection and processing of Blue Box materials

Program Planning and Design

It is important to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus, that, when combined with complementary waste reduction, organics, reuse, and waste diversion incentives (bag limits, user pay); will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Although a program within this grouping will be able to support its own MRF, some program decisions will have a direct impact on the programs in surrounding counties, towns, and townships. A **multi-municipal planning approach** will allow surrounding jurisdictions to work together to make the most efficient use of limited personnel, improve economies of scale, and improve market leverage when contracting for services and marketing recovered materials. This approach also offers participating jurisdictions the opportunity to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced collection routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Because of the size of programs in this group there are opportunities to invest in capital equipment to automate the recycling process and increase the rate at which Blue Box materials are collected and processed. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections below.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would need to **collect the five mandatory Blue Box materials, as well as some of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling.

Collection

Curbside collection of recyclables should be used to service all available curbside-eligible households in the community. Drop-off depots should be utilized to collect overflow Blue Box materials and additional recyclable materials for which curbside collection is not practical or cost-effective. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

Multi-family homes will likely make up a moderate portion of all homes and, thus, cannot be ignored as a source of substantial quantities of Blue Box materials. **Collection of multi-family recyclables should be integrated with curbside collection of recyclables wherever possible, for cost and efficiency reasons.** Because of the unique challenges of multi-family recycling, associated Best Practices are further discussed in the corresponding Best Practice Spotlight.

Providing sufficient **rigid collection containers free of charge** to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated setout volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection.**

Programs within this profile should be collecting recyclables in two streams (i.e., fibres and containers), with the possible exception of keeping glass separate as a third stream. Single-stream recycling is likely not warranted for programs of this profile, unless a regional single stream MRF exists or can be constructed that would process tonnages near or above 40,000 tonnes per year (otherwise capital costs could negatively impact combined collection and processing cost-effectiveness).

Opportunities for increasing recyclables collection efficiencies and reducing costs grow with increased commingling. Two-stream collection enables the implementation of practices, such as **controlled compaction**. Compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, resulting in more productive time spend on route, without resulting in excessive glass breakage. Other opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software and providing carts or dumpsters at multi-family complexes**. These are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should be seriously explored for all programs with this profile in order to maximize processing efficiencies and allow surrounding jurisdictions the benefits of delivering materials to the program's MRF. **Two-stream processing** (fibres and containers) is most appropriate in this tonnage range. The cost of single stream processing is greater than that of two-stream processing at the same capacity, and anticipated savings in collection are able to offset these processing costs only at high throughput tonnages. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include **following generally accepted principles for effective procurement and contract management**. This is discussed, in detail in the corresponding Fundamental Best Practices section.

A Best Practice that specifically applies to this profile is the **alignment of service contract lengths with equipment depreciation terms**. This practice is conditional on the program: (1) contracting with a service provider rather than using municipal staff; and (2) specifying that the service provider provide new collection equipment or design and build a new MRF. The reason for aligning the contract lengths with equipment depreciation terms is to ensure that the program doesn't fully pay for equipment that may have additional life at the end of the contract. In the case of MRFs, the term should be aligned with the first scheduled major overhaul of the plant's equipment. A suitably long term also ensures that equipment is installed that has a life cycle cost advantage that may not be realized by the contractor over a shorter operating period.

When contracting for private sector collection and processing services, consideration should be given to the advantages and disadvantages of separate versus combined contracts and, in both cases, it is important to identify separate costs for collection and processing. When contracting with a private sector MRF operator, the municipality should keep the predominant proportion of material sales revenue.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program on waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Medium Urban Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating between 10,000 and 40,000 tonnes per year
- Residential Density: Greater than 70 homes per kilometre of roads (over 80% urban)

Programs having this profile are urban cities. The challenge in this group is to achieve diversion goals while providing efficient, cost-effective recycling services to all urban residents, including those living in multi-family buildings.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
❑ Optimization of operations in collections and processing

- ❑ Training of key program staff in core competencies required
- ❑ Following generally accepted principles for effective procurement and contract management
- ❑ Appropriately planned, designed, and funded promotion and education program
- ❑ Established and enforced policies that induce waste diversion

CONDITIONAL BEST PRACTICES – applicable to all programs fitting this profile

- ❑ Expanded list of Blue Box materials accepted
- ❑ Two stream collection and processing of Blue Box materials

Program Planning and Design

It is important to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Programs matching this profile are the business and population center of their area. Although a program within this grouping will be able to support its own MRF, program decisions that are made will a have direct impact on the programs in surrounding counties, towns and townships. A **multi-municipal planning approach** will enable neighbouring jurisdictions to work together to make the most efficient use of limited personnel, improve economies of scale, and improve market leverage when contracting for services and marketing recovered materials. A multi-municipal planning approach also offers participating jurisdictions the opportunity to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Due to the size of programs in this group, there are opportunities to invest in capital equipment to automate the recycling process and increase the rate at which Blue Box materials are collected and processed. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would **need to collect the five mandatory Blue Box materials as well as several of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling.

Collection

Curbside collection of recyclables should be used to service all available curbside-eligible households in the community. Drop-off depots should be utilized to collect overflow Blue Box materials and additional recyclable materials for which curbside collection is not practical or cost-effective. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

The urban nature of programs of this profile means that the multi-family population will likely be sizeable. Collection of multi-family recyclables needs to be a substantial part of this program. **On-site collection of recyclables should be used to service all available multi-family households in the community, and service should be integrated with curbside collection of recyclables wherever possible.** Because of the unique challenges of multi-family recycling, associated best practices are further discussed in the corresponding Best Practice Spotlight.

Providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables**,** based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection.**

Programs within this profile should be collecting recyclables in two streams (i.e., fibres and containers), with the possible exception of keeping glass separate as a third stream. At the high tonnage range, the feasibility of single stream collection of recyclables should be weighed against the increased processing required and the potential of decreased revenue. It may be possible to attract tonnage from other jurisdictions to support a single stream program.

Opportunities for increasing recyclables collection efficiencies and reducing costs grow with increased commingling. Two-stream collection enables the implementation of practices such as **controlled compaction**. Compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, resulting in more productive time spend on route, without resulting in excessive glass breakage. Other opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software, and providing carts or dumpsters at multi-family complexes**. These and other collection optimization practices are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should still be explored for all programs with this profile in order to maximize processing efficiencies. **Two-stream processing (fibres and containers) is most appropriate in this tonnage range**. The cost of single stream processing is greater than that of two-stream processing at the same capacity, and anticipated savings in collection are able to offset these processing costs only at high throughput tonnages. However as previously stated, it may be possible to attract tonnage from other jurisdictions to support a single stream program.

Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed, in detail in the corresponding Fundamental Best Practices section.

A best practice that applies to this profile is the **alignment of service contract lengths with equipment depreciation terms**. This practice is conditional on the program: (1) contracting with a service provider rather than using municipal staff; and (2) specifying that the service provider provide new collection equipment or design and build a new MRF. The reason for aligning the contract lengths with equipment depreciation terms is to ensure that the program doesn't fully pay for equipment that may have additional life at the end of the contract. In the case of MRFs, the term should be aligned with the first scheduled major overhaul of the plant's equipment. A suitably long term also ensures that equipment is installed that has a life cycle cost advantage that may not be realized by the contractor over a shorter operating period.

When contracting for private sector collection and processing services, consideration should be given to the advantages and disadvantages of separate versus combined contracts, and, in both cases, it is important to identify separate costs for collection and processing. When contracting with a private sector MRF operator, the municipality should keep the predominant proportion of material sales revenue. Additional items to be considered when contracting for these services are discussed in the corresponding Best Practice Spotlight.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Large Suburban Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating over 40,000 tonnes per year
- Residential Density: Between 10 and 70 homes per km of roads (mixed urban and rural, or suburban)

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs in all profiles
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
❑ Optimization of operations in collections and processing
❑ Training of key program staff in core competencies required

❑	Following generally accepted principles for effective procurement and contract management
❑	Appropriately planned, designed, and funded promotion and education program
❑	Established and enforced policies that induce waste diversion
CONDITIONAL BEST PRACTICES – applicable to all programs fitting this profile	
❑	Expanded list of Blue Box materials accepted

Program Planning and Design

Programs having this profile are large, complex, and urban/regional in nature. The challenge in this group is to achieve diversion goals and maximize efficient, cost-effective recycling services to all residents.

Programs in this group are either a major regional population center or a rapidly growing region at the edge of a major urban center that still has rural portions at its outskirts. Landfill space is either exceptionally costly or is already lost to development. It is important to **maintain and implement an up-to-date plan for recycling, as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Although a program within this grouping will be able to support its own MRF, all such programs will benefit from a **multi-municipal planning approach** to collection and processing of recyclables. This is especially the case for programs handling close to 40,000 tonnes per year, who could host a regional MRF, so that aggregation of blue box tonnage will result in larger MRFs of higher throughput, thereby lowering per-tonne processing costs for all participating communities. A multi-municipal planning approach also offers participating jurisdictions the opportunity to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. This is particularly important, as residents often relocate between neighbouring jurisdictions. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Due to the size of programs in this group, there are opportunities to invest in capital equipment to automate the recycling process and increase the rate at which Blue Box materials are collected and processed. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would **need to collect the five mandatory Blue Box materials as well as several of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling.

For programs over 40,000 tonnes per year, single stream collection and processing is feasible. Single stream recycling offers the potential for increased collection savings and increased recovery of recyclables, but also results in increased processing costs and, depending on the container type used, increased contamination. Despite the recent growth in single stream systems, it would be a mistake to assume that the single stream recycling approach represents the most economical alternative for all communities. In some cases, other approaches, such as the dual-stream, two-bin recycling approach, may prove to be more economical. This conclusion underscores the importance of using local economic and market data in assessing the economic feasibility of single stream recycling for a local community. Refer to the corresponding Best Practice Spotlights for more information on Collection and Processing considerations relating to single stream.

Collection

Curbside collection of recyclables should be used to service all available curbside-eligible households in the community. Drop-off depots should be utilized to collect overflow Blue Box materials and additional recyclable materials for which curbside collection is not practical or cost-effective. Depots may also be warranted in outlying villages in the remaining rural portions of the region. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

The urban portions of programs of this profile will likely have a sizable multi-family population. **Collection of multi-family recyclables needs to be a substantial part of this program. On-site collection of recyclables should be used to service all available multi-family households in the community, and should be integrated with curbside collection of recyclables wherever possible** in order to ensure program success. Because of the unique challenges of multi-family recycling, associated best practices are further discussed in the corresponding Best Practice Spotlight.

Providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection.**

The size of programs within this profile allows for the construction of a MRF that is capable of processing recyclables that have been collected single stream. From a processing perspective, single stream collection of recyclables is not preferred over two stream collection, because the processing cost per tonne and process residue rates will be higher at a single stream MRF compared to an equivalent two stream MRF. Single stream collection costs, however, can be significantly reduced, compared to two stream collection (assuming use of carts and bi-weekly service), and the point at which the combined collection and processing cost favours single stream is approximately 40,000 tonnes per year.

Single stream collection can benefit the remote portions of the region due to reduced collection costs. Furthermore, because transfer of recyclables may be cost-effective for transporting materials from remote parts of the region, handling Blue Box materials in a single stream can minimize glass breakage due to the cushioning properties of paper and plastic products as materials are tipped, loaded into a transfer trailer, and tipped again.

Collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers. Compaction can also be used in two stream collection; however, the per-household cost for collection in single stream systems is typically less than comparable two stream systems because materials can be loaded into a single stream truck in less time.

Another collection practice that is enabled by single stream collection is providing program participants with carts for their Blue Box materials instead of bins. The significantly greater storage volume of carts compared to bins means that overflow Blue Box materials are typically not discarded, although some exceptions may occur. The carts also allow for every-other-week collection of Blue Box materials, with reduced collection cost, compared to weekly collection. The use of carts also allows for fully automated collection, in which a mechanical arm picks up and dumps the cart without the driver having to get out of the truck for the majority of stops. This can allow for collecting more stops per hour, yielding further cost savings. Because machinery is doing the heavy lifting, a more age and gender-balanced workforce can be used and WSIB claims are typically reduced. In areas where fully automated collection is impractical (e.g., due to obstacles impeding collection), semi-automated collection of recyclables in carts may be an option.

It should be noted that many of the practices that are enabled by single stream collection can be achieved by two stream systems that collect paper products and containers on an alternating week basis, including compaction and dual collection. Collecting on an alternating week basis does not mean that the MRF only processes paper products one week and containers the other week; rather it means that half the routes collect one material and the other half of routes collect the other material on any given day. This allows the MRF to be optimally sized. Because solid waste planners seek to optimize an entire integrated solid waste system, a two stream Blue Box system may be preferred over single stream if total system costs are reduced. Planners of programs similar to this profile should carefully develop their business case supporting two stream collection over single stream collection.

Additional opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software and providing carts or dumpsters at multi-family complexes**. These and other collection optimization practices are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should still be explored for all programs with this profile. Any community with a one to two-hour haul distance to a MRF should consider the use of transfer to potentially reduce system costs through economies of scale due to increased throughput resulting from multi-municipal cooperation.

Additionally, MRFs in this profile should investigate the suitability of processing paper and plastics with optical sorting equipment, as utilization of that equipment may be a Best Practice under certain conditions. Typically, the use of optical sorting equipment is feasible in only the highest throughput facilities. In the case of optical sorting of plastics, the equipment is designed for sorting plastic bottles only and therefore is generally not suitable to sorting a mixed plastics stream that includes tubs and lids and polystyrene. Optical sorting of paper is still somewhat developmental and automated sorting of paper may be limited to only certain facilities, based on how materials are sorted into sub-streams. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

A best practice that applies to this profile is the alignment of service contract lengths with equipment depreciation terms. This practice is conditional on the program: (1) contracting with a service provider rather than using municipal staff; and (2) specifying that the service provider provide new collection equipment or design and build a new MRF. The reason for aligning the contract lengths with equipment depreciation terms is to ensure that the program doesn't fully pay for equipment that may have additional life at the end of the contract. In the case of MRFs, the term should be aligned with the first scheduled major overhaul of the plant's equipment. A suitably long term also ensures that equipment is installed that has a life cycle cost advantage that may not be realized by the contractor over a shorter operating period.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Large Urban Southern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Southern community
- Size of Program: Generating over 40,000 tonnes per year
- Residential Density: Greater than 70 homes per kilometre of roads (over 80% urban)

Programs having this profile are large, complex, and urban/regional in nature. The urban nature of programs in this group generally means that landfill space is limited. These programs are also likely experiencing rapid population growth or frequent relocation of residents between neighbouring jurisdictions that surround a major urban center. The challenge in this group is to achieve diversion goals and maximize efficient, cost-effective recycling services to all residents.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables

- Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
- Optimization of operations in collections and processing
- Training of key program staff in core competencies required
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded promotion and education program
- Established and enforced policies that induce waste diversion

CONDITIONAL BEST PRACTICES – applicable to programs fitting this profile

- Expanded list of Blue Box materials accepted

Program Planning and Design

It is important to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Although a program within this grouping will be able to support its own MRF, all such programs will benefit from a **multi-municipal planning approach** to collection and processing of recyclables. This is especially the case for programs handling close to 40,000 tonnes per year, who could host a regional MRF, so that aggregation of blue box tonnage will result in larger MRFs of higher throughput, thereby lowering per-tonne processing costs for all participating communities. A multi-municipal planning approach also offers participating jurisdictions the opportunity to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. This is particularly important, as residents often relocate between neighbouring jurisdictions. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures

and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Due to the size of programs in this group, there are opportunities to invest in capital equipment to automate the recycling process and increase the rate at which Blue Box materials are collected and processed. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

For communities within this profile, programs designed to achieve 60% diversion of Blue Box materials would **need to collect the five mandatory Blue Box materials as well as several of the "supplementary" Blue Box materials** that: comprise a significant portion of the waste stream (as determined by waste audits), have reliable markets, and can be practically recovered for recycling.

Collection

Curbside collection of recyclables should be used to service all available curbside-eligible households in the community. Drop-off depots should be utilized to collect overflow Blue Box materials and additional recyclable materials for which curbside collection is not practical or cost-effective. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

The urban nature of programs of this profile means that the multi-family population will likely be sizeable. Collection of multi-family recyclables needs to be a substantial part of this program. **On-site collection of recyclables should be used to service all available multi-family households in the community, and should be integrated with curbside collection of recyclables wherever possible** in order to ensure program success. Because of the unique challenges of multi-family recycling, associated best practices are further discussed in the corresponding Best Practice Spotlight.

Providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. Collection of Blue Box materials should be at least as frequent as waste collection.

The size of programs within this profile allows for the construction of a MRF that is capable of processing recyclables that have been collected single stream. From a processing perspective, single stream collection of recyclables is not preferred over two stream collection, because the processing cost per tonne and process residue rates will be higher at a single stream MRF compared to an equivalent two stream MRF. Single stream collection costs, however, can be significantly reduced, compared to two stream collection (assuming use of carts and bi-weekly service), and the point at which the combined collection and processing cost favours single stream is approximately 40,000 tonnes per year.

Collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers. Compaction can also be used in two stream collection; however, the per-household cost for collection in single stream systems is typically less than comparable two stream systems because materials can be loaded into a single stream truck in less time.

A second collection practice that is enabled by single stream collection is providing program participants with carts for their Blue Box materials instead of bins. The significantly greater storage volume of carts compared to bins means that overflow Blue Box materials are typically not discarded, although some exceptions may occur. The carts also allow for every-other-week collection of Blue Box materials, with reduced collection cost, compared to weekly collection. The use of carts also allows for fully automated collection, in which a mechanical arm picks up and dumps the cart without the driver having to get out of the truck for the majority of stops. This can allow for collecting more stops per hour, yielding further cost savings. Because machinery is doing the heavy lifting, a more age and gender-balanced workforce can be used and WSIB claims are typically reduced. In areas where fully automated collection is impractical (e.g., due to obstacles impeding collection), semi-automated collection of recyclables in carts may be an option.

It should be noted that many of the practices that are enabled by single stream collection can be achieved by two stream systems that collect paper products and containers on an alternating week basis, including compaction and co-collection. Collecting on an alternating week basis does not mean that the MRF only processes paper products one week and containers the other week; rather it means that half the routes collect one material and the other half of routes collect the other material on any given day. This allows the MRF to be optimally sized. Because solid waste planners seek to optimize an entire integrated solid waste system, a two stream Blue Box system may be preferred over single stream if total system costs are reduced. Planners of programs similar to this profile should carefully develop their business case supporting two stream collection over single stream collection.

Additional opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software and providing carts or dumpsters at multi-family complexes**. These are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should still be explored for all programs with this profile. Any community with a one to two-hour haul distance to a MRF should consider the use of transfer to potentially reduce system costs through economies of scale due to increased throughput resulting from multi-municipal cooperation.

Additionally, MRFs in this profile should investigate the suitability of processing paper and plastics with optical sorting equipment, as utilization of that equipment may be a Best Practice under certain conditions. Typically, the use of optical sorting equipment is feasible in only the highest throughput facilities. In the case of optical sorting of plastics, the equipment is designed for sorting plastic bottles only and may not suitable to sorting a mixed plastics stream that includes tubs and lids and polystyrene. Optical sorting of paper is still somewhat developmental and automated sorting of paper may be limited to only certain facilities, based on how materials are sorted into sub-streams. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

A best practice that specifically applies to this profile is the **alignment of service contract lengths with equipment depreciation terms**. This practice is conditional on the program: (1) contracting with a service provider rather than using municipal staff; and (2) specifying that the service provider provide new collection equipment or design and build a new MRF. The reason for aligning the contract lengths with equipment depreciation terms is to ensure that the program doesn't fully pay for equipment that may have additional life at the end of the contract. In the case of MRFs, the term should be aligned with the first scheduled major overhaul of the plant's equipment. A suitably long term also ensures that equipment is installed that has a life cycle cost advantage that may not be realized by the contractor over a shorter operating period.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Small Rural Northern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Northern community
- Size of Program: Generating less than 10,000 tonnes per year
- Residential Density: Less than 10 homes per kilometre of road (more than 80% rural)

Programs having this profile are rural in nature, with only a small portion of households located in urban areas. They are typically townships, with very little urban development. The challenge in this group is to achieve diversion goals and provide efficient, cost-effective curbside and depot service to rural households.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

There are no Conditional Best Practices that apply to every program in this profile. Several Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program

- Optimization of operations in collections and processing
- Training of key program staff in core competencies required
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded promotion and education program
- Established and enforced policies that induce waste diversion

Program Planning and Design

Limited resources, lack of landfill space, and the need to focus on priorities and be resourceful are the main reasons for **maintaining and implementing an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Programs matching this profile can experience considerable benefits from multi-municipal cooperation. A **multi-municipal planning approach** enables participating jurisdictions the opportunity to evaluate opportunities to work together in making the most efficient use of limited personnel and equipment resources, to generate economies of scale, and to improve market leverage when contracting and moving recyclable materials into the marketplace. In addition, communities can work together in a region to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. Aggregation of blue box tonnage through shared use of processing facilities will result in higher throughput, thereby lowering per-tonne net costs for all participating communities. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

Collection

Rural programs in the North are likely to have high transportation costs associated with getting recyclable materials to market. This, coupled with the low tonnage of materials available for recovery, warrants focusing recycling efforts on capturing Blue Box materials that are marketable and offer the greatest tonnage diversion opportunity.

Use of drop-off depots for recovering the target recyclables is a Best Practice **in low-density rural areas**, where curbside recycling is cost prohibitive. It is more cost-effective to employ the use of depots in areas where curbside collection costs exceed $50 per household per year. This is almost always the case for rural communities generating less than 2000 tonnes per year. (See the text box at the end of the document for specific information on collection and processing best practices for programs of this size.)

Curbside collection of recyclables should be provided to households where such service can be provided for $50 per household per-year or less. Even when curbside collection is provided, **drop-off depots** are the Best Practice **to collect overflow Blue Box materials and additional recyclable materials for which curbside collection is not practical or cost-effective.** Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight. Best Practices for curbside recycling in jurisdictions of this profile type are discussed in the Collection section below, with more information on curbside collection provided in the corresponding Best Practice Spotlight.

Communities of this profile will likely have a minimal multi-family population. **Multi-family recyclables collection, if needed, should be incorporated into curbside collection service routes wherever possible to minimize collection costs.** Because of the unique challenges of multi-family recycling, associated Best Practices are further discussed in the corresponding Best Practice Spotlight.

To increase the economic feasibility of curbside recycling, it is a Best Practice to employ measures that increase the amount of material collected per stop and maximize collection efficiency. This is particularly important in areas of low-density population, as it is more challenging to perform curbside recycling at an annual per-household cost below $50.

For curbside programs, providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box**

materials should be at least as frequent as waste collection when curbside recycling service is provided.

The number of streams collected will be dictated by the processing options available to the program, as discussed in this and the following section. Single stream collection is an option that should only be considered by programs of this profile that are within about a two hour transfer distance of a single stream MRF (e.g., Greater Sudbury, Winnipeg). Collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled, so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers.

Programs that are within about a two-hour transfer distance of a two-stream MRF should consider collecting materials as two streams so that collection costs can be reduced. As with single stream collection, compaction can also be used in two stream collection. Co-collection of waste and recyclables can also be adapted to two stream programs when homes are provided with an alternating collection schedule of Blue Box materials, where waste and fibres are collected one week, and waste and containers are collected the next week.

Additional opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include: the **use of increased commingling, where applicable;** and **reducing non-productive operator time**. These and other Best Practices are expanded upon in the corresponding Best Practice Spotlight.

Processing

Facilities that process less than 10,000 tonnes per year are not as cost-effective as larger facilities, and all programs with this profile should **explore partnership opportunities to maximize the tonnes processed by existing MRFs**, as they are well below that threshold.

Programs that are remote may have to process their own Blue Box materials. Processing costs can be managed by limiting the categories of Blue Box materials collected and sorting most materials at the curb. Processing equipment can therefore be low-cost and limited to a rudimentary sorting line (if required), materials handling equipment, and an inexpensive baler. Because the baler will not be robust, PET plastic bottles will not be able to be baled to a sufficient density to avoid additional freight costs or penalties. Therefore, a Best Practice is to purchase and use densifying equipment, such as a perforator, or baler fluffer to perforate PET bottles, rather than remove caps by hand. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Spotlight: Rural Communities with less than 10 homes per km of roads (80% Rural) where curbside collection is cost prohibitive

Collection

For some rural communities in Ontario, curbside recycling service is cost prohibitive, meaning exceeding or likely to exceed $50 per household per year and often logistically impractical given the limited resources of communities of that size. The best practice for collection of recyclables in these small communities is **use of drop-off depots to collect Blue Box materials**.

Whenever possible (meaning if there is a suitable MRF within a reasonable haul distance), collection should be conducted with the greatest degree of commingling in order to result in significant savings in transfer costs. Furthermore, **controlled compaction** can be used to maximize payloads. Compaction at a depot can take place in the form of a roll-off compactor unit where power and a ramp is available or with the use of front end containers and its associated collection vehicle to collect one or more streams compacted. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials.

Supporting Best Practices related to establishment and operation of drop-off depots are discussed further in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should be explored for such small rural programs. Operating a material recovery facility in this volume range is not feasible. Whenever possible, programs handling less than 2,000 tonnes should **use a larger MRF available in neighbouring jurisdictions.**

In the absence of a neighbouring MRF, the program's next best option is to transfer and ship to a more distant MRF. Any community with more than a one hour haul distance to a MRF should consider the use of transfer facilities to potentially reduce system costs. Preferences should be given to MRFs that can handle single stream materials to minimize transfer costs.

Supporting Best Practices related to transfer of recyclable materials are discussed further in the corresponding Best Practice Spotlight.

Program Profile

Small Suburban Northern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Northern community
- Size of Program: Generating less than 10,000 tonnes per year
- Residential Density: Between 10 and 70 homes per kilometre of roads (mixed urban and rural, or suburban)

Programs having this profile may have a mix of rural and urban areas, with a reasonable portion of households located in urban settings (between 20% and 80%). They are typically small or medium towns. The challenge in this group is to achieve diversion goals and provide efficient, cost effective recycling services to both rural and urban households.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

There are no Conditional Best Practices that apply to every program in this profile. Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables

- Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
- Optimization of operations in collections and processing
- Training of key program staff in core competencies required
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded promotion and education program
- Established and enforced policies that induce waste diversion

Program Planning and Design

Limited resources and the need to focus on priorities and be resourceful are main reasons to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling, as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Programs matching this profile can experience considerable benefits from multi-municipal cooperation. A **multi-municipal planning approach** will enable participating jurisdictions to evaluate opportunities to work together in making the most efficient use of limited personnel and equipment resources, to generate economies of scale, and to improve market leverage when contracting and moving recyclable materials into the marketplace. In addition, communities can collaborate to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. This is particularly important, as residents often relocate between neighbouring jurisdictions. A further benefit is the ability to develop contingency plans with neighbouring jurisdictions. This community group also offers considerable potential for multi-municipal cooperation beyond planning for collection, processing, and marketing. Aggregation of blue box tonnage will result in higher throughput, thereby lowering per-tonne net costs for all participating communities. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

Collection

Programs in the North are likely to have high transportation costs associated with getting recyclable materials to market. This, coupled with the low tonnage of materials available for recovery, warrants focusing recycling efforts on capturing Blue Box materials that are marketable and offer the greatest tonnage diversion opportunity.

Use of drop-off depots for recovering recyclables is a Best Practice **in low-density rural areas**, where curbside recycling is often cost prohibitive. It is more cost-effective to employ the use of depots in areas where curbside collection costs exceed $50 per-household per-year. **Curbside collection of recyclables should be provided to households in more urbanized areas**, where such service can be provided for $50 per household per-year or less. Even when curbside collection is provided, drop-off depots are the Best Practice to collect overflow Blue Box materials and additional recyclables for which curbside collection is not practical or cost-effective. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight. Best Practices for curbside recycling in jurisdictions of this profile type are discussed in the Collection section below. Additional information on curbside collection of a more general nature is provided in the corresponding Best Practice Spotlight.

Communities of this profile will likely have a small number of multi-family homes. **Recyclables collection should be provided to multi-family homes,** and the **collection should be incorporated into curbside collection service routes, wherever possible**, to minimize collection costs. Because of the unique challenges of multi-family recycling, associated best practices are further discussed in the corresponding Best Practice Spotlight.

To improve the economics of curbside recycling collection, it is a Best Practice to employ measures that increase the amount of material collected per stop and maximize collection efficiency. This is particularly important in areas of low-density population, as it is challenging to perform curbside recycling at an annual per-household cost below $50.

Providing sufficient rigid collection containers free of charge to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. Collection of Blue Box materials should be at least as frequent as waste collection.

The number of streams in which recyclables are collected will be dictated by the processing options available to the program as discussed in this and the following section. Single stream collection is an option that should only be considered by programs of this profile that are within about a two hour transfer distance of a single stream MRF (e.g., Greater Sudbury, Winnipeg). Collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers.

Programs that are within about a two-hour transfer distance of a two-stream MRF should consider collecting materials in two streams as collection costs can be reduced. As with single stream collection, compaction can also be used in two stream collection. Co-collection of waste and recyclables can also be adapted to two stream programs when homes are provided with an alternating collection schedule of Blue Box materials, where waste and fibres are collected one week, and waste and containers are collected the next week.

Opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include: the **use of increased commingling** where applicable and **reducing non-productive operator time**. These and other Best Practices are expanded upon in the corresponding Best Practice Spotlight.

Processing

Facilities that process less than 10,000 tonnes per year are not as cost-effective as larger facilities, and all programs with this profile should explore partnership opportunities to maximize the tonnes processed by existing MRFs, as they are well below that threshold.

Programs that are remote may have to process their own Blue Box materials. Processing costs can be managed by limiting the categories of Blue Box materials collected and sorting most materials at the curb. Processing equipment can therefore be low-cost and limited to a rudimentary sorting line (if required), materials handling equipment, and an inexpensive baler. Because the baler will not be robust, PET plastic bottles will not be able to be baled to a sufficient density to avoid additional freight costs or penalties. Therefore, a Best Practice is to purchase and use densifying equipment, such as a perforator or baler fluffer to perforate PET bottles, rather than remove caps by hand. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Small Urban Northern Blue Box Program

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Northern community
- Size of Program: Generating less than 10,000 tonnes per year
- Residential Density: More than 70 homes per km of roads (80% Urban)

Programs within this profile are urban cities. The challenge in this group is to maximize recovery, while providing efficient, cost-effective Blue Box service to all households, including those residing in multi-family units.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

There are no Conditional Best Practices that apply to every program in this profile. Several Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables
❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
❑ Optimization of operations in collections and processing

- Training of key program staff in core competencies required
- Following generally accepted principles for effective procurement and contract management
- Appropriately planned, designed, and funded promotion and education program
- Established and enforced policies that induce waste diversion

Program Planning and Design

Limited resources and the need to focus on priorities and be resourceful are the main reasons to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling, as part of an integrated waste management system, can be found in the corresponding Fundamental Best Practices section.

In many cases, programs matching this profile are likely to be business and population centres of their area. Therefore, program decisions will have a direct impact on the programs in surrounding towns and townships. A **multi-municipal planning approach** enables participating jurisdictions the opportunity to evaluate opportunities to work together to make most efficient use of limited personnel, improve economies of scale, and improve market leverage when contracting for services and marketing recovered materials. In addition, communities in a region can collaborate to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. Aggregation of blue box tonnage through shared use of one MRF will allow for the use of more effective and efficient processing equipment, and will result in higher throughput, thereby lowering per-tonne net costs for all participating communities. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

Collection

Programs in the North are likely to have high transportation costs associated with getting recyclable materials to market. This, coupled with the low tonnage of materials available for recovery, warrants focusing recycling efforts on capturing Blue Box materials that are marketable and offer the greatest tonnage diversion opportunity.

Given the high density of housing in communities having this profile **curbside collection is the best practice means of providing recycling service. Drop-off depots should be utilized to collect overflow Blue Box materials and additional types of recyclables, for which curbside collection is not practical or cost-effective.** Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

Communities of this profile will likely have a sizable number of multi-family homes. Recyclables collection needs to be provided to multi-family homes to achieve the province's goal of 60 percent diversion of Blue Box materials. **Recyclables collection should be provided to multi-family homes,** and the **collection should be incorporated into curbside collection service routes, wherever possible**, to minimize collection costs. Because of the unique challenges of multi-family recycling, associated best practices are further discussed in the corresponding Best Practice Spotlight.

To minimize curbside recycling collection costs, it is a Best Practice to **employ measures that increase the amount of material collected per stop and maximize collection efficiency**. **Providing sufficient rigid collection containers free of charge** to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection.**

The number of streams in which recyclables should be collected is discussed in this and the following section. Single stream collection requires significant capital investments in processing equipment. Programs of this profile do not recover sufficient tonnes to allow for such large capital investments, and, therefore, single stream collection is not a Best Practice for programs of this profile. An exception to this is programs that are within about a two-hour transfer distance of a single stream MRF (e.g., Greater Sudbury, Winnipeg). For those programs, collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers.

Programs that are not near Greater Sudbury should consider collecting materials in two streams if the combined regional tonnage would be approximately 10,000 tonnes per year (enabling construction of a regional two-stream MRF). Collecting materials two-stream allows collection costs to be reduced compared to curbside sorting of materials. As with single stream collection, compaction can also be used in two stream collection. Co collection of waste and recyclables can also be adapted to two stream programs when homes are provided with an alternating collection schedule of Blue Box materials, where waste and fibres are collected one week, and waste and containers are collected the next week.

If it is not feasible to construct a regional two-stream MRF, the preferred collection method would be to sort Blue Box materials at the curb.

Additional opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include: the **use of increased commingling**, where applicable and reducing **non-productive operator time**. These and other Best Practices are expanded upon in the corresponding Best Practice Spotlight.

Processing

Facilities that process less than 10,000 tonnes per year are not as cost-effective as larger facilities and all programs with this profile should **explore partnership opportunities to maximize the tonnes processed by existing MRFs**, as they are well below that threshold.

Programs that are remote may have to process their own Blue Box materials. Processing costs can be managed by limiting the categories of Blue Box materials collected and sorting most materials at the curb. Processing equipment can therefore be low-cost and limited to a rudimentary sorting line (if required), materials handling equipment, and an inexpensive baler. Because the baler will not be robust, PET plastic bottles will not be able to be baled to a sufficient density to avoid additional freight costs or penalties. Therefore, a Best Practice is to purchase and use densifying equipment, such as a perforator, or baler fluffer to perforate PET bottles, rather than remove caps by hand. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Program Profile

Medium Suburban Northern Blue Box Program

Overview

This Program Profile, paired with the Fundamental Best Practice and Spotlight summaries, is designed to provide general guidance to municipalities on how to design, manage, and operate their Blue Box programs under Best Practices. It is specifically tailored to programs of defined size, density, and geography in order to enhance applicability of Best Practices and increase the likelihood of their adoption.

Program Characteristics

The following characteristics were used to define this Program Profile:

- Geographical Region: Northern community
- Size of Program: Generating between 10,000 and 40,000 tonnes per year
- Residential Density: Between 10 and 70 homes per kilometre of roads (mixed urban and rural, or suburban)

Programs having this profile are major regional population centers that have a mix of urban, suburban, and rural homes. The diversity of housing densities and distribution of households over a large land area make it make it difficult to provide Blue Box recycling to all residents in a standardized and cost effective manner. The challenge in this group is to achieve diversion goals and maximize efficient, cost-effective recycling services to all residents, including those living in multi-family units.

Applicable Best Practices

Each of the Fundamental Best Practices listed in the table below applies to all Blue Box programs. These practices are introduced in the text below, and described in greater detail in the separate Fundamental Best Practice summaries.

Conditional Best Practices that apply to every program in this profile are also listed in the table. Several other Conditional Practices are best for some, but not all programs in this profile. These practices and the specific conditions under which they apply are discussed below. Leading practices are presented in bold type, for ease of reference. Additional guidance regarding practices that may be best under certain circumstances is also provided for consideration. Lastly, supplementary best practices guidance for specific program areas (e.g., collection, processing, depot and multi-residential recycling) can be found in the "Spotlight" summaries.

FUNDAMENTAL BEST PRACTICES – applicable to all programs
❑ Development and implementation of an up-to-date plan for recycling, as part of an integrated waste management system
❑ Multi-municipal planning approach to collection and processing recyclables

Use of Program Profile

This document is intended to provide general guidance, not detailed prescriptive recommendations, on how any given program should be structured.

The Project Team believes that by adopting Best Practices outlined in this document, recycling coordinators will improve the performance of their Blue Box program. However, the degree of improvement will vary across municipalities, as multiple factors contribute to overall program performance. Furthermore, more-detailed guidance may be needed by some communities to ensure that practices are truly implemented in a Best Practices fashion.

❑ Establishing defined performance measures including diversion targets and monitoring and a continuous improvement program
❑ Optimization of operations in collections and processing
❑ Training of key program staff in core competencies required
❑ Following generally accepted principles for effective procurement and contract management
❑ Appropriately planned, designed, and funded promotion and education program
❑ Established and enforced policies that induce waste diversion
CONDITIONAL BEST PRACTICES – applicable to programs fitting this profile
❑ Two stream collection and processing of Blue Box materials

Program Planning and Design

Limited resources and the need to focus on priorities and be resourceful are the main reasons to **maintain and implement an up-to-date plan for recycling as part of an integrated waste management system**. Such a plan will ensure a strategic management focus that, when combined with complementary waste reduction, organics, reuse, energy from waste, and waste diversion incentives (bag limits, user pay), will result in a robust Blue Box program. Additional elements of a plan for recycling, as part of an integrated waste management system can be found in the corresponding Fundamental Best Practices section.

Programs matching this profile are likely to be business and population centre of their area. Therefore, program decisions will have a direct impact on the programs in surrounding towns and townships. A **multi-municipal planning approach** will allow surrounding jurisdictions to work together to make the most efficient use of limited personnel, improve economies of scale, and improve market leverage when contracting for services and marketing recovered materials. In addition, communities in a region can collaborate to establish a common list of target materials and similar collection programs. This will create consistency among neighbouring municipalities, which facilitates public understanding regarding what and how to recycle. Additional discussion of the details of a multi-municipal planning approach can be found in the corresponding Fundamental Best Practices section.

Having a plan is of only limited benefit if there are no defined **diversion targets and performance measures, supported by data collection and analysis** that measure the effectiveness of the plan and its implementation. Performance measures and data to be obtained include monitoring of diversion amounts, conducting waste audits, and conducting participation studies. It is with such program monitoring that sound decisions can be made based on local program data, within a framework of a continuously improving the program. Additional discussion of performance measures and program monitoring can be found in the corresponding Fundamental Best Practices section.

Performance data, once obtained and analyzed, will allow for the **optimization of operations**. The benefits of optimization include balanced routes and payloads, reduced collection time (and therefore reduced collection costs), and less costly processing. Specific opportunities that apply to programs of this profile are further discussed in the Collection and Processing sections of this Program Profile.

Collection

Curbside collection of recyclables should be used to service all available curbside-eligible households in the community, supported by drop-off depots to provide access to recycling for residents in areas where density may not support curbside and/or to collect additional recyclable materials that are not collected curbside. It is more cost-effective to employ the use of depots in areas where curbside collection costs exceed $50 per household per year. Supporting Best Practices related to drop-off depots are discussed in the corresponding Best Practice Spotlight.

The urban portions of programs of this profile will likely have a sizable multi-family population. **Multi-residential recyclables collection should be integrated with curbside collection service wherever possible**. Because of the unique challenges of multi-family recycling, associated Best Practices are further discussed in the corresponding Best Practice Spotlight.

.**Providing sufficient rigid collection containers free of charge** to residents will ensure that overflow materials are not disposed. Selection of the size and/or number of containers needs to take into consideration estimated set out volume of recyclables, based on the frequency of collection. Most programs will provide weekly or bi-weekly collection of recyclables. **Collection of Blue Box materials should be at least as frequent as waste collection.**

Programs within this profile should **collect recyclables in two streams** (i.e., fibres and containers), with the possible exception of keeping glass separate as a third stream. Single-stream recycling is likely not warranted for programs of this profile, unless a regional MRF is to be constructed that would process tonnages near or above 40,000 tonnes per year (otherwise capital costs could negatively impact combined collection and processing cost-effectiveness).

Although a highly-capitalized single stream MRF normally requires a greater tonnage than is represented by this profile, single stream processing can be feasible if sorting is primarily manual and/or if single-stream collection provides significant cost savings over two stream collection (e.g., using carts and transitioning to bi-weekly service). From a processing perspective, single stream collection of recyclables is not preferred over two stream collection, because the processing cost per tonne and process residue rates will be higher at a single stream MRF compared to an equivalent two-stream MRF.

Collecting materials single stream allows other collection practices to be implemented that can significantly reduce the collection cost. One of these practices is **controlled compaction** that allows collection to be more productive because trucks can stay on route longer before filling. The compaction needs to be controlled so that the pressure is sufficient to achieve a reasonable amount of volume reduction, without over-compacting the materials. Over-compaction results in glass breakage and flattening of round containers, which can cause the automated systems in a single stream MRF to be less effective in separating flat paper products from round containers. Compaction can also be used in two stream collection; however, the per-household cost for collection in single stream systems is typically less than comparable two stream systems because materials can be loaded into a single stream truck in less time.

A second collection practice that is enabled by single stream collection is providing program participants with carts for their Blue Box materials instead of bins. The significantly greater storage volume of carts compared to bins means that overflow Blue Box materials are typically not discarded, although some exceptions may occur. The carts also allow for every-other-week collection of Blue Box materials, with reduced collection cost compared to weekly collection. The use of carts also allows for fully automated collection, in which a mechanical arm picks up and dumps the cart without the driver having to get out of the truck for the majority of stops. This can allow for collecting more stops per hour, yielding further cost savings. Because machinery is doing the heavy lifting, a more age and gender-balanced workforce can be used and WSIB claims are typically reduced. In areas where fully automated collection is impractical (e.g., due to obstacles impeding collection), semi-automated collection of recyclables in carts may be an option.

It should be noted that many of the practices that are enabled by single stream collection can be achieved by two stream systems that collect paper products and containers on an alternating week basis, including compaction and co-collection. Collecting on an alternating week basis does not mean that the MRF only processes paper products one week and containers the other week; rather it means that half the routes collect one material and the other half of routes collect the other material on any given day. This allows the MRF to be optimally sized. Because solid waste planners seek to optimize an entire integrated solid waste system, a single stream Blue Box system may be preferred over two stream if total system costs are reduced. Planners of programs similar to this profile should carefully develop their business case to evaluate which system best meets overall integrated system objectives.

Opportunities for improving collection efficiencies and reducing costs that apply to programs matching this profile include the **use of route optimization software** and **providing carts or dumpsters at multi-family complexes**. These and other collection optimization practices are more fully discussed in the corresponding Best Practice Spotlight.

Processing

Partnership and transfer opportunities should be seriously explored for all programs with this profile in order to maximize processing efficiencies and allow surrounding jurisdictions the benefits of delivering materials to the program's MRF.

Two-stream processing (fibres and containers) is most appropriate in this tonnage range. The size of programs within this profile allows for the construction of a MRF that is dedicated to the program and is capable of processing recyclables that have been collected in two streams: containers and fibres. The cost of single stream processing is greater than that of two-stream processing at the same capacity, and anticipated savings in collection are able to offset these processing costs only at high throughput tonnages. Other optimization strategies for MRFs are more fully discussed in the corresponding Best Practice Spotlight.

Training

Best Practices include **ensuring key program staff are adequately trained** in the core competencies required for each duty. This is discussed in detail in the corresponding Fundamental Best Practices section.

Procurement and Contract Management

Best Practices include following **generally accepted principles for effective procurement and contract management**. This is discussed in detail in the corresponding Fundamental Best Practices section.

A Best Practice that specifically applies to this profile is the **alignment of service contract lengths with equipment depreciation terms**. This practice is conditional on the program: (1) contracting with a service provider rather than using municipal staff; and (2) specifying that the service provider provide new collection equipment or design and build a new MRF. The reason for aligning the contract lengths with equipment depreciation terms is to ensure that the program doesn't fully pay for equipment that may have additional life at the end of the contract. In the case of MRFs, the term should be aligned with the first scheduled major overhaul of the plant's equipment. A suitably long term also ensures that equipment is installed that has a life cycle cost advantage that may not be realized by the contractor over a shorter operating period.

Promotion and Education

An **effective promotion and education (P&E) program** leads to higher resident participation rates, improved material quality, lower residue rates, and increased customer satisfaction. A variety of P&E strategies can be employed by municipal programs to achieve desired program goals, as described in the corresponding Fundamental Best Practices section.

Furthermore, to increase program effectiveness, municipalities may need to coordinate P&E activities with their neighbours. Multi-municipal P&E enables participating communities to have a common list of target materials and similar collection programs in neighbouring jurisdictions. When combined with the availability of mass media for programs of this profile, a multi-municipal mass media campaign can be employed that allows for consistent promotion of messages, as residents continually relocate between neighbouring jurisdictions.

Policies and Incentives

In order to achieve the 60% diversion target set by the Province, programs in this category will need to **use incentives and policies that promote waste diversion**. Such tools may include solid waste bag limits, user pay program for waste, and/or enforced mandatory recycling bylaws. Each community needs to evaluate its waste diversion plans and initiatives to determine the right balance of economic and non-monetary incentives. A detailed discussion of policies and incentives that, when established and enforced, serve to induce waste diversion can be found in the corresponding Fundamental Best Practices section.

Diffusion of Best Practices

This section outlines suggested next steps and the use of E&E Fund in promoting and diffusing Best Practices province-wide.

Next Steps for Best Practice Diffusion

To help continue the adoption and diffusion of Best Practices, the Team developed a number of suggestions related to the implementation and continuous improvement of practices outlined in this document and individual community reports.

Implementation Plan

For **municipalities that received a customized report** with opportunities for improvement, follow up activities need to be conducted in order to track progress and facilitate implementation of Best Practices. First, a debrief with program staff may be necessary to understand whether:

- Timelines are reasonable
- Opportunities are prioritized correctly
- Sufficient implementation resources exist

This follow up process needs to take place over the first six months after the receipt of the opportunities for improvement report. A post-report survey may also be helpful in gauging the receptivity of the municipality to the contents of the report.

Then, an ongoing dialogue process may be required to help identify barriers to implementation, resolve issues, and provide feedback on direction and progress.

For those **municipalities that didn't receive an individual report**, the results of this project need to be conveyed in a clear and accessible way. This may entail the creation of interactive tools, such as a Decision Tree and Program Profiles, on the Internet (e.g., Knowledge Network, WDO website, Stewardship Ontario website). Posting of background documents, gathered by the project team, may also be helpful in informing municipalities of the content that led to formulation of Best Practices. A guide on the use of these tools would be required.

For **smaller resource-constrained communities**, a Best Practices toolkit may need to be created to assist in understanding, embracing, and implementing Best Practices. This toolkit would contain:

- A Best Practices Checklist, with detailed descriptions of Best Practices and direction on how to implement them
- Templates for key program documents, such as the Master Plan

- Examples of good practices in action, including material audit documents, continuous improvement processes, effective procurement materials, etc.
- Opportunities for Improvement reports from similar communities, if programs elect to make them available for sharing

Regional workshops on Best Practices, explaining the results of this project and the applicability to programs, may help all Ontario communities.

The **audience** for this document and other work products of this project is diverse. Due to the vast array of stakeholders, the expectations of and perspectives on this report may differ drastically among different audiences. The following stakeholders need to be considered in developing communication materials:

- Senior, mid-level, and junior municipal program staff
- Municipal elected officials
- Stewards
- Ministry of the Environment
- Private Contractors
- Residents
- Media outlets

The **messaging** surrounding the distribution of work products of this project may need to differ, depending on the audience receiving them. Similarly to the way Volvo instantly connotes "safety", the positioning of this and other documents needs to be defined, and may be altered for different stakeholders. Positioning may highlight the following elements:

- Environmental Focus
- Program Optimization
- Industry Insight
- Waste Diversion
- Cost Reduction
- Continuous Improvement
- Helpful Guidance

These change management techniques may need to be augmented by developing a clear relationship between the adoption of Best Practices and funding received by the program. Team's observations indicate that funding is a powerful driver of change in the industry; therefore, diffusion of Best Practices may, to a large degree, depend on the municipalities' understanding that funding will be affected (positively or negatively) by the progress made in implementing Best Practices.

Continuous Improvement Mechanisms

To help sustain the momentum of Best Practice implementation and use, municipalities need to employ Continuous Improvement processes in their recycling programs. A culture of Continuous Improvement will help programs reach their operational, financial, and diversion goals faster and more cost-effectively. Leveraging existing Continuous Improvement programs from their own municipality or from programs that have effective Continuous Improvement processes will likely yield good results.

Opportunities for critically assessing program structure and performance arise quite frequently. These include annual events or significant milestones, such as:

- Contract renewal and tendering
- Program budgeting
- Datacall submission
- Program audits – financial and operational

In evaluating program performance and considering changes, municipalities need to ask the following questions:

- Have program cost gone up or down?
- Have diversion rates changed?
- What other changes took place?
- What are the causes of these changes?
- What new Best Practices have been identified and published
- Are current Best Practices still relevant?
- What are the new technologies entering the industry?
- Has the Program Profile (as defined by the Decision Tree) changed due to tonnage and density changes?
- Has political will or direction changed, and how will the program be influenced?
- What changes my neighbours have made?
- Does the program have sufficient skills and resources to continue achieving set targets?
- Are program targets still relevant?

Continuous Improvement also entails the search for new Best Practices. The Team estimates that the implementation of Best Practices detailed in this report may take up to three to five years on an industry-wide basis. During that time, ongoing monitoring and evaluation of Best Practice diffusion may be necessary. After three to five years, a review of changes in industry and changes in practices employed by municipal programs may be required in order to identify new Best Practices in Ontario Blue Box Recycling.

E&E Fund Options for Diffusing Best Practices

Approach to Identify E&E Fund Options

The Project Team reviewed the existing E&E Fund program structure and history, and queried the full project team to obtain their input on how to best use E&E funds to diffuse Best Practices. In addition, a workshop with municipal leaders in recycling was held to gather feedback on project deliverables and discuss potential uses of the E&E fund. During each work session, funding needs were identified, followed by a discussion on actions to be taken in addressing the identified needs. Findings with respect to program needs and specific ideas on the use of E&E funds resulting from these workshops are presented below.

Program Needs

The following is a summary of needs identified in the two sessions:

- Training – province-wide training existed in the past, but it is no longer offered
- Coordination between programs - there appears to a lack of an overarching vision across the province for program coordination
- Northern support – networking and communications are crucial to improving program performance and multi-municipal collaboration
- Standardization of programs – current improvement efforts appear to be focused on tweaking existing programs as opposed to aiming to standardize programs to a common set of materials, processes, and policies
- Leadership – greater leadership may motivate and sustain change
- Additional resources – some programs may lack staff or funding to implement Best Practices
- Marketing knowledge and expertise – information on marketing prices, contacts, companies appears to be fragmented
- Sharing of information among programs Province-wide – industry and program specific information appears to be scattered and isolated
- Additional Datacall training – some program coordinators may not have the adequate degree of knowledge to accurately complete the WDO Datacall

E&E Fund Options

Based on the identified needs, the Team formulated a number of options on how to use E&E Fund resources. These are ideas on potential projects and activities; further evaluations should be conducted to assess the practicality and cost-effectiveness of these projects/activities. Options are presented below, in no particular order:

1. **Training workshops on Best Practices**

Training workshops on the results of this project and adoption of Best Practices could be held at various locations across the Province. A certification program could be created for recycling coordinators to ensure programs are operated by skilled and knowledgeable staff. WDO Datacall training could be integrated into these sessions or could be provided for in separate workshops.

2 Northern support resource

Northern municipalities may benefit from a dedicated recycling specialist who would provide guidance and support to local programs.

3 Workshops by program profile to promote results of this project

Training sessions oriented around Best Practices Program Profiles could be held in various regions, to communicate specific and relevant information to programs matching a given profile. Municipal and steward team members could help facilitate these sessions, aimed at program coordinators, politicians, and private contractors, among others. Development of an electronic, web-based version of the Decision Tree and resource library will help guide municipalities to their respective profile.

4 Development of a tool to gather, maintain, and share recyclable materials and marketing information

A database containing information on commodities, market prices, and buyers could be developed to enable municipalities to maximize their revenues. This would provide transparency and efficiency to an otherwise segmented and siloed industry. Information on marginal, non-mainstream products may be of greatest value to program operators.

5 Overcoming Supply/Market Barriers

E&E resources could be used to analyze the supply and demand of various commodities, identify barriers to enhancing the end use of commodities, and develop strategies to overcome the identified barriers. Regional, provincial, and macroeconomic issues will need to be considered as part of the barriers identification, assessment and strategy development process.

6 Centralized Province-wide procurement portal

A web-based procurement portal could be created to list upcoming and current tenders and RFPs issued by municipal programs. The portal could include service levels and clauses, winning bids and non-winning bids, and actual public contracts, if available. The portal would be aimed at increasing competition and making the market more transparent and efficient.

7 Standardized P&E content

A fully accessible repository of standardized Promotion and Education materials could be developed for use by program operators. The collection of P&E materials could include:

- Graphics and Images
- Wording

- Formats
- Messaging
- Branding

In addition, a centralized P&E campaigns could be launched to supplement P&E performed at the local level.

8 Centralized route optimization

WDO could procure route optimization software centrally, for shared use of multiple municipalities. A centralized approach may reduce costs associated with procuring the software solution by individual municipalities.

9 Regional resources for Southern Ontario municipalities

Adoption of Best Practices by Southern Ontario municipalities may be facilitated by employing full or part-time regional resources. These individuals will have a broader perspective on a number of neighbouring municipal programs, allowing for synergies to be obtained though service standardization and joint processing, marketing, and P&E efforts.

10 Ongoing program run by a centralized information management entity

Development of a centralized information management entity would ensure that information on Blue Box recycling in Ontario is relevant, updated, and easily accessed. Information could include industry benchmarks, studies, links, contacts, and other helpful resources.

E&E Fund Strategy Recommendations

Subsequent to the team and municipal stakeholder workshops, and in response to MIPC feedback, the Project Team supplemented the above findings with the following additional ideas and recommendations.

The stated purpose of the E&E Fund is to reduce the cost of Blue Box programs (enhance program efficiency) and increase the tonnes recovered (enhance program effectiveness). More specifically, the consulting team recommends that E&E funds be utilized to induce improvements in net system efficiency and increasing cost-effective Blue Box materials diversion. Funding should be allocated/ applied in areas where the greatest opportunity to boost recovery and lower costs exists. However, in support of the Blue Box Program Plan, it is also important to provide information and assistance to aid smaller Ontario communities in complying with the Waste Diversion Act and meeting Blue Box program tonnage diversion goals. Furthermore, there is benefit in having a balance of proactive and reactively-determined projects, to foster innovation and continuous improvement.

Given the limited nature of E&E funding, care should be taken to use the available funds strategically. Provided below are specific recommendations of this nature:

- Focus funds on overcoming primary barriers or constraints impeding materials recovery and recycling or contributing to higher program costs, where intervention in the marketplace is deemed both appropriate and able to produce measurable results. This will, of course, require determination of the key barriers and constraints and what is an appropriate market intervention strategy.

- Avoid funding activities that would occur without use of any E&E dollars.
- Seek opportunities that are cross-commodity in nature, thereby boosting recovery and lowering system costs for multiple commodities, as opposed to only specific commodities.
- Seek opportunities that have Province-wide or regional benefits, as opposed to those that only benefit individual jurisdictions.
- Choose the least-cost method of overcoming the targeted barrier or constraint. Often this entails provision of technical or facilitation assistance, as direct allocation of money is typically the most expensive option.
- Use E&E funds to serve as a catalyst to spur further investment by other parties. This is particularly important when cash is to be allocated directly.
- Use E&E funds as a continuous improvement tool assisting in the evaluation of technologies and processes that have the potential for overall system improvements. This may include partial capital funding for specific technologies with more of the funds allocated towards the research/demonstration portion. With respect to this use of funding, it will be important to discern between R&D related to new technology (not recommended) versus testing/demonstrating new applications of existing proven technology (a more appropriate use of E&E funds). For example, E&E funding could be used to research and/or test the applicability of using optical sorting equipment to handle different plastics mixes. This technology is proven with respect to handling bottles, but information is currently lacking regarding its effectiveness in handling a wider variety of plastic packaging.
- The consulting team sees merit in the use of E&E funds for MRF rationalization purposes. Individual local governments are generally not inclined to spend local dollars to build more costly infrastructure so that regional benefits can be achieved. In addition, programs are reluctant to become dependent on the use of facilities that are owned and operated by other jurisdictions. Given this, intervention in the marketplace to spur regional processing capacity development and/or enhancement (without duplicating existing infrastructure and in ways that would generate measurable results) could be beneficial and appropriate, assuming sufficient funding were available. The consulting team was unable to determine what amount of funding that would be appropriate and effective in implementing the above, under the scope of this project

Again, a strategic approach to using E&E funds entails the use of appropriate, least-cost mechanisms to overcome the key barriers and constraints limiting Blue Box program effectiveness and efficiency. Many mechanisms, such as procurement assistance and training, do not involve direct provision of funding.

Appendix A: Visited Municipal Programs

PROGRAM TITLE	MUNICIPAL GROUP	Applicable Decision Tree Profile
HAMILTON, CITY OF	Large Urban	Suburban Medium South
LONDON, CITY OF	Large Urban	City Medium South
PEEL, REGIONAL MUNICIPALITY OF	Large Urban	Suburban Large South
TORONTO, CITY OF	Large Urban	City Large South
YORK, REGIONAL MUNICIPALITY OF	Large Urban	Suburban Large South
DURHAM, REGIONAL MUNICIPALITY OF	Urban Regional	Suburban Large South
ESSEX-WINDSOR SOLID WASTE AUTHORITY	Urban Regional	Suburban Medium South
HALTON, REGIONAL MUNICIPALITY OF	Urban Regional	Suburban Medium South
NIAGARA, REGIONAL MUNICIPALITY OF	Urban Regional	Suburban Medium South
OTTAWA, CITY OF	Urban Regional	Suburban Large South
WATERLOO, REGIONAL MUNICIPALITY OF	Urban Regional	Suburban Medium South
PETERBOROUGH, CITY OF	Medium Urban	City Small South
THUNDER BAY, CITY OF	Medium Urban	City Small North
CORNWALL, CITY OF	Small Urban	City Small South
ORILLIA, CITY OF	Small Urban	City Small South
BLUEWATER RECYCLING ASSOCIATION	Rural Regional	Rural Medium South
CHATHAM-KENT, MUNICIPALITY OF	Rural Regional	Suburban Small South
KINGSTON, CITY OF	Rural Regional	Suburban Medium South
MUSKOKA, DISTRICT MUNICIPALITY OF	Rural Regional	Suburban Small South
NORTHUMBERLAND, COUNTY OF	Rural Regional	Rural Small South
PETERBOROUGH, COUNTY OF	Rural Regional	Suburban Small South
QUINTE WASTE SOLUTIONS	Rural Regional	Suburban Medium South
SIMCOE, COUNTY OF	Rural Regional	Suburban Medium South
WELLINGTON, COUNTY OF	Rural Regional	Suburban Small South
OTTAWA VALLEY WASTE RECOVERY CENTRE	Rural Collection - South	Rural Small South
RUSSELL, TOWNSHIP OF	Rural Collection - South	Suburban Small South
SOUTHGATE, TOWNSHIP OF	Rural Collection - South	Rural Small South
KIRKLAND LAKE, TOWN OF	Rural Collection - North	Suburban Small North
TIMMINS, CITY OF	Rural Collection - North	City Small North
AMARANTH, TOWNSHIP OF	Rural Depot - South	Rural Depot
CARLING, TOWNSHIP OF	Rural Depot - North	Rural Depot
COCHRANE TEMISKAMING WASTE MANAGEMENT BOARD	Rural Depot - North	Rural Depot

Appendix B: Table of Contents of a Sample Program Report

Executive Summary

Current State of Your Blue Box Program

Program Description

Data Call Information and Quantitative Analysis

Observations and Qualitative Analysis

Process Map – Collection

Process Map – Processing

Future State

Applicable Best Practices

Opportunities for Improvement

Implementation Roadmap

Implementation Timelines

Implementation Requirements

Appendix

Current Collection Area

MRF Centralization

Total Content: 15-25 pages

General Resource Assessment

for Community-Owned Biogas in the Kawartha Region

May 2011

ReGenerate

Empowering Ontario to develop community-owned biogas systems

This study has been developed to identify the farms most suitable for the development of community-owned biogas plants in Peterborough County and the City of Kawartha Lakes, together comprising the Kawartha region. A study of Peterborough County was initially commissioned by the Peterborough Green Energy Co-op in 2010; this report is an expansion of the original study.

Goal of the Study

The goal of this study is to uncover the source and quantity of organic waste production around the region, which would allow for the development of biogas plants at individual farms, or clusters of farms working together.

Each of these farms would combine their manure and silage with off-farm waste streams like food waste, fats, oils and greases, and yard waste to make **up to 499 kilowatt (kW) of generating capacity** – allowing them to meet their energy needs independently through on-farm generation of heat and power, or the sale of electricity to the provincial grid through Ontario's Feed-in Tariff (FIT) program.

Overview

Ideal projects are located on farms and fall under the Nutrient Management Act, avoiding the lengthier and more costly processes of a Renewable Energy Approval (REA) for power generation, or a Certificate of Approval for waste management sites.

Preliminary research identified **12 locations with potential to host a community-owned biogas plant**. These are the 'low-hanging fruit': each has enough manure production on-site or within a 5 km radius to host a 100 kW, 249 kW or 499 kW plant, and most are located in close enough proximity to an appropriate electrical distribution line to make the connection costs feasible.

It should be noted that while this is a fairly comprehensive survey of farms in the area, it is not exhaustive. There are more dairy and chicken operations in the region than are shown in the maps provided, and from these maps only select sites are discussed. Farm sizes are approximate estimates, based on discussions with members of the local community. More precise information for various sites can be collected as individual projects are pursued.

This General Resource Assessment (GRA) is the first step toward the development of multiple farm and community-owned biogas plants, generating power for on-farm use and/or sale to the grid.

Description of the Region

Peterborough County is very large geographically; however, not all its land is suitable for agriculture, and most farms are located in Cavan-Monaghan, Douro-Dummer, Otonabee-South Monaghan, and Smith-Ennismore-Lakefield. The total population of the County is currently 133,000, and is expected to grow to 149,000 by 2031, according to the province's 'Places to Grow' projections.

Two different local distribution companies serve the region– Peterborough Utilities Corporation serves the city of Peterborough, Asphodel-Norwood and Lakefield, while Hydro One serves all other areas.

Residential organics collection was piloted in Bridgenorth in 2006, and there is interest in expanding the program, pending the outcome of a current waste management master planning process. The County also has collection containers for organics at 3 waste sites (Buckhorn, 6th Line Havelock, and Hall's Glen) – with approximately 100 tonnes per year collected from the Bridgenorth curbside program and the 3 transfer sites. The County estimates that approximately 30% of the total waste produced by private residences is organics, with a householder participation rate estimated at 30%. Based on these rates, **approximately 2,000 tonnes annually** could be available for biogas plants, if organics were collected across the County.

The City of Kawartha Lakes is a single-tier municipality replacing the former Victoria County and its lower-tier municipalities, amalgamated in 2000. The current population is approximately 75,000 with growth to 96,000 projected by 2031. The municipality is primarily rural, with the agriculture and the agri-food sectors being major contributors to the City's economy. Beef and dairy farming predominate, as well as mixed livestock farming. Hay is the largest single crop grown.

Kawartha Lakes council has stated a commitment to the principle of "environment first" and support for renewable energy and green technologies through such measures as the Green Hub Community Improvement Plan.

The collection of residential organics has been piloted in the municipality of Fenelon Falls, commencing in 2006 with 200 households, and expanding through 2011. The program has had good citizen response and diversion rates, but will end this year with the closure of the current composting site. The municipality estimates organics at 33.5% of the waste stream; assuming a householder participation rate similar to that of Peterborough County, **approximately 1,100 tonnes annually** could be available from City-wide organics collection.

Across the region, dairy farming is the most economically important agricultural sector, as measured by cash receipts for main commodities in 2009 – dairy was the highest at $38 million, followed by cattle and calves at $21 million. Poultry was fourth (after soybeans) with cash receipts of $14 million out of a total of $162 million for all commodities.

Biogas Resources

Focusing on livestock operations, the most applicable to biogas production are dairy, poultry, and hog farms – this is due to the ease of manure collection. As of the 2006 census of agriculture, there were a total of **218 of these farms in Peterborough County and the City of Kawartha Lakes combined**; **151 dairy, 54 poultry and 17 hog farms.**

Peterborough and Kawartha Lakes do not host any of Ontario's largest dairy producers; most of the dairy producers are small to medium operations (25-70 milking cows) and **the average size across the region is 55**. The number of very large dairy producers (those with greater than 300 nutrient units[1] of manure to manage, roughly equivalent to 200 head) is less than a dozen.

For smaller farms, creating clusters of manure and crop silage producers is an attractive option for biogas production. There are currently about 500 producers of suitable crops around the region, some of which are also dairy operations.

The Biogas Process

Biogas plants are systems that use a bacteriological process called anaerobic digestion to convert organic waste into biogas. Biogas is a clean energy source that may be converted to electricity and heat or piped into the natural gas grid.

Waste (in this case manure, silage and food waste) is fed into an oxygen-free vessel where it is stirred and heated for 10-40 days, producing a mixture of methane (60%) and carbon dioxide (40%) – biogas. The gas is either used onsite or piped elsewhere. The digestate is either stored in a lagoon for land application, or dewatered and turned into other products like fertilizer and animal bedding. The **process is continuous** and only requires that the waste keep coming and that the ingredients be generally consistent.

By converting waste into energy, **biogas plants reduce odours and pathogens, produce a high-quality fertilizer** (which has been shown to produce better yields than commercial fertilizer[2]) **and reduce greenhouse gas emissions,** while also **producing power 24 hours a day, 7 days a week.**

Biogas production also has the greatest impact on the food production cycle – it creates **additional revenue streams for farmers**, and creates an **organic fertilizer** free of weed seeds, reducing the need for herbicides. Its added advantages of safely **returning nutrients to the soil** and managing organic waste in an environmentally beneficial manner sets biogas apart from other renewable energy sources.

Profitable on-farm anaerobic digestion can offer practical and sustainable solutions for **nu-**

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[1] OMAFRA measurement. 2 Holstein heifers = 1 nutrient unit (NU). 0.7 milking cows = 1 NU. 6 finishing hogs = 1 NU. 150 chicken layers = 1 NU.

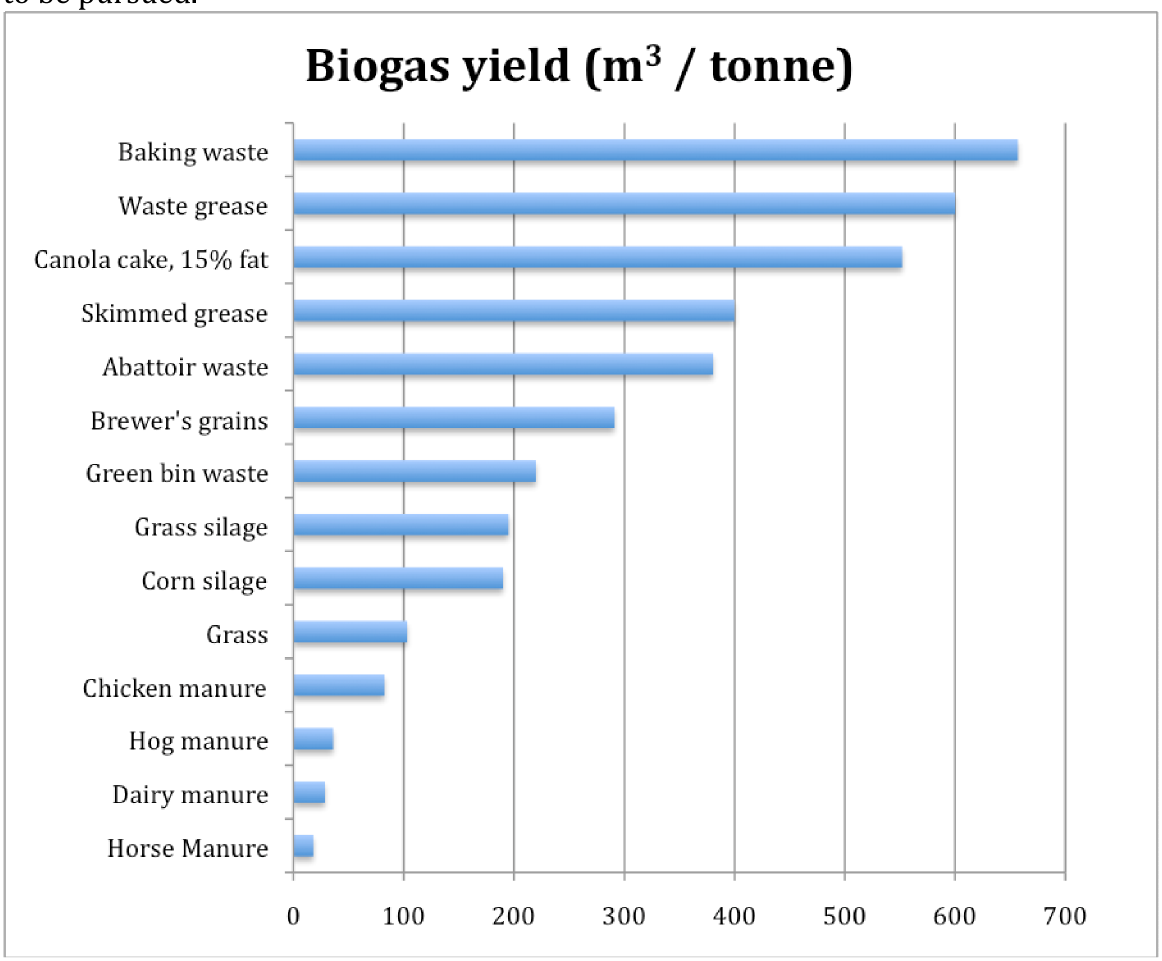
[2] 'Methane Recovery from Animal Manures: The Current Opportunities Casebook'. Lusk, Philip. Department of Energy, National Renewable Energy Lab (DOE/NREL), 1998.

trient management. While it is not a lone solution for all manure management issues, it can be a valuable tool for meeting nutrient management requirements while also generating revenue.

Anaerobic digestion is a **mature and proven technology** that is providing solutions to energy supply and environmental concerns. Worldwide, Germany is the market leader with over 6,000 on-farm anaerobic digesters generating more than 2,300 MW of clean power.

Potential Feedstock Sources

Biogas feedstocks can include any organic waste stream, but each has its own pros and cons. For example, **the simplest one to use is livestock manure because it is produced at a regular, continuous pace and is consistent in make-up**. However, using only manure for a grid—connected power generation project is for the most part not economically feasible at the current time, due to its **low energy value**. Other agricultural waste like silage and off-farm sources like food scraps and 'FOG' (fats, oils and greases), which have a much higher energy value per tonne, are generally needed if a FIT contract is to be pursued.



Source: OMAFRA

- Dairy manure – balanced carbon/nitrogen ratio, low energy value, simple manure collection process
- Chicken manure – high levels of nitrogen require additional carbon-rich feedstock (crop silage, wood waste, paper, etc.), highest energy value among manures, simple manure collection process
- Horse manure – balanced carbon/nitrogen ratio, very low energy value
- Food scraps (known as Source Separated Organics or SSO) – high energy value, requires sorting, less consistency
- Fats, oils and greases (FOG) – very high energy value, requires pasteurization before adding to the digester, readily available now, but potential long term supply issues
- Crop silage – above average energy value, carbon-rich, requires shredding, seasonal availability
- Yard waste – similar to Crop Silage, with lower energy value
- Wastewater biosolids/septage – steady supply, low energy value, requires additional treatment
- Bakery waste – high energy value, limited availability
- Abattoir waste - high energy value, requires additional treatment, limited number of abattoirs province-wide due to strict regulations

In order to comply with the Nutrient Management Act, on-farm biogas systems must be taking in a maximum of 25% off-farm waste, and half of the 75% agricultural waste must be manure. This means the availability and use of crop silage from corn and grasses is an essential part of making many projects viable.

Community-owned Biogas

As is often the case in these situations, not many individuals are so enthusiastic to bear all the risk themselves, but are still enthusiastic about the technology and the environmental benefits. Community-owned biogas is about sharing the risk and the returns with friends and neighbours through a co-operative or limited partnership (LP) ownership structure.

All of the identified projects could be developed by the individual farmers themselves or by the numerous commercial developers who are now operating in the Ontario market. However, if the farmer or the community do it on their own, they are eligible to receive a bonus 0.4¢ per kilowatt hour (kWh) called a 'community adder'. Commercial projects are not eligible to receive this adder.

Some of the benefits of community power include:

- Shared risks and returns
- An **extra 0.4¢/kWh** community adder
- Eligibility for development grants from the Community Energy Partnership Program (**up to $75,000**) and the Green Municipal Fund* (**up to $350,000**)
- Eligibility for **low interest loans** from the Green Municipal Fund* and Infrastructure Ontario*
- **Greater community control over scale** and nature of operations
- **Lower land lease costs** (3% vs. 6% of revenue)
- Improved understanding in the community leads to **faster permitting process**

** Funds only eligible to municipalities, municipally owned corporations and partnerships with municipalities.*

This model has been proven with other technologies around Ontario, most notably wind and solar, and **farmers have expressed interest in sharing waste and risk**, providing stronger support for the potential of community-owned biogas.

The targeted financial structure will be **60% debt, 40% equity**. In each case, grants will fund the early development costs and the equity will be provided by the farmer, his neighbours and/or a community financing group. Farm Credit Canada, the Green Municipal Fund, Infrastructure Ontario, or local credit unions and commercial banks can provide the debt.

Although it requires more effort, there are distinct benefits to partnering with the municipality – primarily low interest rates, a strong credit rating and eligibility for some of the grant funding noted above. The municipality gets an ownership stake and a long-term cash flow, while the other equity holders obtain higher returns. This arrangement is also positive for the local economy as more funds stay within the region than if borrowing from a commercial bank. Borrowing from a local credit union is also positive for the local economy.

There is another option for small and medium-sized operators, or those located at larger distances from the electrical grid, to develop a biogas project at a smaller scale. This micro-digester supplies gas to meet on-farm energy needs, but does not generate electricity for sale to the grid. The benefits in this case are greater energy independence, and avoided heating and power costs. *The capital costs are recouped through energy savings.*

Financial Projections

At current prices offered and the regulatory structure of the market, the most feasible projects are either 249 kW or 499 kW.

Generator Size (kW)	**FIT Rate (¢/kWh)**	**Grid**	**Capacity Exempt**
100	19.9	1-phase or 3-phase	Yes
249	18.5	3-phase	Yes
499	16	3-phase	Yes*

*only capacity exempt on line voltages larger than 15kV

	100 kW	**249 kW**	**499 kW**	**On-farm micro-digester**
Power Sales	$165,000	$390,000	$650,000	n/a
Tipping fees	$26,000	$45,000	$102,000	n/a
Energy savings				$28,000
Operating Expenses	$65,000	$130,000	$230,000	$3,000
Lease Paid to Farmer	$5,000	$12,000	$20,000	n/a
Net Income	$120,000	$290,000	$500,000	$25,000
Capital Cost	$850,000	$1,650,000	$2,500,000	$200,000
Simple Payback	7 years	5.6 years	5 years	8 years

The above estimates are based on a generator availability of 90%. Lease payments to the farmer for a community-owned plant are estimated at 3% of annual revenue.

Projections for electrical generation projects do not include revenues from the sale of carbon credits and fertilizer. For these projects, the Ontario Power Authority keeps the carbon credits as part of the FIT contract, and it's assumed that all digestate would be returned proportionately to the manure producers. The projections also do not include heat savings, which could potentially be realized and would increase returns on investment.

Projections for the on-farm micro-digester include monthly savings, as these are the main driver of payback time. In this scenario, the farmer would be able to keep any carbon credits, which may potentially increase in value over time.

Plant Size Projections

The following are examples of plant sizes that could be built with various feedstocks, using conversion factors from OMAFRA.

To produce enough biogas to power a **100 kW engine**, one would need:

- 1,100 tonnes of dairy manure (approximately 45 cows), 1,100 tonnes of corn or grass silage, 750 tonnes of food waste/FOG
- 850 tonnes of chicken manure (app. 28,500 broilers), 850 tonnes of crop silage, 550 tonnes of food waste/FOG

… A **249 kW engine**:

- 2,500 tonnes of dairy manure (app. 100 cows), 2,500 tonnes of corn or grass silage and 1,650 tonnes of food waste/FOG
- 2,200 tonnes of chicken manure (app. 74,000 broilers), 2,200 tonnes of corn or grass silage and 1,350 tonnes of food waste/FOG

… A **499 kW engine**:

- 5,000 tonnes of dairy manure (app. 200 cows), 5,000 tonnes of corn or grass silage and 3,300 tonnes of food waste/FOG
- 2,500 tonnes of dairy manure (app. 100 cows), 2,500 tonnes of chicken manure (app. 85,000 broilers), 5,000 tonnes of corn or grass silage and 2,750 tonnes of food waste/FOG
- 4,500 tonnes of chicken manure (app. 150,000 broilers), 4,500 tonnes of corn or grass silage, 3,000 tonnes of food waste/FOG

…An **on-farm micro-digester** to reduce reliance on external energy supply:

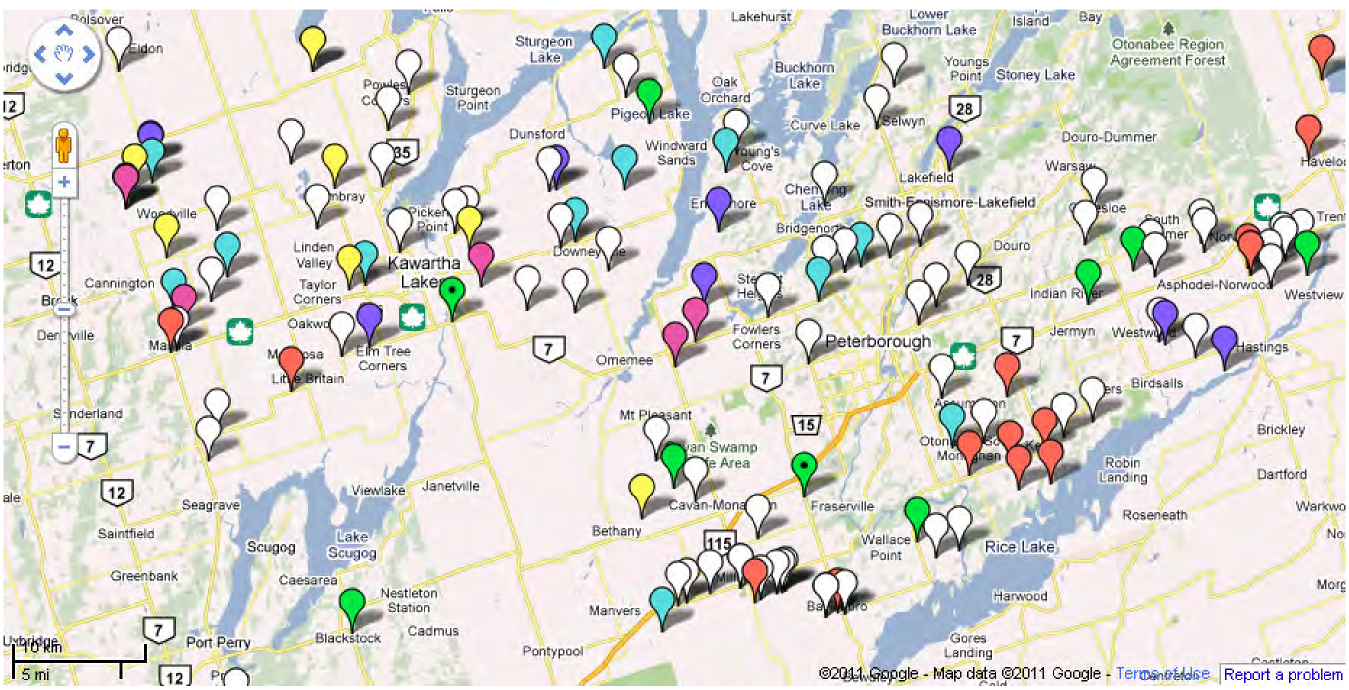
- 2,500 tonnes of dairy manure (app. 100 cows), no additional inputs required.

Potential Projects

This section outlines farms or clusters of farms that may potentially be good candidates for a biogas plant. The first image shows an overview of the rural areas of Peterborough County and the Kawartha Lakes. Images following show, at a larger scale, the areas within which potential sites are located. Only a few of the potential sites have been highlighted and described here.

The place markers are colour coded in the following manner:

Purple = dairy farm, greater than 100 head
Pink = dairy farm, 60-100 head
Light Blue = dairy farm, 40-60 head
Yellow = dairy farm, less than 40 head
Red, no dot = poultry farm
Green, no dot = hog farm
Green, with dot = other
White = dairy farm, size unknown

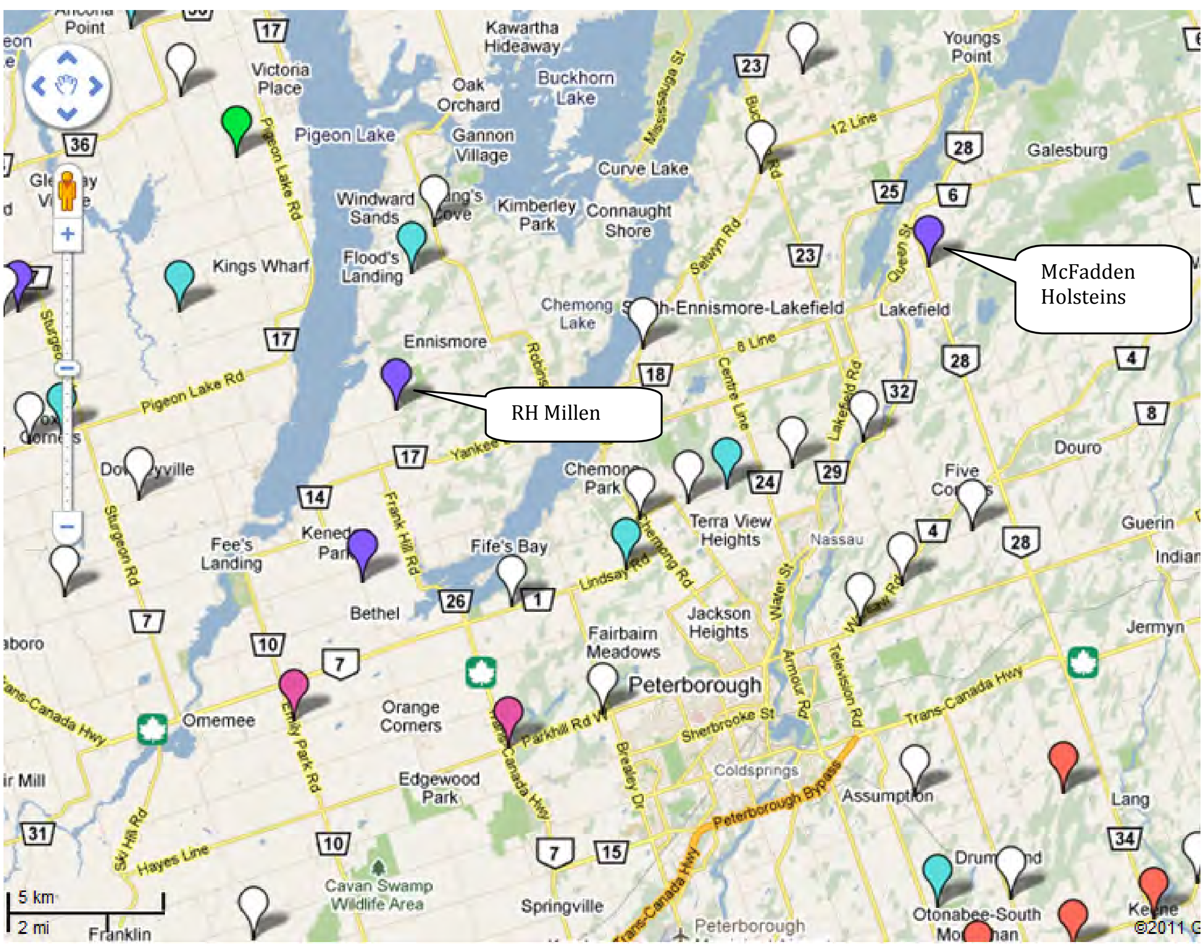


- **Three Roads Farm, Mathers Corners**. A large poultry operation with a couple of other chicken farms within 5 km along Duncans Line. This site is located along an 8.3 kV 3-phase distribution line, limiting potential generating capacity to 249 kW. A 44 kV line is located 2.4 kilometers away, which would increase the potential generating capacity to 499 kW. In addition, the three chicken barns would make use of waste heat from the generator in the winter, saving the farm money and fossil fuel use.
  - From this farm's manure alone, combined with corn or grass silage and FOG, **499 kW could be produced**. In this case, connecting to the higher voltage lines would cost $432,000, so it may not be economically feasible to pay to connect. Further investigation is needed, but a minimum of 249 kW can be produced.

- **Sunwold Farms, Indian River**. A hog farm with greater than 300 nutrient units (at 6 finishing hogs per NU, this translates to approximately 1800 hogs). This site is located along a single-phase distribution line, limiting its potential capacity to 100 kW. A 44 kV 3-phase distribution line, suitable for 499 kW of generating capacity, is 750 m away.
  - From this farm's manure alone, combined with corn or grass silage and FOG, **at least 315 kW can be produced**. Additional waste will be needed from farms within a 5 km radius, but in this case it may be worthwhile to pursue the larger 499 kW project and pay approximately $135,000 to connect.
  - The farm could also forego connecting to the electrical grid, and instead install an **on-farm micro-digester** to offset the farm's gas needs (for chilling units or local heating needs), thereby reducing monthly energy costs.

- **Kawartha Downs Raceway, Fraserville**. The racetrack has its own permanent stables (50-60 horses) and hosts more horses on race nights (up to 150); there are numerous small stables in close proximity, and food service onsite. Kawartha Downs has access to 44 kV 3-phase distribution lines, suitable for 499 kW of generating capacity. Horse manure, however, is not very energy rich, so collecting manure from farms within a 5 km radius is a must at this site. There is also the potential to pursue a greater mix of off-farm waste streams at this site and pursue permitting and approval through the Ministry of Environment instead of the Nutrient Management Act.

- **Erdine Farm, Hastings.** This large dairy farm of approximately 150 head is located on a 3-phase 44 kV line, the largest capacity line. There is another large (over 150 head) dairy farm within a distance of less than a kilometre.
  - Manure from this farm plus silage and FOG could support a plant of up to **375 kW**. Clustering with the neighbouring farm could increase **potential generation capacity to over 500 kW**, and the farm is well located along a 3-phase line with sufficient capacity for this size.



- **RH Millen, Ennismore**. A dairy farm with greater than 300 nutrient units (approximately 200 cows, calves and heifers). This site is located along a single-phase distribution line, limiting its potential capacity to 100 kW. An 8.3 kV 3-phase line is located 100 m away from the farm, and a 44 kV 3-phase line is 1,500 m away, which would increase the potential generating capacity to 249 or 499 kW, respectively.
  - From this farm's manure alone, combined with corn or grass silage and FOG, **up to 500 kW can be produced**. At 1.5 km away, the cost to connect a 499 kW plant would be approximately $270,000, so it may still be worthwhile to pursue the project and pay to connect.
  - Alternatively, this farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.

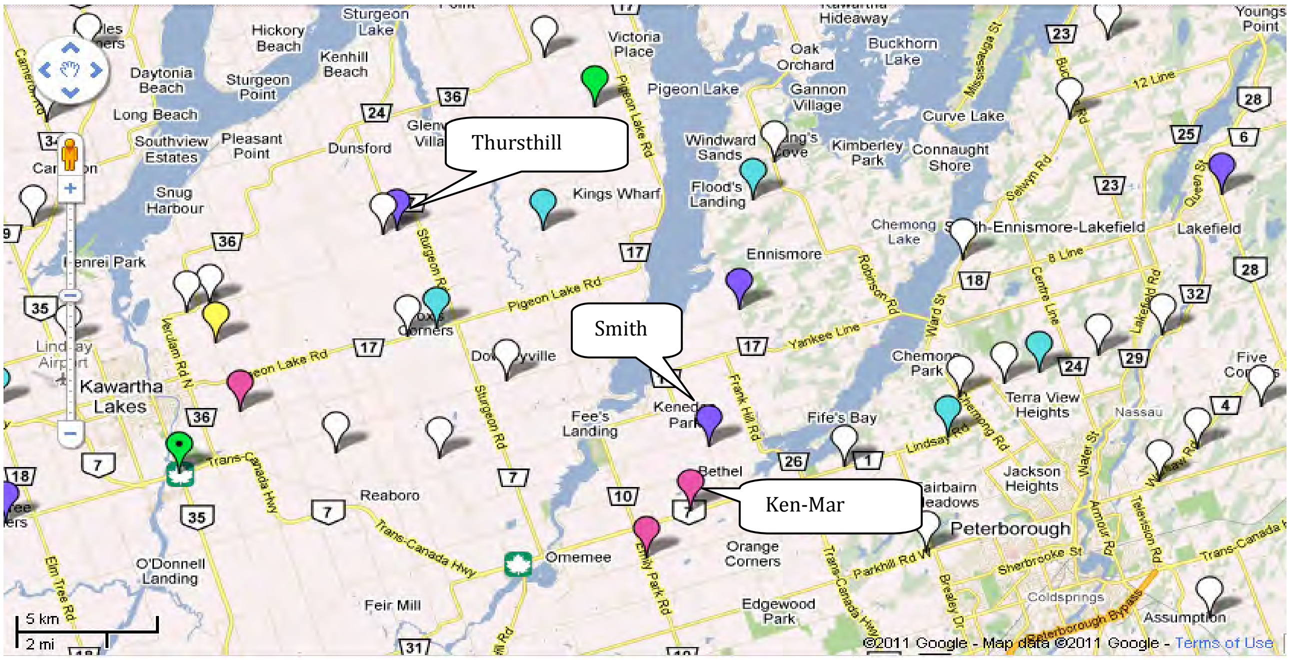
- **McFadden Holsteins, Lakefield**. A large dairy operation with approximately 110 cows. This site is located along an 8.32 kV 3-phase distribution line, limiting its potential generating capacity to 249 kW.
  - From this farm's manure alone, combined with corn or grass silage and FOG, **at least 249 kW can be produced**. Additional waste would be needed from farms within a 5 km radius to reach 499 kW.
  - Alternatively, this farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.

- **Thabor Farms and Clarkridge Farms, Woodville.** These two dairy farms are located in close proximity to each other along County Road 46 and both house over 100 milking head of cattle. There are a number of other farms within a 5 km radius, which could also supply manure and/or silage feedstock to a digester at either of the farms. Neighbouring dairy farms include Timberly Lane (45-50 head), McKev (30 head), Matias (65 head) and Clarkvalley (45-50 head). A 3-phase 8.32 kV distribution line runs along this road, suitable for generating capacity of 249 kW. A 3-phase 44 kV distribution line runs along Glenarm Rd., a distance of just under 2 km from the two farms.

- Manure from either farm alone could supply a plant of **up to 249 kW**, if combined with silage and organic waste. Digestion of manure from both farms together would allow for a plant of **499 kW** with inclusion of silage and FOG, or if manure from the neighbouring farms mentioned above were included. The additional cost to connect to the 44 kV line necessary for a 499 kW plant would be approximately $360,000.
- Alternatively, either farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.

- **Vosbrae Farms, Oakwood.** This medium-sized dairy farm of 65-75 head is located on a single-phase 8.32 kV distribution line, at a distance of 1.7 km from a 44 kV 3-phase line. There are at least 3 dairy farms within a 5-km radius, including Schahill farm (45-50 head), Jlawnt, and Gibbsview. The Manintveld poultry farm, with 2 large chicken barns may also be close enough to supply chicken manure.
  - The farm's own manure plus silage and FOG could support a plant of 145 kW, while clustering with neighbouring farms could support up to 400 kW of generation capacity. However the farm's location on a single-phase line caps potential generation at 100 kW.
  - Alternatively, this farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.

- **Glandine Farms, Little Britain.** This large dairy farm, and others along Little Britain Road, have a good manure resource in livestock numbers, although electrical connections are not optimal. Most of the distribution lines in the immediate vicinity are single-phase lines, limiting potential generation capacity to 100 kW. Glandine Farms is located on an 8.32 kV single-phase line. The nearest 3-phase line is 2.5 km away.
  - This farm's resources could potentially support a 260 kW plant, however its distance from 3-phase distribution lines makes a 100 kW installation the only feasible option for grid connection.
  - Alternatively, this farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.



- **Thursthill Farms, Lindsay.** This diary farm of over 100 milking head of cattle is located along a 3-phase 12.5 kV distribution line. The nearest 44 kV line is along Dunsford Road, 3.9 km to the north. There are at least three other dairy farms within a 5 km radius that could also supply manure to this project.
    - Manure from this farm alone plus silage and FOG could support **a 249 kW plant.** Clustering with neighbouring farms could increase potential generation capacity, but the cost of connecting to a 44 kV 3-phase distribution line 4 km away would be prohibitive (in excess of $700,000).
    - Alternatively, this farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.

- **Smith Dairy Farm, Omemee.** This large dairy farm of 100-120 head is located along a 3-phase 44 kV line, with a medium-sized dairy operation within 3 km (Ken-Mar Farms).
    - Manure from this farm alone plus silage and FOG could support a **249 kW plant**. Clustering with neighbouring farms could increase **potential generation capacity to up to 450 kW**, and the farm is well located along a 3-phase line with sufficient capacity for this size.
    - Alternatively, this farm could pursue an **on-farm micro-digester** for heating and chilling demand, without grid connection.

Next Steps

The next step is to contact the farms listed above and gauge their interest in biogas and, more specifically, community-owned biogas. An excellent way to do this would be to **host a community information session** and **personally invite each of the above farms**, as well as advertising the event throughout the County. This would give us the opportunity to present the idea to potential hosts and other farmers operating in close proximity (who could contribute additional manure and silage), as well as to meet **potential investors who may be interested in investing in the Kawartha Region's energy and food future – with biogas**.

Once specific projects are identified, applications will be made to the Community Energy Partnership Program to help fund development costs, including the business plan, technical feasibility studies, feedstock testing, legal costs and contracting, project management and financing. Note: this is specific to projects intending to apply to the FIT program.

About ReGenerate

ReGenerate Biogas Inc. was founded by Daniel Bida, in order to pursue a solution to both the energy and environmental crises society is facing. ReGenerate provides communities around Ontario with the tools and assistance they need to own and operate their own biogas systems. This enables the production of renewable energy, reduced greenhouse gas emissions, and revenue for farmers.

ReGenerate works with farmers and co-operatives to: assess project feasibility; obtain funding via grants and low-interest loans; procure technology; secure off-farm feedstock supplies; apply for permits and FIT contract; and manage the project's development.

This report was co-authored by Daniel Bida, CFA and Marty Climenhaga, PhD.

Resources

- **Community Energy Partnership Program (CEPP).** www.communityenergyprogram.ca was launched in June 2010 to provide early stage funding to community power projects of up to $200,000 per project. Eligible projects:
    - Have an installed capacity greater than 10 kW and less than or equal to 10 MW;
    - Use wind, solar photovoltaic, biomass, biogas, landfill gas or waterpower;
    - Are located in Ontario;
    - Are economically viable and the subject of a future Feed In Tariff contract;
    - Are not funded by any other OPA funding program; and
    - Are developed by a "Community"

  Up to $75,000 is available to community-owned biogas projects less than 500 kW.

- **Feed-in Tariff (FIT).** http://fit.powerauthority.on.ca/ was launched in October 2009 offering favourable rates for renewable energy projects operating in the Province of Ontario, as per the Green Energy Act passed in May of 2009. The program is administered by the Ontario Power Authority and has thus far awarded 32 contracts to biogas projects (14 on-farm) for a total of 23 MW (3 MW on-farm) of generating capacity. All of these projects must now receive permits and approvals from the newly established Renewable Energy Facilitation Office or the Ontario Ministry of Agriculture, Food and Rural Affairs.

- **Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).** http://www.omafra.gov.on.ca/english/engineer/ge_bib/biogas.htm is an excellent resource for any information needed about biogas in Ontario. It is written at a very accessible level, and continues to be updated with the latest information and studies. OMAFRA awarded 45 $35,000 feasibility grants and 23 $400,000 construction grants to farmers investing in biogas over the last couple of years and has been integral in getting the biogas industry off the ground in Ontario.

- **Renewable Energy Facilitation Office (REFO).** www.mei.gov.on.ca/en/energy/renewable/index.php?page=refo_office A newly created office meant to help renewable energy projects navigate the different departments of the Ontario government that are needed to get approval for many renewable energy projects, including off-farm biogas.

- **Green Municipal Fund (GMF).** http://gmf.fcm.ca/Home/ Administered by the Federation of Canadian Municipalities, the GMF was created to fund clean energy and efficiency projects completed by municipalities, municipally run organizations or partnerships involving a municipality. A $350,000 grant is available for pre-project costs and up to 80% of the capital costs are available in the form of low-interest loans.

- **Infrastructure Ontario (IO).** www.infrastructureontario.ca/en/loan/municipal_corporations/index.asp A lending program through the Ontario government directed at municipalities for a multitude of infrastructure related projects, including renewable energy.

- **City of Kawartha Lakes Green Hub Community Investment Plan.** http://www.advantagekawarthalakes.ca/en/ouruniqueadvantage/greenhubcommunityimprovementplan.asp The plan is intended to encourage investment with a focus on green technologies and services. It is primarily focused on urban regeneration, but also includes a Green Innovation Grant Program with renewable energy as one focus area, with grants of up to $5,000 for project development work such as feasibility studies. The plan targets specific urban areas but also includes the rural hamlets of Little Britain and Woodville.

- **Hydro One.** www.hydroone.com/Generators/Pages/Feed-InTariff.aspx The owner and operator of most of Ontario's transmission and distribution networks, any project outside of the area where Peterborough Utilities Corp operates will need to work with Hydro One to get connected. Many people have lamented the wait times waiting to get connected by Hydro One, increasing the attractiveness of projects where additional wires are not needed. Queue exemption also helps community-owned biogas over larger projects to connect faster.

Acknowledgements

This report was put together from information made available by the following organizations:

- The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)
- Hydro One
- Greater Peterborough Area Economic Development Centre (GPA EDC)
- The City of Kawartha Lakes
- Kawartha Choice
- Trent University
- Green Tractors Omemee

In addition, the authors of this report would like to thank Peter Rodriguez, Peter Doris, Grant Conrad, Jeremy Thurston, Stephen Hill, Beth Evans, and Renato Romanin for their assistance and invaluable advice in its preparation. The Peterborough Green Energy Coop provided the impetus for the initial study.

Electronic copies available upon request

HARTFORD'S HIGH COST OF MATTRESS DISPOSAL

A comprehensive case study of Hartford, CT

***The City of Hartford Department of Public Works** is responsible for and is committed to maintaining the city's physical infrastructure and providing quality services to the citizens of Hartford.*

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About 40 million mattresses and box springs are sold in the United States each year, while the City of Hartford alone collects approximately 18,000 mattresses annually. With per unit disposal fees ranging from $10-$30, Hartford faced mattress disposal costs of more than $400,000 in 2011.[1]

Why the high cost? Most mattresses are currently disposed of in landfills or incinerators where their bulk makes them difficult to handle and expensive to manage. Mattresses do not easily compress in landfills, and their springs get trapped in equipment at Waste-to-Energy (WTE) facilities. Such difficulties have translated into high per-unit disposal fees, which municipalities must absorb.

Motivated to reduce the high cost of mattress disposal, the City of Hartford Department of Public Works, with support from Mayor Pedro E. Segarra and the Connecticut Department of Energy and Environmental Protection (DEEP), sought help from the Product Stewardship Institute (PSI) in developing a legislative product stewardship solution that would increase mattress recycling and decrease costs to the City. While mattresses are one of the most costly waste streams for Connecticut municipalities, electronics and paint products waste streams posed similar difficulties in the past. In both cases, the enactment of statewide extended producer responsibility (EPR) legislative initiatives[2], under which product manufacturers assume disposal costs, relieved local municipalities of significant financial burdens. Both programs have realized waste reduction and cost savings and therefore, the City chose an EPR legislative model as a feasible solution for its mattress disposal problem.

With the support of various nationwide sponsors, PSI launched a national Mattress Stewardship Initiative in April 2011, including representatives from the mattress industry, state and local government agencies, recyclers, and other key stakeholders. Through this initiative, PSI developed a national model for EPR legislation, under which mattress manufacturers would be responsible for the cost of mattress disposal. States across the country could then use this model to develop state-specific legislation for mattress disposal and collection.

The City of Hartford quickly recognized the impact current mattress collection and disposal practices would have on Connecticut-specific future legislation; the City, therefore, conducted a comprehensive case study to analyze the mattress collection and disposal process as performed by the City's bulky waste collection crew. Marilynn Cruz-Aponte, Assistant to the Director of the City's Public Works Department, and Lauryn Wendus, PSI Student Intern, led the study and gathered key information on the quantity and condition of mattresses throughout the disposal process as outlined in the following pages.

1. *While this study was being written, the City of Hartford made an operational decision to select an alternative disposal approach that is estimated to reduce annual mattress disposal costs by up to 60%.*
2. *Connecticut passed Public Act No. 07-189 on electronics disposal in July 2007. Connecticut Public Act No. 11-24 on paint disposal was passed in June 2011.*

EXECUTIVE SUMMARY

The objective of this study was to assess how Hartford's mattress collection and disposal processes may affect:

1. Hartford's current mattress disposal costs.
2. Future legislative initiatives on mattress disposal protocol.

Specifically, this case study focused primarily on the following issues surrounding current practices:

- Quantity of mattresses collected
- Quality of mattresses collected
- Comparison to practices in surrounding municipalities

On the **quantity of mattresses collected**, this study examined a sample of mattresses collected over a three week period, from August 1, 2011-August 18, 2011. During this timeframe, 950 mattresses were collected from curbside pickup, with an additional 93 mattresses collected from residents at the city's transfer station. Using data collected during this period, it is estimated that mattresses made up over half of Hartford's bulky waste loads, by weight. Furthermore, it is **estimated that Hartford should expect to collect about 18,000 mattresses annually.**

Illegal dumping significantly increases the number of mattresses the City of Hartford must collect each year. Residents from surrounding towns aiming to avoid disposal fees may illegally dump mattresses in Hartford's parks, vacant lots, and on city streets. Illegal dumping by seven-and-over family apartment complexes, for which the City is not required to provide waste pickup, is a particular problem. A significant portion of Hartford's population is highly transient, and landlords of large apartment complexes do not want the burden of mattress disposal costs when residents leave behind mattresses and other bulky waste during a move or eviction.

An on-site observation of bulky waste pickup was performed to examine the **quality of mattresses collected**. Upon collection, many mattresses were extremely worn, wet, and dirty. Hartford's bulky waste collection process provides weekly pickup to a given district, so mattresses could remain on city curbs for up to six days before collection. This means that mattresses may be subject to external conditions, such as rain, snow, and traffic debris before pickup, and may not qualify for recycling options. Connecticut's new mattress de-manufacturing recycling facility in Bridgeport, for instance, cannot accept mattresses that have been excessively wet or soiled because recyclable cotton and foam material are likely to be contaminated with mold or other matter that could threaten consumer safety. The facility also has difficulty handling mattresses that have lost their original form, as current recycling processes are mostly manual. **Since Hartford's mattress collection process is not manual, and instead uses a large operator claw that contorts and crushes mattresses upon pickup, it is unlikely that many of Hartford's mattresses will hold up to current recycling eligibility standards.**

To analyze Hartford's collection practices in **comparison to practices in surrounding municipalities**, this study evaluated results of surveys distributed to surrounding towns. There was a noticeable lack of statewide uniformity in mattress collection and disposal processes. Many towns mandated that residents deliver their mattresses to the town's transfer station for disposal or arrange for pickup by a private hauler. This requirement, although perhaps ideal from a municipal collection standpoint, is not feasible for a city such as Hartford where many residents either own economy-sized cars or rely on public transportation.

Other Connecticut municipalities also varied in the use of resident disposal fees and storage methods. Statewide disposal fee discrepancies contribute to illegal dumping in municipalities with no fees. Storage methods among towns varied between open and closed containers; most towns leave their mattresses in open containers, subject to external weather conditions, which jeopardizes mattresses' recyclability. **Such variations, as well as the difficulties associated with mattress collection and disposal practices as noted by many Connecticut municipalities, suggest the need for a uniform solution.**

The high quantity of mattresses collected, declining quality of mattresses collected and stored, and inconsistent statewide mattress collection practices and fees are collectively contributing to Hartford's high mattress disposal costs. While municipalities are responsible for the collection of public waste streams, they should not be forced to handle unlimited quantities of a potentially unrecyclable and expensive waste stream. Under an extended-producer-responsibility legislative model, manufacturers would share responsibility and assume related disposal costs to ease the burden on Connecticut municipalities. While developing this model, however, Connecticut must cautiously consider the impact collection methods and end-of-life product quality will have on recycling eligibility and future disposal costs.

DEFINITIONS

The following terms are used commonly throughout the study and their meanings **as related to the study** are defined below:

- **Bulky Waste & Recycling Center** - Located at 180 Leibert Road in Hartford, Conn., this is the City's permitted bulky waste transfer station facility. This facility will be referred to as "Hartford's transfer station" or "transfer station".

- **Bulky Waste –** Examples of Hartford's bulky waste stream include box springs and mattresses, upholstered furniture, lumber, wood, branches, rugs, and carpets. The City of Hartford has the following resident guidelines for the pickup of bulky waste as cited on its website: All wood and branches must be bundled and tied with strings; rugs and carpets must be folded and tied with strings. Residents may also use the drop-off containers at Hartford's transfer station for scrap metal and bulky waste only; garbage will not be accepted at the landfill.

- **Mattresses –** The term "mattress" refers to mattresses and/or box springs of all sizes, including twin, full, queen, and king. A futon is also considered a "mattress" and is counted as one unit. A mattress/box spring set is counted as two "mattresses" for the purposes of this study. A box spring by itself is counted as one unit.

- **Trip –**The term "trip" refers to the delivery of one truck load of bulky waste or completion of the driver's share of the route. Under either circumstance, the driver is required to dispose of all waste in his/her truck at the transfer station, thereby completing one trip.

- **Load-**One (truck) "load" of bulky waste is considered complete at the time a driver delivers the waste to the transfer station.

- **Mattress Stop**– A "mattress stop" refers to a pickup location within the bulky waste collection route where at least one mattress is included in the bulky waste sample.

STUDY OVERVIEW

The study is composed of five sections:

1. **Bulky Waste Driver Surveys.** Daily surveys were distributed to bulky waste collection drivers from August 1, 2011 – August 18, 2011.[3] The goal of the surveys was to collect data on the quantity and location of mattress pickups along the bulky collection route.

2. **Transfer Station Gatekeeper Surveys.** Daily surveys were distributed to the gatekeeper at the city's transfer station from August 1, 2011 – August 18, 2011[3]. The goal of the surveys was to collect data on the quantity of mattresses that residents delivered to the transfer station.

3. **Bulky Waste On-site Observation.** An on-site observation was performed on the bulky waste collection route on July 27, 2011 to understand Hartford's curbside collection process.

4. **Outreach to Surrounding Municipalities.** Surveys were distributed to surrounding municipalities to gather information on each town's respective mattress collection and disposal process. The following towns responded to the survey: Cromwell, East Granby, Ellington, Glastonbury, Granby, Meriden, West Hartford, Wethersfield, and Windsor Locks.

5. **Pilot Recycling Program.** Information was obtained from Winston Averill, a Connecticut Regional Recycling Coordinator, who is proposing to run a pilot mattress recycling program in 12 southeastern Connecticut towns.

3. The study timeframe does not include dates at the end of the month. While there may be a correlation between the number of disposed mattresses and housing transiency/rent cycles, this relationship does not fall within the scope of this study.

DRIVER SURVEY DATA

Over an approximate three-week period, the bulky waste collection crew collected 950 mattresses. The majority was collected via curbside collection, while a small percentage was collected from parks, vacant lots, and other sources. See *Exhibit A* below for a detailed breakdown of mattress origins.

Exhibit A

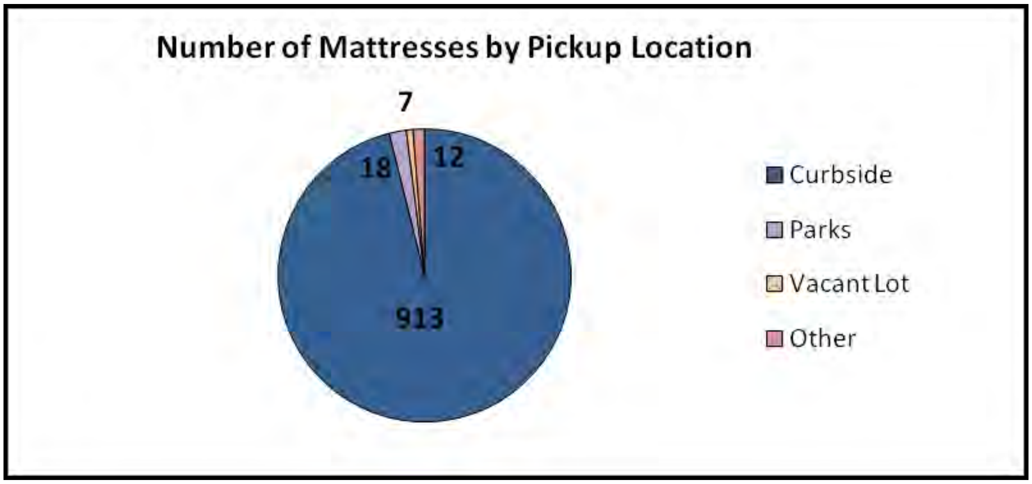

Exhibit A. Of the 950 total mattresses collected, 96% were from curbside collection[4]. Of the remaining mattresses, 2% were collected from parks, with the remaining 2% combined from vacant lots and other sources.

Based on the 950 total mattresses collected, the following statistics were also derived from driver survey data:

- **Average of 1.94 mattresses collected per mattress stop**
- **Average of 12.94 mattresses collected per truck load**
- **Mattresses made up approximately 51% of bulky waste loads by weight.**

See *Appendix A* for a derivation of the above calculations.

Judging from the data above, Hartford's bulky waste collection crew is inundated with mattresses on a regular basis. Assuming the collection statistics are a representative sample of typical mattress collection, Hartford should expect to collect about **16,500 mattresses per year from curbside collection**.

4. The total number of mattresses from curbside collection may include illegal dumping of mattresses at 7+ family apartment complexes. Drivers did not differentiate these pickups from curbside pickups at 1-6 family residences.

GATEKEEPER SURVEY DATA

Over the study period, the transfer station's gatekeeper noted **26 residents** disposing of mattresses, with an average of **3.57 mattresses/resident**. The gatekeeper recorded **93 total mattresses** disposed of by residents. Resident mattresses disposed of directly at the transfer station are likely to be eligible for recycling if stored in a closed container, as they are not typically deformed by collection or exposed to weather elements for long periods of time. Mattresses delivered by residents came from a variety of sources. See *Exhibit B* for a breakdown of the number of mattresses by resident type.

Exhibit B

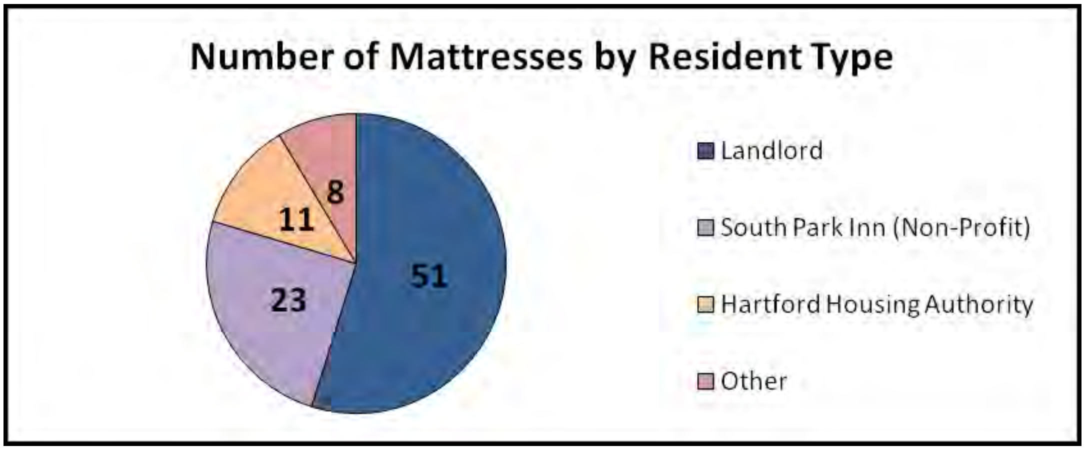

Exhibit B. Landlords delivered 55% of the mattresses to the transfer station. South Park Inn was responsible for 25% of mattresses, followed by Hartford Housing Authority at 12% and other resident businesses and organizations at 8%. **No individual residents disposed of mattresses at the transfer station during the three-week period.**

The following information was also derived from gatekeeper survey data:

Resident Type	Average Number of Mattresses Delivered/Visit
Landlord	2.68
South Park Inn	11.50
Hartford Housing Authority	3.67
Other Business/Organization	4.00

See *Appendix B* for a derivation of the above calculations.

Lack of transfer station use for mattress disposal by individual residents is owed primarily to free, citywide curbside collection. In addition, Hartford residents are also limited by transportation. Many residents do not own vehicles and/or rely solely on public transportation, or own small vehicles not suitable for transporting large and bulky mattresses.

ON-SITE OBSERVATION

An on-site observation of the mattress collection process was performed on Wednesday July 27, 2011. A City car followed one of two bulky waste collection trucks to observe the mattress collection process by Department of Public Works employees. Observations were made on the following attributes:

1. COLLECTION SCHEDULE. The City of Hartford collects bulky waste every week, Monday-Friday, servicing a different city district each day. There are approximately 25,000 stops in total, and the routes are distributed so to serve 5,000-6,000 customers per day. Currently, there is no mandatory on-call system for bulky waste collection, so drivers must cover the entire route in search of curbside bulky waste. On each of the five collection days, two trucks, with one employee per truck, cover bulky waste pickup for a particular district. Each truck's employee is dually responsible for both driving the truck and facilitating the physical collection of bulky waste.

Again, it is important to note that there is no information available to drivers regarding the quantity of waste or pickup location prior to collection. Therefore, employees must coordinate with each other to inspect for bulky waste on each street within the day's covered district. Drivers coordinate with each other while beginning pickup on opposite ends of a particular route, and communicate their status to the opposite driver as they progress through their half of the route. Ideally, both drivers will complete pickup for an equal number of stops, although uneven distribution of waste throughout the route often makes this goal unrealistic.

2. COLLECTION MECHANICS. Collection is not manual. All bulky waste is collected with open trucks featuring an operator "claw" that facilitates the movement of waste from ground level into the truck. The operating mechanics for the claw are located on the outside of the bulky waste truck. Therefore, the employee must exit the truck at each collection point to operate the claw.

Drivers collect waste until the truck is full. Upon each full load, the employee must drive to the transfer station to dispose of all waste collected. After disposal, the employee returns to his or her route to finish collecting waste. According to an interview with bulky waste drivers, the quantity of waste varies by day; Monday, Thursday, and Friday are the heaviest collection days. On a heavy collection day, it may take a driver up to three trips to the transfer station to collect all of the waste on his or her portion of the route. Light to moderate collection days typically produce one to two loads of waste per truck.

Although the operator claw reduces manual labor, it does not preserve the integrity of the items being collected. As can be seen in *Figure 1* below, the claw deforms mattresses – folding, twisting, and crushing them upon collection.

Figure 1

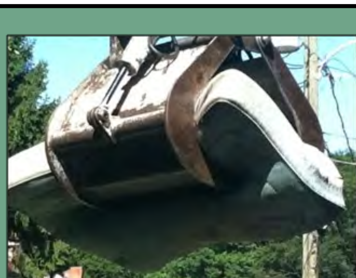

Figure 1-A. A single mattress is handled by the operator claw and creased at the center where the claw arms grasp the mattress.

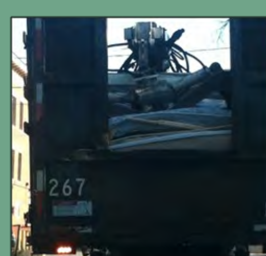

Figure 1-B. Mattresses are crushed by the weight of the operator claw once placed into the collection container.

Figure 1-C. A group of mattresses are mangled by the operator claw. Splintered wood can be seen in the middle of the pile as mattresses are transported.

3. MATTRESS ORIGINS. The majority of mattresses were collected on the curb in front of single and multi-family dwellings for which the city is responsible. However, there were three incidents during which mattress pickup was performed at large, seven-and-over family apartment complexes where private collection services are mandated. **Instances of illegal dumping add to the total cost of mattress disposal for the City of Hartford, and contribute to the large quantity of mattresses found on Hartford's streets.**

4. MATTRESS QUANTITY. Judging by visual observation, mattresses were the most commonly seen item during bulky waste pickup followed by sofas and electronics. It was approximated that roughly ¾ of each load was composed of mattresses.

Over the course of 1 hr, 45 minutes on the first trip, the truck was followed for 14 stops, nine of which included mattresses. Each mattress stop included between two and five mattresses placed for collection, with an average of three mattresses per mattress stop. A total of 28 mattresses were counted over the 14 stops, with an additional eight mattresses likely to be collected before the truck completed its first trip and disposed of a full truck load at the transfer station.

Over the course of approximately 2 hr, 30 minutes on the second trip, the truck was followed for the remainder of its route — a total of 27 stops. Fourteen stops contained mattresses, and there were between one and four mattresses per mattress stop. See *Exhibit C* for data on the quantity of mattresses found and collected along the bulky waste collection route.

Exhibit C

	Total Stops Followed	Stops with Mattresses	Total Mattresses Collected	Percent of Stops with Mattresses	Average Number of Mattresses per Mattress Stop
Trip 1	14	9	28	64%	3.11
Trip 2	27	14	30	52%	2.14

See *Appendix C* for a derivation of the above calculations.

On both trips, over half of the stops included mattresses, with an average of two to three mattresses per mattress stop. A total of 58 mattresses was collected for both trips, and assuming the second truck experienced similar results, we could expect that over 100 total mattresses were collected throughout the day.

ON-SITE OBSERVATION (CONTINUED)

5. MATTRESS QUALITY. Many of the mattresses were extremely worn at the time of pickup, and a number also appeared wet. Because collection for a particular district is only performed once per week, there is no way to tell exactly how long mattresses have been on curbs and subject to various weather conditions (as seen in *Figure 2* below).

Figure 2

Figure 2. Mattresses placed haphazardly on the side of the street among parked cars.

The mattresses in the above image appear excessively worn and dirty. Their placement on the side of the road leaves them subject to debris from nearby traveling vehicles in addition to external weather conditions. In the winter, mattresses can be hidden and buried underneath snow piles for weeks before collection crews are able to pick them up. Subject to such circumstances, mattresses are unlikely to qualify for many recycling options. Bradford Mitchell, Mattress Recycling Project Manager at Park City Green in Bridgeport, states that mattresses cannot qualify for recycling if they are unduly wet or soiled.

Mattresses that are excessively wet or soiled cannot be recycled because recyclable cotton and foam material could be contaminated by mold and other matter. While light dust or dirt does not pose a serious threat, any extensive water or soil damage that is likely to have seeped through the mattress may render it unrecyclable.

It is also important for mattresses to maintain their original form if they are to be recycled, as Park City Green's current mattress recycling practices use manual deconstruction. Deformed mattresses that have been crushed by the weight of Hartford's bulky waste operator claw make manual deconstruction processes more difficult, and consequently more expensive for the recycling facility. As mattress recycling facilities progress, processes may evolve to better accommodate mattresses that have been significantly altered in form, but there is no guarantee of such modifications by recycling facilities at this time.

Therefore, due to the impact that current collection processes have on mattress quality, Hartford's operational method of collection may need to be altered if mattress recycling is mandated in the future.

6. SURROUNDING CONDITIONS. The on-site observation was performed under ideal conditions. The weather was 85 degrees and sunny, and traffic was light to normal throughout the majority of the route. The following items were noted as potential obstacles that directly affected the mattress collection process:

1. **PLACEMENT OF MATTRESS ON CURB.** Throughout the observation, mattresses appeared on curbs and streets in a number of ways. Some mattresses were piled horizontally on curbs, while others were placed vertically leaning on trash containers or surrounding other bulky waste. See *Figure 3* for a detailed depiction of mattress placement.

Figure 3

Figure 3-A. An example of mattresses stacked and leaning on other curbside bulky waste.

Figure 3-B. Mattresses are stacked and leaning on a nearby vehicle. The bulky waste driver must handle mattresses to position for access by operator claw.

Figure 3-C. Mattresses are placed for collection in an area not easily accessible by operator claw. Driver must handle mattresses by hand and potential bedbug contamination is a concern.

The varying placement of mattresses on curbs and streets affected the time it took for employees to collect waste. Under certain circumstances, employees needed to manually move mattresses so they were positioned in a way that the operator claw could effectively lift them into the truck.

Any time employees must physically handle mattresses, bedbug contamination is a possibility. Currently, gloves are the only form of personal protective equipment employees must wear when handling waste. With no other protective equipment required, employees' clothing and skin are at risk for bedbug contamination. If Public Waste employees must continue to manually pick up mattresses, further protective equipment should be provided to address potential health and safety hazards.

ON-SITE OBSERVATION (CONTINUED)

2. **TRAFFIC.** On more than one occasion, traffic negatively affected bulky waste collection. If there was heavy oncoming traffic and trucks were not able to safely cross the street to pick up waste, drivers had to revisit the same street twice to collect waste on both sides of the street.

3. **TELEPHONE POLES AND WIRES.** Nearby telephone poles and wires can make collection difficult with the operator claw (as seen in *Figure 4* below).

Figure 4

While Hartford's Public Works employees are very skilled in maneuvering the operator claw, the danger involved in operating such large machinery near electrical wires should still be noted when evaluating Hartford's current collection processes.

OUTREACH TO SURROUNDING MUNICIPALITIES

Survey results led to the following conclusions regarding mattress collection and disposal in surrounding municipalities:

- **Lack of Uniformity.** Collection methods varied by town. Towns such as Windsor Locks and West Hartford provided curbside pickup with a per-mattress fee ($30 and $45, respectively). Most towns, however, mandated that residents deliver their mattresses to the town's transfer station for disposal or arrange for pickup by a private hauler.

  Disposal fees also varied among towns. Towns such as Glastonbury and Granby charged residents a per mattress fee of $6 and $10, respectively. Other towns, such as East Granby, charge residents only for transfer station permits, and do not charge a per-mattress fee. East Granby representatives noted that because of the town's fee structure, they are concerned that the town is taking mattresses from other communities, resulting in out-of-town residents avoiding per-mattress fees.

  Storage methods of disposed mattresses also varied by community. Only Cromwell and Granby indicated that their town's mattresses were stored in closed containers. The remainder of towns stored mattresses in open containers, which left mattresses subject to environmental conditions, potentially diminishing the quality for recycling.

- **Inconsistent Quality/Acceptability for Recycling.** Statewide variations in collection, disposal, and storage hinder a waste stream with consistent standards. Quality discrepancies will make it difficult for state legislation to mandate mattress recycling because the eligibility of mattresses for recycling is directly tied to municipal collection processes. Issues surrounding municipal collection processes must be addressed when drafting statewide mattress legislation.

PILOT MATTRESS RECYCLING STUDY

As of October 2011, Winston Averill, Regional Recycling Coordinator of Southeastern Connecticut Regional Resource Recovery Authority (SCRRRA), is planning to run a pilot program for the recycling of mattresses in the Authority's 12 member towns, upon approval from the SCRRRA Board of Directors. Averill hopes to establish a trailer at the regional transfer station to collect mattresses and deliver them to the Bridgeport, Conn. recycling facility. Averill plans to measure the following:

- Number of mattresses collected
- Time it takes to fill the trailer with mattresses
- Weight of trailer
- Cost to deliver mattresses to Bridgeport facility (time, transport costs, etc.)
- Unload time of mattresses once delivered to Bridgeport facility

After obtaining the following information, Averill will provide a complete analysis of the process to the City of Hartford and other relevant stakeholders upon request.

HARTFORD'S CHANGE IN MATTRESS DISPOSAL METHOD

With Hartford's mattress disposal costs projected to exceed $400,000 in fiscal year 2011, senior management elected to contract with a private bulky waste hauler in an effort to reduce costs. Whereas Hartford's regional disposal facility treats mattresses as a separate waste stream and charges a per unit fee, mattresses can legally be disposed of with bulky waste, depending on the receiving facility. Therefore, Hartford merged mattresses with other bulky items, and arranged for disposal (at $85/ton) that resulted in a cost reduction of mattress disposal fees. The City of Hartford is working to calculate the exact savings from commingling mattresses with bulky waste, but anticipates an approximate 60% reduction in disposal costs. However, even with significant savings, the cost of mattress disposal remains unsustainable for the City of Hartford, and further strains the City's limited funding.

SUMMARY OF KEY POINTS

Outlined below are a series of key takeaways from this study:

- **In Hartford, mattresses made up approximately 51% of bulky waste loads, by weight.** This is a significant factor when considering the cost to the City of Hartford. Even with the upcoming contractual change to treat mattresses as bulky waste subject to a standardized tonnage fee, mattresses alone will still account for over half of Hartford's bulky waste disposal costs.

- **In Hartford, collection methods affect the ability to recycle this waste stream.** Mattresses cannot be unduly wet and must maintain their original form to be eligible for recycling, and as was observed in this study, Hartford's current collection process is not conducive to meeting these requirements. Collection equipment deforms mattresses, and weekly pickup can leave mattresses vulnerable to roadside debris and weather conditions for up to six days before pickup. While transitioning collection methods from operational to manual pickup may greatly reduce the destruction of mattresses during pickup, it also subjects Hartford Public Works employees to a potential health risk, as mattresses may be infested with bedbugs that can easily contaminate employees' skin and clothing.

- **A lack of statewide uniformity in storage practices creates a substantial degradation in mattress quality for recycling feedstock.** In Hartford and in other parts of the state, mattress collection and/or storage methods degrade mattress quality and render a smaller population of mattresses available for recycling feedstock. Collection methodologies and storage of mattresses in open containers at municipal transfer stations subjects mattresses to harsh weather conditions and other factors that may limit their eligibility for recycling.

- **Instances of illegal dumping add to the total cost of mattress disposal for the City of Hartford, and contribute to the large quantity of mattresses found on Hartford's streets.** There is likely a connection between illegal dumping and the fees charged to residents for mattress disposal in surrounding towns. Frustrated residents who do not want to incur a fee for mattress disposal may illegally dump their mattress in Hartford, knowing the City provides free curbside collection.

RECOMMENDATIONS

Based on the information collected in this study the following recommendations are made:

1. **Mattress disposal costs should not be borne by municipalities.** Municipalities should not bear significant mattress disposal costs simply because they are responsible for collection of public waste streams. Municipalities cannot control the quality or the number of mattresses collected, and under the current model, are forced to handle unlimited quantities of potentially unrecyclable mattresses at their own expense.

   Attempts by municipalities to transfer disposal costs to residents instead of incurring costs directly is also not ideal, as resident fee structures come with burdensome oversight and administrative effects. A lack of standardization among resident fee structures also creates frustration among residents. Varying fees among municipalities may tempt residents to illegally dispose of their mattress in their own town, or in a surrounding town, to avoid paying a fee.

2. **Mattress manufacturers should assume mattress disposal costs**. Manufacturers need to be aware of the lifecycle costs associated with the products they produce. If manufacturers are not held responsible for the environmental and financial impacts of product disposal, there is no incentive for manufacturers to consider such implications during product development. Furthermore, if product disposal is in the hands of private-sector manufacturers versus public government oversight, underlying economic principles should establish the most efficient, cost-effective solution to the problem. Mattress manufacturers do not want excessive disposal costs affecting their bottom line, and will, therefore, have incentive to develop strategies to alter current production processes or standardize recycling practices in exchange for cost-reduction savings.

3. **Caution must be taken in developing mandated recycling goals within future legislation, as collection methods and end-of-life product quality will affect recycling eligibility.** Mattresses must maintain their original form and cannot be severely altered or wet to qualify for current recycling methods.

   - As seen in Hartford, many municipal collection operations may not be suited to handle an immediate shift toward mattress recycling. However, many other institutions (such as hotels, universities, and retailers) have large quantities of mattresses for disposal that are likely to meet the criteria for recycling, and could help provide feedstock for recycling.

   - Mattress recycling must evolve into an affordable disposal solution so manufacturers can absorb the lowest possible cost. The success of mattress recycling facilities is linked to scale, and therefore, there must be enough feedstock to sustain production operations. Sources currently generating acceptable feedstock for these facilities could likely provide a foundation for mattress recycling facilities to grow and expand operations while collection processes are altered to meet recycling compliance standards or recycling practices evolve to accommodate lower-quality mattresses.

The City of Hartford, with the help of the Connecticut Department of Energy and Environmental Protection and the Product Stewardship Institute, is currently working on a statewide Extended Producer Responsibility (EPR) bill to be introduced during the 2012 Connecticut legislative session. For more information or to track the progress of this initiative, visit the Product Stewardship Institute's website at http://www.productstewardship.us/index.cfm.

APPENDICES

APPENDIX A

A sample of truck loads were weighed upon completion and delivery to the transfer station. The following data was collected:

A	B	C	D	E
LOAD #	LOAD WEIGHT IN POUNDS	NUMBER OF MATTRESSES COLLECTED	ESTIMATED MATTRESS WEIGHT IN POUNDS (C x 100) (Assumes an estimated weight of 100 lbs/mattress[5])	MATTRESS WEIGHT AS A PERCENTAGE OF LOAD WEIGHT (D/B)
1	4,880	11	1,100	22.54%
2	3,100	24	2,400	77.42%
3	4,360	24	2,400	55.05%
4	3,180	25	2,500	78.62%
5	4,200	32	3,200	76.19%
6	3,600	23	2,300	63.89%
7	4,360	24	2,400	55.05%
8	3,520	24	2,400	68.18%
9	1,920	9	900	46.88%
10	4,980	17	1,700	34.14%
11	3,320	19	1,900	57.23%
12	3,200	21	2,100	65.63%
13	4,560	22	2,200	48.25%
14	3,520	30	3,000	85.23%
15	4,180	24	2,400	57.42%
16	5,720	26	2,600	45.45%
17	3,720	20	2,000	53.76%
18	1,500	4	400	26.67%
19	4,740	15	1,500	31.65%
20	3,960	19	1,900	47.98%
21	4,180	18	1,800	43.06%
22	4,020	23	2,300	57.21%
23	5,380	31	3,100	57.62%
24	3,660	22	2,200	60.11%
25	1,480	2	200	13.51%
26	5,960	15	1,500	25.17%
27	2,580	7	700	27.13%
28	3,440	28	2,800	81.40%
29	2,900	9	900	31.03%
30	5,280	22	2,200	41.67%
31	4,140	14	1,400	33.82%
32	3,500	11	1,100	31.43%
33	3,320	17	1,700	51.20%
34	5,560	16	1,600	28.78%
35	4,660	23	2,300	49.36%
36	3,580	24	2,400	67.04%
37	5,940	33	3,300	55.56%
38	3,640	23	2,300	63.19%
39	2,540	11	1,100	43.31%
40	5,340	30	3,000	56.18%
41	4,800	12	1,200	25.00%
42	3,360	28	2,800	83.33%
43	3,660	15	1,500	40.98%
44	4,940	29	2,900	58.70%
AVERAGE	**3,963**	**20**	**1,991**	**50.52%**

5. Tempur-Pedic lists their mattresses as weighing anywhere between 60 and 185 lbs., depending on size and model. Foundations are listed as weighing between 50 and 75 lbs. For more information, visit http://www.foamorder.com/tempur-pedic_4.html.

APPENDIX A (CONTINUED)

A	B	C	D	E
Number of Mattresses Collected	**Number of Mattress Stops**	**Number of Loads**	**Average Number of Mattresses/Mattress Stop (A/B)**	**Average Number of Mattresses/Load (A/C)**
950	490	74	1.94	12.84

APPENDIX B

A	B	C	D
Resident Type	**Number of Mattresses Delivered to Transfer Station**	**Number of Visits to Transfer Station**	**Average Number of Mattresses/Load (B/C)**
Landlord	51	19	2.68
South Park Inn	23	2	11.50
Hartford Housing Authority	11	3	3.67
Other	8	2	4.00

APPENDIX C

	A	B	C	D	E
	Total Stops Followed	**Stops with Mattresses**	**Total Mattresses Collected**	**Percent of Stops with Mattresses (B/A)**	**Average Number of Mattresses/Mattress Stop (C/B)**
Trip 1	14	9	28	64%	3.11
Trip 2	27	14	30	52%	2.14

A pet owner's guide to Managing Pet Waste

Did you know that pet waste is hazardous to the health of people and pets? Abandoned pet waste can contain a host of diseases and parasites that can infect other pets or in some cases be transmitted to people.

Not picking up after your dog is considered littering. Owners are required to pick up and properly dispose of feces left by their pet. Dog and cat feces are banned from garbage by Metro Vancouver at the Matsqui Transfer Station.

How to dispose of pet waste

The following options are available to properly dispose of your pet's waste:

- Bury it in your in your backyard or in a pet waste composter. See reverse side for composter ideas.
- Flush it down the toilet. Be sure to remove any kitty litter or dirt. Kitty litter is often made of absorbent clay which can expand when wet and block sewer lines. Remove pet waste from ALL bags before flushing down the toilet. Plastic bags or bags labeled "flushable, water soluble or biodegradable" are not accepted in the sewer system.
- Use a pet waste pick up service. Visit www.abbotsford.ca/engineering for local service companies.
- Kitty litter can be disposed of in the regular garbage according to the following guidelines: Kitty litter must be double bagged and securely tied before being placed in the garbage container. No more than 5L of kitty litter is accepted in any one container.

ABBOTSFORD

Build your own pet waste composter

Follow these steps to properly compost dog waste:

- Choose a location that is a suitable distance away from your other composting systems and vegetable gardens, and from any water body, standing water, high groundwater, or groundwater well.
- Dig a hole in the ground approximately 60-90 cm (2-3 ft) deep and 60 cm (2 ft) across.
- Add a thick layer of shredded cardboard or other carbon-rich, absorbent material (coir, shredded paper, aged straw etc.) in the bottom.
- Use some sort of enclosure over top like a regular plastic backyard composter top. It will control the amount of water added and prevent flooding, allow you to add more material, and will help ward off children and animals.
- Add your pet's waste along with more bedding material or a layer of soil and sprinkle with water following each deposit.
- Finished compost can be used on ornamental trees and shrubs.

DO

Bury pet waste under ornamental trees and shrubs.

Flush pet waste down a toilet where it can be treated by the waste water treatment facility.

Remove pet waste from ALL bags (plastic or biodegradable) before flushing down the toilet. Place soiled bags in the regular garbage.

DON'T

Add pet waste to your backyard compost bin. It could make your compost unhealthy, retain odours and attract pests.

Bury pet waste near a vegetable garden.

Put pet waste into the storm sewer. Storm sewers do not connect to the sanitary sewers and treatment facilities, so pet waste can cause water pollution and present health risks to people and animals.

Compost kitty litter and feces.

Solid Waste as a Resource

Review of Waste Technologies

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TABLES AND FIGURES

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Waste Management System Considerations

The *Solid Waste as a Resource: Review of Waste Technologies* profiles a range of proven and emerging solid waste management technologies appropriate for Canadian municipalities to assist municipal leaders and waste managers select best practices. Although technically feasible technologies are described, preference should be given to those that treat waste as a resource and meet the objectives of sustainable communities.

The broad waste management activities covered are:

- Recycling
- Composting
- Anaerobic Digestion
- Thermal Treatment
- Landfilling

Note that landfilling can be used to manage all materials, whereas the other four technologies are limited in materials to which they apply and tonnage they can manage.

Municipalities mostly deal with residential waste, with some industrial, commercial and industrial (IC&I) waste from smaller generators. Residential waste includes: waste from single family, multi-family, high- and low-rise residences, backyard composting, grasscycling, and waste that is self-hauled to depots, transfer stations and landfills.

There is some variation across Canada based on geography and climate, but in general, multi-family dwellings consistently produce more waste by weight in all categories except for yard waste. Typical residential waste composition, by weight per household per year, in descending order (all in kg/hh/yr):

Waste	kg/hh/yr
Paper	275
Food waste	208
Other (wood, bulky goods, white goods)	167
Yard waste	162
Glass	61
Ferrous metal	31
Film plastic	31
Textiles/leather/rubber	26
Other plastic	21
Non-ferrous metal	8
High density polyethylene	6
Polyethylene terephthalate	4

Composition of waste generated by the IC&I sector depends on regional economic activity, including local industries, manufacturers, and the business community. The top five items in a typical composition are:

IC&I Waste	%
Mixed paper	25
Old corrugated cardboard	15
Food waste	10
Plastics	9
Ferrous metals	8

This waste is generally managed privately by IC&I generators, but some IC&I waste, particularly that from small storefront commercial operations, is managed in the municipal waste system.

When IC&I waste is added to municipal systems, either via residential waste collection or at composting sites, material recovery facilities (MRFs), energy from waste (EFW) plants, or landfills (delivered by a private hauler who pays the tipping fee), it may provide a source of net revenue for the municipality and make waste management operations more economically or technically sustainable.

Definitions Used

Source-separated organics (SSO): A system whereby the waste stream contains food, yard waste, and some papers. SSO is separated by householders according to municipal guidelines, and processed at composting facilities. For planning purposes, it is assumed in this document that a typical SSO program would recover 250 kg of SSO per household per year. The amount of leaf and yard waste varies according to local conditions, e.g., there are few leaves in Saskatchewan.

Source-separated recyclables: A system used in various locations across Canada, whereby residents store recyclable parts of the waste stream in a separate bag, box or bin at home, so that it is relatively uncontaminated when dropped off at the recycling centre or picked up at the curb.

Wet/Dry: The wet stream contains organics plus other wet materials that are typically sent to a composting facility. Dry contains all recyclables plus other dry materials. MRF facilities are designed to separate dry recyclables from residual materials which cannot be recycled or for which there are no or limited markets.

Mixed MSW: A residual waste stream from the residential sector after some recyclables have been source separated. In some Canadian locations this stream is composted. In this document, it is assumed that 550 kg/hh/year of mixed municipal solid waste (MSW) would be treated by the mixed waste processing systems considered.

Technology Vendors

Specific vendors are named in this document if they are the only supplier, or one of a few suppliers providing the equipment being discussed. If there are a number of suppliers, no one supplier is specifically named.

The Government of Canada and the Federation of Canadian Municipalities (FCM), funding partners for the *Solid Waste as a Resource* documents, do not endorse any particular vendor or technology.

Integrated Waste Management Model for Estimating Environmental Effects

The Integrated Waste Management (IWM) model (http://www.iwm-model.uwaterloo.ca/) has been used to estimate the effects of various waste management approaches, compared to landfilling the same material in a well-designed landfill. In all cases cited in this document where scenarios are compared, an amount of 1,000 tonnes was used for the model runs. Results in the following sections are presented in qualitative terms only, as the model results are specific to local conditions and will vary by municipality. Municipal staff is encouraged to use the model to estimate the comparative local effects of various waste management approaches.

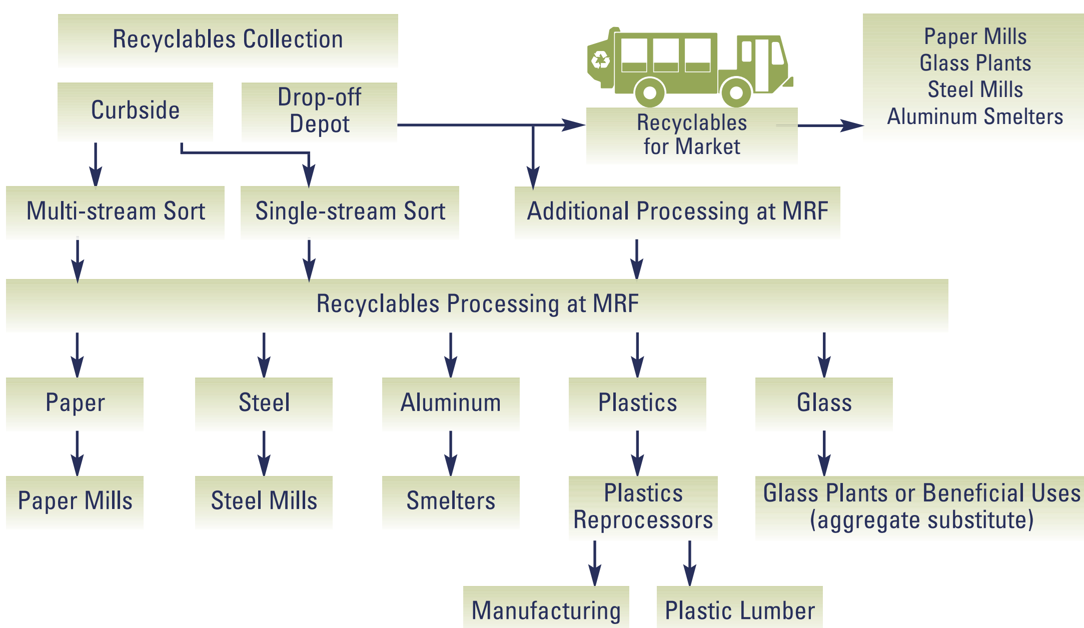
Recycling

General Description

Recycling refers to the recovery of dry materials: paper (old newspapers—ONP; old magazines—OMG; and old corrugated cardboard—OCC), plastics, glass, and metals from the waste stream for incorporation into new uses. Which materials a municipality chooses to recycle depends on several factors, including cost, existence of a market, distance to a market, and public acceptability. Paper recycling can be expanded to include boxboard and mixed papers. Plastics recycling programs most often target PET (polyethylene terephthalate) and HDPE (high density polyethylene), but other plastics, such as polypropylene and film plastic, can also be added. Recycling programs also collect steel and aluminum cans and glass bottles and jars.

Recycling is only applicable to 30 to 40 per cent of the waste stream. (These percentages are adjusted downward, because not all areas of Canada have viable recycling markets for all papers and plastics.) In theory, if all viable materials in the waste stream were captured, recycled and composted, approximately 70 to 80 per cent of the waste stream could be diverted.

FIGURE 2.1 TYPICAL RECYCLING SCHEMATIC



Markets

Markets for recyclable materials are the most critical factor in the success of any recycling program. If material cannot be sold, or used to displace another material, it would normally not be included in a program. However, materials often are targeted for recycling by municipalities for a variety of reasons not related to their marketability (e.g., politics, regulations).

The markets—all end users of recyclable materials—to which recyclable materials are sold for revenue are critically important as they specify types, quantities, and quality of materials that will be purchased. These requirements fundamentally influence processing, collection, and all aspects of a recycling program's operation. Some recovered recyclable materials are directed to "beneficial use" (e.g., when collected glass is crushed and used as an aggregate substitute), which offsets the cost of procuring raw materials.

General principles to apply to recyclable materials markets:

- Markets should be as secure as possible;
- Market requirements and location influence program collection and processing;
- Markets need high quality (materials are processed to meet market specifications), volume and consistency;
- Market fluctuations must be considered in program planning;
- There must be a market for materials made from recycled products to "close the loop."

Whereas a waste manager is a service provider, with a responsibility to collect waste and keep citizens satisfied with service, a recycling manager must also provide quality feedstock to an industrial process, ensuring clean, consistent volumes of useable material.

Traditional revenue generating markets require the following:

- High and predictable quality feedstock (i.e., uncontaminated recyclables);
- Sufficient volumes to be cost effective;
- A consistent supply.

These market requirements dictate the appropriate recovery technique, equipment, and recyclable material revenues.

Recyclable material revenues (and the stability of end markets) are affected by:

- Business cycle;
- Energy prices;
- Transportation costs;
- Exports and imports;
- Size and proximity of the market;
- Demand and supply of a particular material;
- Competition;
- Labour issues;
- A development/change in end use;
- Demand and supply of virgin materials;
- Innovations in raw material supply;
- Regulations, institutional, and government issues;
- Quality/quantity and consistency of supply of material;
- Landfill costs (indirectly).

Selecting End-market Options

Delivery options of processed materials to end markets are as follows:

- Haul recyclable material directly to material consumer (the mill) where it is processed and used in an industrial process;
- Haul to an intermediary (a broker or dealer) who processes it to specification and hauls it to the mill;
- Have an intermediary pick up recyclable materials;

- Adopt a regional approach with smaller, feeder programs decontaminating and storing materials to feed into larger regional processing centres that process materials and haul to market.

Factors to consider in choosing a recyclable materials market:

- *Distance to the market* – The greater the distance, the higher the haulage costs and the greater the need to reduce material volume through compacted/baled loads.
- *Required specifications for material preparation* – In general, select the market with the minimum specifications and the highest price. For a stable situation, it is important to balance the two elements, and look at patterns and history.
- *Tonnages* – Programs with larger tonnages can sell directly to a market, ensuring a higher price. Smaller programs require a broker/merchant to obtain a lower price.
- *Revenue:cost ratio* – Maximum revenue implies a higher processing cost, therefore there is a need to select the optimum revenue:cost ratio. It is important to find a balance between the two.

Steps to Finding Markets

Determining the best market for a material requires four steps: identifying, contacting, selecting, and contracting with buyers. This process takes time and resources to ensure it is done well.

Step 1 – Identify Potential Buyers: Contact information can often be found from talking to other recycling program operators, or by contacting national and provincial recycling and/or industry organizations.

Step 2 – Contact Potential Buyers: This step involves requesting information regarding the market. Some questions might include:

- Price paid for material;
- Material specifications (degree of contamination acceptable, densification required);
- Transportation costs;
- Minimum loads;
- References;
- Payment terms.

Step 3 – Select a Buyer: This step may involve interviewing potential buyers and assessing them based on a set of criteria.

Step 4 – Contract with a Buyer: A written agreement protects a relationship with a buyer as competition for markets escalates. Contracts can be useful when markets take a downturn because buyers may only service customers with written contracts. Written agreements may include letters of intent to purchase material as well as formal contracts. Provisions in a written agreement may include tonnage and volume requirements, material quality specifications, and provisions for delivery or pickup, termination provisions, length of commitment, and the pricing basis.

Co-operative Marketing

Where recycling programs are relatively small and do not benefit from economies of scale, co-operative marketing is beneficial. Co-operative marketing is the co-ordination among public and private sector recyclers facilitating more efficient and cost-effective movement of recyclables from sellers to buyers. Pooling the recyclables means sellers of recyclables have enough volume to enter large markets and command better prices for recyclable goods; it also allows access to longer-term, more reliable markets. From the buyers' perspective, it is often preferable to deal with large suppliers because this reduces overall purchasing costs.

Additional advantages of co-operative marketing include:

- Minimizing storage requirements at the processing facility (a full load of PET plastic is not required before it can be shipped out, because the co-operative efforts allow for a part load from each participant);
- The potential to organize more efficient transportation networks (due to larger volumes of recyclables).

Possible disadvantages include:

- Loss of total control or flexibility of the local recycling program;
- Potential to alienate private recycling businesses (brokers that no longer have your business);
- Difficulty to ensure that all loads meet quality specifications (it is often hard to determine what material originated from which program, which would have to be addressed in a regional agreement).

Local Market Development

Reuse and recycling industries convert materials from solid waste into marketable products. A range of materials is processed—paper, plastic, metals, tires, wood, textiles, construction and demolition waste, and organic garden and food waste. The sources of these materials are post-industrial (process scrap, off-cuts, off-spec materials) and post-consumer (used products and packages).

There is potential for the growth and development of reuse and recycling industries, especially where a large infrastructure for the collection of secondary materials already exists.

Local reuse and recycling industries offer several environmental benefits, including: diversion of solid waste from landfill; energy conservation; reduced transportation; and local employment. There are a number of studies on the viability of establishing local, small-scale industries to absorb locally collected recyclables. Examples of where this has been successful exist (Arcata, Calif.), but are limited and only absorb small amounts of the feedstock available.

Local reuse occurs in many Canadian locations. Ninety per cent of Manitoba's recycled glass is used locally (e.g., road construction). In the past, the Northern Ontario Recycling Association (NORA), a collection of rural and small town recycling programs in Northern Ontario, transported glass to Consumers Glass in Toronto. Since the market for glass is negative anyway, local uses for the glass in construction projects were adopted, rather than sending to distant markets (transportation costs of $65/tonne were higher than revenues of $43/tonne).

Technologies

Collection

Collection includes source separation of recyclable materials by the householder (optional), pickup of those materials from the householder (or drop-off systems in which the householder takes the materials to a specific site), and transport of the recyclables to either a transfer station or a processing facility. The issue of integrating recyclable collection with recyclable processing that suits local conditions is a key factor in the success of any recycling program.

The actual collection decision is based on several local factors, such as fleet age. Collection and processing decisions must be made together, because processing needs and design depend on how material is collected. The trade-off between cost and complexity of collection and processing is illustrated in Figure 2.2 on page 152. Effective recycling collection programs share the following characteristics:

- Convenience for operator and residents;
- Consideration for and integration with current waste management practice. For example, a community without curbside waste pickup would not have curbside recyclable pickup. On the other hand, making recycling more convenient than waste can realize greater diversion, but this requires political commitment;
- Flexibility to respond to changes in the recycling program. For example, it should be relatively easy to add new materials to the collection systems, although it is necessary to have a MRF that can handle the additional materials and to understand that removing them is often difficult (because of resident habits);
- Strong emphasis on communication and education programs.

Collection – Curbside Collection

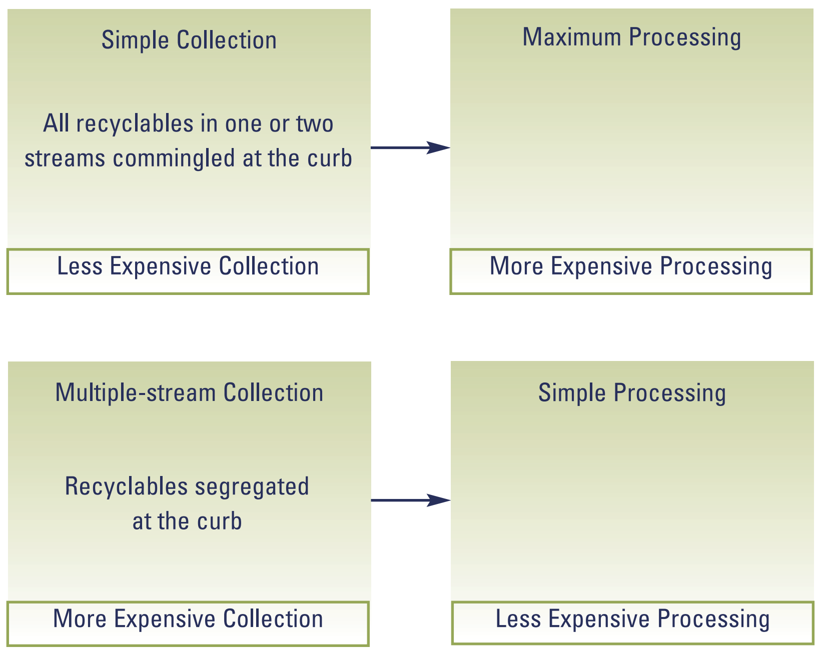
Curbside collection programs involve collecting recyclable materials directly from householders. Typically, recyclable material is placed in a recycling container and is collected by a vehicle dedicated to collecting recyclable material only, or in co-collection vehicles, where recyclables are collected along with garbage or organics. Well-designed and well-promoted programs can achieve high participation and recovery rates. This increased recovery potential comes at a cost: most curbside programs are more expensive to establish and maintain than depot systems.

A key decision for curbside collection is the level of commingling at the curb. This influences types of material collected, types of trucks used, and the design of the processing facility. Decision-makers must decide whether to invest more effort in the collection system (maximum source segregation/minimal sorting) or in processing (commingled collection/maximum processing). Collection costs are typically higher with more detailed material separation curbside, but processing costs can be lower. When material is commingled curbside, collection costs are lower, but processing costs can be higher. Collection and processing costs need to be combined to assess the most cost-effective system.

Another key consideration is collection frequency, which is decided in conjunction with other factors. Where collection and processing are split between two jurisdictions, the decision is even more challenging. Higher recovery is obtained with more frequent collection. Recycling collection on the same day as refuse also increases recovery. However, a number of other factors, including policies such as user pay, also have an effect on participation in and recovery from recycling programs.

Curbside collection options include: single-stream collection (fully commingled); two-stream collection (partially commingled); multi-stream collection (segregated), and co-collection.

Figure 2.2 Decision Tree for Recyclables Collection and Processing



Single-stream Recyclable Collection

Single-stream collection involves all fibre and container recyclables, fully commingled, in a single vehicle compartment. This results in a lower collection cost because collection is quicker, decreasing labour and other operating costs, and more efficient, lowering the size of the fleet required. All sorting takes place at a processing facility. The major disadvantage is that the processing facility must be capable of segregating all materials, including fibres, but this increases both the capital and the processing cost of the facility. It also increases potential for cross-contamination, lower quality and unhappy markets, and results in higher residue rates.

This approach is gaining popularity due to technical advances in processing that make it more cost-effective to separate the fibre/container stream. Minimizing collection time and associated costs are key considerations since collection expenses are typically the largest cost component of the recycling system. The single-stream recyclable collection system is well suited for large urban centres, where population density is high and traffic is a key concern, as it considerably shortens collection time.

Advantages include:

- No need for specialized collection vehicles (i.e., opportunity to use existing fleet);
- Lower collection capital investment (i.e., a rear-packer or side-loader used to collect garbage can be used);
- The system is more convenient for the householder, usually resulting in increased material recovery;
- Leads to simpler, more efficient and cost-effective collection systems (compaction, higher collection productivities, and it facilitates co-collection);
- Protection of valuable materials, such as aluminum cans, from scavenging.

Two-stream Recycling Collection

Curbside material is separated into two streams of recyclables, commingled fibres (cardboard, boxboard, paper) and commingled containers (glass, plastic, metal). Material can be collected in a single compartment truck, where one of the recyclable streams is bagged and the other is loose, or in a two-compartment vehicle. In the latter case, vehicle compartments are not properly matched to the proportions of recyclables set out at the curb; it is possible that one compartment may fill up before the others, reducing collection efficiency.

Advantages include:

- Cleaner, more marketable materials, since material has not been mixed and will not require separation at the MRF (driver can also check for contaminants). Some material may not meet specifications if not sorted at the curb (e.g., colour-sorted glass);
- Fewer processing requirements (e.g., sorting);
- Where the fibre stream is collected in a single-compartment truck, the material can be compacted to maximize the load and minimize the number of loads as long as the processing facility can process the material in that condition.

(Note that two-stream collection of recyclables is different from two-stream wet-dry systems, which are part of composting.)

Disadvantages include:

- Partially commingled collection requires various levels of intermediate processing capability, depending on the collection truck and number of materials collected;
- Higher levels of non-recyclable materials at the processing facility, since this approach normally involves less sorting and thus less contaminant removal at the truck;
- The compaction of commingled containers must be limited to avoid crushing glass containers, because anything less than two inches is usually not recovered.

Multi-stream Recycling Collection

Multi-stream collection means sorting recyclables into more than two streams at the curb. Since collection efficiency decreases with the number of sorting activities curbside, this system is more costly. However, processing requirements and costs decrease. This system is particularly appropriate for small programs with no local processing capability.

Advantages are similar to those of the two-stream system, although the benefits are more fully recognized. In particular, the quality of the material streams is usually higher since the driver/sorter is most likely to leave non-recyclables at the curb.

Co-collection

This approach is essentially the simultaneous collection of two or more material streams (e.g., recyclables and garbage, or recyclables and organics) with one vehicle. Co-collection may provide improved efficiency over operating two (or more) collection vehicles on the same route.

Co-collection may involve any combination of refuse, recyclables, and organics. If properly designed, co-collection systems can be cost-effective, and achieve high recovery and participation rates. Most communities choose to co-collect for economic reasons, especially because of the potential to provide a simple, low-cost approach to curbside collection of recyclables.

Advantages include:

- The need for fewer trucks and less labour (most co-collection systems require only one or two employees while separate collection requires two trucks and usually more personnel);
- Decreased road wear and tear (especially rural dirt roads);
- Reduced fuel consumption and associated pollution;
- Reduced compensation costs for workers;
- Increased efficiency in rural areas as truck volumes are optimized.

Co-collection systems have been tested in rural and urban settings in North America and Europe. Canadian communities now using co-collection: City of Guelph, Ont., (two-stream, wet/dry); Regional Municipality of Halifax, N.S., (three-stream recyclables and garbage with alternating week collection); Northumberland County (wet and dry streams); Bluewater Recycling Association, in Southwestern Ontario, (recyclables and garbage); and the City of St. Thomas, Ont., (recyclables, organics, and garbage on biweekly schedule).

Collection – Curbside Collection Equipment

Household Recycling Containers

Blue, black or green boxes, plastic bags, or roll-out containers, facilitate storage and contribute to collection efficiency and ongoing promotion/peer pressure to participate. The existence of a container has been shown to significantly increase participant rates. Different containers are suited to different systems.

Bags

Several bags are currently on the market, including recyclable or reusable plastic or mesh bags. Kraft bags are increasingly used for organic material, especially yard waste. Bags require less storage space in the home than containers, and they are easy to collect by the driver. Other containers must be emptied and returned to the curb. Additional considerations if bags are used:

- Reyclables need to be debagged before processing;
- If bags are opaque, the driver cannot spot contaminants;
- If recyclable, the bags will require processing;
- Bags require a permanent distribution system.

Canadian municipalities using bags for collection of recyclables: City of Edmonton, Alta.; City of Guelph, Ont.; Regional Municipality of Halifax, N.S.; and City of Kelowna, B.C.

Containers

Blue, green, grey, and black boxes are more common in Canada than bags. Some programs provide two boxes (one for containers, the other for fibres). Product specifications to consider when purchasing containers:

- Container size, weight, and volume capacity must be large enough to handle several materials, yet small and light enough for transport to the curb;
- Handle design should be safe, comfortable, and easy to grasp;
- Drainage holes – container should allow for some liquid accumulation during in-house use, but permit rainwater drainage outside;
- Durability – able to withstand temperature extremes, rough handling, household chemicals;

- Nesting capability – for storage and shipping efficiency;
- Attractive colours enhance participation and may significantly affect program success;
- Large flat surface for program message delivery;
- Plastic containers should contain an ultraviolet stabilizer to protect from sun damage.

Rollout Containers

Carts or wheelie bins potentially can be stored outside. These bins also hold more materials, allowing recycling of a larger number of materials and greater diversion.

Disadvantages include:

- A tendency to have higher contamination levels, as the containers can not be checked by the driver before dumping in the vehicle;
- Rollout carts need specialized vehicles with hydraulic lifting, require cycle time for the lift mechanism and, therefore, slow collection productivity;
- Rollout carts are much more expensive;
- The larger size of rollout carts is often not appreciated by householders with limited storage space.

As programs move towards more commingled collection systems, the use of carts and bags will increase. Many municipalities favour rollout carts because semi- or fully automated trucks reduce worker injury.

Collection – Collection Vehicles

Basic recycling vehicles include:

- Closed-body vehicles;
- Low-profile closed-body vehicles;
- Hydraulic side-loading trucks;
- Compactor trucks;
- Dual- or multi-compartment collection vehicle;
- Co-collection truck.

Recycling vehicle design has a significant effect on collection productivity. Collection vehicles have become more diverse as fleet managers demand models and design features best suited for local conditions and needs. Considerations for recycling vehicles include:

- Vehicles with separate compartments (co-collection of recyclables) for each material will result in cleaner, more marketable materials (requiring less processing) than recyclable material that is commingled;
- Vehicles that avoid compaction generally result in more marketable materials than those that compact materials (although this is improving in more recent co-collection vehicles);
- Vehicles that dump recyclables from a height tend to lead to higher glass breakage;
- Vehicles used for refuse and recyclables must be well cleaned between uses to avoid contamination;
- Some vehicles can be equipped with processing equipment (e.g., a plastics compactor);
- Vehicles that collect fully commingled recyclable streams have greater collection efficiencies than those that collect materials in separate compartments. Vehicles with only one compartment have greater capacities, which has a positive effect on collection efficiency;
- Vehicles that are obviously designated for "recycling" encourage participation.

Hydraulic Side-loading Recycling Truck

This type of truck was specifically designed to overcome some problems associated with operation of manual-loading recycling trucks. Rather than sorting materials directly into the body of the truck, materials are sorted into a segmented trough on the side of the vehicle. When full, the trough is raised mechanically or hydraulically to the top of the truck and dumped in.

Table 2.1 Advantages and Disadvantages of Hydraulic Side-loading Recycling Truck

Advantages	Disadvantages
■ One-person operation	■ High capital costs
■ Dual drive	■ Dumping height of side buckets can result in increased glass breakage (can be reduced by commingling glass with metal/other plastic containers
■ Easy exit and entry	■ Roof height when loading (some models)
■ Hydraulic unloading	
■ Distinct, specialized recycling vehicle contributes to promotion effect	
■ Hydraulic side buckets result in constant low loading height increasing ease of loading and collection efficiency	
■ Full volume of truck can be used (typically 31 cu yds)	
■ Dumping mechanism can be used to service large collection containers from apartments and commercial establishments	

Conventional Rear-packer Truck

This type of truck is the most commonly used vehicle for residential garbage collection in North America. Garbage is loaded into a hopper at the rear of the vehicle and, when the hopper is full, "swept" into the body and compacted. These trucks are also used to collect single-stream recyclables, or wet and dry waste in a wet/dry program.

Table 2.2 Advantages and Disadvantages of Conventional Rear-packer Trucks for Collection of Recyclables

Advantages	Disadvantages
■ Available and familiar in most communities	■ Can not be used for multi-material collection, as only one compartment is available
■ Well-suited for refuse collection (may integrate recycling with refuse collection)	■ Normally two- or three-person operation
■ Easy to load and unload	■ High capital and operating cost related to hydraulic system
■ High cargo weight	■ Only one compartment available
■ Suitable for collection of cardboard	■ Contamination problems if truck is also used for refuse collection
■ Low loading height	■ Residents might be confused with regular refuse collection (if not using good signage)
■ Loader can ride on back	
■ Lower cost	
■ Availability	

Dual-compartment Collection Vehicle

These trucks are now common in side-loader and rear-loader models. They allow compaction in both compartments. Vehicles have a horizontal or vertical split depending on specific manufacturers or designs.

Table 2.3 Advantages and Disadvantages of Dual-compartment Collection Vehicles

Advantages	Disadvantages
■ Permits two material streams to be collected on one vehicle at the same time ■ More efficient in rural areas with a single pass	■ Compartments may fill at different rates, unless the partition is self-adjusting ■ High cost

Collection – Co-collection Equipment and Technologies for Recyclables

Collection programs require MRFs capable of handling increased commingling of recyclables. Two-facility-siting considerations affect efficiency due to distance between facilities and routes, and proximity of one facility to another (e.g., of the MRF to the landfill). In a co-collection program, the closer the facilities are, the more likely the co-collection will result in savings.

Equipment for these programs, such as household storage containers (bags to carts) and vehicles, can vary. Vehicles range from refuse side-loaders to specialized collection vehicles. A number of vehicle configuration options exist: using an existing truck (e.g., packer) with bags; towing a trailer behind an existing garbage truck; retrofitting an existing truck; and using a specially designed co-collection vehicle. Vehicle design considerations include:

- Vehicle configuration;
- Overall truck capacity;
- Useful volume of truck and compartment configuration;
- Hopper size;
- Loading and unloading configurations;
- Special design features (e.g., electronic transmission instead of mechanical to improve fuel mileage, specialized brake recovery system).

Factors influencing the cost-effectiveness of a co-collection program:

- Proximity of the processing facility and disposal sites;
- Number of staff/truck and wage rates;
- Truck capacity by material;
- Cycle time during collection;
- Household participation rate;
- Amount set out per household by material;
- Non-collection time;
- Physical conditions for truck operation.

Switching from a dedicated recycling and garbage system to co-collection is likely to affect program costs.

- *Number of trucks:* Typically, the same number or fewer co-collection trucks is needed compared to recycling plus garbage truck use (co-collection trucks tend to be bigger).

For instance, moving to co-collection in the City of Guelph, Ont., reduced routes from nine to eight.

- *Increased capital costs/truck:* Co-collection trucks cost more than dedicated recycling or garbage trucks. However, this may be offset by the requirement for fewer trucks with co-collection.
- *Operating costs:* A co-collection vehicle costs more to maintain (by virtue of its hydraulics); however there may be fewer trucks to maintain. Fuel costs typically decrease.
- *Wages:* The number of crew (and wages) likely decrease.

Collection – Drop-off Programs/Depots

Depots involve the public bringing material to a site or container from which it is collected and transported to a market directly for recycling, or to a MRF for processing before recycling. This involves free-standing containers placed at specific locations where the public deposits a variety of materials. Some programs include only a single container for a material such as glass or fibre. Others use a mini recycling centre that houses three to four containers for different materials, or a large recycling centre that has reception areas for many materials, including refuse, but that also carries out salvage operations on the materials (sorting, crushing, baling, resale to public). The containers are emptied frequently.

Table 2.4 Advantages and Disadvantages of Drop-off Programs/Depots for Collection of Recyclables

Advantages	Disadvantages
Inexpensive to install and easily available	Risk of material contamination/vandalism
Established and well understood system which raises public awareness	Relatively low recovery rates (typically 10-15 per cent relative to curbside, though glass recovery rates of more than 60 per cent have been reached at some depot centres)
Provides service to most dwelling types, including high density; easy to extend or contract by placing depots in other areas	Typically participation is in the 15-20 per cent range (less convenient for residents than curbside)
Can handle wide variety of materials (more than is practical to collect at curbside)	Not typically used for collection of organic materials
Can be used to help community groups raise funds	Requires minimum amount of recyclable material to be economical
Convenient, round-the-clock access is possible	Not energy efficient if public makes extra trips to use the site
Investment costs can be carried by merchants and/or retailers	
Relatively easy to manage and quick to implement	
Energy efficient provided public use them as part of their normal routine	
Good for seasonal populations	
Good for sparsely populated areas	

Variables affecting recycling recovery from drop-off systems:

- Location and number of locations or sites;
- Type of sites (permanent, mobile);
- Range of materials accepted;
- Promotion and education;
- Public access (hours of operation);
- Whether household storage containers are distributed to residents or not;
- Seasonal variations;
- Whether the site is staffed or not staffed.

Differences in site design and sophistication have developed relative to capital constraints and anticipated program life cycles. The key consideration from an operator's point of view is the collection and handling system for recovering the materials deposited in the depot.

Drop-off Depot Options

The most common containers used in drop-off programs include:

- Bulk-lift containers (with compartments for different types of the same material, e.g., glass bottles sorted by colour, or open containers for green refuse or demolition type materials);
- Roll-off containers (top-loading, capacity from 240 to 1,100 litres);
- Multi-purpose depot systems.

In deciding on the type of container to install, attention should be given to:

- Aesthetic, well-maintained containers that can be placed in high-profile/easy-to-access locations serving as a constant reminder of the recycling program;
- A low loading height with access holes within reach for children and with handicap access;
- Customized openings to encourage correct separation of materials;
- Modular design allowing optimal utilization of storage capacity while minimizing host space utilization.

Bulk Lift Containers

The introduction of self-dumping depots responds to the inherent handling problems of small unstaffed depots. Basically, each depot container is mechanically lifted and its contents off-loaded directly into the collection vehicle. The primary impetus was the development of recovery systems for waste glass in European and some U.S. cities, where a dense network of depot sites can be serviced economically. Key limitation: a special collection vehicle may be required with appropriate storage compartments for each material handled.

The "igloo" system is a commercially available depot, originally developed in Europe. The igloo-shaped, fibreglass reinforced, polyester depots have two steel eyelets at the top and steel trap doors on the bottom. Each igloo is approximately five feet high with a capacity of three cubic yards and handles a single material. Igloos exist with one, two, or three compartments, creating separate volumes of 1.6 to 8 cubic yards. This allows the construction of drop-off depots in the right shape and size for every application. A roll-off truck fitted with a hydraulic crane best services the depots. The crane picks up the depot by the steel eyelets, the contents are emptied into the roll-off container by releasing the trap door, and the empty depot is returned to the ground. If handling more than one material, the roll-off container can be divided into sections. The truck can hydraulically unload the collected material at the processing facility. The number of depots that can be serviced by one truck depends on the variety of materials handled, the distance between sites, and collection frequency.

Another bulk lift system utilizes a deep well whereby two thirds of the container is actually underground. This system has several benefits: a relatively small ecological footprint; and the contents are less likely to smell, given the cooler in-ground temperature. A disadvantage is the need for a special truck with a hydraulic arm. The

City of Toronto, Ont., has been testing some of these containers at some apartments.

The City of Calgary, Alta., operates 44 residential recycling depots within city limits using specially designed, high profile Haul-All containers. Containers are available in 4- or 6-cubic-yard capacities (3 or 4.5 cu metres). Specially designed openings for different material types minimize contamination. Haul-All side-loading collection vehicles service the depots.

Bulk lift container systems are well suited for high-rise neighbourhoods, institutions, factories, retail, and recreational areas.

Roll-off Containers

The containers are made from a standard enclosed roll-off container (capacity from 240 to 1,100 litres), modified by dividing it into separate compartments for glass, cans, plastic bottles, and newspaper. Small holes are cut in the top or side for glass, cans, and plastic bottles. Doors are cut in the side for newspaper and cardboard. The dividers are hinged to allow materials to be hydraulically unloaded, one at a time.

Since the depot is of sufficient size, less frequent servicing is possible, making this system best suited for rural areas where infrequent servicing is desirable. Many rural programs locate a specially divided, open-top, roll-off container, with an access ramp, at the local landfill site. Given that the siting of a depot will often require a concrete or asphalt pad and a large area for the collection vehicle, it is generally not suitable for high-rise complexes or small commercial/retail sites.

Multi-purpose Depot Systems

Systems equipped with a hook-lift system are used in smaller municipalities. They use truck platforms that can accommodate various containers or bodies, including those suitable for use as recycling depots. These depots are modified, closed, roll-off containers with multiple compartments, each equipped with a door. The trucks can also be used as a roll-off truck, a dump truck, or a flat bed, allowing a small operator a wide range of services from a single vehicle.

Some communities operate larger-scale depot programs that collect a wide range of material. The Region of Peel, Ont., operates four sophisticated public waste and recycling depots. The depots are located in convenient and accessible industrial areas. There are four main components to each facility, including a recyclable material drop-off (for material not suitable for curbside collection, such as bulky items, electronic goods), household hazardous waste drop-off, a reuse centre, and an organic material drop-off and compost sale.

The Nova Scotia Resource Recovery Fund Board (RRFB) operates almost 90 Enviro Depots for drop-off of a number of materials.

Mobile Drop-off Programs

If a community cannot justify a stationary depot site, an alternative is a mobile program. Mobile stations can visit temporary drop-off locations in multiple communities on a rotating basis, are usually staffed, and residents know site schedules. These are more typically used for the collection of household special waste, where costs of operating permanent depots is high.

Collection of Recyclables from Multi-family Buildings

Servicing residents living in multi-unit buildings presents unique challenges. Common approaches involve providing residents with a recycling container (bag or box) and encouraging them to take recyclables to a central storage area, which may include rollout carts outside the building or a designated room on each floor where residents sort materials into larger containers.

Some high-rise buildings with garbage chutes have implemented a multiple chute system that can service both garbage and recyclables. One system allows the traditional garbage chute to be used for up to six different materials. Residents select one of a series of buttons on a control panel that relocates a diverter or carousel at the bottom of the garbage chute to direct materials into a specified storage bin. One button is always for garbage, but additional buttons can specify segregated recyclable streams (e.g., commingled papers and commingled containers). The most common system includes buttons for garbage, and commingled papers and containers and requires a minimum of three bins at the chute base.

The systems can be installed in new buildings or as retrofits. The two and three separation systems are particularly effective for retrofits because existing compactors, garbage, and recycling bins can often be used.

Hi-Rise Recycling Systems Inc in Miami, Florida, offers a number of models capable of multiple separations in multi-unit buildings. The City of Toronto, Ont., has tested various approaches in chute designs.

Processing

Processing involves getting collected recyclable materials into a form suitable for sale to markets through removal of contaminants, densification, and baling. Once markets have been determined, a decision can be made on how to process materials to meet market specifications. Processing includes:

- Sorting material (removal of contaminants);
- Grade sorting (i.e., sorting different grades of paper); and
- Separating mixed recyclables.

Processing includes compaction of materials for transportation, storage of materials, and then loading onto transfer containers to be hauled to market. The processing needs of recycling programs vary from regional facilities requiring a full complement of sorting and densification equipment to small programs carrying out minimal material handling.

Processing – General Variations on Recyclables Processing Design

Key principles of recyclables processing:

- *Economies of scale* – The greater the throughput of recyclable materials, the less expensive (per tonne) it is to process the materials.
- *Value added or cost versus revenue* – Processing recyclable materials is normally justified by more revenue obtained for those materials. Other factors, such as citizen demand or provincial regulation, also influences decisions.
- *Efficiency* – Minimize double handling where possible.
- *Flexibility* – Maximum utilization of equipment and labour (finding the optimum balance between manual labour and equipment).
- *Provide adequate floor space* – To meet local or regional capacity and sufficient unloading and storage areas.

Processing – Equipment Overview

Table 2.5 on page 162 outlines typical processing equipment used at MRFs to process collected recyclables to a quality suitable for sale to market.

The main techniques used to process collected recyclables involve sorting materials using a variety of methods and approaches including:

- *Manual labour* – Sorters along conveyors pull specific materials off the line.
- *Size* – Trommel screens, disc screens, and vibrating screens allow materials of a certain size to pass through.
- *Weight* – Chain curtain inclined vibrating tables and air classifiers sort materials based on weight.

- *Density* – Although not common, materials may be sorted with liquid floatation systems based on density.
- *Magnetic properties* – Ferrous metals can be sorted based on their magnetic properties.
- *Electrical properties* – An eddy current and conductivity can be used to sort materials based on electrical properties of the materials (materials are given an electrical charge).
- *Shape* – Flat/round separators, such as disc screens, bounce cohesion conveyors, etc., sort materials based on their shape.

Table 2.5 Typical Processing Equipment at MRFs

Steps	Equipment for Large Facilities (more than 30K households)	Equipment for Small Facilities (less than 30k households)
UNLOAD COLLECTION VEHICLES	■ Bunkers/bags ■ Skid steer loader ■ Front end loader ■ Ramps ■ Conveyors ■ Weigh scale ■ Concrete tipping floor	■ Rollout containers ■ Weigh scales ■ Bunkers ■ Trolley/wheeled container ■ Roll-off containers ■ Igloos ■ Ramps ■ Tipping floor ■ Pallet jack
SORTING	■ Sort equipment (mechanical) ■ Air classifier ■ Conveyors ■ Magnetic separators ■ Sorting platforms ■ Trommels ■ Eddy current separators ■ Screens	■ Skid steer loader ■ Blowers ■ Grade separation ■ Conveyors
COMPACTION	■ Baler ■ Densifier ■ Compactor ■ Shredders ■ Granulator	■ Small baler (dedicated to one material and less automated) ■ Front-end loader
STORAGE	■ Bunkers/bays (covered) ■ Building ■ Containers ■ Trailers ■ Cages	■ Roll-off containers ■ Bunkers/bays (open/covered)
LOADING FOR SHIPMENT	■ Forklift ■ Front-end loader ■ Walking floor trailer ■ Conveyor ■ Blower	■ Skid steer loader ■ Blowers ■ Grade separation ■ Forklift with self-tipping hoppers
SHIPMENT TO MARKET	■ Roll-off containers ■ Trailers ■ Weigh scale ■ Barge ■ Rail	■ Roll-off containers

Processing – Residue Levels

Residue is produced when recyclables are processed to meet market specifications. Residue rates are lower in source-separated recycling programs and higher when recyclables are commingled. Residue levels at a MRF depend on the recycling system and can vary from two to 15 per cent for a MRF receiving source-separated recyclables (i.e., high level of control at the curbside). Residue rates of up to 40 per cent are experienced at mixed waste and two-stream MRFs. Residue is either sent to landfill or incineration or is reincorporated into the processing system. High residue levels are generally considered unacceptable and are a reason to investigate for causes.

Residue can be intercepted/avoided by:

- *Source separation by the resident* – Significant communication with residents is required to educate them regarding what materials are and are not acceptable, and how they must be prepared. Several curbside recycling programs find it effective to promote instructions for recycling in appropriately prepared recycling containers.
- *The collection crew* – An important line of defence in a successful recycling system, especially a source-separated collection system. They must leave unacceptable materials behind and often can speak directly to the public, explaining why materials cannot be accepted. Some containers (for example carts and bags) are more difficult for drivers to monitor for contamination.
- *The design of the collection system* – Some contribute less to contamination and residue, for example, those that involve a detailed curbside sort.
- *Processing modifications* – Installing a second magnetic separator ensures that more steel is recovered from the aluminum stream. Inspection or pre-sort stations at the start of the sorting line can also reduce unwanted objects, as can screening equipment that screens off fines too small for marketing.

In general, there is a correlation between the collection/processing system and level of residue. Typically, residue is higher in recycling processing facilities that accept commingled materials.

Processing – Relationship Between Processing and Collection

The type of collection program directly affects the waste processing options available. A recycling system that relies heavily on sophisticated processing will have a simple and inexpensive collection system, while a system requiring little processing has a more complex and costly collection approach. A municipality considering recycling collection and processing operations will confront the issue of whether to invest more effort in the collection system (maximum source separation/minimal processing) or in the processing system (commingled collection/maximum processing). The decision is one of economics, level of diversion desired and regulations, and is heavily influenced by community demographics. In large urban centres, where population densities are high and traffic a concern, minimizing collection time and associated costs are key considerations since collection costs are typically the largest component of the waste management stream.

Table 2.6 Recycling Collection and Processing Combinations

Collection Approach	Processing Approach	Municipal Example Where Used	Typical Residue Rates
SINGLE-STREAM Fully commingled recyclables collection (no sorting)	Maximum processing required to separate different recyclables from single collection stream	Edmonton, Alta.	15%
TWO-STREAM Partially commingled recyclables collection (minimal sorting); typically fibre stream and container stream	Basic sorting and processing to separate different grades of paper (ONP, OCC, etc.) from fibre stream and different container materials (glass, plastic, aluminum, ferrous) from container stream	Peel, Ont.	6%
MULTI-STREAM Segregated recyclables collection (maximum sorting)	Minimal processing required because most streams already separated into separate materials during collection. Processing usually only required to consolidate/bale material for market	Quinte, Ont.	<3%

Single-stream Recyclable Processing: Required when the collection of recyclable materials is fully commingled. This approach is gaining interest throughout North America. In 1997, there were three reported MRFs in the U.S. processing single-stream recyclables; in 2001, there were more than 80.

While this system makes collection quicker and therefore cheaper, it also presents more complicated sorting and processing challenges (resulting in higher capital costs) for the efficient separation of fibres and container materials. Maximum processing is required, which is costly, and there is an increase in contamination levels and residuals (especially mixed broken glass). The dramatic growth of these systems in recent years has largely been the result of significant technology advances in the development of "star" or "disc" screens, which assist in the primary separation of fibre grades and perform the majority of the fibre/container separation.

Other sorting processing equipment may include: mechanical sort equipment; air classifiers, blowers; magnetic separators; conveyors; sorting table; manual labour sorting systems; and trommel screens.

Compaction equipment may include balers and densifiers.

Two-stream Processing: Required when recyclable materials are collected in two groupings during collection, e.g., fibres and containers (partially commingled). The approach is commonly used in curbside collection and sometimes in drop-off programs. Typically this approach involves commingling all fibre material (ONP, OCC, boxboard, mixed paper) in one compartment, and mixed containers (glass, plastic, aluminum, steel) in another.

Basic sorting and processing is required under this approach, as well as some consolidation of materials. Sorting processing equipment may include conveyor belts, sorting table, and a manual labour sorting system. Compaction equipment may include balers and densifiers.

Multi-stream Processing: Used when recyclable materials are segregated to the maximum degree during collection. This approach is commonly used in drop-off programs, and sometimes in curbside programs. Minimal separation is required during processing. Typically, only compaction is required, and material is sometimes shipped directly to the market or broker. Compaction equipment includes balers and compactors.

Figure 2.3 Typical Processing Requirements for Single-stream System

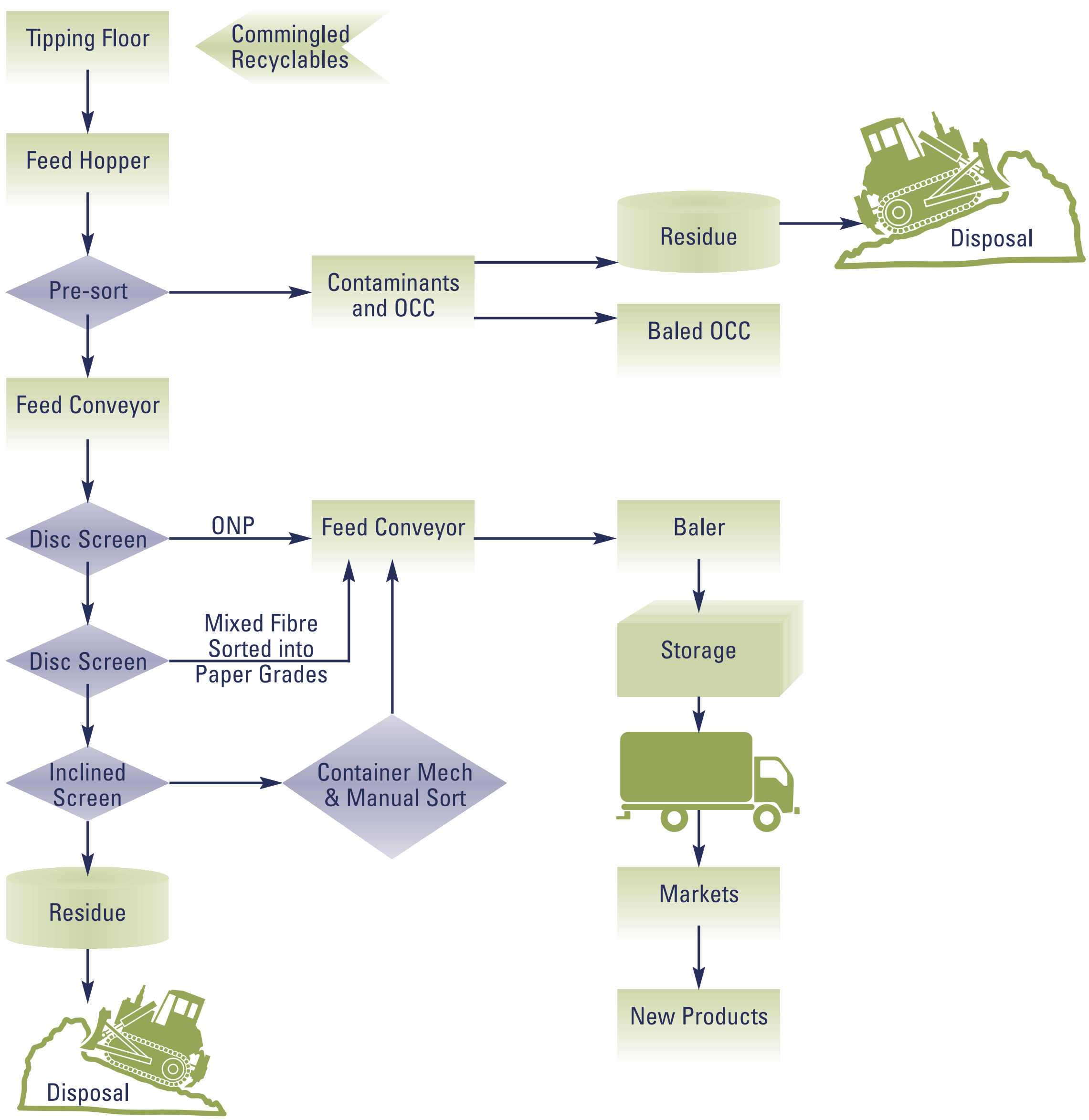


Figure 2.4 Typical Processing Requirements for Partially Commingled System – Container Fraction Only

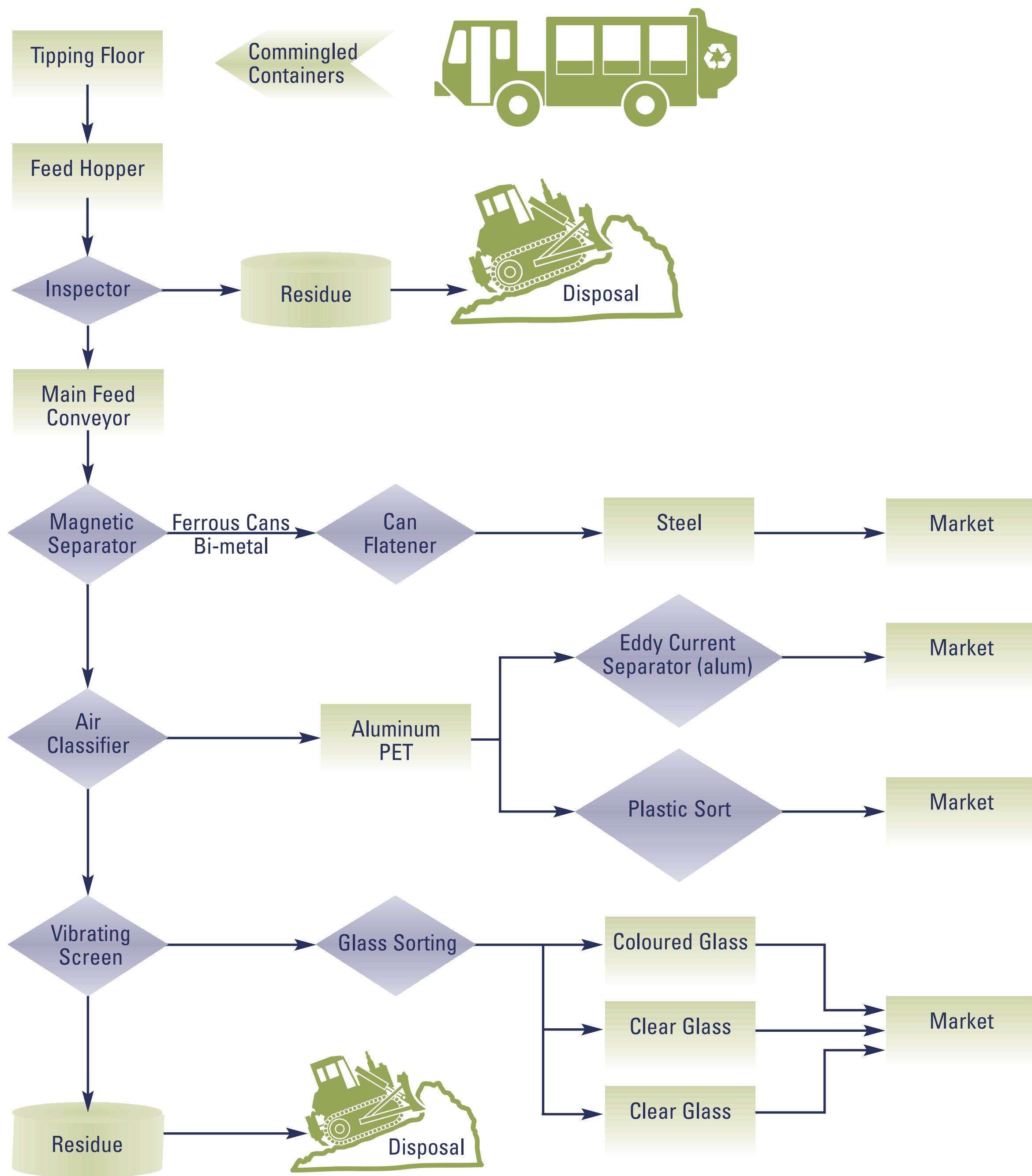


Figure 2.5

Typical Processing Requirements for Partially Commingled System – Fibre Fraction Only

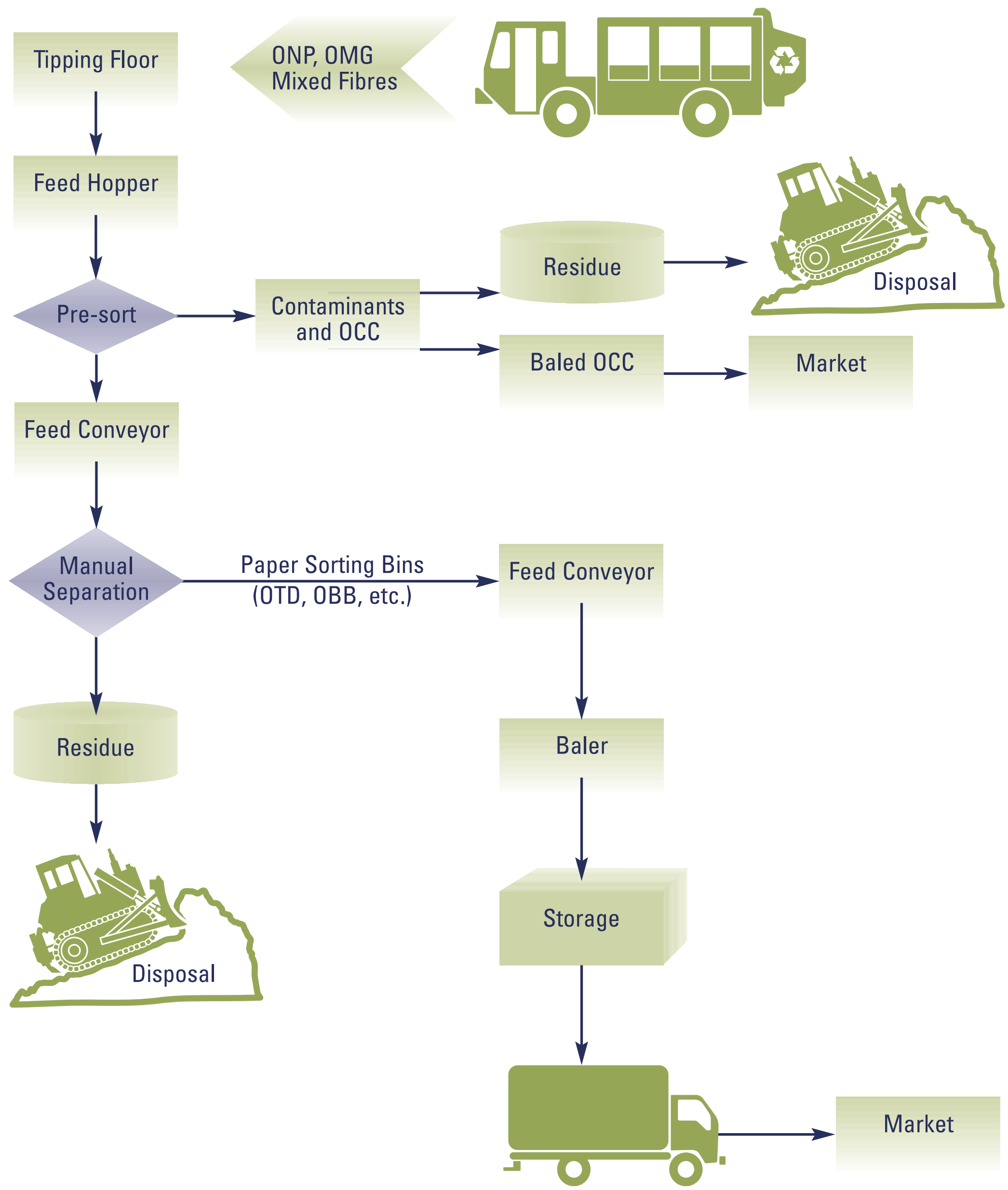
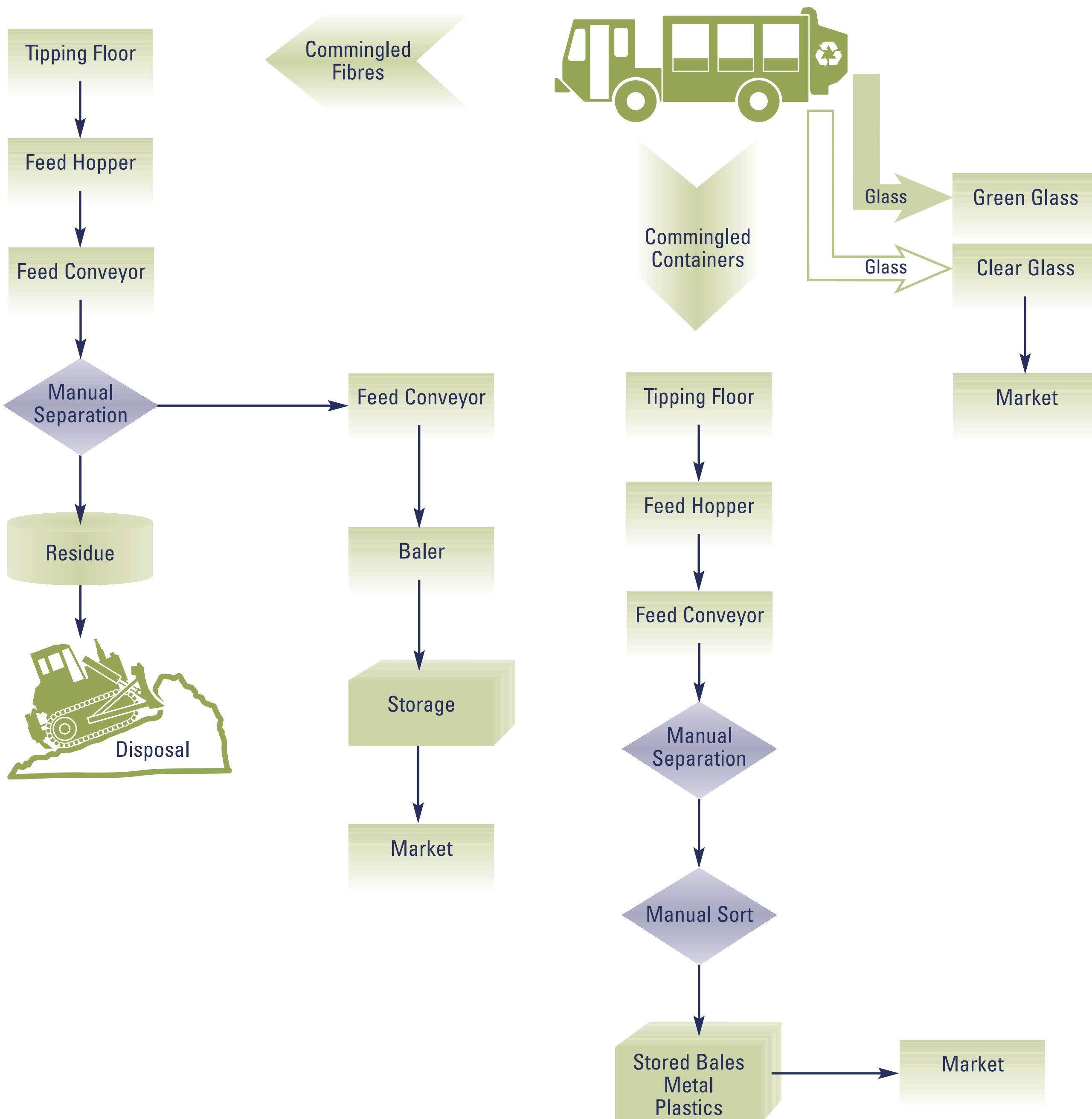


Figure 2.6 Typical Processing Requirements for Fully Segregated Recyclables



Processing – Processing Technologies for Recyclables

Bag Breakers/Openers: Needed when recyclables are collected in plastic bags. There is much variety in the market, but most products can be categorized as either slitters or augers. There is no mechanical "debagger" that does an efficient job of breaking the bags and mechanically collecting the plastic. All units require some degree of downstream manual separation of the plastic film.

Auger-type bag openers rely on a screw auger rotating in a cylinder. As bags are moved through, they are ripped by the action of the auger against the inside cylinder wall. These have achieved mixed success with bagged recyclables. Glass breakage is more severe in these breakers. This breaker is more popular for use with bagged organics (e.g., as in the City of Guelph, Ont., wet composting plant).

Capital costs of bag breakers are approximately $150,000.

Air Classifiers for Light/Heavy Sort: Low velocity air is used to separate lighter materials (e.g., aluminum and plastics) from heavier materials (glass). This can be accomplished by:

- Blowing the lighter materials across an air knife to another conveyor at a conveyor tail pulley (heavier materials drop over the tail pulley); or
- Using suction above a commingled container stream on a conveyor to remove the lighter material (heavier material stays on the conveyor). Once removed, the lighter materials are directed to a separate sorting conveyor.

In the vacuum system, air velocities within the pickup unit can be adjusted to create multiple pressure drops. Heavier items will drop out first and lighter second. Vacuum systems are popular for conveying materials, such as film plastic, PET and HDPE containers and aluminum cans, from sorting stations to a remote cage or bunker.

The use of an air classifier is common in a container MRF, with most units ranging in throughput capacity from 5 to 10 tonnes/hr. Capital costs are approximately $55,000.

Inclined Conveyors for Light/Heavy Sort: Bezner introduced the first inclined heavy/light sorting conveyor system into the North American market at the Rhode Island Johnston MRF. It uses an inclined conveyor and a series of parallel chain curtains to separate light containers (plastic and aluminum) from heavy containers (primarily glass). Lighter containers are directed along the conveyor and discharge off the end. Glass containers are encouraged down the side-slope and removed. Manufacturers of disc screens, such as Bollegraaf, CP Manufacturing, BHS and Machinex, also produce similar inclined conveyors for separation of containers and miscellaneous fibres.

An inclined conveyor with a throughput capacity of approximately 10 tonnes/hr has a capital cost of approximately $230,000.

Trommel Screens for Size Separation: Rotating, inclined drums primarily use a combination of rotation and screening to separate materials. The tumbling motion created by the rotation drum shakes loose smaller-sized objects (dirt, grit, bottle caps, broken glass) that exit through holes in the drum. Larger materials exit at the downstream end. Trommels can be designed with a variety of hole diameters, staged in sequence to separate different container sizes.

Trommel screens can also be used as bag breakers. For this application, triangular steel "knives" or spikes are welded to the inside of the drum. As bags containing recyclables or mixed waste tumble in the drum, the bags are ripped open. One disadvantage is pronounced breakage of glass if it is intended that glass be manually colour sorted and when ceramic content must be reduced.

Trommel/Magnets for Size Separation: Several manufacturers offer a combination trommel screen and ferrous separation. The combination trommel-magnet has a stainless steel tube welded to the end of the trommel. A magnetic field is created in the tube to attract ferrous recyclables. Ferrous materials attached to the inside of the tube rise with the rotation of the trommel. At a predetermined point in the rotation, the magnetic field weakens, allowing the ferrous to drop via a chute into a bin or onto a dedicated conveyor.

The trommel-magnet is less expensive than a cross-belt magnet, yields a high ferrous recovery with almost the same purity, and also removes fines. These trommel systems handle 4-9 tonnes/hr of commingled containers with prices starting at approximately $30,000. This trommel also provides some space savings over a conventional trommel and fines screen combination.

Star Screens (Disc Screens) for Size Separation: Popular in a variety of sorting applications:

- Single-stream MRFs to perform an initial separation of fibre and container materials;
- Fibre sorting applications to separate OCC or ONP from other fibre grades;
- Commingled container sorting systems, as an alternative to vibratory screens and trommel screens for removing fines, debris, and broken glass from larger containers;
- Commingled container sorting systems, to sort containers from miscellaneous fibre contaminants.

These screens consist of a number of rotating axles, each containing a number of "star"- shaped wheels. The spacing between axles is adjustable, as is the star diameter. Spacing depends on the sorting function. The screen bed is tilted upward. As the commingled stream is directed onto the lower end of the screen, oversized material bounces along the top in the direction of the star rotation, and smaller material falls through the open spaces between the stars. In most Canadian MRF applications, these screens would be used on a container sorting line to remove fines, debris, and broken glass. In a single-stream (fully commingled mixture of fibres and containers), disc screens are used for OCC and ONP separation. They handle up to 25 tonnes/hr and range in cost from $150,000 to $250,000.

Glass Sorting: Mechanical sorting of glass cullet is relatively new in North America. The sorting technologies are more common in larger glass reprocessing facilities, where larger throughputs are necessary to justify the capital outlay for the sophisticated equipment. Optical sorters generally work effectively on glass pieces ranging in size between one and four centimetres. Sorting equipment is operated to remove ceramics from a mixed glass stream, or colour sort a mixed glass stream.

Deciding to purchase glass-sorting equipment should depend on several factors. Years ago, high market value of glass made glass-sorting equipment a more viable option than today. The local glass market value, transportation costs, tipping fees, amount of glass recovered, and equipment cost all play a role in the purchase decision. Glass-sorting technology is available and in operation in MRFs throughout the U.S. Some manufacturers claim that a MRF must have in excess of three tonnes/hr of glass throughput to achieve a payback in a reasonable number of years, although others suggest that a volume of at least nine tonnes per day of glass is necessary.

Plastics Sorting: In North America, plastic container sorting at a MRF is primarily a manual task. In contrast, in Europe, automation of this process has been implemented more widely because of high manual labour costs. Most automated bottle-sorting systems in North America are located at plastics processing facilities and plastic reclaimers, where the volume can justify the system costs.

In general, there are two methods of feeding automated bottle-sorting equipment: singulated feed and mass feed. In singulated feed, objects are fed to the sensor one-by-one. In most MRFs, the mix of container materials (metals, tetra, trash) mean that a singulated feed system is not particularly suitable unless plastic containers are first separated from non-plastic containers. These systems require relatively complicated space-intensive feed systems, and have a feed rate limitation of 570 to 680 kg per hour. Capital cost for these systems, including feed and singulation conveyors, range from $315,000 to $400,000. These systems are best suited for high volume plastics reprocessors.

The material properties of plastic can be sensed and identified through either transmission or reflection. Transmission identification mode (x-ray, visible light) is used widely to determine resins and colours in plastic reclaiming facilities that have a controlled material stream. It can also be used in some MRFs, where contamination input stream is limited. Reflective near infrared (NIR) sensors are used in dirtier MRF applications, where the mixed input material stream does not allow for transmission sensor design use.

The mixed container stream is the main reason for the use of reflective NIR sensors. The sensor module can be placed on top of the sorting conveyor and does not come in contact with the material being sorted. A limitation is that it is not suitable for multiple sorts unless there are back-to-back systems, each tasked to separate a particular resin type according to its physical and/or chemical properties. For most efficient plastic sorting, the MRF process should provide for prior removal of oversize objects and film, ferrous and non-ferrous metals, and undersize materials. Capital cost for a complete mass feed system ranges from $270,000 to $315,000.

Germany has the highest level of automation for sorting equipment. As with all NIR sensors, cost is the major reason for hesitation by North American MRF operators. Experience in development and operation of plastics separation systems shows proper feeding and preparation of the feed stream as well as the quality of the sensing system are critical to optimal separation efficiency.

MSS has developed a high capacity plastic bottle separator (Alladin) that contains multiple identifications and sorting capabilities: it performs two needed tasks—resin and colour identification. This is a mass feed system—no singulation is necessary. The system combines full spectrum colour and NIR detection in one sensor to allow separation of three different fractions. The system has a throughput capacity of 3.6 to 5.5 tonnes/hr. Due to this high throughput capacity and cost ($270,000), this machine is geared to serving high volume plastics reprocessors or regional MRFs with high plastics throughput.

The MSS "Saffire" sorting system ($120,000) is targeted for MRFs processing commingled containers. This equipment mechanically sorts a single resin type (1.5 – 3 tonnes/hr). A number of units must be placed in a series to undertake sorts of multiple resin types. There are approximately 18 systems installed in German MTFs but none in North America.

TiTech, a Norwegian company, developed an automated plastics sorting system to separate a single plastic resin from a mixed stream of beverage cartons using near infrared particle detection and selective impulses of compressed air. The system has capacity for up to four tonnes/hr depending on conveyor width and the material to be sorted. This equipment is now distributed in North America. Approximate cost of one unit (one unit is required for each target resin type) is approximately $145,000.

Eddy Current Separators: These are designed to separate conductive but non-ferrous metals from other lightweight commingled materials. This is a mature technology widely used for sorting aluminum in MRFs. There are two basic types of separator designs: one uses a rare earth ceramic rotor to separate small, non-ferrous material; the second, which uses a strontium-ferrite-ceramic rotor, has less power, but is ideal for separating aluminum cans. Consequently, these separators can be smaller and less powerful and still achieve high recovery rates. High-speed oscillating magnetic fields are produced, which induce an electric current in the conductive object. The oscillating fields can be adjusted to optimize separation. This electric current generates a magnetic field, which causes objects (e.g., aluminum cans) to be repelled from the primary magnetic field.

Aluminum cans are removed at a point in the sorting process where they are the dominant material, or at least one of only a few on the conveyor. Typically, separators are placed at the end of a sorting process where aluminum is separated from a plastic mix, or after positive sorting of plastics takes place. This ensures the separator operates at maximum efficiency and that aluminum cans do not get "buried" under other containers (and that other materials don't get pulled off with aluminum cans).

Models designed for MRF applications cost approximately $63,000 to $80,000.

A relatively new development is a machine that sorts aluminum based on thickness and is able to differentiate asceptic packages (e.g., tetra boxes) from aluminum cans. The machine senses the thickness of aluminum in a container (using a patented LEAS sensor technology) and through use of air jets at the end of a sorting conveyor, ejects the targeted container over one of two "air knives." This equipment is now used in several French MRFs, typically at the end of the container-sorting conveyor after a positive plastic sort. This manufacturer has expressed interest in the North American marketplace. No cost information is available.

New and Emerging Technologies

There is a trend towards more automation of processing with equipment such as optical sorters for glass and plastic, and disc or star screens for paper sorting. The costs of these new approaches can only be justified by building larger, regional MRFs where economies of scale are possible. Recent research indicates that a single-stream MRF can be constructed and operated for $1.17/tonne more than a two-stream MRF, when capital amortization and all other factors are taken into account. This is approximately a five per cent increase in processing costs for a significant reduction in collection costs compared to other alternatives. Single-stream MRFs have higher equipment capital and maintenance than two-stream MRFs, but the relatively small increase in processing costs is more than offset by the significantly quicker and therefore cheaper collection involved (estimates indicate a 30 per cent reduction in collection costs). This conclusion is likely to prompt many municipalities in Canada to re-evaluate their current collection and processing operations to find additional cost-savings through system design changes.

There also is a trend towards commingling (collecting a number of materials in a single stream and designing a MRF to process this more complicated stream).

Evaluation

General Systems Performance

Waste stream composition information shows that approximately 40 to 50 per cent of residential waste is potentially recyclable. The actual amount depends on whether there is a deposit-return system on various containers, which affects the amount of plastic and metal packaging available for recycling. The top eight recyclables in municipal waste streams in Canada (percentage of residential waste composition):

Waste	%
Newsprint	12
Mixed paper	11
Plastics	6
Glass	6
Corrugated cardboard	3
Office paper	2
Steel cans	3
Aluminum cans	1

Ideally, each community should do its own waste characterization analysis to guide its decisions. The methodology developed by a working group (including municipalities) of the Canadian Council of Ministers of the Environment (CCME) is recommended (http://www.ccme.ca/assets/pdf/waste_e.pdf).

The actual amount recycled, and therefore the amount of diversion that can be achieved by recycling systems, depends on the type of collection system (curbside or depot), and materials collected.

Good curbside recycling programs should achieve 90 per cent participation or higher. Even when households participate they do not always recycle all material collected by the program, therefore participation must be multiplied by capture to estimate the proportion of the waste stream that will be recovered in a program. Experience has shown that capture varies by material, generally related to how complicated the recycling message is. In mature curbside programs, people understand that cans, bottles, and newspapers are recyclable; therefore capture of these can be as high as 80 or 90 per cent where good promotion and education programs exist and in communities with user pay systems, which encourage participation. Once new materials are added in an expanded collection program, people are often confused (e.g., different kinds of plastics and mixed paper).

In Canada, curbside recycling programs (which are the most mature and sophisticated in the world) divert 15 to 20 per cent of the residential waste stream. Depot programs generally divert seven to 12 per cent. Deposit or return-to-retail systems typically recover more than 80 per cent of targeted beverage containers.

Residue rates also vary depending on how materials are collected. "Typical" residue rates are five to seven per cent or less for curbside sorted materials, and 20 per cent for bag or cart collection systems, or where no curbside sort takes place.

Wet/dry programs, where waste is collected in two streams, experience a combined 30 per cent residue rate in their wet and dry streams (because wet/dry programs usually direct non-divertible materials into one stream or the other).

Given the Canada-wide agreed goal of 50 per cent waste reduction, it is clear that more needs to be done.

Community Characteristics

A community of any size can recycle. Traditionally, small communities (5,000 households or less) use drop-off sites for recycling; larger communities use curbside programs. One exception is the City of Calgary, Alta. (population 800,000), which has a depot rather than a curbside program. This decision was made to provide reasonably convenient recycling at low cost ($7/household for drop-off depots compared to $22/household for curbside recycling). The decision on curbside or depot depends on goals; if high diversion is essential, then curbside collection is the better option, but is more expensive than depot collection.

Rural communities can implement curbside collection if an efficient co-collection system can collect garbage, recyclables, and organics at the same time. The Bluewater Recycling Association in Southwestern Ontario and the Quinte collection system in Eastern Ontario are excellent examples of recyclables curbside collection offered to rural and small town areas. Bluewater has achieved system efficiencies through co-collection; Quinte has reached system efficiencies with extensive curbside sorting—households are asked to sort materials into nine separate groupings at the curb. User pay also plays a strong role in both of these communities. This leads to a simple, inexpensive MRF design.

Significant economies of scale are realized in larger MRF processing operations. This leads municipalities to share processing facilities where practical and haul costs are reasonable. The need to consolidate recyclables for processing is a challenge for small, remote communities. The decision whether to recycle and what to recycle needs to be made based on whether sustainable markets and end uses can be found for the recovered materials. It is usually better to join forces with neighbouring municipalities to increase the catchment area for collecting recyclables, increase the tonnages collected and the size of MRF constructed, and therefore lower the costs (Figure 2.2 on page 152).

There are no simple "rules of thumb" regarding what size of community should consider establishing its own MRF; the rule is simply the larger the better.

Costs

Cost has an enormous influence on design decisions.

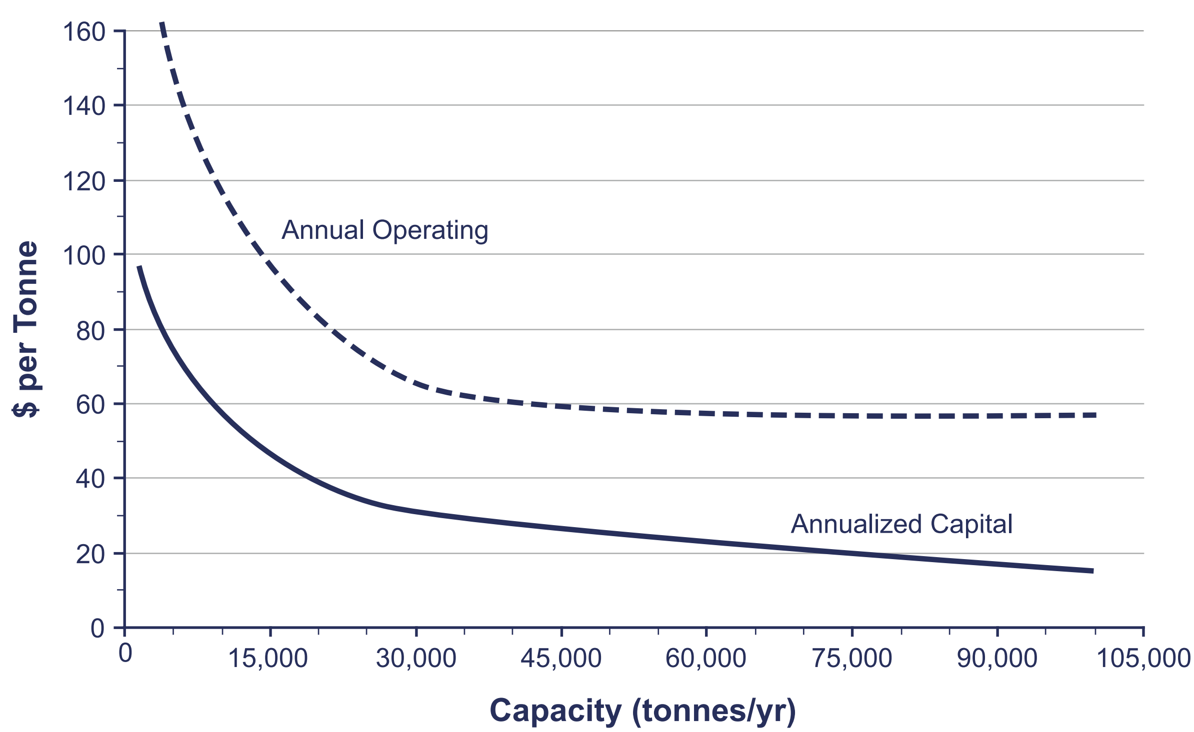
The varying cost of recycling programs depends on vehicles used, how material is collected, what materials are included, whether bags or boxes are used, distance to markets, and strength of markets. The economics of recycling also change significantly from one year to another based on the material revenues received. These are dependent on world markets for commodities and fluctuate with the health of the economy and demand for different materials.

General guidelines for urban areas are that the combination of collection plus recyclables processing should cost approximately $150/tonne (with collection higher for curbside sort, but processing lower, and the opposite for single-stream collection. Revenues for the "basket of goods" collected will vary throughout Canada (from $50 to $150/tonne), depending on the materials collected and revenues available locally. Depending on market conditions, the net cost of recycling can be anywhere from $0/tonne to $100/tonne.

In terms of cost per household, weekly curbside collection should cost $20 to $25/household/year (higher in rural areas). Recyclers generally estimate that processing and revenues cancel each other out, and that the net cost of recycling is actually the collection cost, hence ongoing efforts to reduce collection costs.

Figure 2.7 shows the capital costs and operating costs per tonne for a typical MRF based on the capacity of the MRF in tonnes. Generally, the higher the capacity, the lower the processing costs. However, the curve begins to flatten at a processing capacity of approximately 30,000 tonnes/year, which is the amount of recyclables collected from a community of more than 100,000 households (300,000 population). At lower capacities, processing costs are higher, and each community needs to decide the point at which processing costs justify partnering with neighbours to reduce costs. Longer transportation costs to the MRF must be considered in this decision.

Figure 2.7 MRF Annualized Capital and Operating Costs Curves



Environmental Effects

IWM Model

Using recycled materials to manufacture paper, aluminum, plastics, glass, and ferrous metal reduces the energy and raw material requirements in the manufacturing processes. The IWM model was used to determine the environmental effects of recycling versus landfilling the same material. Two views were considered: the total waste management system and the net life cycle inventory.

A value of 1,000 tonnes of typical recyclables (paper, glass, metals, and plastics) was considered for each model run, shown in the following three tables. The energy emissions for residential collection of recyclables were not included, because they were considered very small compared to upstream benefits.

Tables 2.7, 2.8 and 2.9 estimate emissions of greenhouse gas (GHG), acid gas, smog precursors, and toxic emissions from recycling compared to landfilling.

Table 2.7 GHG Emissions from Recycling Compared to Landfilling 1,000 Tonnes of Recyclable Materials in a Well-designed Landfill with Leachate Collection, Gas Recovery and Conversion

GHG Emissions	Highly Engineered LF (tonnes)	Recycling (tonnes)
CO_2 Equivalents	Higher	Lower

Table 2.8 Acid Gas Emissions and Smog Precursor Effects from Recycling Compared to Landfilling of 1,000 Tonnes of Recyclable Materials

Acid Gas and Smog Precursor Emissions	Highly Engineered LF (Kg)	Recycling (Kg)
NO_x	Similar	Similar
SO_x	Lower*	Higher
HCl	Similar	Similar
PM	Higher	Lower
VOCs	Similar	Similar

** Indicates an energy offset or avoided emission.*

In the scenario assumed, landfilling produced similar NO_x emissions to recycling. The landfilling option resulted in a reduction in SO_x emissions (through energy offsets, shown by an *). HCl emissions were similar.

Table 2.9

Toxic Emissions from Recycling Compared to Landfilling of 1,000 Tonnes of Recyclable Materials

Toxic Emissions	Highly Engineered LF	Recycling
AIR		
Pb (kg)	Lower (offsets)	Higher
Hg (kg)	Lower (offsets)	Higher
Cd (kg)	Lower (offsets)	Higher
Dioxins (TEQ) (g)	Higher	Lower
WATER		
Pb (kg)	Lower (offsets)	Higher
Hg (kg)	Higher	Lower
Cd (kg)	Higher	Lower
BOD (kg)	Higher	Lower
Dioxins (TEQ) (mg)	Higher	Lower

Energy Implications

Recycling requires relatively small amounts of energy to operate. Energy requirements are mostly related to fuel for recycling trucks, and relatively small energy requirements to run conveyor belts, balers and other MRF equipment. Energy input for recycling processing ranges from 88MJ/tonne for manual processing operations to 154MJ/tonne for highly mechanized recycling operations (Tellus Institute study). The energy expended on collection of recyclables is estimated at 475MJ/tonne collected, compared to 167MJ/tonne for garbage collection. The difference is related to slower collection time for recyclables compared to garbage. This value may decrease as completely commingled collection of recyclables gains in popularity. GHG emissions related to collection of recyclables are estimated at 33.6 kg CO_2 per tonne of recyclables collected.

However, recycling of materials has a significant energy effect in reducing the amount of raw material extracted (which is an energy intensive business), and also in remanufacturing using recycled materials. Aluminum is the best example of energy saved. It takes 95 per cent less energy to manufacture aluminum from recycled aluminum than from virgin material. The relative energy intensity is less dramatic for other materials, but is still significant.

Table 2.10 Examples of Energy Savings Resulting from Using Recycled Rather than Virgin Feedstock in Manufacturing Operations

Material	Energy Requirements Using Virgin Material Inputs (MJ/t)*	Energy Requirements Using Recycled Material (MJ/t)*	Reduction in Energy Requirements When Using Recycled Rather than Virgin Inputs (%)
UNBLEACHED COATED BOXBOARD	71,321	40,483	43
LINERBOARD	73,552	41,203	44
CORRUGATED MEDIUM	55,274	40,111	27
ALUMINUM	241,688	9,668	96
GLASS	15,686	11,503	27
STEEL	22,774	19,637	14

*Source: *Perspectives on Solid Waste Management in Canada; An Assessment of the Physical, Economic and Energy Dimensions of Solid Waste Management in Canada,* prepared by Resource Integration Systems Ltd for Environment Canada, March 1996

Lessons Learned

Collection represents the highest cost in recycling. Measures to lower these costs are evaluated by municipalities across Canada.

Ongoing promotion and education is critical to the success of recycling programs to ensure that residents understand which materials to include, and also that recycling behaviour is constantly reinforced, resulting in high participation and capture. Generally, the more materials collected, the cheaper the program (depending on location and technologies used).

Lessons learned in co-collection programs:

- More time on route is needed to collect recyclables and garbage;
- Co-collection trucks are often long, and may be harder to maneuver along some streets;
- Mechanical/maintenance problems may be an issue with some specialized vehicles (hydraulics);
- Commingled collection vs. more segregated collection increases contamination rates and may decrease the amount of materials marketed;
- Determining the ultimate compartment for multi-compartment trucks has been problematic in some co-collection programs;
- Significant program planning is required since it may not be simple to add materials after a co-collection vehicle has been designed and built (vis-à-vis compartment volumes).

Glass breakage is a concern with some bag co-collection systems. Some strategies to reduce/eliminate glass breakage:

- Collect glass separately (e.g., collecting glass on side racks on the trucks);
- Exclude glass from a co-collection program (e.g., encouraging residents to recycle glass through a drop-off program);
- Lighten compaction to reduce breakage (however, this decreases collection efficiencies);
- Cushion glass by collecting and commingling with many other materials, including paper and plastics;
- Some communities separate glass and paper products to reduce the contamination of paper with glass fragments.

Table 2.11 Recycling Summary

Factor	Summary
DESCRIPTION	Some dry components of the waste stream (paper, glass, metal, plastic) can be collected through drop-off or curbside collection Dropped-off material: directly to market if clean enough or further processing Curbside material: collected in different streams (through separate compartments in the collection truck) and processed at a fairly simple MRF (material recovery facility). More mixing of streams requires more complicated MRF design
GENERAL PERFORMANCE	15% to 25% municipal waste stream diversion, depending on materials collected and residue rates at the MRF 2% to 5% residue at simple MRFs with source separation 20% to 40% residue (depending on materials) with commingled collection
COMMUNITY CHARACTERISTICS	Any size community, but different designs required Small communities (<10,000 households) and low-density rural areas: Drop-off collection performs well. Co-operation with neighbouring communities can facilitate curbside collection, e.g., Bluewater and Quinte areas of rural Ontario. Recyclables have to be shipped to larger facilities Larger urban communities: curbside collection is cost-effective Recyclable processing follows a steep cost curve; cost decreases substantially as MRF size increases, particularly beyond 30,000 tonnes/year.
COSTS	Drop-off depot costs: $10 to $25 per household/yr, including processing. Lower end for large system, e.g., Calgary; high end for a rural consortium Large urban curbside collection (including processing) cost of about $25/hh/year, depending on housing density Collection and processing $150/tonne; revenues $50 to $150/t; net $0 to $100/t Processing costs decrease with economies of scale. Smaller communities (< 10,000 hhlds) need to combine processing needs with neighbours
FACTORS THAT INFLUENCED ACQUISITION	Politically driven; a community decision regardless of cost Mandated recycling systems (e.g., Ontario) Should start with an assessment of markets, but this rarely happens Landfill crisis (i.e., existing landfill is running out of capacity, high new landfill costs and public opposition) Availability of markets for recovered materials should drive, but often does not

Factor	Summary
NEW AND EMERGING TECHNOLOGIES	More efficient methods of collection and processing of recyclables Star and disc screens have improved processing of papers, making single stream collection of recyclables more viable Optical sort systems for plastics have limited success; more recent designs work better
ENVIRONMENTAL EFFECTS	Saves resources otherwise lost to landfill or thermal treatment Paper: highest and best use to recycle into new paper. Avoids the need to cut trees; manufacturing energy savings (recycling is less energy intensive than making paper from virgin pulp). The "upstream" benefits of recycling are significant, in that each tonne of paper or metal recycled saves a number of tonnes of greenhouse gases and other air and water contaminants Metals (e.g., steel, aluminum): conserves non-renewable resources, reduces manufacturing energy, and reduces environmental effects Glass: saves natural resources but energy savings less significant. Substituting glass as an aggregate saves on the environmental effects of mining new aggregate
ENERGY IMPLICATIONS	Curbside pick-up or drop-off depot is a low energy process, mainly from transport. MRFs have minimal energy needs (conveyor and baler) Major benefit is the "upstream" energy benefit of reducing the need for primary resource extraction (see Environmental Effects above)
LESSONS LEARNED	Materials produced are totally vulnerable to market conditions. When markets fail, recycling an expensive way to process waste Solutions to market vulnerability: ■ structuring contracts to share market risk with either a recycling contractor, or directly with the market itself ■ sign a long term contract (five yrs), with guaranteed rates The early years focused on efficient collection and processing. Collection more expensive part, therefore attention now on reducing collection costs. Current trends moving towards faster single stream collection with more expensive MRF as cheaper overall

SECTION 3

Composting

General Description

Composting refers to a family of processes that can be used to recycle organic fractions of the waste stream into a valuable end product called compost. Composting is a biological process in which organic matter is consumed through microbial activity, in the presence of oxygen, to produce a peat-like humus. In an oxygen-rich (or aerobic) environment, composting releases a significant amount of energy due to the metabolic activity of the bacteria, fungi, and actinomycetes present on the waste. In fact, it is often desirable within a composting process to"turn" the composting piles regularly or ventilate them continuously to remove excess heat, since temperatures above 65°C can readily be achieved, and this limits microbial activity and the efficiency of the composting process. A well-run process requires effective management of the same basic elements needed by all aerobic organisms—an adequate supply of oxygen, water, and food.

Composting reduces the waste mass by approximately 40 per cent (through evaporation of moisture). It is not the only process suitable for processing organic waste (see Anaerobic Digestion, Section 4). Adding some low-value paper products means that composting and anaerobic digestion (AD) can address 50 per cent or more of the waste stream.

The chief objectives of composting residential or municipal solid waste are to:

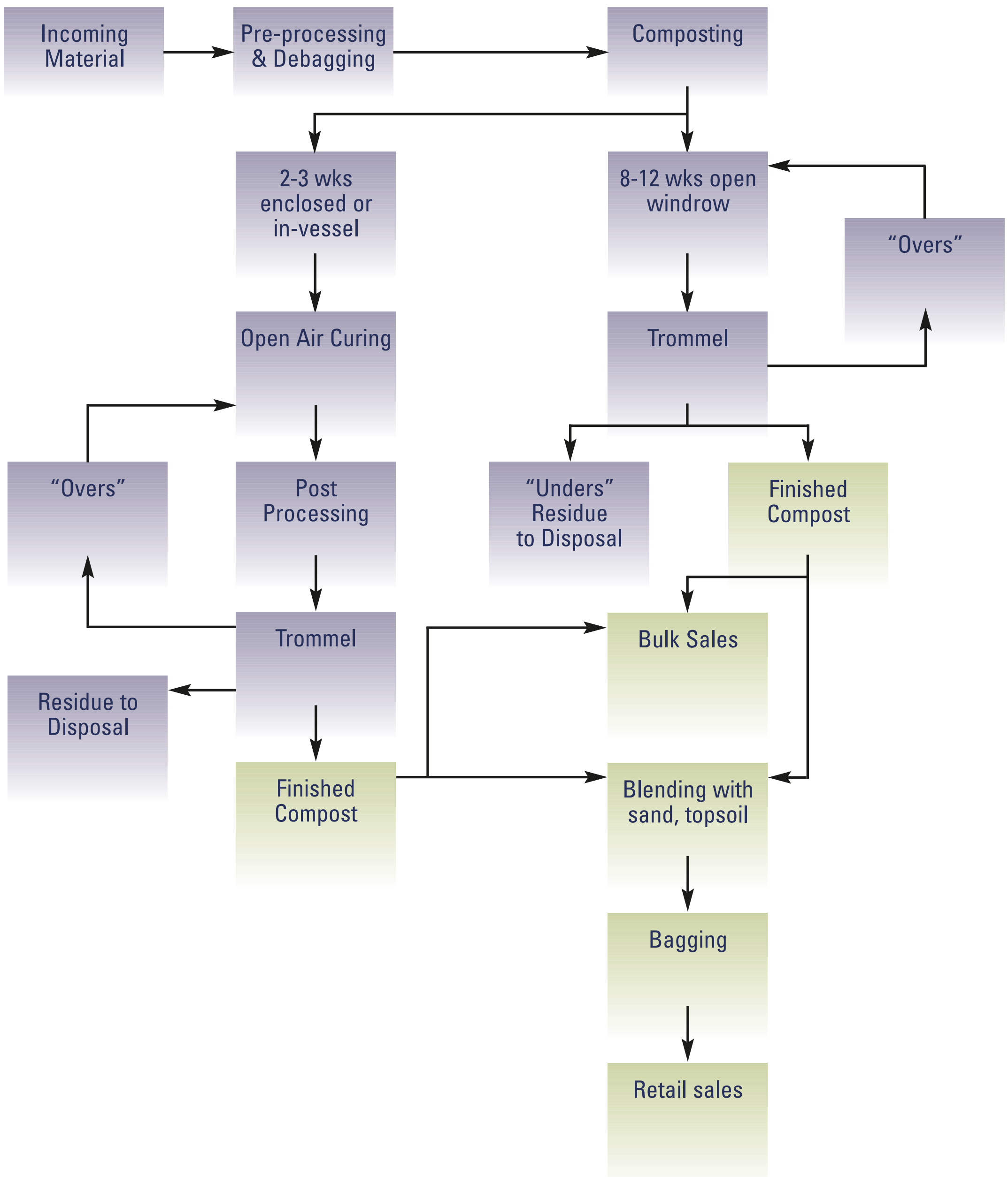
- Divert solid waste from landfill;
- Stabilize organic material; and
- Produce a reusable, beneficial soil amendment.

Generally, higher quality compost is produced from source-separated feedstock. Composting of MSW faces tougher challenges meeting compost quality guidelines. Reasonable revenues can be obtained for high quality compost, whereas zero revenue can be expected for lower quality compost.

Because organic material makes up approximately 40 to 50 per cent of residential solid waste, composting must be part of any system seeking to achieve diversion levels of 50 per cent or more (residential and IC&I combined, excluding construction and demolition waste).

Figure 3.1

Simplified Composting Schematic



System Approaches

Many municipalities encourage backyard composting as the lowest-cost approach to diverting some organics from the waste stream. Many collect and compost yard wastes (e.g., brush, leaves, grass clippings, and other summer yard wastes), because they already collect this material separately, or because their province mandates such composting. Many municipalities have more comprehensive, year-round programs to collect a broader range of residential organic wastes (including food wastes) because of local policy or provincial mandate. Some municipalities have included provision to compost commercial organic wastes to encourage landfill diversion or to improve economies of scale for residential programs.

The Composting Council of Canada's 1998 national survey found more than 340 composting facilities in Canada, with different technologies represented in every province and the Yukon. Those facilities processed an aggregate of more than 1.6 million tonnes of solid waste. Though challenging to implement, a wide range of precedents have been successfully established, providing new facility planners with a wealth of models to build on.

Backyard Composting

The simplest and most cost-effective way to remove residential food and garden waste from the waste stream is through backyard composting. Citizens benefit directly from their own efforts by producing valuable compost for their gardens, and municipalities save collection and management costs.

Municipal backyard composting initiatives range from simple educational programs, to active programs subsidizing the purchase of backyard composting units, to intensive programs to install free units in virtually every backyard.

The GAP method (see www.csr.org) assumes that each distributed backyard composter diverts 100 kg/year of organic waste. Some provinces assume a higher number (e.g., B.C. assumes 125 kg/hh/yr). General rules of thumb assume that 25 to 30 per cent of single-family households will use a backyard composter in moderately promoted programs and approximately 55 per cent in an intensely promoted program.

Programs providing municipal subsidy (commonly around 50 per cent of purchase cost) for backyard composter purchases were relatively common in Canada in the 1990s. When supported by education and promotion, this can be a cost-effective method, but has a hard-to-measure effect on solid waste diversion.

One of the most aggressive backyard composting programs mounted in Canada was in the City of Port Colborne, Ont., in 1993. Free backyard composters were delivered and installed for every home in the city (population 20,000). More than 80 per cent of households agreed to participate. Student employees trained in backyard composting, who went door-to-door, heavily supported the program.

A detailed assessment of the project four years later found that 63 per cent of households were still using the system effectively, collectively diverting approximately 27 per cent of the city's residential waste stream. Cost for building and operating the system was $32 to $45/tonne of organic material diverted—well below the cost of other available waste management systems (including collection costs), according to a city report.

Some critics cite issues, such as nuisance potential of backyard composters, the possibility for generating GHGs from poorly managed composters or the possibility of pesticide residues on food entering the garden. Minor effects have been found but do not detract from the significant benefits of backyard composting in raising awareness of waste management issues.

Leaf and Yard Waste

Many municipalities historically have collected some yard wastes, typically leaf and yard waste in spring and fall. These materials are almost always processed at outdoor windrow facilities. Municipalities provide one of the following initiatives:

- Drop-off depots;
- Dedicated collection in the spring or fall;
- Weekly or biweekly curbside collection programs during the entire growing season.

Most yard waste composting programs successfully operate at total costs, (collection and processing, net of any proceeds from selling compost), that are equal to or better than the prevailing local cost of conventional waste collection and disposal.

Some municipalities, enjoying relative success in collecting and composting yard wastes, have also collected food waste from households, usually either because of a policy to divert more waste from disposal, or because of a provincial mandate to do so. In some provinces it is relatively easy to add fruit and vegetable waste to an existing yard waste program without affecting operations or permit requirements.

Residential Organic Waste (leaf and yard waste, food waste, some paper)

A handful of large Canadian municipalities have dedicated systems to collect and compost a larger fraction of the organic waste stream. The highest concentration of year-round comprehensive household organics collection programs is found in Nova Scotia, where organic waste has been banned from landfill disposal by the province.

To ensure the highest percentage recovery and the best quality final product, household organic material should be source-separated by the householder and collected separately from other household waste. For this reason, municipalities are closely examining cost-effective, source-separation strategies for residential organic waste.

Comprehensive household organics collection programs offer year-round municipal collection of a broader range of organic material, generally including kitchen food wastes. All require a more sophisticated composting facility to process such wastes year round. Many, but not all, have moved to capital-intensive enclosed composting facilities. Most tend to operate at a net cost (collection and processing, less revenue from compost sold) that is higher than conventional collection and landfill disposal of waste. This tendency towards higher cost has prevented these projects from becoming more ubiquitous in North America and the UK.

Organic Waste from the IC&I Sector

Most municipalities play a limited role in the IC&I waste management, preferring to leave this to private-sector collectors and private disposal facilities. Perhaps as a result, few municipalities compost IC&I waste. Occasionally, municipalities compost IC&I waste because they want to improve the economies of scale of existing operations, or because the IC&I sector may be a source of desirable waste (e.g., carbonaceous wastes to balance out high-nitrogen food wastes from residential sources). Often, IC&I waste contains fewer contaminants than residential wastes, simply because it can consist of uniform industrial by-products, such as food processing wastes or "off-spec" material (e.g., expired food).

A distinct advantage of including IC&I wastes in a composting system is that the private waste generators are likely to provide their own shipping to the composting facility, and will still pay a tipping fee. An unlimited range of wastes can be received under such programs, including:

- Paper mill sludge;
- Other, low-solids sludge, such as from food processing;

- Off-spec food products, such as jams, jellies, ravioli;
- Slaughterhouse wastes;
- Non-recyclable paper grades.

Mixed-waste Composting

Mixed-waste composting refers to:

- Composting of the whole municipal waste stream without recyclable source separation (Medina, Ohio, and other U.S. communities, but not in Canada);
- Composting of MSW from which recyclables are removed (Town of Tracy, Que., or the City of Edmonton, Alta.).

In this approach, essentially no special collection system is used. The entire waste stream is collected as recyclables and garbage. The garbage bag is delivered to a composting facility equipped with intensive systems for pre-processing and post-processing. These "clean up" the mixed waste so that a useable compost product can be produced. Often, the pre-processing system is designed to recover some marketable recyclables from the waste stream as well.

Note: This equipment and approach are used where organics are collected as part of the "wet" stream in a two-stream wet/dry system, such as in the City of Guelph and Northumberland County, Ont., and the Regional Solid Waste Commission of Westmorland-Albert, N.B.

A problem with this approach is that the final compost product is inferior, may include a higher level of visible contaminants, such as glass and plastic, and may be characterized by higher levels of heavy metals. Given the types of compost quality standards prevalent in the U.S., facilities of this type have been able to meet regulatory standards for compost, if not necessarily market-driven standards.

In Canada, where provincial standards exist, such plants cannot meet Canadian compost standards. Some notable exceptions are the Comporec facility, which operates in the Town of Tracy, Que., and Edmonton's facility. The Comporec plant compost does not currently meet federal compost guidelines developed by the CCME for unrestricted use compost, because of elevated levels of copper, but meets restricted use guidelines. Edmonton's facility co-composts sewage biosolids with mixed waste after source separation of recyclables, and produces compost that is sold. The market may be affected by some public distaste for co-composting with sewage sludge.

Landspreading

Landspreading is the placement of organic materials on the ground for decomposition under uncontrolled conditions. Where circumstances allow (usually only for fall leaf wastes), landspreading can be significantly cheaper than composting, since no facility needs to be constructed. Simple interventions, such as reducing feedstock particle size or periodically turning materials with a plough, can help accelerate decomposition.

Organic waste used on agricultural land must benefit crop production and pose minimal risks to plant growth, crop quality, long-term land productivity, public and animal health, and local environment quality.

This approach is most applicable to shredded leaf wastes. The Regional Municipality of Waterloo, Ont., discovered that landspreading of shredded leaf wastes costs about $2/tonne, compared to $8/tonne to compost at their own site. In a research project in 2000 to explore the viability of expanding their program, the region found the greatest challenge was identifying sufficient farmers willing to take the material.

Some provincial jurisdictions may still require that a permit be procured before a landspreading program can proceed.

Technologies

Collection

Collection – Service Level

There are a number of options available to collect organic wastes, including:

- Public drop-off only;
- Seasonal, unscheduled curbside service;
- Weekly or biweekly curbside service.

The latter two need to be evaluated in the context of recycling and garbage collection carried out by the municipality, to assess if the addition of organics warrants a complete collection redesign where the benefits of co-collection or reduced collection frequency are viable.

Public Drop-off Only – Is used by many municipalities, and provides the most basic level of yard waste programs. Residents self-haul most of the yard waste to central locations. Even in municipalities that have full-service, weekly curbside collection of yard waste, self-haul is often left in place as an option for those waste generators producing more yard waste that the system is designed to collect (e.g., large quantities of brush), or who simply prefer to self-haul.

Public drop-off is generally the system of choice for municipalities where low cost is more important that achieving significant waste diversion.

Table 3.1 Advantages and Disadvantages of Public Yard Waste Drop-off Systems

Advantages	Disadvantages
Lowest-cost option; most of the work is done by residents	Generally lowest level of waste diversion, since inconvenience to residents is highest
Potential for good policing of contaminants, if drop-off area is well supervised	Potential for problems with contaminants if drop-off area is not well supervised
	Potential odour issues, particularly with grass clippings, since grass may have to sit for some time before processing

Seasonal Curbside Service: Is generally used in spring and fall, coinciding with maximum production of yard waste by municipalities with dedicated curbside leaf collection programs. Residents set out leaf and yard waste curbside (in plastic or paper bags, plastic or metal reusable bins). Generally, the municipality will publish a start and end date for the service. Seasonal service is the system of choice for municipalities seeking to offer good-quality leaf and yard waste collection service, without collecting summer yard waste.

Table 3.2 Advantages and Disadvantages of Seasonal Curbside Service

Advantages	Disadvantages
■ Dedicated curbside service means higher waste diversion ■ Generally less expensive than weekly collection through whole season	■ Higher cost than public drop-off

Weekly or Biweekly Curbside Collection of Organics: Is most common in large municipalities offering comprehensive yard waste diversion. It is also the only system used if a municipality is collecting a broad range of residential organics. An approach that parallels garbage and recycling collection is created—i.e., organic waste is collected on a regular basis, on the same day each week (or every other week) in a given part of the municipality, during the entire year (or growing season, if only for yard waste). This system is used by municipalities seeking maximum waste diversion, for which they are willing to pay. Additional collection resources must be made available when demand peaks (at additional cost). Some municipalities reduce collection frequency in the winter, because there is less organic waste and cooler temperatures mean fewer odour or insect concerns.

Table 3.3 Advantages and Disadvantages of Weekly or Biweekly Curbside Collection

Advantages	Disadvantages
■ Generally produces highest levels of waste diversion ■ Regularity of collection makes participation easy for residents ■ Streets are tidy because waste is not at curb for long	■ Highest cost ■ Weekly collection can lead to inefficient use of vehicles during low-growth seasons, volume of materials to be collected at peak seasons can overwhelm collection fleet and create problems if material is not picked up when expected

Collection – Organic Waste Set Out

The methods for curbside collection or to package organic waste for drop-off include:

- No packaging (yard waste only);
- Plastic bags (debagged at site);
- Plastic bags (debagged at curb—yard waste only);
- Compostable paper bags (yard waste only);
- Compostable paper bags (for food waste as well);
- Rigid plastic containers.

Loose Material: Collection can include Christmas trees, seasonal brush, or leaves collected using vacuum equipment. In a City of Ottawa, Ont., pilot project, staff determined that vacuum collection is more costly per tonne than regular curbside pick up. Curbside brush chippers or large-volume, grapple-equipped trucks are used to handle brush in particular. Compost facility operators can easily process vacuumed leaves, as they are clean, pure, dense, and partly shredded.

TABLE 3.4 ADVANTAGES AND DISADVANTAGES OF LOOSE MATERIAL SET OUT

Advantages	Disadvantages
■ Lowest cost and effort level for residents	■ Does not work with grass clippings
■ Tends to mean low contamination, since there is no packaging source of contamination, and residents can not hide litter inside bag or other containers	■ Requires use of specialized equipment in many cases—vacuums, chippers, grapples
■ Generally lower cost than de-bagging leaves by hand	■ Vacuums also pick up gravel and litter, which are problematic

Plastic Bags Debagged at Site: Collection of organic waste in plastic bags is common, but can result in compost quality problems since all plastic cannot be removed. Plastic bags are a convenient and low-cost packaging system, readily acceptable to residents. As well, bag makers have promoted this option to municipal officials. The decision to collect bagged waste and deal with the bags later is driven primarily by maximizing public convenience. Debagging curbside takes roughly twice as long per tonne collected as getting the bags off the street. It costs a lot to have a truck idling at the curb while staff debag. There is considerable debate between the proponents and opponents of using plastic bags in organic waste programs.

Many municipalities tried debagging yard waste by hand, at the composting site, using their own or contract staff. With leaves, this can be back-breaking work, which is carried out late in the season, in unfavourable weather conditions. If plastic bags containing grass sit in the hot sun at curbside, odours are generated because of anaerobic conditions. If these bags sit on-site for days or weeks it creates odour problems and a poor work environment.

Several proprietary debagging machines and systems have been invented, but they tend to only capture some of the plastic, and are expensive to purchase and operate. A satisfactory, all-mechanical system for debagging remains elusive. Because of problems marketing compost that contains plastic remnants, several Canadian municipalities (Toronto, Peel) no longer collect yard waste in plastic bags. This material must be set out in paper bags or plastic and metal reusable bins.

Some collection systems designed for a broad range or organics, including residential food wastes, continue to use plastic bags, but debagging is difficult since it can be wet and odorous. As well, frozen food waste collected in the winter cannot be debagged, since the bags tend to fold into the waste.

The only option in this event is to shred the waste, including bags, and to try to recover as much of the plastic as possible during subsequent pre- and post-processing steps, which can be challenging.

Table 3.5 Advantages and Disadvantages of Plastic Bags, Debagged at Site

Advantages	Disadvantages
■ Lowest-cost collection among curbside options which use bags ■ Plastic bag is cheap, familiar to residents ■ Existing collection fleet (packer trucks) well-suited using plastic bags	■ Plastic bag removal is problematic. No simple, effective system exists ■ Plastic bags can be used to hide other garbage, especially in a user pay collection environment ■ Plastic and other contaminants left in compost can complicate marketing ■ Plastic bags tend to increase odour problems with grass clippings and food wastes ■ Regardless of its content, a plastic bag at the curbside does not promote diversion

Debagged Organic Waste at Curb (Yard Waste Only): Curbside debagging avoids some of the challenges of debagging at the composting site. This approach is used by the City of Barrie, Ont., during the entire yard waste season. In return for reduced truck productivity, a clean product can be produced, eliminating problems at the composting facility. Crews hang jute or similar sturdy bags at the back of the truck. As plastic bags are removed from yard waste, they are placed in the jute bags. When full, the jute bags can simply be added to the truck hopper for later recovery. As an incentive for truck crews, it is best to inspect each incoming load as it is dumped, and require collection crews to clean up and remove any missed contaminants at that time. Municipalities that have abandoned other approaches, and who are committed to producing high diversion and a quality compost, have adopted this approach.

Table 3.6 Advantages and Disadvantages of Plastic Bags, Debagged at Curb

Advantages	Disadvantages
■ Produces clean product, while allowing resident convenience ■ Households that mix non-targeted materials with organics can be identified and educated	■ Significantly higher truck and crew cost than debagging at site ■ Reduced collection productivity

Compostable Paper Bags (Yard Waste Only): First adopted as the exclusive method used by the City of Ottawa, Ont., for its comprehensive curbside system, and subsequently by the City of Toronto and the Regional Municipality of Peel, Ont., to address compost quality problems. All three municipalities allow residents to put yard waste in reusable bins or cardboard boxes. Yard waste bags need to be shredded to accelerate their decomposition, but otherwise create no special operational problems. However, these bags are more costly than plastic bags and need to be made especially available to residents—the best approach is for the municipality to encourage local retailers to stock them, however, at the outset of the program, the municipality is well advised to distribute free samples to each household (bag manufacturers will help interested communities with this effort). Ongoing use is enforced by collection crew refusal to collect targeted materials set out in an undesirable manner.

Compostable Paper Bag (for Organic Waste): In recent years, paper bags for wet food waste have been developed and tested in a number of Ontario communities, including Ottawa, Simcoe County, and Sarnia. The Food Waste Bag is produced in a large or small format and is virtually leak proof as a result of its biodegradable cellulose lining. The small bag has proven to be particularly popular for moving food waste from the kitchen to an outdoor bin. While the bag is relatively expensive at this time (10 small bags for $4), as sales increase the price of the bags is certain to fall (as was the case with the larger yard-waste paper bag).

Table 3.7 Advantages and Disadvantages of Compostable Paper Bags

Advantages	Disadvantages
■ Provides for easy collection and tidy packaging, without any of the downside of having to debag ■ No specialized equipment required ■ Organic waste will not go anaerobic because of the bag's ability to "breathe"	■ Relatively high cost of the bags. Either resident or taxpayer will have to absorb cost

Rigid Plastic Containers: Used in programs that collect a broad range of organic wastes, including food. The large carts are intended to contain residential food wastes, and most yard wastes.

Relatively large, wheeled carts have been used for this purpose in central Europe for many years, where regular curbside collection of organic wastes for composting was first developed. The carts are relatively easy to move because they are on wheels. Since they are closed containers, they can effectively seal in odours, and resist attack by animals. Mechanized systems are widely available to facilitate the rapid lifting of such carts for emptying into collection vehicles. It has been argued that rigid containers (much like the blue, grey, black, or green box used in recycling programs) tend to encourage participation, since the physical presence of the container at the curbside is a constant program reminder.

Some Canadian municipalities have also experimented with smaller rigid containers, designed to contain food waste only, as demonstrated in the City of Toronto.

The chief problem with rigid containers is cost, and this is partly why more municipalities have not moved to adopt this system. However, this situation is in constant flux as new containers are developed (the Toronto bin plus a kitchen catcher is approximately $20, but cost depends on the number being ordered).

Collection – Collection of Brush

Should brush be collected with or separately from other organic wastes? Many municipalities have not considered the possibility that brush can be collected on its own and commingle brush with other yard wastes, which leads to one of the following problems:

- Windrows contain unground brush, which does not compost, and has to be removed from the windrow at the end of the process;
- All combined waste has to be ground, at significant increased cost (from $15 to $20 per tonne);
- Combined yard waste that is left unprocessed while waiting for a grinder can result in odour problems. However, it can still be composted if the larger woody material and brush is screened out and chipped. The brush can increase the porosity of the pile, which enhances the composting process.

Brush (branches, hedge trimmings, Christmas trees, stumps) is unique among yard wastes in that it needs to be ground or chipped

Table 3.8 Advantages and Disadvantages of Rigid Plastic Containers

Advantages	Disadvantages
■ Well-established system to collect all types of organic waste neatly, while controlling odours and preventing animal access ■ With some modification, existing types of waste hauling vehicles can be used ■ Visibility of container tends to promote participation	■ Cost higher than any other system

before processing. To minimize the capital and operating costs of grinding or chipping, the brush can be separated from the other organic waste material before it is collected.

Grass and residential food wastes need to be processed ideally on the day they are received at the compost site, and many provinces have specific requirements on this. Leaves should be processed into a windrow within a week of receipt. Brush and other woody wastes can be accumulated for an indefinite period before processing, because they will not begin to compost and create odours. The brush can be accumulated and stockpiled for long periods of time to justify bringing in grinding equipment.

Brush should generally be managed separately from other yard wastes via:

- Some element of resident self-haul, if this is practical in local circumstances;
- Periodic collection of loose brush waste perhaps in the last week of each month during the growing season. This could be done using either conventional equipment (packer trucks) or specialized equipment (such as dump trucks with chipper trailers).

Since most residents can store brush without creating odour problems on their own property, the key is to limit collection, and to keep from commingling brush wastes with other materials that do not need to be ground.

Processing

Processing – Centralized Composting Processing

All centralized composting technologies typically include three major components:

- Pre-processing;
- Composting; and
- Post-processing.

Pre-processing: Involves turning the source-separated organic waste into a suitable, refined feedstock, ready for introduction to the composting process. Pre-processing techniques include particle size reduction, screening, and addition of amendments. Pre-processing operations include bag opening (if required), shredding, mixing, and manual inspection. The amount and cost of pre-processing required is dependent on the nature of the organic waste stream and the technology used.

Every composting process requires hard, carbonaceous wastes, such as wood, brush, and large cardboard boxes, to be shredded. Technologically, simple composting facilities that process relatively uncontaminated feedstock may need no pre-processing other than the size-reduction of one or a few components of their total input stream. Some enclosed composting technologies also require that all of the feedstock be fully shredded before composting, and/or blended with amending materials, such as wood chips. Generally, the more contaminated the feedstock wastes, the greater the need for pre-processing technologies to "clean up" the material before composting. Pre-processing systems can be quite capital-intensive, and some—involving hand-picking of contaminants from conveyors—can also be highly labour-intensive.

It should be noted that one of the challenges in designing an organics diversion system is to decide whether the advantages of collection systems that produce a more contaminated waste stream are worth the much higher pre-processing cost of removing those contaminants at the facility, and the lower quality of end product.

Composting: Includes many technologies and vendors, all of which work in a range of applications and scales. All systems are designed to provide an environment in which the natural process of aerobic degradation of the organic waste is optimized, so that a stable product (compost) can be produced. For a composting equipment and technology supplier list in Canada, see the Composting Council of Canada's Web site at www.compost.org.

Technologies can be categorized as:

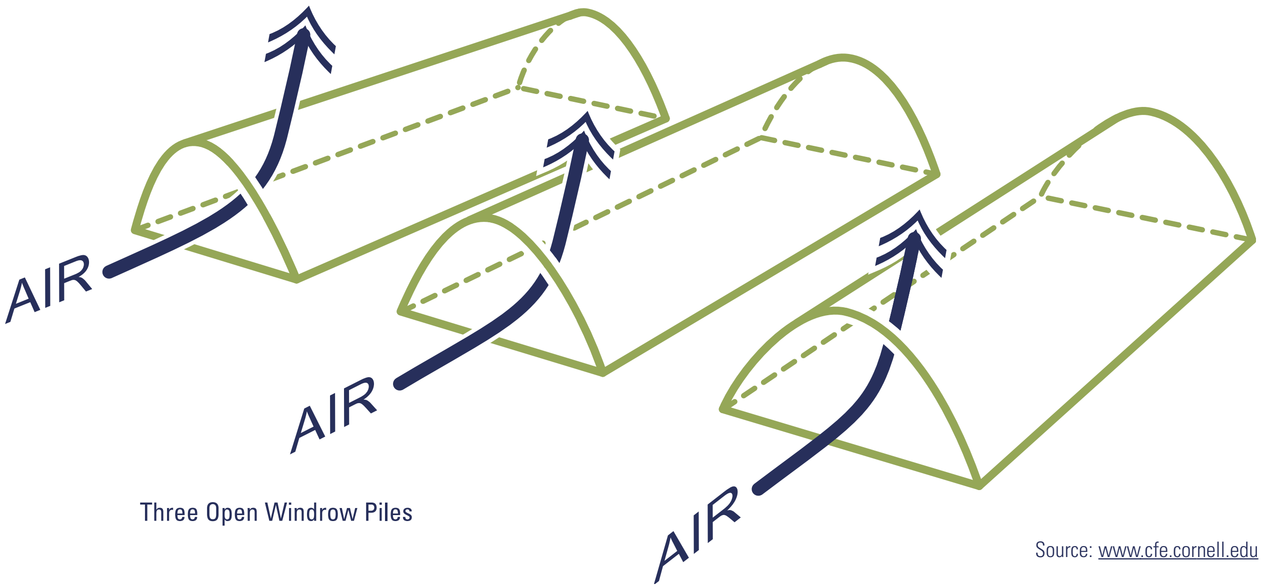
- **Turned-windrow composting:** waste is formed into long piles called "windrows" and regularly mixed and manipulated to achieve a number of purposes;
- **Aerated static pile composting:** similar to windrow composting waste is not moved and is aerated either actively or passively while remaining in place;
- **Enclosed channel composting:** waste is contained, usually between parallel walls of some type, and regularly moved and turned by some form of suspended machinery;
- **In-vessel composting:** any technology where the waste is sealed into a chamber, where the environment is closely controlled, and facility personnel do not normally enter. In-vessel systems include vessels that are fixed, portable, and even non-rigid. In-vessel systems may or may not include internal systems for agitation or maceration while in process, and commonly include internal systems for monitoring and addition of oxygen.

The first three can take place inside or outside of buildings (generally channels are inside buildings, static piles and windrows outside). In all cases, composting occurs in an environment

The Regional Municipality of Niagara, Ont., facility at Port Colborne is an approach to open windrow composting applicable to many Canadian communities. The region owns a composting facility located at a landfill that is operated by a private sector contractor with specialized expertise. Originally established in 1990 as a 300-tonne-per-year leaf-composting site, the facility has gradually grown to process 25,000 tonnes per year of a diverse range of organic materials. The site operates with an active composting area of four acres of asphalt, plus several acres of adjacent land used to store finished compost and soils for blending. The entire operation takes place outdoors, six days per week, 52 weeks per year.

Range of wastes processed includes: yard wastes, food wastes from restaurants and major food processing industries, paper mill sludges, etc. Most originates in the IC&I sector, and much of that originates from outside of the Niagara Region. Bringing in such wastes offsets the region's own operational costs. The facility operates with five full-time staff and seasonal staff. Although located on a landfill property, the site is within 150 metres of a local trucking firm, and 0.5 km of a residential neighbourhood. It has successfully processed a diverse organic waste stream and operates within provincial regulations.

FIGURE 3.2 OPEN WINDROW COMPOSTING SYSTEM



Source: www.cfe.cornell.edu

that is open to and accessible to machinery, facility staff, and the atmosphere.

Turned-windrow and aerated static pile systems tend to use public-domain technology, albeit sometimes with the aid of specialized equipment provided by various vendors. Enclosed channel and in-vessel systems tend to be available only from vendors of proprietary technologies.

Turned-windrow Composting

The term windrow refers to a pile of material that is characterized by a generally triangular cross-section and a length that may vary significantly depending on available space. What defines turned-windrow composting is that the material being processed is formed into a standing pile, and is regularly and completely moved or "turned" (once a day to once a month), usually by mobile heavy equipment. This aerates the material, macerates it, blends it, and often gradually moves it through a processing area.

Turned-windrow composting includes facilities that pile the material in much larger piles, and includes facilities in which all composting operations are carried out inside an enclosed building. Most windrow facilities, however, are located outdoors.

Commonly, windrows are between two and four metres in height, since smaller windrows would not retain the requisite heat involved in the process, and larger ones are hard to move and aerate.

Regular turning of material can result in a finished, stable (fully degraded) product in approximately 13 weeks, though some facilities choose to take longer, and save operating costs. Some mechanism to apply water to the material is often required.

The greatest advantage of turned-windrow composting is its flexibility. Many facilities dramatically vary windrow size, turning frequency (from several times daily to once a month) and how space at the site is used, to accommodate wide fluctuations in incoming waste tonnages and composition.

Windrow composting sites process leaf and yard wastes and can be used to process materials collected by SSO programs, although this is less common and requires an experienced operator to avoid odour problems.

Outdoor, turned-windrow composting is the most widely used system for centralized composting in North America. It can deal with a wide variety of organic wastes at almost any operating scale. Windrow composting has been successfully operated in the range of 5 tonnes/day to 100 tonnes/day (1,000 tonnes/yr to 25,000 tonnes/yr); large mechanized windrow operations may go up to 100,000 tonnes/yr.

Given low demand for capital equipment, and low operating costs, windrow systems are widely recognized as a lowest-cost composting approach. Windrow composting has rather large land requirements if more than modest quantities of organic materials are processed. It is a non-proprietary technology that is most viable in rural sites or areas with large buffer zones.

A properly managed turned-windrow composting facility does not pose a greater odour problem than more capital-intensive, enclosed facilities. Odour problems are managed through facility design and management expertise, with on-site staff well-trained in compost biochemistry and trouble-shooting when problems arise. However, there have been a number of cases in Canada where windrow facilities have failed due to poor or inconsistent management.

Capital costs of open windrow composting facilities are highly variable, yet tend to be relatively low. For example, a facility of 30,000 tonnes annual capacity should cost approximately $2 million, exclusive of land costs. Operating costs tend to be $20 to $30 per tonne (including amortized capital). This facility could process leaf and yard waste from 300,000 households, at a cost of $3.00/household for processing only. Collection would be an additional $8 to $10/household/year or $80 to $100 per tonne.

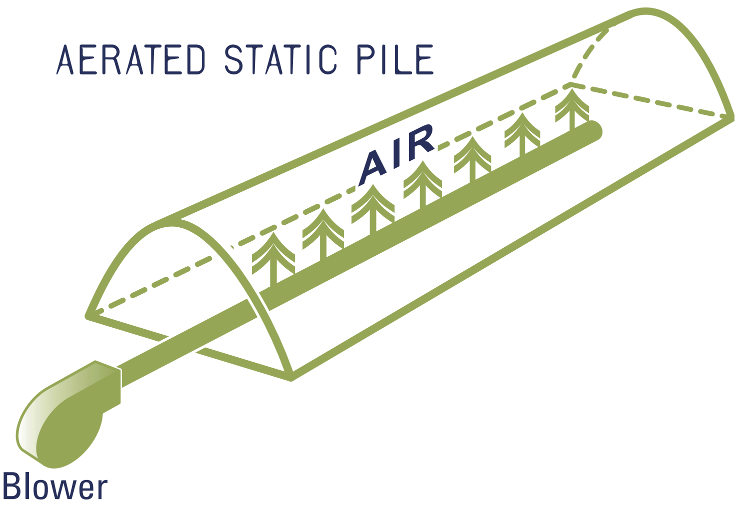
Placing piles out-of-doors exposes them to precipitation, which can result in runoff, which must be collected and treated, or added to incoming feedstock to increase its moisture content. Piles can be placed under a roof, although this adds to capital costs, and can make it more difficult to move material around.

Many channel and in-vessel composting systems use windrow (or aerated static pile) composting to complete the composting process after the initial composting using the more capital-intensive channel or in-vessel technology is completed.

Table 3.9 Advantages and Disadvantages of Turned-windrow Composting

Advantages	Disadvantages
■ Great flexibility to vary feedstock and capacity	■ Large area required
■ Relatively low capital costs	■ May have odour management problems if not managed well
■ Relatively low operating costs	■ Siting any outdoor facility may be difficult politically

FIGURE 3.3 AERATED STATIC PILE COMPOSTING SYSTEM



Source: www.cfe.cornell.edu

Aerated Static Pile Composting

This type of composting is similar to turned-windrow composting except the windrows or piles remain stationary for most of the composting process.

In an actively aerated system, a fan (or air supply blower) forces air into the pile or draws air out of it. The air is circulated through the pile via a diffuser (a pipe with holes to allow distribution of air). A timer or temperature feedback system similar to a home thermostat controls fans. Air circulation in the piles provides the needed oxygen for the composting microbes and also prevents excessive heat build-up. Removing excess heat and water vapour cools the pile to maintain optimum temperatures for microbial activity. A controlled air supply enables construction of large piles, which decreases the need for land as compost and does not need to be moved. Odours from the exhaust air can be substantial, so biofilters are generally used.

When the composting process is nearly complete, the piles are broken up. The compost is then taken through post-processing, possibly including turned-windrow composting for further product stabilization. Producing finished compost usually takes approximately 12 weeks. Aerated static pile composting systems have been used successfully for municipal solid waste, leaf and yard waste, biosolids, and industrial composting.

Because the compost mass is never disturbed, the mix and ratio of waste feedstocks must be correct from the start.

One advantage of aerated static pile composting over turned-windrow composting is the management of odorous materials in an undisturbed mass, until they have stabilized. This is one reason the technology has been popular in the processing of sewage biosolids (in the U.S., but not so common in Canada).

Table 3.10 ADVANTAGES AND DISADVANTAGES OF STATIC PILE COMPOSTING

Advantages	Disadvantages
■ Forced aeration reduces area requirement and helps avoid odour problems ■ Piles do not require turning (low maintenance requirements) ■ Lower space requirements than windrow ■ Good odour control with problem wastes ■ Lower operating costs	■ Higher capital cost than windrow ■ Does not deal well with fluctuating waste composition ■ Forced air may not be evenly dispersed through the pile

The infrastructure necessary to provide for forced aeration requires higher capital costs, although staffing needs are lower as the compost piles do not need turning.

Enclosed Channel Composting Systems

This composting system tends to be constructed inside buildings. The "windrow" is laid down between two long, parallel walls, usually constructed of concrete. These walls are commonly approximately two metres high, (about the same height as most turned windrows) and may be constructed a few metres apart, or many metres apart. Instead of the windrows forming a natural triangular cross-section, they fill the space between the walls.

The material is mechanically turned by a machine riding on rails along the tops of the walls, or suspended over the composting mass. Usually, aeration is supplemented by a forced aeration system in the floor of the channel, not unlike that used with some static pile systems. As the turning mechanism passes repeatedly down the channel, it gradually moves the waste from one end to the other. Primary composting process is largely completed by the time the waste is discharged from the end of the channel. Outdoor turned windrow or aerated static pile approaches are then used to complete the composting process.

Channel composting systems currently in operation in Canada accept a wide range of annual tonnage scales. Waste can only be added once, and consequently must be in a perfectly proportioned blend with each application. This can create problems when unusual surges of waste occur. One feature that most channel systems share with static pile and turned-windrow systems is that different sources of waste can remain segregated. In each case, a given waste stream can be kept in an independent windrow, pile, or channel, if needed.

Since most channel systems are constructed inside buildings, odours can be controlled more easily. Enclosed channel systems are generally less costly than in-vessel systems. Since most of the technology associated with the turning system is suspended over the biomass, servicing and repair of equipment tends to be straightforward.

Figure 3.4 Channel Composting System

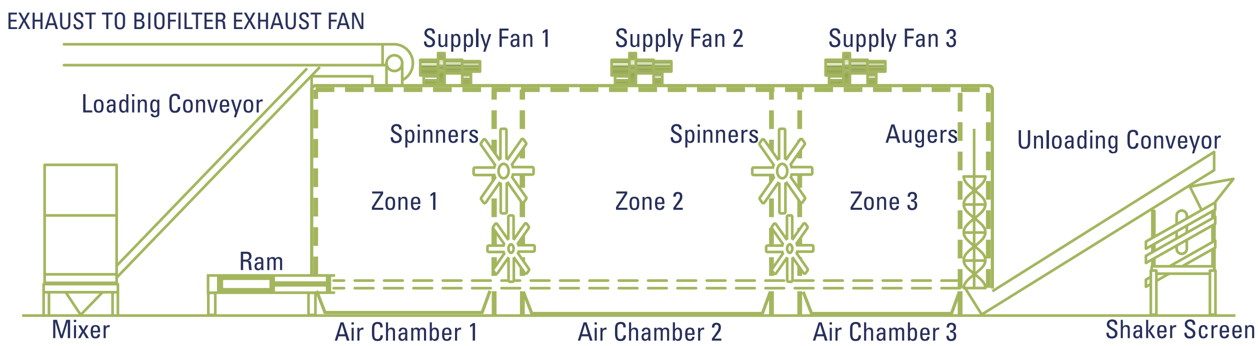
Photo: Janet R. Woodruff

This 175-foot in-channel composter is used for research at Lower Eastern Shore Research and Education Center—Poplar Hill Facility, Maryland, U.S.

Table 3.11 Advantages and Disadvantages of Channel Composting

Advantages	Disadvantages
■ Moderate capital and operating costs	■ Like in-vessel, system lacks flexibility in dealing with variable feedstock
■ Usually in buildings, so usually no odour problems	■ Large volume of air to be managed in odour control system
■ Lower space requirements than windrow	■ Off-site odours are possible if the system is poorly operated

Figure 3.5 In-vessel Composting System



In-vessel Composting Systems

In this system, the composting process itself is conducted inside a sealed container or chamber where the environment is highly controlled and access restricted. These tend to be the most capital-intensive approaches available. The big advantage is that they take up less space and may be viable where others are not. These systems are usually installed inside sealed buildings.

Some in-vessel technologies are designed to have a continual (albeit slow) flow of waste, while others process one complete batch of compost at a time, and then are emptied before receiving a fresh batch.

Early in-vessel composting systems had chambers permanently installed within buildings, and were constructed of concrete and/or corrosion-resistant metals. This type of "fixed" vessel can come in a wide range of sizes, shapes and design. All include a mechanism to feed raw waste into the vessel, another to remove compost from it and a monitoring system for at least temperature and oxygen content within the vessel, and a forced-aeration mechanism to amend the oxygen content.

A second family of in-vessel systems, commonly called "container" systems, uses a number of modular composting vessels that may be moved around the facility. A 6,000 tonne/year facility in Halifax, N.S., and a 30,000 tonne/year facility in P.E.I. use this technology. The containers are filled with raw, pre-processed organic waste, sealed, and then moved to a composting area where they are attached to air handling manifolds and monitoring equipment. In this way, each vessel is provided with the same support facilities common to the fixed-vessel systems. At the end of the primary composting process, the container is disconnected from air and monitoring systems, emptied, and then made available for another cycle. All operations are totally enclosed, limiting contact with the organic material, thus minimizing occupational health and safety concerns.

A unique variant by a U.S. company called Ag-Bag Environmental is based on technology used to wrap and seal large, round hay bales, creating a flexible "vessel." Pre-processed waste is forced into a long, heavy-gauge plastic bag, of either 1.8 metre or 3 metres (6 or 10 feet) in diameter (and virtually any length), which is laid

In-vessel container systems

Halifax Regional Municipality: treats approximately 6,000 tonnes/year of SSO waste from 110,000 households at two separate facilities.

Meaford, Ont.: an in-vessel fixed system treats approximately 180 tonnes/year of SSO from a small town, at a rate of approximately 500 kg/day.

Region of Peel: eight Herhof Rotteboxes at its Caledon Landfill Site. Each box can process 1,500 tonnes per year of organic material for a total capacity of 12,000 tonnes per year.

on the open ground. A ventilation hose providing forced aeration is installed as the bag is filled. Once completed and sealed, the bag is outfitted with blowers to provide oxygen. The Ag-Bag system's novel approach avoids the cost of constructing a building. The Ag-Bag system is presently not used in Canada.

Virtually all in-vessel systems rely on either turned-windrow or aerated static pile systems to complete the composting process after the waste has undergone primary composting in the vessel.

Odours can be managed reasonably well, because all operations are sealed in a building and exhaust air passes through biofilters. However, a number of in-vessel composting facilities in Nova Scotia, Quebec, Ontario, and B.C. have experienced off-site odour despite the high technology, so regardless of the system, operational expertise is key. These systems are designed to create ideal composting conditions within the vessel at all times, and so should be able to process compost at the fastest rate. As a consequence, these facilities tend to consume the least amount of land of all composting technologies. However, they also tend to be the most expensive approaches to centralized composting.

Processing – Post-processing

Post-processing involves preparing the end product from the composting operation for market and may include drying, screening, blending, or bagging. Post-processing will depend on end-market requirements, and the degree to which contaminants are still present. Most operations include screening compost to homogenize it and remove oversize materials. Given generally stringent compost quality standards in Canada, it is more effective to try to remove most contaminants during the pre-processing stage.

Compost, in its pure form, is not a particularly good growth medium for plants. It is most effective when combined in significant amounts with other soil materials, such as sand, loam, or peat. Consequently, compost facilities relying on product sale revenues often blend their product on site before releasing it for sale.

Compost produced in Canada is generally subject to regulation by provinces. While details differ, most standards require that attention be paid to:

- Levels of 11 heavy metals and PCBs in the end product;
- Presence of visible contaminating materials, such as glass, plastic, or pieces of metal;
- Organic matter content;
- Proof that the compost has experienced sufficient temperatures for enough time to achieve "pathogen reduction"—the significant elimination of weed seeds, and plant and animal pathogenic organisms;
- Stability, since unstable compost is actually harmful to plants.

Agriculture and Agri-Food Canada also regulates compost sold in Canada through the federal *Fertilizers Act*, when specific claims are made regarding a company's utility in plant growth. The CCME has also worked to establish national guidelines for compost quality for reference in those provinces without standards.

In addition, Le Bureau de normalisation du Québec (BNQ), a member of the Standards Council of Canada, has developed national, voluntary industry compost quality standards. Compost that meets this standard can bear a BNQ label as an indication of quality.

New and Emerging technologies

Composting vendors are always inventing new ways of doing the same thing, which is composting organic waste in the presence of oxygen. Different vendors adjust airflow rates, some leave the waste in one place, whereas others move the waste around or agitate the waste, whichever approach is considered to reach the objective of waste stabilization in the fastest time. (See Composting Council of Canada's Web site at www.compost.org)

Some provinces have turned to regulations to compel municipalities to achieve the 50 per cent diversion target—effectively mandating organics diversion, (e.g., Nova Scotia, Prince Edward Island).

Due to some composting facility failures in the past 15 years, and to the obvious potential for odour production, the siting of new composting facilities has become the object of public resistance. Bringing such facilities on line may take years and involve consideration of several sites. This adds significantly to the cost of developing the system, makes startup dates difficult to predict, and makes private-sector vendors nervous about accepting the full risk of developing facilities to a municipal schedule.

Municipalities have responded to the cost issue by experimenting continuously with new collection strategies. No obvious solution to the need to provide low-cost and effective collection has yet appeared for broad adoption of organic matter content.

Evaluation

Despite the growing popularity of composting, communities face several challenges in developing and operating successful composting programs:

- Lack of experienced designers, operators, and technical staff;
- Difficulty of choosing from different technologies, many of which claim to be uniquely superior;
- Siting of a composting facility can be as politically challenging as the siting of any waste management facility.

General Systems Performance

Composting can process about 25 per cent of the residential waste stream in a SSO program, where 40 to 50 per cent of the residential solid waste is organic. Current SSO programs show variable residue rates of one to 20 per cent of the incoming waste stream depending on participation, contamination, etc. In general, however, the possible net diversion through composting is approximately 20 per cent of the residential waste stream. Mixed waste composting (after source separation of recyclables) can process up to 55 per cent of the residential waste stream. Residue rates for a mixed program are 35 to 40 per cent of the incoming tonnage, therefore mixed waste plants can divert approximately 33 per cent of the residential waste stream.

Composting systems will operate successfully and produce a stabilized end product as long as they are operated by well-trained staff. Composting is a biological process that requires tweaking on a regular basis by an experienced professional.

Community Characteristics

A composting facility sited in or near a large urban, downtown area must be different than one serving a small town with surrounding rural lands, and again different from a remote northern community.

If the only available land is highly urbanized, then a composting technology should be constructed inside a sealed building to control odour. There are successful Canadian examples of turned-windrow, aerated static pile, channel, and in-vessel systems, all in sealed buildings. Alternatively, transferring and hauling waste to more remote (and potentially outdoor) sites should be explored, since this may be less expensive than building a capital-intensive urban facility.

Locale will also affect cost of waste management alternatives—particularly disposal. In some parts of Canada, the cost to dispose of solid waste in landfills is extremely low—in the range of $10/tonne after collection—and is expected to stay at this level for the foreseeable future. In this financial environment, municipalities may find it hard to argue for a capital-intensive composting approach. Other Canadian jurisdictions are burdened with high disposal costs, which can make a broader range of composting technologies attractive. Cost has been the prevailing reason why more Canadian municipalities are not composting.

All four general technologies described—turned-windrow, aerated static pile, enclosed channel, and in-vessel—are in operation in North America at scales from well below 100 tonnes per annum to 100,000 tonnes per annum. None of these approaches is associated with a given scale.

One might think that climate is a significant issue, particularly with outdoor technologies. But the one facility in the Yukon is an outdoor turned-windrow, and the technology is used throughout the coldest Canadian winters.

Costs

It is very difficult to establish specific dollar ranges for the systems that have been discussed in the preceding pages. Local circumstances and firm quotes for composting operations need to be taken into consideration. Roughly speaking, program collection costs are $20 to $25 per household per year for 250 kg/year/household of SSO (approximately $80 to $100/tonne). In comparison, garbage collection costs for households are $35/household/year for collection of approximately 700 kg/year/household (approximately $50/tonne).

Open windrow composting costs $20 to $30/tonne, excluding land costs; enclosed channel facilities— $45 to $60/tonne, and in-vessel systems—$60 to $80/tonne. These costs convert to $10 to $20 per household/per year for processing of SSO, for an overall cost of $30 to $45 per household/per year. A mixed-waste composting program handles a greater proportion of the waste stream, and costs around $70 to $120/household/year (including collection).

Factors Influencing System Choices

These factors must be considered before developing a composting system:

- Is there a strong municipal policy to mandate greater diversion from landfill? High landfill diversion can rarely be achieved without an organics program.
- Is a composting system demonstrably cheaper than alternative systems for waste management previously used (e.g., local cost of disposal is high)?
- Is there a provincial mandate compelling the creation of a composting system, regardless of cost?

A number of Canadian jurisdictions explored developing a full organics diversion system, and at least temporarily abandoned the idea after comparative costs were found to be too high. However, many large Canadian communities are pursuing a comprehensive organics strategy—it all depends on local circumstances.

Environmental Effects

Composting ensures that organic waste is diverted from landfill. This has a number of important, beneficial effects:

- Keeps organic waste out of landfill where it generates an acidic leachate. This precipitates metals from landfilled waste into the leachate, resulting in an acidic, metal-laden leachate which must be treated prior to discharge;
- Organic waste generates methane gas as it decomposes. In well-engineered landfills, this gas is collected and in some cases recovered for energy. However, in many landfills the gas is lost as it is flared or simply escapes to the atmosphere as methane, which is a powerful GHG (21 times more powerful than CO_2);
- Composting produces a material that can be spread on soil to add nutrient value and to return carbon and structure to the earth.

The IWM Model was used to compare the environmental effects of composting versus landfilling the same waste. A high-end engineered landfill design with a leachate collection system, a landfill gas (LFG) recovery system, and a gas-to-energy conversion system was assumed for the analysis.

A total of 1,000 tonnes of typical composting waste (50 per cent yard, 30 per cent food, 20 per cent paper) was considered for each run of the model. The energy emissions for residential collection of the waste were not included. Residue rates of 15 per cent were assumed.

Results are given in qualitative terms only, as the actual values will vary throughout the country, and need to be estimated using IWM, and inputting local numbers and conditions. Where an offset value is shown, it indicates that energy was recovered or emissions were avoided.

Table 3.12 Estimated GHG Emissions from Composting 1,000 Tonnes of Organic Waste Compared to Landfilling

GHG Emissions	Highly Engineered LF (tonnes)	Composting (tonnes)
CO_2 Equivalents	Higher	Lower

Overall, composting produces fewer tonnes of eCO_2 when compared to landfilling the same waste.

Table 3.13 Acid Gas and Smog Precursor Emissions from Composting 1,000 Tonnes of Organic Waste Compared to Landfill

Acid Gas and Smog Precursor Emissions	Highly Engineered LF (Kg)	Composting (Kg)
ACID GASES		
NO_x	Higher	Lower
SO_x	Lower*	Higher
HCl	Lower*	Higher
SMOG PRECURSORS		
PM	Similar	Similar
VOCs	Higher	Lower

** Indicates an energy offset or avoided emission.*

In this model run, landfilling produces more NO_x emissions than composting. The landfilling option results in a reduction in SO_x and HCl emissions (through energy offsets, identified with *). The higher composting emissions result from the transportation of the residue from the composting process to a nearby landfill. The landfill option produces more VOCs but somewhat less particulate matter (PM) than composting.

Table 3.14 Toxic Emissions from Composting 1,000 Tonnes of Organic Waste Compared to Landfilling

Toxic Emissions	Highly Engineered LF	Composting
AIR		
Pb (kg)	Lower*	Higher
Hg (kg)	Lower*	Higher
Cd (kg)	Lower*	Higher
Dioxins (TEQ) (g)	Higher	Negligible
WATER		
Pb (kg)	Lower*	Higher
Hg (kg)	Higher	Negligible
Cd (kg)	Higher	Lower
BOD (kg)	Higher	Lower
Dioxins (TEQ) (mg)	Higher	Lower

** Indicates an energy offset or avoided emission.*

Air and water emissions were considered in Table 3.14. Landfill generated fewer air emissions, except for dioxins. Landfill had more water emissions, except for lead.

Energy Implications

Energy usage at composting facilities is low, because only simple motors or vehicle use is required. A 1996 report to Environment Canada by Resources Integration Systems Ltd., suggests that composting energy requirements are estimated to be in the range of 20 to 40MJ/tonne. In the absence of detailed estimates, it is assumed that collection of organics requires similar inputs to the collection of recyclables, at 475MJ/tonne. Collection of mixed waste for processing at a mixed waste composting plant is assumed to be the same as garbage collection at an energy requirement of 167MJ/tonne.

The upstream benefits of composting, in terms of saving the production of some fertilizers, are reflected in the environmental benefits estimates presented in the previous section.

Lessons Learned

- If municipalities want to achieve the 50 per cent target to divert waste from landfill, adopted by the federal and most provincial governments, they must make provision to collect and process organics.

- Source separation, collection, and composting of the organic stream are some approaches—and the most commonly adopted to date—to process municipal and commercial organic solid wastes. Other technologies, such as anaerobic digestion, are emerging, but so far have played a small role.

- Programs to collect and compost organic solid wastes tend to be more costly than conventional waste collection in most Canadian jurisdictions. Part of the cost issue stems from the need to continue to offer a parallel system to collect non-compostable wastes for disposal, unless a "two-stream" waste management system is adopted. While used successfully in some areas, the two-stream approach has not been widely adopted. Given recent trends in broad cutbacks of tax-supported core services, the cost of new organics diversion programs has been a major barrier to adoption by Canadian municipalities.

- Municipalities tend to implement full-scale organics collection and composting programs where it is legislated provincially, or where cost structures make it attractive.

- The design of an organics diversion system is complex. Unlike the blue box system for recyclables, no single approach dominates. The lack of a simple system endorsed by all complicates the problem of trying to roll out more programs.

- Successful programs for diverting organics (and for diverting material from disposal to recycled use) focus on identifying specific markets for the intended product first, then on designing a system to meet that market specification, and finally on designing a collection system that will collect the materials in a form needed by the processing system. Historically, system designs that start with collection convenience as the primary objective have had sustainability problems.

- Well-designed collection systems for household and commercial organics sustain participation rates that are equal to the best blue box programs.

- Well-designed and well-managed composting facilities are capable of processing the materials collected by any type of residential and commercial organics program on a sustained basis. More capital-intensive enclosed facilities tend to have higher operating costs (inclusive of amortized capital), but tend to have a better track record on odour management. Still, many good outdoor windrow facilities exist across Canada, and there have been failures of enclosed facilities.

- Compost that can pass prevailing Canadian standards tends to be produced from waste materials collected from source-separated, rather than mixed waste. Compost that has been produced by competent facility managers, using a clean feedstock, and then marketed in an entrepreneurial fashion, is always readily sold to markets that can absorb any quantity produced.

Other lessons learned include the:

- Importance of well trained staff, particularly when a plant receives an unusual load of waste which puts the system out of balance;
- Importance of developing good relationships with site neighbours;
- High cost of odour problems in terms of community relations;
- Importance of keeping tight control over the process at all times to avoid odour development;
- Importance of removing as much contamination as possible from the feed stream to improve the quality of the finished compost;
- Critical importance of markets for the end product, to make the composting operation economically viable;
- Difficulty of locating an open windrow site near built-up areas, and the fact that an enclosed composting facility with a biofilter for odour control is required near built-up areas.

Table 3.15 COMPOSTING SUMMARY

Factor	Summary
DESCRIPTION	Complex process; low technology. Three components: pre-processing (shredding, bag breaking); composting; post-composting (drying, blending, bagging) Composting: Open windrow: low tech; least cost; significant amounts of land (including buffer zones); most suited to rural locations Enclosed channel: medium tech; much less land; more costly because of the buildings and equipment required; suitable for rural and urban areas In-vessel composting: high tech; highest cost; most tightly controlled; smallest amount of land; urban areas
GENERAL PERFORMANCE	Can divert approximately 50% residential waste stream, depending on the process Source-separated organics: residue rates and capture rates lower but the finished compost is of higher quality, readily sold Mixed-waste composting: diverts up to 50% residential waste stream; high residue rates; 100% participation; lower market demand 100 to 100k tonnes/yr for any technology

(continues on page 208)

(continued from page 207)

Factor	Summary
COMMUNITY CHARACTERISTICS	Composting technologies can operate in all Canadian climates, although active composting in open windrow only occurs in warm temperatures Open windrow sites are not suitable for location in urban areas Enclosed channel and in-vessel facilities can be located at the edge of or in urban areas
COSTS	Backyard composting most cost-effective (e.g., $32 to 45/t) Pre-processing: depends on source and composting technology; fairly costly $10 to $20 per household per year (open windrow composting at the lower end of this range, excluding land costs) Big challenge to drive costs out of collection
FACTORS THAT INFLUENCED ACQUISITION	50% diversion target infers targeting the organic, biodegradable waste that is half the waste stream Yearly operation requires costly equipment
NEW AND EMERGING TECHNOLOGIES	New approaches frequently introduced, generally optimize one operational variable
ENVIRONMENTAL EFFECTS	Reduction in acidic leachate, metal precipitation; reduced gas generation. Excellent source of carbon and some nutrients when compost land applied
ENERGY IMPLICATIONS	Low energy
LESSONS LEARNED	No single approach dominates in Canada, many different approaches work Essential elements: ■ Markets for finished compost ■ Well-trained staff ■ Avoidance and early correction of odour problems ■ Continuous education of homeowner

Anaerobic Digestion

General Description

Anaerobic digestion (AD) is a biological process using microbes to break down organic material in the absence of oxygen. Digestion takes place in a special reactor, or enclosed chamber, where critical environmental conditions, such as moisture content, temperature and pH levels, can be controlled to maximize microbe generation, gas generation, and waste decomposition rates.

AD can work well in Canada although there have been some technical difficulties that require adjustments to the mixtures. The main deterrent is one of economics. It is expensive compared to other options for the volumes of waste produced by most Canadian municipalities. AD is more viable in Europe, where there is little landfill space and environmentally sound incineration is very costly.

The biological and engineering principles of AD are well understood and have been implemented extensively worldwide. AD is used at a household and community level in China and India, where low-tech digestion systems are used to generate heating and cooking fuel for local households. The most common municipal application is the treatment of biosolids from wastewater treatment plants. Globally, some 100,000 wastewater treatment plants use AD to process sludge generated by their operations. Historically, wastewater solids were digested anaerobically in Exeter, England, in 1895, to recover methane gas, which was then used as an energy source for lighting the area around the treatment plant. Still, the potential application of this technology as a waste diversion method for municipal solid waste is a relatively recent development.

Virtually all examples of AD facilities treating municipal waste (SSO or mixed waste) are in Europe, with commercially available technologies primarily in Denmark, Belgium, France, Germany, and Switzerland. High capacity systems to treat mixed waste are under construction in Spain and Italy, but have no operational experience to date. New construction of plants in Europe experienced exponential growth between 1990-1995 (with capacities of processing 30,000 tonnes of organic waste per year) and 2001-2002 (capacities of 300,000 tonnes per year).

The majority of European AD plants—many of which are 10 to 15 years old—process relatively little organic waste, in the range of 8,000 to 15,000 tonnes/year. Facilities constructed recently tend to have larger design capacities, in the range of 40,000 tonnes/year. The trend towards larger processing plants is a reflection of engineering advancements, which have enhanced the technical and financial viability of AD in municipal applications. However, the financial viability of these European systems is predominantly the result of:

- High landfill tipping fees ($150 to $200/tonne), making AD economically competitive;
- The European Union Landfill Directive prevents the landfilling of unstabilized organic waste, therefore requiring stabilization by either incineration, composting, or digestion;

- Some European countries (Switzerland and Belgium) have renewable energy policies in place that require local utilities to buy all "green" power from AD plants at prices of 15 cents per kilowatt hour, therefore helping the economics of the systems.

Canada

There are three AD plants in Canada. The Canada Composting Inc. facility in the Town of Newmarket, Ont., uses BTA (a German technology) and can process up to 150,000 tonnes/year of SSO, plus some mixed waste loads. A second facility using BTA was constructed at Toronto's Dufferin Transfer Station and has been operational since September 2001. The facility is designed to process 25,000 tonnes of SSO per year, but can be expanded to 165,000 tonnes per year. It is being used to test system performance with different loads of mixed and source-separated waste.

A facility in the City of Guelph, Ont., developed by the Super Blue Box Recycling Corporation (SUBBOR), uses a unique two-stage design with a steam explosion process after the first stage to increase gas production in the second stage. Negotiations between SUBBOR and potential customers have been largely unsuccessful so the plant has announced its forthcoming closure.

Key Elements of AD Facilities

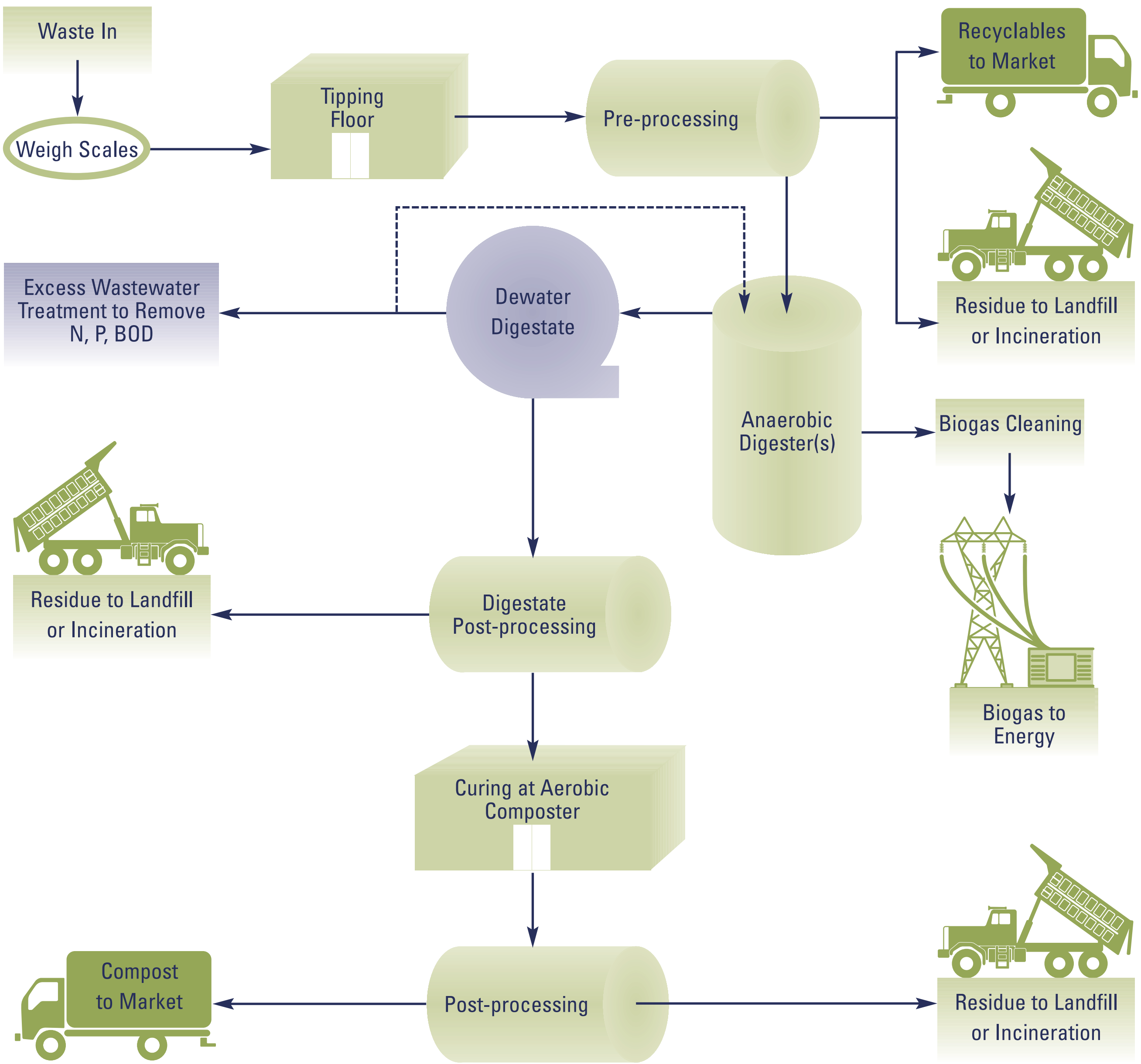
The operation of an AD plant generally involves three steps:

- Pre-treatment;
- Digestion; and
- Aerobic curing.

Pre-treatment converts incoming organic material into a raw material that is fed into the digestion reactor. Pre-treatment can include size reduction, screening to remove oversized materials, and mechanical and manual sorting of contaminants and recyclables. Residue (metals, wood, plastic) is removed for proper disposal, while the remaining clean and pulverized organic waste is mixed with water to create an organic-rich slurry with the physical properties required to optimize digestion inside the reactor. Pre-treatment of incoming SSO generally relies on mechanical separation techniques to remove metals and oversized contaminants. Plants designed to process mixed MSW require a relatively elaborate pre-treatment scheme that involves extensive mechanical and manual processing to maximize the removal of materials, such as reyclables, wood and other contaminants, to improve the quality of the finished digestate.

Equipment required for an AD pre-treatment system is similar to that found in a MRF that processes dry recyclables (see Section 2), including a series of platforms, conveyors, sliding belts, and chutes to move material from the tipping floor to various sorting stations that employ magnetic separators to remove ferrous metals and eddy current separators to remove aluminum. Size reduction equipment, such as a hammermill, is used to reduce the particle size of the organic waste stream according to the digester's specifications. Equipment to separate incoming waste on the basis of particle size, such as a trommel screen, is used to mechanically remove inorganic contaminants (plastic, glass, and metal) or pieces of organic material too large to be processed. A series of elevated platforms and chutes that allow manual sorting of the incoming waste may also be required in a plant that processes mixed MSW. Depending on the way organic waste is collected and the amount of waste to be processed, a mechanical debagger may be required to open all incoming bagged waste.

Figure 4.1 Typical Schematic of an AD Plant



Once the organic waste is loaded into the reactor, **digestion** takes place. In the first stage of digestion, generally referred to as hydrolysis and acidification, organic material is broken down by a group of microbes called acid formers. Fatty acids are one of the end products of this stage. In the second stage, generally referred to as methanogenesis, a group of microbes called methane producers convert fatty acids into a biogas, which consists of 55 per cent methane, 45 per cent carbon dioxide, and other trace gases. Once the organic material has been digested, fresh organic waste is loaded into the reactor while an equal volume of digested material is removed and pumped to a dewatering machine where excess liquid is collected for treatment.

In some AD designs, the reactor is heated, which uses a portion of the biogas.

Dewatered digestate is not fully stabilized and usually requires 60 to 120 days of **aerobic curing**, during which pathogens are killed by high temperatures in the compost pile. In this third step, drying and stabilization can be carried out in an outdoor aerobic composting facility or an in-vessel aerobic composting system (see Section 3). The dried digestate is screened to remove remaining impurities and is ready to blend with other materials, such as sand or peat, to produce a marketable soil conditioner.

Feedstock

AD can be used to process a variety of feedstock, including sludge from municipal wastewater treatment plants and livestock manure as well as mixed waste from residential sources (mixed MSW) and SSO from residential and non-residential sources. Mixed MSW is generally defined as residential and small-scale commercial solid waste that excludes material captured by waste diversion activities, such as recycling and composting. SSO is a stream of municipal waste collected and stored by household residents for separate management from garbage and includes food waste plus a range of other organic materials, including soiled paper, diapers, and leaf and yard waste.

AD does not compete with traditional recycling systems, because commonly recycled materials, such as metal, glass and plastic containers, can not be digested. The one exception is paper, which is biodegradable, but also digestible, and therefore can be recycled or digested. The preference for paper is, where possible, to recycle it so that it can displace the need to harvest new virgin sources of paper.

Feedstock selection is a key decision when designing an AD system because it affects every step in the planning process, including plant design capacity, waste diversion potential, and the existing residential garbage collection system. The design capacity of a mixed MSW plant is largely determined by the size of the community and the amount of garbage currently set out by local residents for regular waste collection, though some additional processing capacity should be anticipated if local commercial establishments participate in the program. Statistics Canada research indicates that 330 kg/capita/year of waste is currently generated, 100 kg/capita/year is currently diverted and 230 kg/capita/year is currently disposed. The average Canadian household generates approximately one tonne of residential waste per year, and disposes of approximately 700 kg/household per year. If a mixed MSW AD plant were implemented in an average community, approximately 550 kg/hh of this total would be sent to the AD plant for processing.

Based on data from a number of SSO programs operating in Canada, recovery estimates of 250 to 350 kg/single family household/year can be expected from SSO programs. Recovery rates vary depending on a number of factors, including range of organic materials targeted for collection, participation rates, and the extent of promotion and education programs. One challenge associated with the implementation of a SSO program is how to incorporate multi-family dwellings into the collection system. Lack of outside storage space and uncertainty about resident participation are two barriers often cited when planning any source separation program for apartment buildings and condominiums. Given these challenges, municipalities may choose to implement a SSO program for the single-family housing sector first, while investigating cost-effective methods for separating, storing, and collecting organics in multi-family dwellings. SSO programs therefore can expect to handle less tonnage compared to mixed MSW operations, because fewer households are provided with the service (at least during the initial stages of implementation), and because only the organic portion of the waste stream is targeted for collection and processing.

Diversion and Residue Rates

Feedstock selection will also affect a community's overall waste diversion rate because of the amount of residue recovered at the AD facility. As a general guide, 10 to 20 per cent of all waste delivered to an AD facility processing SSO will require disposal, assuming an appropriate level of investment in promotion and education programs, and mechanical separation techniques at the plant to remove contamination. The remaining 80 to 90 per cent will be diverted from disposal through the production of finished compost from digestate (a humus-like material that can be used to produce a soil conditioner), liquid waste (the amount will vary depending on the technology used) and dry recyclables.

The residue rate at an AD plant processing mixed MSW (i.e., residential waste from which recyclables have been removed) will likely be 25 to 40 per cent of all incoming waste depending on the quality of the feedstock, and the type of mechanical and manual sorting systems used. The City of Edmonton, Alta., and the Town of Tracy, Que., process mixed MSW (after source separation of recyclables by residents) in composting facilities and report residue rates of approximately 35 per cent. Therefore, as a planning guide, a mixed MSW AD plant could expect to divert approximately 60 to 75 per cent of all incoming waste, although this material cannot be considered diverted unless markets can be found for the composted mixed waste digestate produced. The incoming material is likely to contain non-organic material, such as plastic and glass, which ends up in the final product and causes a marketability problem. Also, some metals may be at a high enough concentration to limit the uses to which this material can be directed. This is the toughest challenge facing municipalities considering mixed waste processing using composting or digestion. Public perception against the use of "biosolids" also causes challenges in establishing co-digestion approaches.

The capacity of AD to reduce the amount of disposed garbage is dependent upon the quality of the system's by-products. If the compost produced as a result of stabilizing the plant digestate cannot be marketed, treated for reuse, or dedicated to beneficial uses, the comparative advantage of AD is reduced. Finished digestate (after composting) in particular will need to meet provincial standards for unrestricted use if its market potential as a blending material for a soil conditioner is to be realized. Experience suggests that provincial standards, particularly for trace element concentrations, can be achieved by source separating organics prior to digestion. A successful mixed MSW AD plant will likely require extensive mechanical systems complemented by manual sorting to remove materials that contribute to trace metal concentrations, such as batteries, plastics and light bulbs, among others.

Technologies

Fundamental Features of the Digestion Process

Generally, AD technologies can be categorized broadly on the basis of three variables:

- Amount of water added to the incoming waste during pre-treatment;
- Reactor's optimal operating temperature; and
- Number of digestion stages in separate reactors.

The amount of water added to the feedstock is an important distinction among AD systems.

- "Dry" systems mix enough to produce an organic slurry that consists of 15 to 40 per cent solid waste. Examples of commercially available dry digestion systems: Dranco, Kompogas and Valorga.
- A "wet" system processes a more diluted organic slurry with 10 to 15 per cent solids. BTA and Wassa are two examples.

Operating Temperatures: Thermophilic and Mesophilic Systems

Regulating the temperature inside the digestion reactor is central to the chemical reaction process that unleashes the stages of microbe development. Commercial AD reactors are generally operated at either a mesophilic temperature (approximately 35°C), or a thermophilic temperature (approximately 55°C).

Operating temperatures do not appear to affect subsequent composting of the digestate.

A mesophilic AD plant generally requires a retention time of 12 to 25 days; a thermophilic reactor can achieve the same results in approximately six days. The time required to fully convert the organic slurry into a partially stabilized digestate depends on the amount of organic material in the feedstock, seasonal variations affecting the quantity and composition of the waste stream, and the chosen technology.

One-stage and Two-stage Systems

Wet and dry AD facilities can be operated as one- or two-stage systems. In single-stage systems, hydrolysis and methanogenesis take place in one reactor. This is the oldest and most common approach to AD processing in Europe.

In the newer approach of two-stage systems, one reactor is dedicated to the acidification process and another to methanogenesis. According to some sources, the principal advantage of the newer two-stage systems is the opportunity to control two separate environments, which is an important separation for research institutions.

When processing municipal solid waste, separating biological processes into two or more reactors does not appear to yield significant advantages. According to some sources, both systems perform equally well when processing municipal waste in terms of the amount of waste that can be processed on an annual basis and the rate of biogas production. Approximately 90 per cent of all European AD plants processing municipal organic waste use one-stage technologies. The predominance of one-stage systems is in part due to this technology's relatively simple design, less frequent technical failures, and lower capital costs.

The full-scale demonstration SUBBOR plant in the City of Guelph, Ont., consists of two digesters. After the first stage, partially digested organic waste is removed, dried, and subjected to elevated temperatures and pressures. The goal is to break down some of the complex chemical bonds and improve the digestibility of the material going into the second-stage digester. The final step is to prepare a slurry in preparation for loading into the second reactor to complete the digestion and biogas recovery process.

BTA is a German digestion technology licensed to Canada Composting Inc. (CCI) in the Town of Newmarket, Ont. A unique aspect of BTA is that organic waste is mixed with water (hydropulping) to remove small particles of contamination, such as glass and plastics not removed during the mechanical pre-treatment process. The organic slurry then passes through a hydrocyclone, which removes minute particles of glass shards, sand, and small stones. BTA operates one- or two-stage digestion systems. According to published sources, the one-stage BTA system, which includes mechanical and wet preparation, is suited for facilities using an existing digestion reactor.

New and Emerging Technologies

There are many variations on the AD process design for SSO or mixed MSW. Generally, they are wet or dry, one- or two-stage, thermophilic or mesophilic. Trends in Europe are towards:

- Thermophilic systems, because of increased pathogen kill;
- Dry digestion systems;
- Discontinuation of the conventional two-stage digestion system design. Experience has shown that gains in optimizing operating conditions in two reactors are not worth the extra cost.

Evaluation

General Systems Performance

AD is used in Europe for processing SSO and mixed MSW. There is little operational experience in Canada. This technology works well at scales of 10,000 to 20,000 tonnes/year of SSO. Larger plants are currently being constructed. Supportive renewable energy policies and the relatively high costs of landfilling in Europe make the economics more favourable than in Canada.

AD has a significant benefit from a GHG point of view. It produces methane from the degradation of organic waste in a controlled environment. The methane can be used to displace fossil fuels. In addition, it avoids the production of this methane over a much longer period in a landfill, where its maximum energy potential would not be realized.

Advantages of AD technology include:

- *Increased diversion of waste from disposal* – AD technology offers the potential to increase municipal waste diversion rates to 40 to 70 per cent by diverting the organic component of the waste stream from disposal. (The digester converts the materials to solid and liquid streams and biogas, which must be productively used to achieve real diversion.)
- *Reduced GHG emissions* – Proper digestion converts a portion of the organic waste to methane, which is converted to carbon dioxide (CO_2) when combusted, thereby considerably reducing GHG emissions from landfills. Methane gas is 21 times more powerful than CO_2 as a GHG.
- *Net energy production* – AD is a net energy-producing process that produces sufficient energy to meet in-plant needs, and can export 50 to 80 per cent of the energy produced to off-site energy users.

Disadvantages of AD technology include:

- Anaerobic digestion has a higher cost per tonne compared to landfilling or composting in Canada;
- AD cannot process the entire waste stream. AD systems process and treat only the biodegradable organic fraction;
- The markets for bi-products, such as soil conditioner and liquid fertilizer, are somewhat uncertain; and

- AD of mixed waste is an emerging practice in North America, and is therefore not considered fully proven.

Community Characteristics

Table 4.1 has been developed assuming an average recovery of 250 kg/household/year for SSO programs, and that mixed waste programs would process an average of 550 kg/household/year, when recyclables have been source separated, and material, such as bulky waste, is removed from the waste stream before delivery to the AD plant. The table also assumes an average household size of 2.7 people for Canada (based on a population of 28.8 million and 10.82 million households).

The minimum throughput required to justify the cost of an AD facility is at least 10,000 tonnes/year, or the amount of SSO produced by 40,000 households or up to 110,000 people, according to a 2001 *Biocycle* article. The rationale for this minimum design capacity is partly based on the range of commercially available technologies and cost, given that small-scale facilities tend to have relatively high per tonne operating budgets. The population base that could support this minimum level of operation depends on feedstock, amount of material generated by each household, and the mix of single and multi-family dwellings. For mixed waste, a 10,000 tonne per year plant would process waste from about 18,000 households (assuming mixed waste to the digester would be approximately 550 kg/household/year)

As a general planning guide, a service area with a population of more than 100,000 residents could generate enough material to justify an investment in a 10,000 tonne/year SSO AD system. A service area could include a single municipality or a group of urban and rural communities working together. The actual number of households required in a service area could depend on:

- The number of single-family households;
- Whether or not multi-family and local commercial establishments will be required to separate organics;
- The average amount of SSO set out at the curb for collection each year.

Table 4.1 AD Facility Sizes Required for Different Feedstock and Community Sizes (tonnes per year – tpy)

Households Served	Feedstock	Plant Size (tpy)	Population Served
40,000	SSO	10,000	110,000
18,000	Mixed MSW	10,000	50,000
200,000	SSO	50,000	550,000
90,000	Mixed MSW	50,000	250,000
400,000	SSO	100,000	1.1 million
180,000	Mixed MSW	100,000	500,000

Implementation of a mixed MSW AD program would require a considerably smaller service area because the amount of waste collected from each household is greater than that for a SSO system. Depending on the local waste management conditions of any given municipality, a service area with a population of approximately 50,000 (18,000 households) could expect to generate enough material to feed a 10,000 tonne per year facility that processes mixed MSW, excluding bulky items (see Table 4.2 on page 218).

Costs

Net System Costs: The general lack of AD experience in North America makes it difficult to estimate net system costs based on practical experience here. Based on conversations with AD systems manufacturers, ballpark costs can be modeled for dry, single-stage thermophilic facilities by calculating the cost of the operational components. These include the approximate level of capital investment required for the AD equipment and building as well as annual operating expenses, annualized capital costs, and projected revenue from the sale of finished digestate and energy.

It is important to note the key assumptions regarding what is and is not included in the calculation of planning budgets. The following budget items have not been included in the calculation of costs developed for this report, but require careful attention:

- The purchase and preparation of serviced land;
- Costs associated with implementing a SSO curbside collection program;
- The cost of purchasing and distributing bins so that residents may store SSO;
- Potential avoided disposal savings that may be incurred by reducing waste sent for disposal after implementing an AD system.

Capital Costs: Economies of scale favour large facilities when comparing capital costs measured on the basis of per tonne of design capacity. Estimates include the cost of digestion reactors, buildings, and pre-treatment equipment (see Table 4.2 on page 218).

The capital cost of processing equipment for MSW and SSO are comparable. A municipal program generating 100,000 tonnes/year of SSO requires a reactor that can digest approximately 80,000 to 90,000 tonnes/year after residue is removed, while 100,000 tonnes/year of mixed MSW requires a reactor that can digest approximately 70,000 to 80,000 tonnes/year after residue has been removed. The mixed MSW plant will require a smaller reactor, and a greater investment in pre-treatment capital and operating costs.

Generally, the capital cost of a wet system is comparable to a dry AD plant design. A wet AD system requires a larger and, therefore, more expensive reactor because the large quantity of water added to the incoming organic waste stream increases the volume of material to be digested. This higher reactor cost may be offset by relatively lower costs for material handling equipment. Dry AD systems require more robust equipment to handle bulky dry organic feed. However, wet technology also has a higher parasitic load of energy (energy required for internal plant uses), and less energy available for export. Some of these assumptions may be tested at a wet AD facility, which began operation at Toronto's Dufferin Transfer Station in September 2001.

Net Annual Operating Costs: Annual operating expenses include annualized capital costs, operation and maintenance of the plant and building, residue disposal, and digestate curing.

Table 4.2

Estimated Capital and Operating Costs for "Generic" AD Plants (tonnes per year design capacity)

Budget Item	10,000 tpy		50,000 tpy		100,000 tpy	
	SSO	MSW	SSO	MSW	SSO	MSW
CAPITAL						
CAPITAL INVESTMENT	$10,000,000	$10,000,000	$22,000,000	$23,000,000	$33,000,000	$35,000,000
CAPITAL COST/DESIGN TONNE	$920	$990	$440	$465	$330	$350
NET OPERATING COSTS						
ANNUALIZED CAPITAL	$1,000,000	$1,100,000	$2,400,000	$2,600,000	$3,600,000	$3,800,000
OPERATING EXPENSES	900,000	900,000	3,500,000	3,200,000	6,600,000	6,000,000
SUBTOTAL GROSS OPERATING	$1,900,000	$2,000,000	$5,900,000	$5,800,000	$10,200,000	$9,800,000
REVENUE	300,000	200,000	1,500,000	1,000,000	3,000,000	2,000,000
NET ANNUAL COSTS	$1,600,000	$1,800,000	$4,400,000	$4,800,000	$7,200,000	$7,800,000
HOUSEHOLDS SERVED	40,000	18,000	200,000	90,000	400,000	180,000
COST/TONNE FEED	$160	$180	$90	$100	$75	$80
COST/HOUSEHOLD/YEAR	$40	$100	$22	$54	$18	$44

The following assumptions were used:

- Cost of residue transfer and disposal has been assumed at $55 per tonne;
- Cost of curing is $15 per tonne of unfinished digestate at an open windrow facility located close to the AD plant, so transportation costs are minimal;
- Plants processing mixed MSW require additional expenses to cover costs of manual sorting of incoming feedstock;
- Cost figures for SSO options exclude the purchase of vehicles and household bins, bags, or other receptacles used for the separate collection of the SSO stream;
- Figures for each SSO option include a $7 per tonne design capacity planning estimate to develop, produce, and staff a promotion and education program that would need to accompany any significant changes to a municipality's current residential curbside collection system

The net annual operating cost to digest mixed MSW, assuming an efficiently operated facility, is approximately 10 per cent higher than for a SSO plant on an annual cash flow basis. Actual costs incurred could vary depending on local disposal conditions and competitively priced access to private sector firms that provide aerobic curing services.

Revenue: AD plants produce two types of marketable products that can generate revenue: finished digestate (as a blending agent to produce a soil conditioner) and surplus energy. These facilities also produce a nitrogen-rich liquid that could be used as a fertilizer, although the market value of this product in Canada is unknown.

Assuming that a SSO plant product meets CCME and provincial guidelines for unrestricted use, a market value of $25 per tonne from the sale of finished digestate is possible based on the experience of many Canadian municipalities producing soil conditioners in aerobic compost facilities. At this price, average revenue potential measured on the basis of incoming feedstock is approximately $10 per tonne of incoming SSO, assuming the plant is operating at full capacity. For plants processing mixed MSW, an average market price of $25 per tonne of finished digestate is equal to approximately $6 per tonne of feedstock delivered to the facility. This comparatively low revenue potential is due to the higher residue rate anticipated for this feedstock. The revenue potential of any soil conditioner made with finished digestate from a mixed MSW plant is dependent upon the production of a digestate that meets guidelines for unrestricted use.

A second potential source of revenue is the sale of surplus energy (see Section 5). There are basically four market options:

- Clean the biogas to extract methane gas, which can then be exported and sold as a substitute for natural gas;
- Burn methane gas in an internal combustion engine to produce electricity for sale off-site while collecting a small amount of heat from the engine's exhaust and cooling system to produce steam;
- Burn the methane gas to produce steam and generate a small amount of electricity, both for sale off-site;
- Convert methane gas into compressed natural gas (CNG) to fuel light and heavy-duty vehicles. Vehicles powered by CNG, such as municipal buses, offer several environmental benefits, including reduced noise levels and cleaner emissions compared to diesel-powered vehicles. CNG-powered vehicle operators have also reported that vehicle maintenance costs are 40 to 50 per cent lower compared to diesel fuel.

The production of surplus methane gas also assumes that methane represents 55 per cent of the biogas gas (with the remaining 45 per cent consisting largely of carbon dioxide) and that 20 per cent of the gas generated by the AD facility is used for on-site energy needs. Based on these assumptions, an AD plant processing SSO could generate a stream of revenue equivalent to approximately $20 per tonne of incoming feedstock assuming the plant operates at design capacity. Facilities processing mixed MSW should generate a revenue stream of approximately $15 per tonne of incoming feed.

Estimated Net Per Household Cost of AD: The per household cost varies between SSO systems, where only 250 kg/household/year is processed by the plant, and mixed MSW systems, where we have assumed that 550 kg/household/year is managed at the AD plant and little waste requires landfilling.

Cost differences for SSO plants are dramatic as plant size increases. There is not a significant cost reduction between 50,000-tonne and 100,000-tonne AD plants when measured on a per household basis ($22/hh vs. $18/hh). The large economies of scale occur between the 10,000-tonne and 50,000-tonne plants. The same significant economies of scale are clear when moving from a mixed waste system (10,000 tonnes/year) serving a community of 18,000 households ($100/hh/yr), to a facility serving 90,000 households to $54/hh/yr. A doubling of capacity from 50,000 to 100,000 tonnes/year results in a 20 per cent reduction in per household costs (from $54 to $44/hh).

Factors that Influence Decisions on Choosing AD Technology

While it is difficult to estimate accurately the cost of these systems in Canada, figures developed for this analysis (which includes avoided disposal costs) indicate that AD costs more than landfilling. From a broader economic perspective, an AD plant offers the potential of supporting a number of public policy objectives, including:

- Reduced reliance on traditional waste disposal methods, the cost of which may not always reflect broader environmental effects;
- Development of emergency power applications;
- Conversion of collection and transfer vehicles to natural gas;
- Production of "green" power;
- Avoidance of GHGs produced in a landfill;
- Capture and use of this gas to displace non-renewable fuels.

AD and Existing Collection System

Implementing an AD system that processes mixed MSW likely requires few changes to a community's existing municipal waste handling system. In most Canadian municipalities, mixed MSW is set out curbside by residents of single-family homes and in dumpsters for multi-family dwellings and small commercial establishments. As material separation occurs in the plant, household residents are not required to change.

SSO implementation programs could require significant changes to the existing waste handling system, though careful planning may mitigate effects. The central planning challenge is determining the most cost-efficient method of adding a new service while ensuring that all collection systems are compatible with downstream processing operations. Although the simplest solution is to implement a dedicated fleet providing curbside SSO collection services, the capital and annual operating costs could be considerable.

Another option is co-collection. Curbside collection of two or more waste streams has been implemented in several Canadian municipalities, including the Regional Municipality of Halifax, N.S., and the cities of St. Thomas and Guelph, Ont. The specific features of each municipal co-collection program vary depending on number of sorts at the curb, container provided to households and truck technology, which highlights the importance of identifying and evaluating options that address a community's unique political, social, and financial characteristics.

Availability of Land

A number of technologies employ a tall, vertical digestion reactor, which can be quite economical in terms of land use. Some estimates suggest that a 50,000 tonne/year reactor that processes a dry stream of organic waste will require a footprint of 400 square metres while the entire site can be implemented on 10,000 square metres. Other technologies employ modular 10,000 tonne/year horizontal reactors, each requiring approximately 2,000 square metres. Although a modular system offers a number of advantages—including ease of capacity expansion—land requirements may be considerable. The provision of 50,000 tonnes/year digestion capacity with modular units would require a total reactor footprint of approximately 10,000 square metres in addition to other site uses, such as roads for truck circulation and loading/unloading, pre- and post-processing equipment, material transfer, and setbacks.

Environmental Effects

Environmental benefits of AD include:

- Diversion of organic waste from landfill or incineration to a technology where the gas potential of the waste is realized in three weeks rather than 30 years or more in a landfill;
- Methane produced by AD plants is collected and managed in an environmentally sound manner and is converted to CO_2, which is less damaging as a GHG than methane;
- Methane produced in the digester is used as a fuel and, if it displaces oil, natural gas or coal, has significant GHG benefits;
- AD plants need small footprints, therefore do not cause significant displacement of land;
- AD of organic municipal waste lowers the requirement for landfill capacity and preserves existing landfill capacity for other wastes where diversion options are less viable, thereby resulting in reduced environmental displacement effects of landfill;
- Organic waste is stabilized outside of a landfill, reducing effects on landfill leachate production and quality;
- Some wastewater is produced by AD plants, but is easily treated to bylaw limit requirements by currently available technologies.

Greenhouse Gas Effects

AD facilities are designed to promote rapid anaerobic decomposition of solid waste. The resulting methane (and other gases) is used as an energy source, from which electricity (and sometimes steam) is recovered. Relatively little information is available on the GHG emissions and sinks from AD for SSO and other wastes.

Categories of potential GHG emissions or sinks/offsets from AD facilities:

- Methane emissions;
- Electricity offsets;
- Soil carbon sequestration. (The AD process also generates CO_2 emissions but it is not counted in emission inventories using International Panel on Climate Change [IPCC] protocols and methods, and is therefore not addressed in this analysis.)

AD facilities are designed and operated to capture methane, thus it is reasonable to assume methane emissions are negligible.

The effect of soil carbon sequestration in the AD emission calculations was taken from the 2001 Environment Canada report, *Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions*. After digesting MSW anaerobically, AD facilities use aerobic composting to further stabilize the organic materials. The resulting compost would then be applied to soils as a soil amendment. Assumptions used to estimate GHG effects of AD were:

- For yard trimmings, the residual carbon content remaining after the AD/aerobic sequence is the same as the residual carbon after centralized composting (previously estimated by various USEPA studies); and
- Because neither newsprint nor yard trimmings generate much methane, their soil carbon benefits exceed the carbon dioxide emissions avoided through electricity offsets from AD.

When AD facilities generate electricity, they can offset fossil fuel use at other electric generating units. For purposes of evaluating the effect of energy efficiency, renewables, or other offsets, it is Canada's policy to assume that the marginal fuel offset by electricity generators (as a result of using gas generated by AD facilities) is natural gas. The key steps in estimating the magnitude of electricity offsets are to:

- Estimate yield of methane in AD facilities, on a material-specific basis;

- Estimate the conversion efficiency (or heat rate) of methane to electricity.

The biogas from anaerobic digesters is upgraded for energy use by removing moisture, CO_2, and other by-products. This gas can be used as a substitute for natural gas, either in boilers producing hot water and steam for industrial processes or to generate electricity. Energy is needed for the process (heating, mixing, drying, etc.) and is usually supplied from the biogas product. Values quoted by suppliers varied from 15 to 20 per cent of in-plant energy generation needed to meet in-plant needs, and up to 80 per cent available for export or sale.

Waste Diversion Effects

AD can ideally be applied to any biodegradable fraction of the municipal waste stream. Counting paper, food, and leaf and yard waste, the total biodegradable fraction of the waste stream handled by Canadian municipalities is more than 60 per cent. How much is realistically divertible depends on the system collecting and sending the waste to the digester, combined with end-market availability. SSO systems provide a cleaner feedstock (below 10 per cent contamination), and high-end markets are available to absorb the finished materials. Mixed waste streams are more contaminated with non-biodegradable materials (up to 30 per cent), and the resulting finished compost may not be as readily absorbed by high-end markets.

Wastewater Discharge Effects

While of high strength, wastewater produced by AD plants is easily treated on-site with currently available technologies to meet typical Canadian city sewer use bylaw limit requirements.

It is estimated that a 10,000 tonne per year AD facility would discharge 9 m^3/day of wastewater if a dry AD technology is used and 17 m^3/day if a wet technology is used. Typically dry AD systems generate the most wastewater due to the extraction of moisture from the input material. In wet AD systems, moisture is added to facilitate the digestion process. However, the wastewater from the dewatering process is

Table 4.3 GHG Reductions of a 10,000 tonne/year AD Plant With and Without Carbon Sequestration (tonnes eCO_2/year)

	Waste Stream Processed	
	SSO	Mixed MSW
NO CARBON SEQUESTRATION	1,730	1,550
CARBON SEQUESTRATION INCLUDED	1,840	1,865

Reduction of eCO_2 emissions in tonnes/per year for a 100,000 tonnes/per year AD plant, when treating SSO and mixed waste, including and excluding the effect of carbon sequestration.

recirculated through the plant for reuse in the incoming waste stream, and relatively small amounts are discharged.

Energy Implications

AD is a net energy-producing process. The plant's internal energy needs (parasitic load) is approximately 20 per cent of the energy produced for dry AD technologies, and approximately 50 per cent for wet AD technologies. In both cases, considerable excess energy is available for export as either a natural gas substitute or other forms.

Estimating potential value of surplus energy is dependent on many variables, including:

- *Feedstock selection* – SSO contains a higher proportion of easily digested organic waste, but mixed waste contains more paper, which, depending on quality, is also a digestible source of gas (e.g., fine papers are readily digestible and high gas producers).
- *Seasonal variations* – Spring and summer seasons lead to leaf and yard waste, two types of organic waste that do not break down easily and can reduce the rate of biogas production.
- *Plant operation* – High rates of annual biogas production depend on the digestion reactor's efficiency.
- *Local market conditions* – Access to potential buyers and a distribution system, as well as local prices for methane gas, steam, and electricity will affect revenue potential.

Reported biogas production for SSO and mixed MSW AD facilities is in the range of 100 to 110 cubic metres of biogas per tonne of incoming feedstock. Estimating production rates for any given community requires a detailed evaluation to estimate the amount of digestible organic material in the local waste stream and, therefore, biogas gas production potential.

A proper assessment requires a detailed technical and financial analysis of local market conditions. For instance, connections to the electrical system, steam and/or hot water piping, biogas piping, and to natural gas lines may be possible but require extensive review for optimal energy performance. This illustration assumes the sale of methane gas to an industrial consumer located close to the AD plant. The market value of methane is assumed to be 45 cents per cubic metre, which includes a price of 28 cents per cubic metre plus an avoided natural gas transmission cost of 17 cents per cubic metre (both figures are indicative of prices in the City of Toronto as of December 2001). If a sales contract with an industrial consumer located close to the AD plant cannot be secured, transmission costs will likely be incurred, thereby lowering the revenue potential of the AD plant.

The production of surplus methane gas also assumes that methane is 55 per cent of the biogas (with the remaining 45 per cent consisting largely of carbon dioxide) and that 20 per cent of the gas generated by the AD facility is used for on-site energy needs. Based on these assumptions, an AD plant that processes SSO could generate a stream of revenue equivalent to approximately $20 per tonne of incoming feedstock assuming the plant operates at design capacity. A facility processing mixed MSW could be expected to generate a revenue stream from the biogas of approximately $15 per tonne of incoming feed.

Lessons Learned

With the exception of the CCI plant in the Town of Newmarket, Ont., and the SUBBOR plant in the City of Guelph, Ont., there is no experience in AD of SSO or mixed MSW in North America.

Various European vendors have successfully run AD plants which process 10,000 to 20,000 tonnes per year of SSO. Designs have been modified based on operational experience. These vendors have recently started to build larger plants, in the 50,000 tonne/year range (e.g., Valorga has a 50,000 tonne/year plant in Tilburg, The Netherlands; DRANCO has recently expanded its original Brecht plant in Belgium to process 50,000 tonnes/year). Time will tell if these operate successfully.

Can these plants process mixed waste successfully? One fundamental difference between Europe and Canada is that the European plants do not depend on compost revenues. In virtually all cases, compost is given to farmers or soil blenders. Canadian plants would need compost revenues for the economic viability of AD plants, and there are many unanswered questions about compost quality at the end of the mixed waste digestion design.

AD of MSW or SSO on a large scale is also unproven. Large plants are currently being constructed in Europe, and it would be prudent to observe them.

Some key lessons for any organics diversion program:

- Establish measurable targets to assess overall program performance;
- Anticipate seasonal variations in material collected and build capacity into the processing plant;
- Consider implementing bylaws requiring mandatory participation and the hiring of bylaw enforcement officers to promote the program and help maximize participation rates;
- Consider implementation of a collection pilot to assess potential SSO recovery rates. This information can then be used to adjust planning assumptions about the plant's design capacity;
- Strike a volunteer steering committee to help secure public support and participation;
- Informal workshops to disseminate information on new collection programs were held in one Canadian community, but did not achieve expected results;
- Compare fully AD of SSO vs. composting of SSO.

Table 4.4 Anaerobic Digestion Summary

Factor	Summary
DESCRIPTION	Organic biodegradable waste broken down without oxygen (anaerobic) to produce methane gas, carbon dioxide, water, and digestate (which is composted). Can be wet or dry AD
GENERAL PERFORMANCE	Can divert all or most organic and biodegradable products (food, yard waste, some papers)
COMMUNITY CHARACTERISTICS	Anaerobic digestion is a high-tech system that requires skilled technical operators. It is most suited to reasonably large urban areas with at least 18,000 to 40,000 households as a minimum threshold to justify the construction of the system
COSTS	Costs require a plant of at least 10,000 tonnes/year Costs decrease dramatically towards 50,000 tonnes/yr Greatest economies of scale at 100,000 tonnes/yr (mixed waste from 180,000 households or source-separated waste from 400,000 hhlds)
FACTORS THAT INFLUENCED ACQUISITION	Availability of local energy
NEW AND EMERGING TECHNOLOGIES	Methods to digest mixed waste effectively are currently being explored
ENVIRONMENTAL EFFECTS	Diverts organic waste from landfill, minimizing generation of acidic leachate and methane Generates methane under controlled conditions, as an energy source, displacing other sources of power
ENERGY IMPLICATIONS	Net energy generator, with 50% (wet plants) to 80% (dry plants) available for export
LESSONS LEARNED	Plants of 10,000 to 20,000 tonnes/yr source-separated organics work well in Europe. Little track record for larger plants currently in operation

SECTION 5

Thermal Treatment

General Description

Thermal technologies involve high-temperature processing to reduce the quantity or to stabilize material requiring disposal, and to recover energy and potentially material resources. Thermal technologies are designed to process wastes with a heat value, but can handle most wastes. Glass and metal have no heat value and are generally collected in a recycling program. Large items, such as bulky goods (sofas, fridges), are also generally removed ahead of the thermal unit.

Although individual facilities may vary, the process of thermal treatment/destruction generally involves:

- Physical processing equipment (mechanical and manual) to recover recyclable materials contained in the incoming waste stream;
- Thermal treatment/destruction unit (e.g., combustion or gasification chambers);
- Heat and/or energy recovery system;
- Air pollution control system;
- Ash management system.

Overall, thermal treatment/destruction facilities are designed based on:

- **Site-specific needs;**
- **Energy consumer needs;**
- **Applicable regulatory requirements, (in particular, air emissions performance standards).**

TABLE 5.1 CANADIAN EXAMPLES OF THERMAL TREATMENT/DESTRUCTION TECHNOLOGIES

Technology	Details	
ROTARY KILN INCINERATOR	Canadian Example	**GM Autoplex, Oshawa, Ont.**
	Capacity	50 t/d
	Cost (Capital and Operating Costs)	$125 to $150 /t
	Environmental Effects	Ash quality must be controlled by removing non-combustible or large-size material from the feed waste
	Energy Implications	Heat recovery is possible, however, economic study is recommended for decision-making regarding investment
	Community Characteristics	Typically for towns of approximately 25,000 hh
	Other	Facility processes non-hazardous solid wastes, reasonably typical of the garbage component of municipal residential three-stream waste programs. Higher operating maintenance costs than other conventional technologies

Table 5.1 Canadian Examples of Thermal Treatment/Destruction Technologies (cont'd)

Technology	Details	
MASS BURNING	Canadian Example	**Burnaby Incinerator, Burnaby, B.C.**
	Capacity	720t/d
	Cost (Capital and Operating Costs)	$65/t
	Environmental Effects	Facility exceeds existing requirements and proposed new CCME metals and organics emission concentration guidelines
	Energy Implications	Facility has excellent efficiency as steam is used by nearby paper recycling facility to replace natural gas use
	Community Characteristics	Large cities, typically 250,000 hh or greater
	Other	Well established technology, more than 50 years old. State of the art technology for large facilities
STARVED AIR INCINERATOR (Two-staged Combustion) Continuous Feeding	Canadian Example	**KMS, Brampton, Ont.**
	Capacity	140 t/d
	Cost (Capital and Operating Costs)	$100/t
	Environmental Effects	Facility has consistently incorporated state-of-the-art air pollution control technology upgrades and, as a result, enjoys strong support from the host community
	Energy Implications	Heat recovery can be economically advantageous. An economic study is recommended
	Community Characteristics	Typically for small towns to medium-sized cities, 5,500 to 20,000 hh, although can serve larger communities with multiple units
	Other	Extensively used. Well-known technology and stable operation. Sensitive to operating conditions
STARVED AIR INCINERATOR (Two-staged Combustion) Batch Operation	Canadian Example	**EcoWaste Solutions, Burlington, Ont.**
	Capacity	0.5 to 3 t/d
	Cost (Capital and Operating Costs)	$72 to $200 /t
	Environmental Effects	Long residence time yields good ash quality. May require additional air pollution control equipment to meet future air emission regulations. Or community education programs could result in removal of significant amounts of contaminant precursors from incoming waste streams
	Energy Implications	Electrical energy production not generally economical given small facility size. Heat recovery for heat energy use in industrial applications adjacent to facility can make energy recovery viable.

(continues on p. 228)

Table 5.1 Canadian Examples of Thermal Treatment/Destruction Technologies (cont'd)

Technology	Details	
Batch Operation (con'td)	Community Characteristics	Small towns, typically 2,500 hh
	Other	**Extensively used** Well-known technology
FLUIDIZED BED	Canadian Example	**Enerkem, Sherbrooke, Que.**
	Capacity	0.1 to 3.5 t/d (European facility capacity: 100 t/d)
	Cost (Capital and Operating Costs)	NA
	Environmental Effects	Potential significant net environmental life cycle benefits of resources recovery
	Energy Implications	Significant benefits may be achieved through the use of synthetic gas, including in fuel cells
	Community Characteristics	Typically for towns ranging from 5,500 to 20,000 hh
	Other	Completion of Sherbrooke pilot testing and ability to scale up and receive typical MSW under current and forecast project application specific energy and landfill tipping fee circumstances requires address
REFUSE DERIVED FUEL (RDF)	Canadian Example	**HUWS, Caledon, Ont.**
	Capacity	10 to 30 t/d
	Cost (Capital and Operating Costs)	N/A
	Environmental and Energy Effects	Potential for net life cycle environmental benefits of displacement of conventional fuels used in heat-intensive industrial applications, such as cement manufacture
	Other	No commercial applications established for RDF produced by current technology/facility
PYROLYSIS/ GASIFICATION	Canadian Example	**Enerkem, Sherbrooke, Que.**
	Comments	Refer to Enerkem – fluidized bed, above
PLASMA TECHNOLOGY	Canadian Example	**RCL, Ottawa, Ont.**
	Comments	To date, only bench scale applications to selected waste streams. Ability to scale up to process typical MSW streams must be established
THERMO-CHEMICAL REDUCTION	Canadian Example	**Eli Eco Logic, Rockwood, Ont.**
	Comments	No demonstration of commercially viable application to municipal solid waste streams

To achieve waste volume reduction, physical/chemical stabilization and energy and recyclable material recovery from thermal destruction, the following are required:

Waste Pre-processing and Feed Rate Control

Incoming waste is inspected to isolate unacceptable materials (e.g., hazardous or oversized materials) and mixed to create a blend that is homogenous in physical, chemical, and heat value characteristics. Wastes may be mechanically processed (e.g., shredded and screened) to create a uniform practical size, protecting the integrity of and optimizing the utilization of the design capacity of the technology. Incoming waste can be mechanically and/or manually processed to recover recyclable materials that were not captured in curbside recycling programs. Once "pre-processed," waste is fed into the thermal treatment/destruction units. Careful control of feed rates, often via computerized weight/volume measures, is necessary to protect and optimize the design capacities to the "downstream" elements (thermal units, air pollution control systems, energy recovery and power generation systems) of the facility.

Thermal Treatment/Destruction

Waste is treated and/or destroyed via application of temperature under various chemical environments (principally oxygen concentrations). Temperature drives various physical/chemical transformations of the waste. Generally, waste is either rapidly oxidized to convert carbon/hydrogen molecules into carbon dioxide and water, or is reduced to convert complex carbon/hydrogen molecules into simpler elements, such as constituent oils, carbon monoxide, and hydrogen gas. In both cases, the waste materials remaining are substantially reduced—some being converted from solid to gaseous states—and are of a simpler, stable chemical composition. Thus the remaining solid waste material is more amenable to landfill disposal.

Energy Recovery

Municipal solid waste contains substantial heat energy. Unprocessed, unprepared MSW has a heat value of approximately 12 giga-joules/tonne (5,500 Btu/lb). The heat energy contained in five tonnes of waste, released through thermal treatment/destruction and subsequently captured and converted into electricity, can supply the annual power needs of a typical Canadian home. Actual heat values depend on specific composition of the waste, including the circumstances of its collection and delivery to a facility, and the extent to which it is pre-processed to remove inert and high moisture content materials.

To illustrate this point, consider the difference between a load of yard waste—principally grass collected after a week of rain—and a load of waste collected from a strip-mall—principally comprised of plastic materials from fast-food outlets. In the latter case, the non-recyclable plastic generated over one year by a municipality of one million has been calculated as sufficient to "fuel" a five megawatt power facility, at an assumed energy recovery/conversion efficiency of 37 per cent.

Heat energy recovery systems have historically involved boilers. The heat energy released from waste is transformed to steam that is then converted to electricity via turbine/generators. Energy recovery/conversion efficiencies of 20 per cent to 30 per cent are associated with conventional thermal treatment ("incineration") and boiler technologies. Steam and/or hot water can be used directly, as in the case of district heating systems or applications in industrial manufacturing processes. In recent years, combined-cycle gas turbines (combustion exhaust gas powers a gas turbine and at the same time, excess heat is captured to power a steam turbine) have substantially improved energy efficiencies. Use of newer gasification treatment and combined cycle gas turbine technologies can yield energy efficiencies of 40 to 60 per cent. In some gasification technologies, synthetic gas is produced that can be fired in internal combustion engines or used to drive hydrogen fuel cells. Energy efficiencies of 80 per cent plus can be achieved where refuse derived fuel (RDF) is used to fuel existing industrial thermo-chemical applications, such as clinker production in cement kilns.

Air Pollution Control

An air pollution control system is used to treat gaseous products (typically flue gas) from the thermal treatment/destruction units. The design is a function of the composition of the in-feed waste, the treatment/destruction technology, and the environmental performance regulations applicable to the facility. The latter parameter includes consideration of the thermal technologies' generic environmental track record and the circumstances of site location where thermal treatment is to occur (surrounding land use context and ambient air quality). Typical air pollution control systems are comprised of:

- Flue gas cooling for subsequent physical/chemical capture and removal;
- Acid gases scrubbing (neutralization by lime injection), heavy metals capture (bag house filtering and activated carbon and/or catalytic reactor adsorption);
- Trace organics (e.g., dioxins and furans) destruction and/or avoidance of substance formation (via temperature greater than 1,000°C to 1,200°C exposure and avoiding formation of free chlorine by use of low oxygen reducing conditions);
- Capture (bag house filtering and activated carbon and/or catalytic reactor adsorption);
- Particulate collection (bag house filtering and/or electrostatic precipitators).

Air pollution control systems include equipment to continuously and/or periodically monitor emissions performance, and to report performance for process control and regulatory compliance purposes. Modern systems are interlinked to the waste in-feed control, thermal treatment/destruction units, and energy recovery/conversion units of a facility, so that trends in emission performance are discerned and appropriate adjustments made to ensure emissions meet or exceed regulatory standards.

Ash Management

The solid residue remaining after thermal treatment/destruction is typically termed "bottom ash." It is mechanically collected, cooled, magnetically/electrically screened to recover recyclable ferrous/aluminum materials, and removed for "ultimate" management, typically landfilled. The material can, depending upon its chemical composition and physical state, be used as a form of aggregate substitute. Air pollution control systems generate the other solid residue from a facility (fly ash), which is made of fine particulate contaminants captured from the flue gas and the reagents (e.g., lime) used to effect capture. Fly ash is classified as hazardous waste and is usually managed via further chemical stabilization and ultimate disposal in secure hazardous waste landfill sites. Certain thermal technologies employ extremely high temperatures to convert ash into inert vitrified substances, either as an integral element of converting the waste into gas and recoverable chemical elements or as a dedicated ash management process.

Technologies

Thermal technologies considered "proven technologies" and used or under consideration for use in the management of municipal solid waste include:

- Rotary kiln incineration;
- Mass burn incineration;
- Starved air incineration;
- Fluidized bed combustion;
- Pyrolysis and gasification;
- Plasma technology;
- Thermo-chemical reduction; and
- Refuse derived fuel.

Differences among these technologies relate to process temperature, process oxygen concentration, point of application of gas cleaning/air pollution control, and physical location where energy is recovered.

Rotary kiln, mass burn, starved air incineration and fluidized bed units have been used extensively for the past 50 years in Europe and North America to treat municipal solid waste. Canadian examples include the City of Charlottetown, P.E.I.; the City of Sydney, N.S.; Quebec City, Que.; the Region of Peel, Ont.; and the Greater Vancouver Regional District, B.C.

Pyrolysis/gasification, plasma arc, and thermo-chemical reduction technologies have historically been utilized in Europe and North America for the management of special wastes (hazardous wastes—such as PCBs, biomedical, nuclear—and homogeneous industrial waste streams—such as petrochemical and paper pulp sludge wastes). Canadian examples include technology developers located in the City of Montreal, and the Cities of Ottawa, Kingston and Rockwood, Ont. These technologies are now actively being considered for application to municipal solid waste as new and emerging technologies. Commercial scale facilities are now in the commissioning and/or full operation stages in Europe. Commercial-scale applications to municipal solid waste in Canada are not, as yet, in existence. However, a pilot-scale gasification facility is being tested in the City of Sherbrooke, Que., and vendors of these types of technologies are in discussions with a number of municipalities across Canada.

Specific Technologies/Evaluation

Rotary Kiln Incineration

Rotary kiln incineration has been used for the thermal destruction of MSW since the 1950s and is also widely used for the disposal of a variety of solid and liquid hazardous wastes, including thermally stable compounds, such as PCBs. Rotary kilns are suitable for management of wastes for municipalities of approximately 25,000 households.

Operation

These incinerators are computer-controlled, two-stage combustion systems with a primary rotary kiln and a secondary combustion chamber. Waste is fed into the kiln, and burned for approximately 30 minutes at a typical temperature of 850°C. Solid wastes are batch fed into the kiln by a ram feed system, or screw fed through a rotating air lock. Liquid wastes can be blended with solids or injected into the primary (or secondary) chamber through atomization with steam or air. The secondary combustion chamber is between 30 and 60 per cent of the size of the primary kiln, where combustion temperatures range between 1,000° and 1,200°C at two seconds residence time.

Cost and Capacity

Rotary kiln incinerators have typical capacities ranging from 10 to 50 tonnes per day. The technology is relatively capital intensive. Combined annualized capital and operating costs (net of recovered energy revenue) range from $125 to $150 per tonne of waste processed, estimated over a 25-year capital payback period.

Environmental Effects and Energy Implications

Rotary kiln incinerator technology applications can meet all Canadian environmental regulatory requirements. However, due largely to a relatively short combustion residence time, the quality of ash can be disadvantageous from a life cycle management cost standpoint. To improve the ash quality, feed waste may be pre-processed to remove non-combustibles and the combustible portion of the feed may be shredded prior to incineration to reduce residence time required for complete burning.

Rotary kiln incinerators involve relatively high operating costs. It has been shown that high operating temperatures periodically destroy the seals in the rotary unit and cause leakages, which result in poor combustion and energy recovery performance. The tumbling action caused by rotation can also result in dense waste particles cracking the refractory brick, leading to frequent and expensive shutdown and repair. Again, pre-processing the waste can solve this problem.

Heat recovery is possible, however, economic cost-benefit studies are required to identify the level of capital investment required.

Mass Burn Incineration

Mass burn incineration is a well-established technology developed more than 100 years ago for energy generation from municipal solid waste. The units are large in capacity and involve operations that can range from single-stage combustion to a form of two-stage combustion. Mass burn incineration is used in cities of at least 250,000 households. At this size and greater, economies of scale are experienced.

Operation

Waste is fed "as received" into a single combustion chamber onto one or more grates (multi-grate systems) where the following functions occur:

- Drying—water content is reduced to prepare material for burning;
- Primary burning—the more readily combustible materials are oxidized;
- Finish burning—fixed carbon is oxidized.

Depending on temperature and oxygen content of operations, and design of the internal physical configuration of the combustion chamber, waste can either be oxidized in a single- or two-stage function. The latter is more typical as it yields better control of combustion, more complete "burn-out" (less ash of a more inert nature), and more optimal energy recovery capability. Waste is burned on the grate(s) in what is commonly referred to as sub-stoichiometric conditions, where sufficient oxygen is not available for complete combustion. The available oxygen is approximately 30 to 80 per cent of the required amount for complete combustion, resulting in the formation of pyrolysis gases (flue gas). These gases rise in the combustion chamber where they are combined with excess air and complete oxidation occurs. The remainder of the system (energy recovery via boiler, air pollution control, and ash management systems) is similar to that for the rotary kiln incinerator.

Cost and Capacity

Mass burner facilities range in capacity from 100 to 1,000 tonnes per unit per day. Facilities with a total unit capacity of 5,000 tonnes per day are in operation in North America. However, in Canada, typical facilities have a total capacity of between 400 and 850 tonnes per day. Combined annualized capital and operating costs (net of recovered energy revenue) range from $65 to $85 per tonne of waste processed, estimated over a 25-year capital payback period.

Environmental Effects and Energy Implications

Mass burn technology applications meet all Canadian environmental regulatory requirements. They produce good ash quality due to long residence times on the grate(s). Heat recovery and electricity generation are possible and, with modern boilers, a high level of energy efficiency can be achieved. Mass burn facilities have excellent energy efficiency and generally export their energy as either steam or electricity. Example: steam produced at the Greater Vancouver Regional District, B.C., incineration facility is used by a nearby paper recycling facility to replace the use of natural gas.

Starved Air Incineration ("pure" two-stage combustion)

Starved air incinerators, also known as controlled air incinerators, have been used extensively for municipal solid waste and hospital waste treatment. The primary difference with mass burn incineration lies in the control of oxygen: there is a higher degree of oxygen control in a starved air system. The technology evolved from mass burn units, which were operating in two-stage combustion mode. The distinction is that the newer "pure" two-stage technology "guaranteed" a separation of the first and second stages for even better combustion control, ease of air pollution control, and improved energy recovery potential. Starved air incineration has been relatively continuously developed to achieve increased reliability through improved design of component functions/equipment. Today, it is a well-established technology with a stable and reliable process.

Operation

Starved air incinerators are two-stage combustion systems. The primary chamber burns carbon to produce carbon monoxide. Solid waste is fed, in an as-received state, into the chamber and volatilized on a stationary hearth in a sub-stoichiometric, or low-oxygen environment. Volatile gases enter the secondary chamber for a more complete burn, where auxiliary fuel burners and combustion air blowers provide supplemental heat and excess air to maintain temperatures up to 1,200°C. The secondary chamber is designed for a residence time of one to two seconds.

Two types of starved air incineration systems are available for use in the treatment of municipal solid waste: semi-continuous incinerators and batch units.

Semi-continuous Starved Air Incinerators:

These systems are appropriate for smaller municipalities as their design capacity is in the 10- to 100-tonne-per-day range, or a population of 4,000 to 40,000, assuming residential waste and limited IC&I waste collection.

The stepped hearth is a common type of starved air incinerator, containing two to four stationary hearths. Waste is injected onto the first hearth about every 10 minutes, with each successive charge of waste moving the previous charge through. When the charge gets to the end of the first hearth, it free-falls 30 cm to 60 cm onto the second hearth. This allows the waste to mix with the combustion air and exposes new surfaces to the high temperatures.

Waste is burned at approximately 850°C under sub-stoichiometric conditions in the primary chamber, producing ash (fixed carbon) and flue gas, which contains the gaseous products of incomplete combustion (such as carbon monoxide). Flue gas from this stage feeds into the secondary stage, where it is heated to approximately

1,000°C and injected with excess air to complete the combustion process. The post-incineration portion is similar to that used in mass burner and rotary kiln systems.

Batch Process Starved Air Incinerators: Batch starved air facilities are suitable for small communities of as few as 2,500 households.

Waste is fed into the primary chamber of the unit as a one-time function at the start of the batch operation, and is burned at a temperature of 850°C under sub-stoichiometric conditions. Products of this stage are ash, fixed carbon and flue gas, which contains the gaseous products of incomplete combustion.

Flue gas feeds into the secondary stage and is heated to 1,000ºC, where it is injected with excess air to assist in completing the combustion process.

The post-incineration portion of the system is somewhat different from the previous incinerators, with considerably less equipment. The flue gases are cooled and treated in a low-tech acid scrubber to lower acid content. Stack gases are then continuously monitored for the concentrations of air pollutants as they are released into the atmosphere.

Cost and Capacity

Semi-continuous Starved Air Incinerators: Typical capacities range from 10 to 100 tonnes per day. Combined annualized capital and operating costs (net of recovered energy revenue) from $100 to $150 per tonne of waste processed, estimated over a 25-year capital payback period.

Batch Process Starved Air Incinerators: Typical capacities range from 0.5 to 3 tonnes per day. Combined annualized capital and operating costs (net of recovered energy revenue) are in the range of $75 to $200 per tonne of waste processed, estimated over a 25-year capital payback period.

Environmental Effects and Energy Implications

Semi-continuous Starved Air Incinerators: This incinerator technology can meet all Canadian environmental regulatory requirements. The low levels of turbulence in the primary chamber reduce particulate carry-over in the flue gas stream. As a result, particulate matter emissions are lower than those for other types.

Heat recovery and electricity generation are feasible and can be economically advantageous. Generally, heat recovery is not economical for small facilities, but is worthwhile for larger facilities. In all cases, a cost-benefit study is required to assess feasibility.

Batch Process Starved Air Incinerators: The advantages of this system include good ash quality and relatively small amounts of particulate emissions. Low levels of turbulence in the primary chamber reduce particulate carry-over and, as a result, particulate matter emissions from this incinerator are lower than for other incineration technologies.

The drawback of the technology now in commercial operation, is the absence of air pollution control systems for mercury and other heavy metals emissions, and for trace organics emissions (dioxins, chloro-benzene, chlorophenol). In the absence of such systems, it cannot be generally stated that this technology meets all Canadian environmental regulatory requirements. This is compounded by the fact that there are two Canada-wide standards for air emissions from incinerators (i.e., for mercury and for dioxins and furans). Provinces are in various stages of implementing new standards.

Solutions include retrofitting air pollution control equipment into the operations of existing facilities or facility designs. Also, the composition of incoming wastes can be influenced through public education, waste set-out and collection specifications, as well as pre-processing prior to feed, to produce a composition that minimizes air pollution effects.

Eco Waste Solutions of the City of Burlington, Ont., manufactures a batch process starved air unit that has been used in a number of MSW management applications at military installations and eco-sensitive contexts, such as destination tourism locations in Canada and the U.S. These applications have been associated with relatively remote geographic locations, where waste management options are limited (e.g., prohibitions against landfill disposal in the high-north); higher costs have simply been absorbed.

Electrical energy production is not generally economical given the small facility size. Heat recovery for industrial applications at adjacent facilities may be viable.

Fluidized Bed Systems

Fluidized bed systems are capable of destroying a wide range of wastes. While the technology is commercially used for material of homogeneous nature (sewage sludge, petroleum waste, paper industry waste), fluidized beds can also be used for municipal solid waste treatment. They are suitable for use in communities ranging from 5,500 to 20,000 households.

Operation

A fluidized bed is a large incineration chamber with silica sand at the bottom. Air is injected and dispersed into the sand through a series of air dispersion nozzles, decreasing the density of the sand mass to enable it to transport air and heat to the particles of waste substance to be treated (combusted). A burner at the bottom of the bed raises the sand mass' temperature to approximately 850°C.

Pre-processed waste is moved into the body of the sand bed by the convection current movement of the air and sand particles. The waste is burned to produce carbon monoxide and other volatiles. These gases undergo further combustion in the upper section of the incinerator chamber, above the surface of the bed, where additional combustion air is injected. Flue gases are then directed into the air pollution control system. Ash deposited on the bed is evacuated on the side opposite to waste injection.

Cost and Capacity

Fluidized bed systems range in capacity from 50 to 500 tonnes of waste per day. Combined annualized capital and operating costs (net of recovered energy revenue) range from $80 to $110 per tonne of waste processed, estimated over a 25-year capital payback period.

Environmental Issues and Energy Implications

High residence time in the incinerator results in smaller amounts of trace organics emissions. Pre-processing the waste to smaller particle sizes and the physical action of convection movement through the sand bed medium increases surface areas resulting in good "burn-out" and better ash quality (i.e., low unburned carbon content).

However, large amounts of fine ash are carried by air movement in the furnace into the flue gases, placing an added burden on the air pollution control system. Fluidized bed systems require extensive air pollution control systems with oversized equipment, including particulate removal devices in the gas stream, and thus require intensive maintenance.

Advantages of this technology stem mostly from the fact that these systems have simple designs, low capital cost and long service life.

The absence of moving parts means fewer breakdowns and simpler, less costly maintenance.

Due to high thermal inertia, fluidized bed systems also are versatile in that they can tolerate large fluctuations in waste composition and rate of feed. However, these systems require skilled labour, as they involve more sophisticated electrical components than older technologies. They are also highly sensitive to particle sizing—particles too large that stay at the bottom of the bed unburned. Other special considerations include bed degeneration, buildup and removal of residual materials from the bed, and the formation of eutectic moistures that fuse in the furnace.

In terms of energy potential, significant benefits may be achieved through the use of synthetic gas, including its use in fuel cells.

Refuse Derived Fuel (RDF)

RDF systems treat waste to produce fuel that can be used to substitute conventional fossil fuels, typically coal, in industrial manufacturing (e.g., cement kilns), utility power generation, and institutional applications (e.g., district heating).

Refuse derived fuel technology has been employed principally in Europe. In Canada, a pilot-scale refuse derived fuel production facility is in operation in the Regional Municipality of Peel, Ont. However, commercial use of the facility's fuel product has yet to occur.

Operation

Pre-processing of waste is carried out to improve the fuel's combustion characteristics. Pre-processing converts waste into a fuel with heat values, and inerts, moisture and contaminant concentrations approximating those of conventional fossil fuel.

Various levels of processing are possible, but all involve the same basic operations. Non-combustibles are removed from the waste to reduce the quantity of ash per unit of waste, and increase the heating value of the waste to be processed by the incineration unit. Also, removing certain materials containing higher concentrations of heavy metals and trace organics improves the effectiveness of the air pollution control system employed post-RDF combustion. Recyclable materials may also be captured at this stage and organic matter removed for composting, or the moisture content of the organic fraction of the incoming waste stream may be driven off to render the organic material more suitable as a fuel. RDF is particle-sized—usually by shredding to decrease the residence time and/or the incinerator size required to achieve acceptable ash quality. The RDF can be pelletized through compression to facilitate transportation to the point of usage—usually a large industrial or utility facility (e.g., cement kiln, metals smelter, electric power generator).

Cost and Capacity

Capacities are defined by the size of energy customer markets for RDF. A typical cement kiln could use in the range of 500 tonnes per day of RDF. The combined annualized capital and operating costs (net of the energy revenue value of the RDF) to process waste into RDF are $25 to $100 per tonne of waste processed, estimated over a 25-year capital payback period. (Costs are dependent upon scale of operation and extent of processing activities required.)

Environmental Issues and Energy Implications

The direct advantages of pre-processing waste into RDF include reduced greenhouse gas emissions, better ash quality, economic benefits from recovered marketable recyclable materials, access to a wider range of potential energy recovery opportunities (i.e., refuse derived fuel industrial/institutional applications) given the readily transportable state of RDF. The indirect advantages lie in the net environmental benefits of replacing consumption of fossil fuels. It can also be used at electricity generating stations (e.g., as a substitute for coal).

New and Emerging Technologies

New and emerging technologies are discussed here in some detail, as there are frequent misunderstandings over terms, the potential for technology applications and performance capabilities. New and emerging technologies do not yet have a history of commercial application to municipal solid waste streams upon which understandings of performance can be based. To date, knowledge of the technical design, and environmental and economic performance of these technologies, generally lies with a relatively few proprietary technology vendors.

A number of new and emerging technologies exist in concept, bench-scale or as pilot-scale demonstration units, with theoretical advantages over conventional thermal treatment/destruction technologies. Potential advantages include low contaminant emissions (particularly trace organic substances), and the possibility to recover material resources, such as synthetic oils and gases. In general, these technologies involve creating more sophisticated environments in which thermal treatment occurs. Despite the potential advantages, the complexity of new and emerging technology system operations, coupled with the varying and highly heterogeneous composition of MSW, has been a significant economic barrier to commercial applications to municipal waste streams. To date, their use has been limited to processing industrial sludge, wood wastes, and select hazardous wastes of homogeneous composition. However, due to their potential environmental and net energy generation advantages over conventional systems, these technologies are being actively considered for municipal waste treatment.

Pyrolysis/Gasification

Both pyrolysis and gasification systems convert solid waste into gaseous, liquid, and solid fuels. There is some confusion in the literature and within industry practice between "true" pyrolysis systems and sub-stochiometric, starved air combustion systems and gasification systems. Many of the latter two systems are called pyrolysis systems by mistake.

Principal differences:

- Pyrolysis uses an external source of heat to derive the endothermic (heat-requiring) pyrolysis reactions in an oxygen-free environment. Synthetic liquid fuels (oils) and carbon char are produced as the desired output;
- Starved air and gasification systems consist of exothermic (heat generating) processes, and are self-sustaining. Some oxygen may be used for the partial combustion of solid waste. Combustible gases are produced as the desired output. In the case of starved air, these gases are combusted integral to the system. In the case of new and emerging gasification systems, these gases are cleaned and become a resource output product—synthetic gas.

As a general statement, if gaseous fuels are desired, gasification is a simpler and more cost-effective technology than pyrolysis.

Plasma arc and thermo-chemical reduction technologies have historically been used in Europe and North America to manage special wastes (hazardous wastes—PCBs, biomedical, nuclear, and homogeneous industrial waste streams, such as petrochemical and paper pulp sludge wastes). Canadian examples are found in the City of Montreal, Que., in the Cities of Ottawa and Kingston, Ont., and in the Town of Rockwood, Ont. Commercial-scale facilities are now in the commissioning and/or full operations stages in Europe. Commercial-scale applications to municipal solid waste in Canada do not exist.

However, a pilot-scale gasification facility is being tested in Sherbrooke, Que., and vendors of these types of technologies are in discussions with several Canadian communities.

Pyrolysis, and new and emerging gasification systems have yet to be successfully commercially applied to the management of municipal solid waste. However, if the economics associated with the production of synthetic liquid fuels (oils) and gases (including monetization of environmental credits) change, these systems may become economically viable.

Pyrolysis Systems (or Destructive Distillation Systems)

Pyrolysis systems refer to the thermal processing of waste in the complete absence of oxygen. The process is highly endothermic, requiring an external heat source.

Major component fractions result from the pyrolysis process:

- A gas stream containing primarily hydrogen, methane, carbon monoxide, carbon dioxide, and various other gases depending on the organic characteristics of waste material being pyrolyzed. This gas is consumed internal to the process of generating the desired liquid and solid product fractions;
- A liquid fraction of an oil stream containing acetic acid, acetone, methanol, and complex oxygenated hydrocarbons (tars). The liquid fraction may be further processed for use as a synthetic fuel oil as a substitute for conventional No. 6 fuel oil;
- A char consisting of almost pure carbon plus any inert material originally present in the solid waste.

The only full-scale pyrolysis system operating on MSW was built in the U.S. in El Cajon, California. The system failed to achieve its primary operational goal (production of a saleable pyrolysis oil). The facility was shut down after two years of operation.

Pyrolysis is still widely used for industrial purposes. However, the pyrolysis of municipal solid waste has not been successful apparently due to the inherent complexity of the system, and a lack of appreciation by system designers of the difficulties of producing a consistent feedstock from MSW. Pyrolysis may be a new energy user or producer, depending on factors, such as the nature of the waste, feedstock, and scale of operation. A product of pyrolysis, synthetic gas, can offer significant energy benefits, including use of the gas in fuel cells.

Gasification Systems

Gasification systems have been used since the 19th Century. By the early 1900s, gasifier technology was used on certain industrial waste streams to produce "synthetic" natural gas fuel for stationary and portable internal combustion engines. The gasoline shortages of World War II provided an impetus for the development of gasifier technology. However, with the return of relatively cheap and plentiful gasoline and diesel oil after the end of the war, gasifier technology was all but forgotten.

Gasification is the general term used to describe the process of partial combustion where a fuel is combusted with a quantity of air that is deliberately set below the amounts required for complete combustion. It is an energy-efficient technique for reducing the volume of solid waste and for energy recovery. The process involves the partial combustion of carbonaceous fuel to generate a fuel gas that can be combusted in an internal combustion engine, gas turbine, or boiler under excess-air conditions, or used as feedstock for hydrogen fuel-cell electricity generators. The generated fuel gas has an energy content of approximately 5.5 mega-joules/cubic metre[3], if air is used as the oxidant. Use of pure oxygen can yield gases with twice that energy content. The use of oxygen has obvious safety and economic implications. The operation of air-blown gasifiers is quite stable, with a fairly constant quantity of gas produced over a broad range of air input rates. Gasifiers have the potential to achieve low air pollution emissions with simplified air pollution control devices. The emissions can be comparable to or less than those from excess-air combustion systems (incineration technologies) employing far more complex emission control systems.

Enerkem Technologies Inc. of Montreal, Que., has built a demonstration gasification unit in Sherbrooke, Que., modelled on a full-scale unit existing in Spain. The Sherbrooke unit is currently being tested on waste feed rates in the range of 5 kg/hr. It employs fluidized bed technology, is targeted at receiving an RDF type waste feed of high heat value (as may be associated with MSW waste streams in the future), and is being used to drive a hydrogen fuel-cell for electricity production. As the composition of MSW changes, particularly the substitution of plastic for glass and metal containers, and as high moisture content kitchen food organics are increasingly removed at source for central composting programs, high heat value, non-recyclable residual "garbage" is expected to become more readily available at lower cost than thermal treatment processors. Further, if fuel-cell technology advancement brings power generation costs down in relation to conventional generation, this gasification technology could become commercially viable for typical Canadian municipal applications.

THERMOSELECT S.A. has a full-scale technology application in Europe that is responding to Canadian municipalities' requests for waste management facility development proposals. The THERMOSELECT process converts waste to clean synthetic gases, and recoverable metals and minerals. High temperatures (2000°C) and oxygen concentrations are used in the gasification stage. Subsequent rapid cooling is used to prevent formation/reformation of trace organic contaminants in the synthetic gas. A 225,000 t/y THERMOSELECT plant in Karlsruhe, Germany, has been in the commission stage since 1999. The plant generates electricity and supplies heat energy for district heating. Information provided by the technology's business development representative indicates that net costs for this size of facility in Canada, would be in the range of $100/tonne. This price is generally disadvantageous under current landfill tipping fee circumstances. If landfill capacity availability and operating costs change and/or if the circumstances of energy prices (and related monetization of environmental life cycle costs/benefits) change, this technology could be attractive.

Plasma Technology

Industrial applications of plasma arc technologies are well established, and include electric arc furnaces used in the steel industry and arc-welding units used in the construction industry. Plasma technology is also used for treating hazardous waste. The technology involves relatively high capital and operating costs, but can offer some environmental advantages, including the destruction of highly problematic hazardous materials, such as PCBs and complex stable volatile organic compounds, due to the application of extremely high operating temperatures, and the resultant production of an inert ash.

Plasma arc processes use extremely high temperatures in an oxygen-starved environment to pyrolyze waste into simple molecules. A thermal plasma field is created by directing an electric current through a low-pressure gas stream, thereby creating a stream of plasma at temperatures of 5,000ºC to 15,000ºC. By-products are slags and combustible gases. The combustible gases are subsequently either combusted in an afterburner or treated by catalytic conversion.

Despite considerable research into the environmental applications of the technology, it is still at the developmental stage. Currently, there are no commercial-scale units managing municipal solid wastes in North America. There are, however, different patented plasma arc systems proposed for the treatment of hazardous wastes. Modification of these processes to potentially treat municipal solid waste has been proposed but not commercially realized as yet.

For example, a plasma arc process known as PLASCON, developed by SRL Plasma Limited, in Australia, has been in commercial use for the destruction of chlorinated organic wastes from a pesticides production facility since 1992. In that process, liquid and/or gaseous waste is injected directly into a plasma torch, attaining extremely high temperatures. The waste stream must be a liquid or gaseous stream. If this technology is to be applied to municipal solid wastes, the waste must first undergo pre-processing (such as desorption, gasification) upstream from the PLASCON process unit. The capacity limitations and economic costs of this operation are significant.

Resorption Canada Ltd. has proposed to use plasma technology to treat the municipal solid waste of Mississippi Mills, Lanark County, in Eastern Ontario. The process of considering this proposal may contribute to a more general understanding of whether plasma technology can be used on MSW at a commercial scale and at costs approximating other thermal treatment technologies.

Plasma may be either a net energy user or producer depending on factors, such as the nature of the waste, feedstock, and scale of operation. The sythetic gas produced by plasma technologies can be used in many applications, including fuel cells.

Thermo-chemical Reduction

Thermo-chemical reduction is a well-known technology for treating hazardous wastes. With lower operating temperatures than conventional technologies, this process has the environmental advantage of smaller rates of emissions. The following is a description of a patented thermo-chemical process, developed in Ontario.

The Eco Logic process was developed by Eli Eco Logic International Inc., of Rockwood, Ont. It is a process for destroying hazardous wastes. Eli Eco Logic has developed the process through bench-scale, lab-scale, and pilot-scale demonstration tests, and has recently begun operating commercially.

The process is based on the gas-phase thermo-chemical reaction of hydrogen with organic and chlorinated organic compounds at elevated temperatures. At 850°C or higher, hydrogen reacts with organic compounds, in a process known as reduction, to produce methane and other light hydrocarbons. Chlorinated organic compounds are reduced to methane and hydrogen chloride. This reaction is enhanced by the presence of water, which can also act as a reducing agent, and is essentially the opposite of incineration (oxidation). The process differs from pyrolysis due to the addition of an active reducing agent, hydrogen, which also prevents the formation of heavy hydrocarbon products.

Approximately 40 per cent of the methane produced can be subsequently converted to hydrogen via the water/gas shift reaction; thus the process, under pre-defined conditions, may operate without an external supply of hydrogen.

Thermo-chemical processes can be net energy users or producers, depending on the circumstances. The synthetic gas produced can be used in a number of applications, including fuel cells.

Costs and Capacities

Generic data on capacities and costs related to commercial-scale applications, relevant to Canadian waste management, environmental, and energy contexts, are not available. This data is often proffered in business development and proprietary contexts by vendors.

As a general rule, the relatively low cost of alternative waste disposal technologies, principally landfills (at approximately $12 to $30 per tonne tipping fees), and low utility electricity energy price ($0.025 to $0.05 per kWh), precludes all but potential niche applications of new and emerging technologies. This circumstance is in flux. Landfill capacity is becoming more difficult to permit due to community responses and landfill operating, closure and perpetual care costs are increasing with more stringent environmental control standards. One can speculate that the value of indigenous sourced "green-power" with its environmental benefit "credits," will eventually result in energy pricing which reflects prices paid for waste-derived energy in European communities, where preferential price structures result in subsidies in the range of $0.05/kWh, or total prices of $0.10/kWh and higher.

Environmental Effects and Energy Implications

In principle, the relatively high operating temperatures of many of these technologies are expected to generate reduced trace organics emissions. In principle, recovery of materials, such as metals, oils and synthetic gases, can result in raw material and energy resource consumption avoidance credits, including energy credits. The generation of synthetic fuels, which can be readily transported for off-site consumption (including uses in internal combustion engines, existing industrial thermal processes and/or fuel cells), should significantly broaden these technologies' ability to supply future energy.

Evaluation

Volume Reduction

Thermal treatment reduces the amount (by volume) of waste that requires landfilling by 90 per cent. (Volume and not weight is the principal operating parameter when considering implications of reducing the amount of waste sent to landfills.) Accounting for the requirement to manage thermal treatment process residues (i.e., ash), the technology can net a reduction in landfill requirements of approximately 70 per cent (by weight) of the total waste stream.

There is no consistent approach in Canada on how to account for reductions from thermal processing. However, in all Canadian provinces and territories, this reduction in landfill requirements is counted as resource (materials and energy) recovery, not waste diversion from disposal. In a number of Canadian provinces, from time to time, thermal processing is/has been considered "pure" disposal, and is not counted towards diversion targets. In the extreme cases, thermal treatment of municipal solid waste has been prohibited by provincial regulation. The rationale against thermal technologies is that thermal treatment will compete with waste recycling and/or composting programs or discourage improvements in product design that will facilitate recycling.

Even after the best source-separation programs, combustible materials that cannot be composted or recycled remain in the waste stream. Recent waste composition studies have indicated that thermal treatment can manage a portion (typically 30 to 40 per cent by weight) of the municipal solid waste stream without competing for or being a disincentive to waste diversion (recycling/composting) programs. In addition, analysis of the full life cycle implications of various waste management practices indicates that, in some circumstances (in terms of energy resource values and recovered material markets), thermal treatment of certain wastes can be preferable to landfilling.

Waste Capacity

Thermal treatment technologies are commercially available in capacities ranging from a few hundred tonnes to more than one million tonnes per year. Thus, thermal treatment can be a component of any municipality's integrated waste management system, regardless of the community's size. However, once the financial commitment is made to use thermal treatment, there is relatively limited flexibility to reduce the role the technology plays within the system. The highly engineered design and relatively complex operations means that the capacity of a facility is relatively fixed. Coupled with high capital costs, this means that a facility must, over its life, actually receive (on a daily rate basis) close to the amounts of waste that were predicted at the time of the facility's original design. This relative inflexibility can be problematic if it discourages other waste management practices, such as recycling or composting programs. This problem can be addressed if firm commitments to realizing diversion program targets are achieved and the quantity of waste allocated to thermal treatment is clearly defined.

In addition, certain thermal technologies can be designed to deliver a defined total capacity via a number of "modules." This approach allows these technologies to operate on a reasonably flexible in-feed waste quantity, by shutting down or firing up additional modules in response to changes in waste quantities driven by changes in diversion program capacities and performance.

Costs

The method used to consider thermal treatment technology costs is to assume capital costs are at the rate of $150,000 to $200,000 per tonne per day capacity. A facility serving a municipality of 200,000 to 300,000 population would be in the 200 tonnes per day range, or have a capital cost of $30 to $40 million. Operating costs are significantly defined by the costs of managing process residues both non-hazardous bottom ash and potentially hazardous fly ash (air pollution control residues) and the revenues from energy sales. Typical net operation costs are in the $25 to $45 per tonne range. Total costs (annualized capital cost and operation costs, net of recovered energy revenue) are $65 to $150 per tonne of waste processed. As discussed above, capital and operating costs vary widely with the specific thermal technology, the scale of operation and the characteristics of the waste stream.

Environmental Effects

The operation of thermal waste processing systems involves gaseous and particulate air emissions, solid residues (ash) management, and, in the case of certain thermal technologies and related air pollution control systems, liquid effluents management. In general, properly designed and operated facilities can meet all Canadian environmental regulations. These
regulations set limits on the quantities of pollutants that a facility can emit. It is noted that the complexity of the pollution control systems necessary to achieve such performance can be

significant. Environmental control systems on average constitute between one third and one half of a facility's total capital and operating cost.

Specifically, air emission performance for thermal technologies is defined by a combination of federal-provincial guidance and provincial regulation. The CCME established and maintains guidelines for the environmental performance of municipal waste incineration facilities. The guidelines identify limits for the concentrations of contaminants in stack emissions from facilities, as well as describing current "best available" technologies and practices, including methods of monitoring and controlling air emissions. The CCME has recently decreased allowable concentrations for trace organics—dioxins and heavy metals, such as mercury—in light of emission control performance being achieved by current best available technology (activated carbon injection and catalytic reactor technology).

Provinces are responsible for regulating air emissions for MSW thermal treatment facilities. These regulations are equal to or more stringent than the CCME guidelines. Provinces have various regulations pertaining to stack emission contaminant concentrations, ambient air quality standards, and maximum point of stack plume impingement contaminant concentrations. One or more of these is considered when an application to discharge contaminants to the air is made in conjunction with an application for approval to establish and operate a thermal treatment facility. Certificates of Approval (Air) normally specify minimum facility design and operating parameters, including requirements for continuous and periodic air emission monitoring and reporting.

Ontario has the most comprehensive guidelines and regulatory standards for thermal treatment technologies in Guideline A-7 (Combustion and Air Pollution Control Requirements for New Municipal Waste Incinerators). These replaced the provincial ban of the 1990s of MSW thermal treatment after a comprehensive review of other jurisdictions' policies and regulatory regimes, the state of best available technologies' performance capabilities, and the health risks of air emissions from MSW incineration. Thus, Guideline A-7 and the most recent CCME proposals for dioxin and mercury stack emission concentrations can be viewed as the benchmark. Again, the thermal treatment technologies reviewed in this report can meet this benchmark.

The Integrated Waste Management Model was used to determine the environmental effects of energy from waste (EFW) processing versus landfilling waste. A high-end landfill design, with leachate collection system, a landfill gas (LFG) recovery system, and a gas-to-energy conversion system was used for the comparison. Results are presented in qualitative terms only, as the IWM model needs to be run by municipal staff using local conditions.

The model runs were carried out using 1,000 tonnes of typical municipal waste after source separation of some recyclables. Ash residue equal to 30 per cent of incoming waste tonnage was assumed, with 28 per cent being bottom ash, directed to municipal landfill, and two per cent being fly ash, sent for secure disposal. The energy emissions for residential collection of the waste were not included in the analysis.

Results from the IWM model are given in terms of net energy emissions. A positive number indicates that energy was consumed or an emission was released. A negative number indicates that energy was recovered or emissions were reduced. In the following tables, negative numbers are shown with an asterix, indicating an offset.

TABLE 5.2

Estimated GHG Emissions from EFW Compared to Landfill of 1,000 Tonnes of Waste

GHG Emissions	Highly Engineered LF (tonnes)	EWF (tonnes)
CO_2 Equivalents	Higher	Lower

Overall the EFW process produces less eCO_2 when compared to landfilling the waste.

TABLE 5.3

Estimated Acid Gas and Smog Precursor Emissions from EFW Compared to Landfill of 1,000 Tonnes of Waste

Acid Gas and Smog Precursor Emissions	Highly Engineered LF (Kg)	EFW (Kg)
NO_x	Lower	Higher
SO_x	Lower*	Higher
HCI	Lower*	Higher
PM	Higher	Lower
VOCs	Higher	Lower

*Indicates an energy offset or avoided emission.

The landfill produces less NO_x compared to EFW, but EFW produces less SO_x and HCI, primarily through energy offsets.

Table 5.4

Estimated Toxic Emissions from EFW Compared to Landfill of 1,000 Tonnes of Waste

Toxic Emissions	Highly Engineered LF	EFW
AIR		
Pb (kg)	Lower*	Higher
Hg (kg)	Lower*	Higher
Cd (kg)	Lower*	Higher
Dioxins (TEQ) (g)	Lower	Higher
WATER		
Pb (kg)	Lower*	Higher
Hg (kg)	Higher	Lower*
Cd (kg)	Higher	Lower
BOD (kg)	Higher	Lower
Dioxins (TEQ) (mg)	Higher	Lower

*Indicates an energy offset or avoided emission.

There are fewer air emissions (Pb, Hg, Cd and dioxin emissions) for the landfill option compared to the EFW process.
The comparative toxic emissions to water vary depending on the parameter considered. In all cases, the numbers are very small.

Energy Implications

Thermal treatment of solid waste converts waste to energy, which may be recovered to increase the overall energy efficiency of the thermal treatment facility and, in turn, to partially offset the economic costs and environmental effects of waste management practice. Combusting the waste converts it to thermal energy (heat), which can be captured in the form of steam. Pyrolysis and gasification convert waste to chemical energy in the form of liquids or gases. Once solid waste has been converted to thermal or chemical energy, it may be used directly or it may be converted to mechanical or electrical energy:

- Steam can be used either directly for industrial purposes or space heating, or for producing mechanical or electrical energy via a steam turbine;
- Degraded steam/hot water, can be used for low-temperature industrial or space-heating applications;
- Gases and liquids can be used either directly to fuel reciprocating engines, gas turbines and fuel cells, or to fuel boilers to produce steam.

Refuse derived fuel (RDF) converts waste to fuels that can be substituted for conventional fossil fuel use. Net energy efficiencies range from 20 per cent for conventional thermal technologies (incineration) fired with "as-received" waste and employing conventional boilers/steam turbines to 60 per cent in cases of modern gasification units, fired with processed waste (RDF) and employing combined cycle turbines and subsequent applications of degraded steam/hot water in district heating or industrial process applications. Eighty per cent-plus efficiencies can be achieved where RDF is used to fuel thermo-chemical reactions in industrial processes, such as cement clinker production.

Lessons Learned

There are no insurmountable regulatory, technical-design, environmental, or related economic barriers to establishing proven thermal treatment facilities. However, opposition to thermal treatment facilities from local community and environmental interest groups can be a problem. It would be instructive for a municipality planning a resources and waste management system to review the circumstances of the failures of the Cities of Halifax and Montreal's thermal treatment project proposals, the Ontario Government's banning MSW incineration juxtaposed with the success of the KMS Peel Region EFW facilities' bid for expansion. Some strategic measures to manage barriers:

- Counter the fear that waste disposal through thermal treatment will be a disincentive to recycling, composting, and other diversion programs, by clearly establishing the maximum role to be played by the thermal facility within a municipality's integrated system of waste diversion and disposal practices. Develop the definition of such a system through a process of long-term waste management planning, which incorporates consultation with stakeholders, including community and environmental interest groups.

- Set clear targets for the diversion programs component. These targets should then define the role for the thermal facility as being the ultimate disposal of residual waste. Invest authority in these targets, including the maximum role for disposal by adopting the long-term plan at the highest levels—municipal works committee and council. Publicly report progress in achieving the targets at least annually and undertake periodic reviews of the targets in light of progress.

- Address concern that thermal treatment has a significant adverse effect on the environment by: publicly reporting the results of monitoring emissions from other municipalities' facilities, and comparisons of performance to regulatory standards; committing to use only the best available technology; and annually reviewing and implementing where technically feasible, advancements in operational practices. Quantify the life cycle environmental performance of your municipality's waste management practice options, including potential role for thermal treatment. Tools such as IWM model (www.iwm-model.uwaterloo.ca) may help.

- Address concerns of the immediate local communities by undertaking a comprehensive comparative analysis of prospective sites and selection processes that integrates consideration of community effects as well as technical/financial costs as part of facility planning. Establish a Host Community Liaison Committee, with authority to oversee performance of the operation of any facility, including implementation of environmental management system disciplines. This committee can be invested with authority to direct the application of community impact mitigation funds derived from levies on waste processing fees. Typically these funds are $0.50 to $2.50 per tonne of waste processed. Property Value Protection Agreements can be used in place of or in conjunction with these funds.

Table 5.5 Thermal Treatment Summary

Factor	Summary
DESCRIPTION OF THE TECHNOLOGY	Waste is broken down to produce heat. There are numerous different thermal technologies
GENERAL PERFORMANCE OF THE SYSTEM	Thermal treatment can divert 70 per cent of waste from landfill
COMMUNITY CHARACTERISTICS	Thermal treatment is a high-tech system that requires skilled technical operators. Depending upon the specific technology, it is suitable for communities ranging from small villages to large urban centres
COSTS	Costs will vary depending upon the specific thermal technology used and the operating capacity required
FACTORS THAT INFLUENCED ACQUISITION	The availability of local energy markets is a critical factor in the decision
ENVIRONMENTAL EFFECTS	Thermal treatment has the benefit of diverting waste from landfill and therefore minimizing generation of acidic leachate and methane. It has the added benefit of generating energy, therefore displacing the need to use other sources of power
ENERGY IMPLICATIONS	Thermal treatment is a net energy generator
LESSONS LEARNED	Although technically sound and proven in Canada in terms of environmental and energy considerations, public perception/opposition is such that the siting of new facilities is difficult

SECTION 6

Landfilling

General Description

Canadians dispose of approximately 23 million tonnes of non-hazardous wastes annually, according to a 2000 Statistics Canada survey. Landfill disposal is a necessary element of an integrated approach to waste management and will be for the foreseeable future to dispose of residual waste, even after maximum recycling and diversion efforts.

Landfill waste disposal has evolved significantly from historic practices, driven largely by public concerns regarding potential environmental effects and public interest in adopting more sustainable waste management methods. This has led to increasingly rigorous regulations pertaining to landfills and more extensive community consultation programs associated with waste management planning and landfill siting processes. Similarly, public demand for innovation in waste management has also been a key motivator for developing new and emerging technologies, such as bioreactors.

Landfills established within the past 25 years have been permitted within a regulatory framework that did not address as many environmental issues or considerations as today's framework. Current regulatory approaches pertaining to planning and siting of landfills vary across Canada, ranging from broad performance-based environmental protection regulations to regulations defining minimum standards for specific technical elements. In some jurisdictions, combinations of performance-based and prescriptive regulations are applied. Regulatory processes may also include alternative procedures or applications that vary dependent upon the site and/or site location.

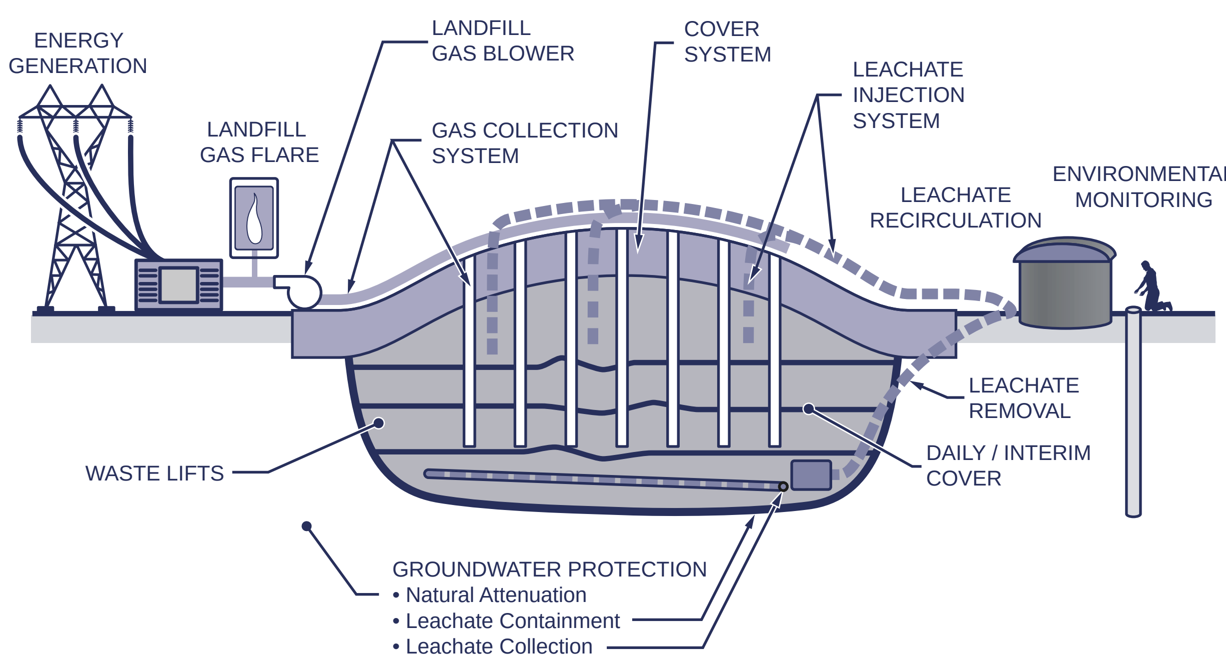
Municipal solid waste landfills receive a wide variety of non-hazardous wastes, dependent upon the context of the landfill within the overall waste management approach. There is a trend towards excluding or banning disposal of some materials. Disposal of liquid wastes is no longer acceptable at many sites due to concerns about possible increased leachate effects. Hazardous wastes are managed at specifically designed landfills, which are different from municipal landfills.

In some areas, materials that can be dealt with by other means are banned from landfills. In communities where recycling is available, it is generally not acceptable to dispose of recyclables in landfills. Other examples: drywall, auto hulks, construction/demolition debris, organic wastes, and other materials dependent upon availability of alternative material management options. These bans generally aim to ensure that wastes are managed properly and that landfill disposal is reserved for materials that cannot be managed by other means.

Technologies

A landfill is a facility in which solid waste is buried. There is wide variety of approaches to siting, design, construction, operation, and post-closure landfills management. This stems from the specific community-based context defining the needs for a landfill as an element of a larger waste management program, as well as the site-specific requirements of each facility to minimize environmental effects within applicable regulatory frameworks.

FIGURE 6.1 RANGE OF PRINCIPAL TECHNICAL ELEMENTS OF A LANDFILL



Landfills consist of a complex system of interrelated excavations, components and sub-systems that act together to break down and stabilize disposed wastes over time.

Some key factors to consider in the siting and design of contemporary non-hazardous waste landfills:

- Site setting – geology, land use, local effect potential, i.e., groundwater, surface water, noise, traffic, dust, visual effects, odour, air quality;
- Public consultation;
- Hydrogeology and groundwater protection – natural attenuation capacity;
- Ecology;
- Site design – disposal capacity, soils balance, configuration, site infrastructure needs;
- Leachate containment and collection systems;
- Leachate disposal/treatment requirements;
- Storm water management;
- Landfill gas collection;
- Daily, interim cover materials;
- Environmental monitoring and performance;
- Operational and maintenance protocols;
- Health and safety;

- Cap systems;
- Closure and end use;
- Post-closure management.

Landfill cells are constructed either by excavation or by construction of cell containment berms. Once prepared, wastes are placed and compacted into the landfill cell and are generally covered with soil or other alternative material at the end of each day. Cover reduces windblown litter, limits odours, and prevents scavenging and burrowing by animals and insects. Waste filling continues in this manner until final grades are achieved.

Groundwater protection priorities may be addressed by the natural attenuation characteristics of a site, use of leachate collection systems, and/or use of leachate containment systems. The approach to groundwater protection is based on site-specific considerations and can involve detailed assessment of the hydrogeologic conditions, potential for effects, anticipated contaminating lifespan of a site, and the capability of the environment to effectively manage it. Site characteristics, such as configuration, waste depths, landfill daily cover materials, cap design, etc., have a profound influence on groundwater protection at landfills.

Natural attenuation includes the inherent characteristic of a site and its geologic setting to dilute, disperse, degrade, and adsorb contaminants in soils and groundwater. Most sites have some degree of natural attenuation. Natural attenuation may prove to be an acceptable primary method of ensuring groundwater protection or may need to be combined with other measures.

Leachate containment systems may consist of soil liners constructed from native and/or imported materials, synthetic membrane liners, or composite liner systems using soil and synthetic liners. Leachate containment systems may be included in the design of a site to limit the flux of leachate from the wastes into the ground.

Leachate collection systems are incorporated into some contemporary landfills to prevent build-up of liquid within the wastes. This assists with groundwater protection and prevents seepage of leachate from the above-ground side slopes of the landfill surface to avoid potential surface water contamination as well as exposure of people and animals to contaminants. These systems can be designed and constructed in conjunction with development of landfill cells or, if suitable conditions exist, installed after landfilling has taken place.

Approaches for management of collected leachate:

- Off-site transport (via truck or sewer) to a suitable sewage treatment facility;
- On-site treatment to meet acceptable discharge criteria;
- Leachate evaporation;
- Leachate recirculation.

Selection of the preferred leachate management approach is complex and must consider the anticipated range in leachate quantities and characteristics as well as the technical feasibility of treatment, proximity and availability of suitable off-site treatment facilities, transportation costs, capital and operating costs for on-site treatment, and the regulatory context for leachate treatment and discharge. Biological, physical, and chemical methods are available for the treatment of landfill leachate. Use of engineered wetlands as an ecologically based treatment process is also gaining recognition as a potentially viable component of an overall treatment system. Determination of the exact processes required for effective leachate treatment is site-specific and requires detailed bench testing and pilot-scale implementation to verify its suitability.

Evaporation of leachate using landfill gas (LFG) utilization as a fuel has been applied in some locations. Important considerations include availability of sufficient gas supply, acceptability of emissions, management of waste sludge, and the capital and operating costs of the technology relative to other options.

Recirculation of leachate into landfilled wastes has been applied as a liquid management technique for years at a number of sites. Leachate recirculation has been demonstrated to enhance rates of waste stabilization, increase landfill settlement and LFG generation rates, and provide some treatment effect on the leachate. Leachate recirculation has contributed to development of the bioreactor landfill, a new technology discussed on pages 252 to 254.

Landfill gas, composed primarily of methane, CO_2, and trace organic compounds, is produced by the decomposition of landfilled wastes. Emissions of landfill gas to the atmosphere can raise concerns related to odours, air quality, and potential adverse health effects. Landfill gas is also a potent greenhouse gas. Migration of landfill gas into the soil surrounding a site can create safety and health concerns, particularly if allowed to accumulate at explosive concentrations within enclosed or low-lying spaces.

There are numerous methods to mitigate these potential effects. Control of landfill gas emissions to the atmosphere, when required, is often accomplished by actively extracting landfill gas from wastes. The collected gas is then combusted or used as an energy resource. Subsurface migration of landfill gas can be mitigated through active collection or by other methods, including passive venting of gas from below ground. Care must be taken when venting landfill gas to protect against local adverse effects, such as odour or air quality problems.

Collection and flaring of landfill gas is effective in mitigating its potentially harmful effects. Utilization instead of flaring landfill gas provides additional benefits, primarily the potential to generate revenue. This may defray some costs of operation and maintenance of a landfill site. There is growing public awareness of energy conservation issues. Landfill gas, as a relatively clean-burning fuel, can offset consumption of other non-renewable resources whose production and use may be more detrimental to the environment.

Numerous successful landfill gas utilization projects have been carried out in Canada and the U.S. There are many technologies available for utilization of landfill gas, including:

- Generation of electricity;
- Space heating;
- Process heating;
- Production of pipeline quality gas.

Generation of electricity and heating applications are the most common. The feasibility of landfill gas utilization is dependent on availability of markets and market pricing, and the costs of implementing landfill gas utilization at a particular site.

Research and development of emerging technologies—such as small-scale generation of electricity using micro turbines, production of vehicle fuel derived from landfill gas or of methanol from landfill gas, and cryogenic processing of landfill gas into a compressed liquid fuel—offers promise for future landfill gas utilization ventures.

The primary impediments to landfill gas utilization are related to the perception of risk due to a lack of knowledge of the potential resource, current low energy rates, the absence of a renewable energy industry in Canada, and limitations on access to energy markets. This state of affairs is in flux. Growing public awareness of the value of renewable energy, combined with progressive energy sector deregulation, will contribute to overcoming some of the current obstacles.

Landfill Capping Systems

Landfill capping systems are applied to isolate wastes from the environment when cells or portions of a landfill reach design final grades. As a fundamental component controlling the moisture content of the wastes, landfill caps can have a strong influence on the processes involved in decomposition and stabilization of wastes over the long-term. Until recently, conventional approaches to landfill cap design were based primarily on minimizing the amount of moisture entering the wastes, thereby limiting the generation and build-up of leachate within the site. Moisture limiting caps are generally constructed from low permeability soil materials and/or synthetic membranes.

Landfill caps are one element that may be included in plans for landfill closure. When implemented, landfill closure plans can define the method of closure and provide a basis for establishing end use of a site, including requirements for site security, post-closure management, maintenance, and monitoring. Many sites do not have formal end-use programs, while at some Canadian landfills innovative end uses, such as passive recreational and golf course development, have been successfully applied.

Within the last decade, there has been a growing recognition of the merit of an alternative approach to cap design that encourages infiltration of moisture into the landfill, thereby enhancing biodegradation and speeding the rate of decomposition and stabilization of the wastes. Moisture infiltration caps are generally constructed from highly permeable sandy soils. Observations indicate that significantly increased rates of settlement and gas generation are realized. Subsequent studies have strengthened the understanding that leachate recirculation and addition of moisture enhances the biological decomposition process and may provide some leachate treatment effect, potentially shortening the contaminating lifespan of a site. The evolution of leachate recirculation has led to a landfill design approach that is generally referred to as the bioreactor landfill.

Typical Vendors of Equipment

Landfills are custom designed and constructed to suit specific site and waste disposal applications. The design process generally involves adaptation and synthesis of many existing and innovative technological approaches for the elements making-up a landfill. While this process may include identification and selection of a number of specific products, there is no single vendor of "pre-packaged" landfills.

New and Emerging Technologies

The bioreactor landfill is a new technology evolved from contemporary landfill design in response to demands for more sustainable approaches to waste disposal. Bioreactor treatment of solid wastes involves design, construction, and operation of a landfill cell that is specifically engineered to enhance the decomposition of wastes through careful manipulation of site conditions. In essence, bioreactor technology provides a method of processing or treating wastes within the confines of a tightly controlled landfill cell.

Many elements of a bioreactor are similar to the components of a modern, engineered sanitary landfill site. The primary differences lie in the increased level of process control. The primary benefits of bioreactor treatment:

- Rapid stabilization of wastes resulting in the shortening of a site's contaminating lifespan during the period of time when engineered controls are most effective;

- Faster landfill settlement allowing for optimal use of existing approved waste disposal capacity and forestalling the need for new sites;
- In-situ treatment of leachate to reduce the contaminant loading; and
- Enhanced landfill gas recovery potential, thereby improving the feasibility of energy generation and engaging market forces to motivate even greater levels of emission reductions.

Some suggest that typical waste stabilization periods in a bioreactor might be in the range of 10 to 15 years, as compared to more than 50 years expected in a conventional sanitary landfill. Another benefit of rapid stabilization is reduction of the period when post-closure monitoring and care are required, which cuts the potential for long-term effects and environmental and financial risks often associated with old landfills.

Bioreactor landfills need significant quantities of moisture that may have to be added to the wastes to optimize decomposition. It must contain landfill leachate and be evenly distributed for optimal bioreactor performance. Typically, horizontal liquid injection pipe galleries are installed within the wastes as filling progresses. Alternative methods include vertical injection wells, infiltration ponds, and surface spray application systems. Moisture distribution may also be enhanced by the placing of permeable or wicking materials in layers as alternative cover on the wastes during filling.

Extensive in-situ monitoring instruments and control systems are used to manage moisture injection and optimize waste treatment. In-situ monitoring may incorporate arrays of moisture, temperature and/or hydrostatic pressure sensors located within the wastes. Sophisticated bioreactor systems provide the ability to carefully monitor chemical characteristics of the injection liquids and, if advantageous, to adjust the liquid chemistry to further improve bioreactor performance.

By enhancing the rate of waste decomposition, landfill gas generation rates are also increased. Landfill gas collection systems are installed at bioreactor landfills to control potential gas effects. The increased rates of gas generation can provide greater landfill gas recovery, thereby reducing the overall landfill emissions. Increased early rates of landfill gas recovery improve the economics of landfill gas-to-energy projects by providing better economies of scale in power plant size selection and allowing a faster return on capital investment during the early years of operation when maintenance costs are lower.

Enhanced rates of landfill settlement provide opportunities to increase the effective use of landfill space, thereby reducing the need for replacement landfills. In its advanced form, the bioreactor offers the opportunity to replace waste disposal with a more sustainable method of waste treatment.

Public attitudes and perception regarding bioreactors may be better than conventional landfills due to its enhanced environmental performance. The bioreactor can play a key role in a larger IWM system and is complemented by current waste diversion and recycling efforts. In this context, it has been envisioned that advanced anaerobic bioreactor landfills could be developed in conjunction with aerobic bioreactor and/or landfill mining techniques to provide a sustainable approach to waste management.

Table 6.1 Two Bioreactor Landfills Approved in Canada

Site Name	Site Owner	Location	Primary Site Features
BIOREACTOR LANDFILLS Ste. Sophie Landfill	Intersan (Canadian Waste Services)	Ste. Sophie, Que.	• Partial synthetic liner • Leachate collection system • Leachate recirculation/moisture addition • Landfill gas collection and flaring • Landfill gas utilization (potential future) • Process monitoring instrumentation and controls
Lafleche Landfill Site	Lafleche Environment Inc.	North Stormont, Ont.	• Natural soil liner • Leachate collection system • Leachate recirculation (future) • Landfill gas collection and flaring (future) • Landfill gas utilization (potential future) • Monitoring instrumentation and controls

Evaluation

General Systems Performance

Waste input rates, site size, disposal capacity, and site life all form the basis for determination of the waste disposal performance of the landfill.

Programs to divert waste materials from landfill disposal through source reduction, recycling, and organic waste diversion are decreasing the quantity of wastes requiring disposal. There remains a defined need for disposal of some waste materials that cannot yet be dealt with cost-effectively within the context of existing proven waste management technologies. Innovation and ongoing development of IWM approaches will continue to reduce the quantity of waste destined for landfill disposal.

Landfill disposal continues to be a low-cost alternative when compared to most options on the basis of short-term costs. However, costs of landfill disposal are increasing due to more rigorous regulatory requirements and increasingly complex approvals processes driven by growing concerns about the environment. Similarly, there is a growing recognition of the long-term liabilities, and their potential costs, associated with landfill. Despite these trends, landfill disposal remains among the lowest-cost alternatives, and costs continue to be a primary factor influencing waste management decisions.

Regulations governing siting, design, construction, operation, monitoring, and post-closure management of contemporary landfills are intended to protect against negative environmental effects. However, poor historic practices and public perception of landfills, including concerns over vehicle traffic, visual effects, and perceived land value effects, often mobilize opposition to new landfills and influence municipal decision-making regarding broader waste management issues.

The availability of alternative waste disposal capacity at a reasonable cost and within a reasonable transportation distance is also a key factor in decision-making on landfill disposal of wastes. Not only does this affect cost, but also availability of alternative disposal sites, even at greater costs, often will mobilize public opposition to local waste disposal options.

Conversely, limited options can direct decisions on waste management choices. This is particularly apparent in considering the large number of smaller landfills in Canada in comparison to the trend towards fewer, relatively large regional sites located close to major population centres. The unit costs for smaller sites can be much higher than those for the larger regionalized sites. Even so, landfill disposal costs remain lower than the start-up and operation costs of other waste management alternatives, which are influenced by economies of scale to an even greater extent than landfills.

Community Characteristics

All communities in Canada continue to rely on landfills for final disposal of waste and residual materials. In areas near major population centres, there has been a trend towards regionalization of landfills to share increasing costs associated with landfill disposal of wastes. Conversely, in areas with different market conditions, more numerous smaller sites are in operation and many are being expanded.

Costs

Costs associated with landfill disposal of waste are highly variable and influenced by numerous site-specific factors, market forces, and other considerations.

The full scope of potential costs include:

- Waste management planning and site selection;
- Detailed site assessment, including baseline studies and impact evaluations;
- Land acquisition;
- Site permitting;
- Public consultation;
- Detailed design;
- Site development and infrastructure construction, including control systems that may be required;
- Energy recovery;
- Site operations labour and equipment;
- Administration;
- Multi-use facilities (i.e., household hazardous waste depots, composting);
- Site closure;
- Post-closure maintenance;
- Environmental monitoring and reporting;
- Long-term financial assurance;
- Implementation of contingency remedial measures, if required.

Historically, the costs associated with landfills have not always been fully accounted for and assigned to the wastes disposed in a site. Sites established within the approvals frameworks of the past 20 to 25 years have generally applied a more comprehensive approach to recognizing the costs of landfill waste disposal. Still, more needs to be done.

Many of these cost elements are dependent on individual site design and operational parameters. There are also a number of cost variables that are not necessarily specific to a particular site, but are influenced to a greater extent by local market forces. The primary market forces can include:

- Regional supply/demand for landfill airspace;
- Proportion of public or private ownership of landfills;
- Proximity of available disposal alternatives to waste generation centres.

Other influencing factors include host community agreements and public policy decisions that direct disposal options and/or establish pricing criteria. Agreements are often established whereby a community may receive a financial benefit in the form of discounted or no-charge waste disposal and possibly revenue from royalties for wastes received at their site. Public policy decisions, such as bans on certain waste disposal options, may be made that influence options for disposal of wastes.

Tipping fees charged at landfills reflect the site-specific costs, market influences, and other cost elements, as well as the fundamental business decisions of the site owner. Charges over and above strict costs may include allocations for anticipated future waste management expenses, indirect subsidies for dealing with certain specific waste management tasks other than landfill disposal (i.e., household hazardous wastes, recycling of banned materials), return on investment requirements, and profits.

As a broad generalization, tipping fees for landfill disposal of waste generally fall within the range of $20 to $100/tonne. Within the last 20 to 25 years, many site-specific costs for landfill disposal have increased due in large part to implementation of more rigorous regulations as well as increasingly complex approvals processes. In some areas, these cost increases have been realized as higher tipping fees; in other areas increasing site-specific cost elements are offset somewhat by market factors, such as increases in the local supply of landfill airspace, contributing to increased competition for waste disposal revenue.

One additional generalization that can be made is related to the economies of scale that can be realized at the larger regionalized sites versus the higher unit costs often prevalent at smaller sites with lower waste input rates. This generalization holds true for sites established within the approvals frameworks of the past 20 to 25 years, given that a similar level of priority is applied to environmental issues. From this distinction it can be estimated that many smaller sites with lower waste input rates may experience disposal costs nearing, and in some cases exceeding, the $100/tonne upper bound of the disposal cost range expressed earlier. Conversely, the larger regionalized sites located nearer population centres may have tipping fees that are closer to $40 to $60/tonne.

Landfill gas utilization (LFG) has the potential to generate revenue at some sites. Given the current energy market in Canada, many potential LFG utilization projects are not economically feasible on a stand-alone basis. However, the energy market is in a state of flux and may evolve to provide sufficient economic incentive to undertake more LFG utilization projects. There is also a growing recognition of the pollution reduction value of landfill gas collection and energy recovery that could motivate additional interest in LFG utilization.

Environmental Effects

Contemporary landfills are designed and constructed to manage environmental risks. Details of design are generally determined on a site-specific basis to mitigate potential environmental effects within the context of regulatory requirements. Highly engineered landfills minimize environmental effects of landfilling.

Potential adverse environmental effects often associated with landfills include:

- Groundwater effects;
- Surface water effects;
- Odours;
- Air quality;
- Noise;
- Litter;
- Dust;
- Ecological effects;
- GHG emissions;
- Competing land use pressures (i.e., habitat);
- Inefficient use of materials and resources.

The extent to which any of these may occur and/or require mitigation depends on site-specific conditions and is generally assessed during the process of site design and approvals. Specific environmental performance criteria are determined by the applicable regulatory framework, within which a given landfill is governed. Regulatory approaches to landfills in Canada generally fall to provincial governments and vary considerably.

Energy Implications

The primary energy implication associated with landfill disposal is the potential to recover energy from the wastes through collection and utilization of landfill gas. There are numerous methods of recovery from landfill gas, including use of the gas as a heating fuel for industrial and/or space heating applications, generation of electricity from landfill gas, and other new innovative approaches, such as use of the gas to produce vehicle fuel. Use of energy from landfill gas provides supplementary GHG emission reduction benefits by avoiding consumption of the fossil fuels that would otherwise be required to produce an equivalent amount of energy. Examples of landfill gas utilization projects in Canada:

Electricity Generation

- Optigaz, Montreal, Que.,
- Saint Michel, Montreal, Que.,
- Waterloo Landfill, Waterloo, Ont.,
- Clover Bar Landfill, Edmonton, Alta.;

Direct Fuel Use

- Cambridge Landfill, Cambridge, Ont.,
- Jackman Landfill, Langley, B.C.,
- Port Mann Landfill, Surrey, B.C.

There are many potential LFG utilization projects throughout the country. However, given current energy markets, most are not economically feasible on a stand-alone basis. The dynamics of Canada's energy industry, growing interest in renewable energy resources, and the recognition of the many significant environmental benefits associated with LFG collection and utilization are contributing to increasing interest.

Bioreactor landfill is still being developed as a widely applicable waste management option. Currently, the bioreactor landfill does not fit neatly within standardized permitting and approvals processes defined for waste disposal sites and, as such, will generally require a highly site-specific approval methodology. Some considerations in developing bioreactor landfill design:

- Leachate containment and collection system design parameters and performance;
- Moisture balance requirements and liquid distribution system;
- Active gas collection capacity and combustion/utilization;
- Enhanced in-situ monitoring and control systems;
- Waste stability;
- Settlement effects on engineered systems;
- Detailed bioreactor management plan, including: liquid injection program; bioreactor performance assessment program and action/response plans; a bioreactor site-specific waste disposal operations plan, and comprehensive impact monitoring and contingency response program.

Lessons Learned

Opposition to landfill establishment from local community and environmental groups is the largest single barrier to realizing this component of a municipality's waste management system. There are no insurmountable regulatory, technical design, environmental, or related economic barriers to establishing and operating a landfill facility. The concerns can be addressed by a combination of the following strategies:

- Counter fear that landfill will be a disincentive to recycling, composting, and energy recovery diversion programs, by clearly establishing the maximum role to be played by landfill within a municipality's integrated system of waste diversion and disposal practices. Define a system through a process of long-term waste management planning, which incorporates consultation with stakeholders, including community and environmental interest groups. Set clear targets for the diversion programs component of the long-term plan. These targets should then define the role for landfill as being the ultimate disposal of "residual waste," i.e., quantity of waste, post-diversion. Invest authority in these targets, including the maximum role for landfill, by adopting the long-term plan at the highest levels—municipal works committee and council.

- Address concerns that landfilling has a significant adverse effect on the environment by: monitoring landfill leachate and gas emissions; publicly reporting a comparison of performance to regulatory standards; and periodically reviewing and implementing, where technically and economically feasible, advanced landfill design and operations practices (e.g., bioreactor design).

- Address community concerns by establishing a Landfill Host Community Liaison Committee, with authority to oversee operations performance, including implementation of environmental management system disciplines. This committee can be vested with authority to direct the application of community impact mitigation funds derived from levees on landfill tipping fees. Property Value Protection Agreements can be used in place of or in conjunction with these funds.

Table 6.2 Landfilling Summary

Factor	Summary
DESCRIPTION OF THE TECHNOLOGY	Waste placed in a landfill breaks down over time due to biological, physical, and chemical processes Emerging technologies, such as bioreactor landfills, may offer more sustainable approaches to landfill disposal of wastes
GENERAL PERFORMANCE OF THE SYSTEM	A wide range of performance is available. Individual facilities are custom designed and constructed to meet desired waste management objectives
COMMUNITY CHARACTERISTICS	Landfill disposal of waste is a necessary element of an integrated approach to waste management in all Canadian communities
COSTS	Costs can vary significantly depending upon waste input rates and characteristics, site-specific conditions, regulatory requirements, size of facilities and economies of scale, design and construction requirements, and local/regional competition from other landfills
FACTORS THAT INFLUENCED ACQUISITION	Low costs relative to other options. Limitations on availability of other alternatives
ENVIRONMENTAL EFFECTS	Individual facilities are custom designed and constructed on a site-specific basis to mitigate potential environmental impacts within the context of compliance with applicable regulatory requirements and to meet environmental objectives
ENERGY IMPLICATIONS	The primary energy implication associated with landfill disposal of wastes is the potential to recover energy from the wastes through collection and utilization of landfill gas. Use of energy from landfill gas provides supplementary greenhouse emission reduction benefits by avoiding consumption of the fossil fuels that would otherwise be required to produce an equivalent amount of energy
LESSONS LEARNED	Landfill disposal of waste has evolved significantly from historic practices. Elements of siting, design, and construction of a contemporary landfill site are generally determined on a site-specific basis with the fundamental context being to manage potential environmental risks within the framework of applicable regulations Opposition to landfill facility establishment (siting new facilities and/or expanding existing facilities) from local community and environmental interest groups is the largest single barrier to realizing this component of a municipality's waste management system

Glossary

TERM	DESCRIPTION
Anaerobic digestion (AD)	A biological process using microbes to break down organic material in the absence of oxygen. Digestion takes place in an enclosed chamber, where critical environmental conditions (e.g., moisture content, temperature and pH levels) can be controlled to maximize microbe generation, gas generation, and waste decomposition rates.
Backyard composting	Composting of residential organic materials by a household, usually in the backyard. Generally considered a method of source reduction.
Buy-back	A staffed facility that usually purchases post-consumer recyclable containers and materials, such as aluminum cans, glass, and newspapers from the public. May consist of mobile units. They seldom perform materials processing.
Centralized composting	Process using a central facility within a defined area to compost organic material.
"Clean" recyclable or compostable material	Material collected in a source-separated program, where contamination is minimal.
Commingled	Recycling programs where a number of different materials are mixed together, not collected separately.
Composting	A biological process whereby organic matter is decomposed through microbial activity, in the presence of oxygen, to produce a peat-like humus.
Container material	Recyclable materials used in drink and food containers, typically plastic, metal and glass.
Contamination	Material that is collected as part of a recycling or organics program and that must be removed before processing or marketing.
Co-collection	The collection of recyclables and organics together with municipal garbage in one truck; separated later for recycling and composting/digestion or disposal.

Collection	The process of picking up waste, recyclables, or compostable material from a household or business.
Curbside collection	Collection of waste, organics, or recyclables from the curb.
Deposit/refund systems	Systems to collect fees on items when sold; fees are reimbursed when the used product is returned.
Disposal bans	Regulation prohibiting disposal of materials or products (e.g., yard waste, or lead-acid batteries) in landfills and/or incinerators; typically targets items that contribute substantial volume or toxicity to the solid waste stream.
Drop-off/depot	Facilities (staffed or unstaffed) where the public brings recyclable materials, organics, or garbage for management by the municipality. Separate drop boxes may be available for different materials, such as newspaper, glass, or metal.
Fibre	Paper materials, such as cardboard, newsprint, and mixed papers.
Flow control	Legislation that limits free market access to specific wastes and ensures their disposal at a particular processing or ultimate disposal facility.
Full cost accounting	Assigning all known waste management costs to the waste management program, including those shared with other operations or programs. May also be applied to landfills.
Grasscycling	Leaving grass clippings on the lawn and allowing them to decompose naturally instead of collecting them for composting, digestion, or disposal.
Hierarchy (for waste)	A hierarchical method of solid waste management. The following practices are ranked in order of preference: source reduction; reuse; recycling; energy and material recovery; and landfill disposal.
In-vessel composting	Composting involving a closed tank or unit with physical controls.
Landfill mining	Materials are recovered from a landfill by excavation. Organic matter may be reused as a daily cover, and material, such as wood, metal, brick, plastics and glass, may be recovered and recycled.

Landspreading	A procedure whereby organic material is applied directly to land (usually agricultural) to improve the physical and chemical properties of soil.
Mandatory separation	A regulation requiring waste generators to separate designated recyclable or compostable materials from the waste stream for recycling.
Market development	Policies or measures used by organizations or governments to stimulate demand for secondary materials (i.e., procurement policies, regulations, or mandated recycled content).
Material recovery facility (MRF)	A facility that separates and processes source-separated secondary materials (such as glass, metals, plastics, or paper) into marketable materials.
Mixed MSW	Mixed municipal solid waste. The residual waste stream after some recyclables have been removed.
Mixed-waste processing	Through manual or mechanical means, some recyclable material is removed from waste. The remaining fraction may be used to make a fuel product, be composted, or both.
Municipal solid waste composting	The controlled decomposition of municipal solid waste, including some form of preprocess to remove non-compostable material.
On-site composting	Composting conducted at or near the (generation) source of the organic material.
Organics	The organic fraction of the waste stream, consisting of material that is biodegradable, typically food, yard waste, and paper.
Processing	Preparation of solid waste for sale to markets through such activities as hand sorting, magnetic and/or mechanical separation or shredding, composting, or digestion.
Procurement	The purchase of goods or services, usually by an organization or government. Procurement policies or regulations may establish requirements for purchasing goods that contain a minimum level of recycled content and/or are recyclable.
Rendering	Processing of animal wastes at high temperatures to produce oil, fats, or animal feed.

Reuse	The use of a product, such as a refillable beverage bottle, more than once, possibly with slight modification.
Source reduction (also waste reduction at source)	The conservation of materials and energy by preventing the formation of wastes such that no treatment, reuse, or disposal is required of excess or discarded materials. Source reduction is a subset of waste reduction.
Source separation	The separation of materials suitable for recycling or composting from solid waste at the source of generation (e.g., households, businesses).
Thermal treatment	Technologies that process waste using high temperatures to reduce the quantity of material requiring disposal, stabilize the material requiring disposal, and recover energy and potentially material resources.
Tipping fee surcharges	A surcharge or levy applied on a per-tonne basis to all wastes delivered to landfill sites, waste-to-energy plants and/or other waste handling facilities.
User pay	Waste collection system whereby generators pay for disposal according to tonnage or volume of waste produced. User pay systems may result in a reduction of the amount of solid waste requiring collection and management.
Variable tipping fees	Different fees may be charged at waste recovery, processing, and disposal facilities based on the particular kind of wastes in a specific load and/or the extent to which waste has been source-separated.
Vermicomposting	Worms digest organic wastes.
Waste composition	The various component materials of the waste stream, typically described as a percentage of the entire waste stream by weight.
Waste diversion	The redirection of generated wastes away from disposal through reuse, recycling, or recovery. It does not include source reduction.
Waste diversion credits	Financial incentive provided by municipalities to encourage or to reward waste diversion based on tonnage diverted from the waste stream.

Waste exchange	System for transferring waste material from one company to another that can use it. For example, packaging foam received by one company can be transferred to a stuffed toy manufacturer for use as stuffing.
Waste minimization	Measures or techniques, including plans and directives, that reduce the amount of wastes for disposal to the greatest degree practical. (Getting as close to zero waste as practical.) Methods to achieve minimization include source reduction, reuse, environmentally sound recycling, and recovery.
Waste reduction	The decreasing to some extent of the waste stream, requiring disposal through source reduction, reuse, recycling, or recovery. It is often confused with the more limited "source reduction," which deals with policies and approaches only from the curbside on, not further upstream.
Waste stream	The waste output of a community, region, or facility. Total waste can be categorized into different waste stream components (e.g., wet organic waste, construction waste, household hazardous waste, or white goods).
Wet/dry collection	The separation of residential solid waste into at least two components for collection: wet wastes, which are organic and collected for composting; and dry wastes, which are sorted at a central facility where the recyclables are removed for further processing.
Windrow composting	Composting process whereby piled organic material is placed in a series of rows, usually two metres deep. The rows are turned periodically for natural aeration.

Acronyms

A
- **AD** – anaerobic digestion
- **AMRC** – Ontario's Association of Municipal Recycling Coordinators

B
- **BEST** – Businesses for an Environmentally Sustainable Tomorrow
- **BNQ** – Le Bureau de normalisation du Québec
- **BOD** – biological oxygen demand
- **BRBA** – Buy Recycled Business Alliance in the U.S.

C
- **CCI** – Canada Compost Inc.
- **CCME** – Council of Ministers of the Environment
- **Cd** – cadmium
- **C&D** – construction and demolition
- **CFCs** – chlorofluorocarbons
- **CNG** – compressed natural gas
- **CO_2** – carbon dioxide

D
- **DfE** – design for the environment

E
- **eCO_2** – equivalent carbon dioxide
- **ECS** – eddy current separators
- **E-E** – Eco-Emballages
- **EFW** – energy from waste
- **ENGOS** – environmental non-profit organizations
- **EPA** – Environmental Protection Agency
- **EPP** – environmentally preferable procurement
- **EPR** – extended producer responsibility

F
- **FCM** – Federation of Canadian Municipalities

G
- **GAP** – Generally Agreed Principles
- **GERT** – Greenhouse Gas Emission Reduction Trading
- **GFNCR** – Greening of Facilities National Capital Region
- **GHG** – greenhouse gas
- **GIPPER** – Governments Incorporating Procurement Policies to Eliminate Refuse
- **GJ**– Gigajoule, a measure of energy. A joule is a watt per second
- **GMF** – Green Municipal Funds
- **GVRD** – Greater Vancouver Regional District

H
- **HCl** – hydrochloric acid
- **HDPE** – high density polyethylene
- **Hg** – mercury
- **HHW or HSW** – household hazardous waste (called household special waste in some provinces)
- **HRM** – Halifax Regional Municipality

I
- **IC&I** – industrial, commercial and institutional
- **IWM** – integrated waste management

L
- **LCA** – life cycle analysis
- **LFG** – landfill gas

M
- **MRF** – material recovery facilities
- **MSW** – municipal solid waste
- **MTCE** – metric tonnes of carbon equivalent

N
- **NaPP** – National Packaging Protocol
- **NIR** – near infrared
- **NORA** – Northern Ontario Recycling Association
- **NRC** – National Recycling Coalition
- **NO_x** – nitrogen oxides

O
- **OCC** – old corrugated cardboard
- **ONP** – old newspapers
- **OMG** – old magazines

P
- **PAYT** – pay-as-you-throw
- **Pb** – lead
- **PET** – polyethylene terephthalate
- **P&E** – promotion and education
- **PERT** – Pilot Emissions Reduction Trading Project
- **PROs** – Producer Responsibility Organizations
- **PM** – particulate matter

R
- **RDF** – refuse derived fuel
- **RMDZ** – recycling market development zones
- **RRFB** – Nova Scotia Resource Recovery Fund Board
- **RRQ** – Reseau des Ressourceries du Quebec

S
- **SOx** – sulphur oxides
- **SSO** – source-separated organics
- **SUBBOR** – Super Blue Box Recycling Corporation
- **SDS** – sustainable development strategies
- **SWICO** – Swiss Association for Information, Communication and Organization

V
- **VOCs** – volatile organic compounds

W
- **WRAC** – Ontario Waste Reduction Advisory Committee

FEDERATION OF CANADIAN MUNICIPALITIES

Solid Waste as a Resource

GUIDE for Sustainable Communities

FCM

Canada

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UTILIZING WOOD WASTE FROM CR&D AND URBAN FORESTRY

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Summary

Different cultures throughout the ages have associated trees with deep and sacred meanings; seeing them, and the wood they contain, as powerful symbols of growth, decay and rejuvenation. Today we appear to be approaching a bit of a renaissance in the appreciation of forests and trees, as people grow more concerned about the sustainability of our planetary ecosystems. It is all the more surprising then, to learn of the amount that we waste of this precious resource every year. Wood represents the single largest component of Canadian Construction, Renovation and Demolition (CR&D) waste streams, amounting to almost a million tonnes, or the equivalent of around 1 million harvested trees annually! When you include trees that are removed from the landscape as part of site preparation, or due to storm damage and for other reasons, the waste more than doubles. Most of this material is not utilized or recycled, and that which is, will normally be burned - not what you would expect in an increasingly resource constrained world that has a growing respect for forests and trees.

This paper will examine wood waste within the CR&D industry, and recommend directions for improving recovery and utilization of this resource. We will also consider waste from the removal of trees in the urban forest, since that represents an enormous and growing source of character virgin wood, that to date has not been effectively utilized. Moreover, urban forestry is an activity that centers on evolving and maintaining the build environment, and often involves many of the same stakeholders as CR&D.

Contents

Introduction

Scope

The 'Build Environment' essentially is composed of man made elements of our urban living space. It includes, but is not limited to, buildings and man made structures. Even forested parks are considered part of the build environment, since they are not strictly natural, but rather man made in origin.

For the purposes of this document we are focused on waste that is generated from the construction and evolution of our 'Build' environment - Construction, Renovation and Demolition (CR&D), as well as Urban Forestry. We have excluded those activities that simply occur as part of living and operating within the 'Build' environment. This includes consumer waste and Industrial, Commercial and Institutional (IC&I) waste streams. They typically involve a different set of stakeholders and will not be covered here.

Little has been done about wood waste from urban forestry operations within the context of Municipal Waste Management Strategies despite the scale of the issue, cost and opportunities. Although municipal forestry departments are primarily responsible for these challenges, tree waste can contribute to municipal waste management issues and so invariably will also involve municipal solid waste departments. We will consider the waste resulting from the removal of trees due to construction site preparation and landscaping as well as that arising from the removal of diseased, storm damaged and troublesome trees.

Importance of Trees and Wood within the Build Environment

Trees, and the wood resources that they provide, represent one of the most important resources that nature has blessed us with. As most school children now know, trees are responsible for filtering the air and adding oxygen, while helping to moderate urban temperatures, and storing vast amounts of carbon, which in turn helps combat climate change. In addition to their vital ecosystem role, wood from trees represents an important renewable resource that underpins much of our build environment. More wood fiber is used to support our society every year, by weight, than our combined consumption of steel, plastics, and portland cement. In fact, roughly one-half of all industrial materials used in North America are wood-based. Homebuilding, remodeling and home improvements collectively represent the largest single use of lumber and wood products, accounting for about *two-thirds* of domestic wood product consumption. Every year, construction of new homes[1] in Canada will consume

[1] There are approximately 200,000 houses built every year in Canada based on 2010/11 data from the CMHC

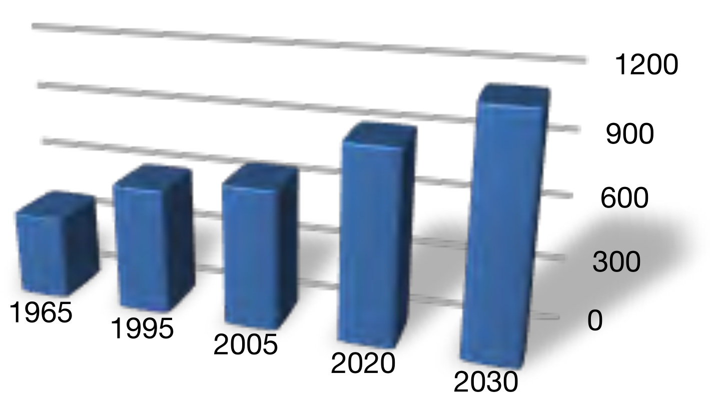
around 2 billion board feet of solid wood components, or over 7 million trees![2] This is based on an average single family home being 2,190 square feet in size. US data concludes that a home of this size will contain 14,200 board feet of lumber and up to 14,000 square feet of panel products. That includes wood products ranging from structural beams and flooring to the sheathing, trim and panelling.

Unlike, metal and plastics, wood is renewable, and represents a virtually inexhaustible source of material when properly managed. But our forests are under stress today, whether it is from invasive insects, or climate change and previous aggressive harvesting practices, Canadian forests face some serious threats. As global demand for wood products continues to increase(see table 1), we must take steps to reduce logging demands on our wilderness forests as well as better maintain them or we will risk further compromising this vital resource.

In order to do this we must make better use of the wood material within our build environment. This not only includes existing wood products, but also felled trees from within our urban forests. It is estimated that roughly 7 billion trees are growing in Canadian cities, suburbs and other metropolitan areas, and this figure is growing as Canadian cities grow in size.

Table 1: Wood Products Demand forecast (cubic meters) from the Food & Agriculture Organization of the UN - FAO

	Actual			Projected	
	1965	**1990**	**2005**	**2020**	**2030**
Sawn Wood	358	471	421	515	594
Wood-based Panels	42	128	241	391	521
Total (cm)	**400**	**599**	**662**	**906**	**1115**



Global Demand for Wood Products - millions of Cubic Meters (cm)

[2] Assume 250+ board feet of good saw grade lumber per tree, with a significant amount of the remaining wood supporting OSB and/or particle board product or other Wood Product Composite.

Wood Waste

Obtaining detailed national Canadian figures on wood waste can be difficult and so in some cases approximations were derived based on inferences from American data. The table below is based on a 2004 study by NRCan on the amount of disposed waste material in Canada. It concluded that 875,000 tonnes of CR&D waste wood was being disposed of each year in Canada.

Table 2: NRCan assumed CR&D waste percentages from a March 2006 report on waste recovery opportunities

	Residential			Non-Residential		
Material	Construction	Renovation	Demolition	Construction	Renovation	Demolition
Concrete	9.4%	13.9%	31.3%	12.4%	14.9%	10.9%
Asphalt	4.4%	6.6%	14.7%	5.8%	7.0%	5.1%
Wood	47.5%	30.5%	18.4%	34.5%	24.4%	40.4%
Drywall	20.5%	11.8%	2.6%	4.0%	35.4%	0.1%
Ferrous	1.5%	0.6%	0.3%	1.6%	1.4%	1.0%
Nonferrous	5.0%	1.9%	1.0%	5.3%	4.6%	3.3%
Cardboard	8.0%	0.8%	0.2%	10.7%	0.2%	0.3%
Other	3.8%	33.9%	31.5%	25.8%	12.1%	39.0%
Total	100%	100%	100%	100%	100%	100%

Construction

Studies have indicated that as much as 19% of the wood material in new home construction ends up as waste. Although today the average wastage is substantially less, it is still unacceptably high. The precise portion of wood *within* the overall construction waste stream varies a great deal with the type of construction; from a ratio in the single digit percentages when dealing with high-rise office buildings to as much as 47% in the event of single family home construction (a California study, which is consistent with data from NRCan findings as high-lighted in the table above). Recent Canadian studies have reported 39% wood waste by weight in Calgary construction on a given year and 26% for Alberta as a whole. The consensus of experts appears to be that the average amount of wasted wood accounts for somewhere between 20% and 30% of all waste generated in the construction of new homes. Put another way, it has been estimated that following today's construction practices, builders waste as much as a kilogram of wood per square foot of building constructed. This means that construction of a typical 2,500 sf home can result in approximately 2 metric tonnes of wood waste!

For yet another perspective on the wood waste situation, consider that, by one American estimate, there is approximately 28,000 board feed of wood (14k bfm of solid wood and 14.2k bfm of Wood Product Composites, or WPCs) in the average home, and that approximately 8% of that figure is wasted in the construction process. Now consider that there will be approximately 200,000 homes built in Canada this year - 2011 - and we arrive at a figure of 2.8 billion board feet of solid wood consumed and 233 million board feet[3] of solid wood waste. Thus, ignoring the larger amount of WPCs, we can see that close to 1 million trees (assuming 250 bfm of saw lumber / average tree cut in the forest) were harvested unnecessarily this year, just to support the waste of solid wood components in housing construction alone! When you include WPCs that figure goes up substantially! And when you include non-residential construction, that figure goes up higher still.

Of course, the impact of such waste is even worse than those figures indicate, since they don't account for embodied energy and other externalities associated with harvesting, processing and transporting the material.

Urban Forestry

Extensive utilization of urban trees in the creation of products is still a fairly new idea. The idea, however, is drawing more attention particularly in the US, as communities have battled significant increases in tree mortality due to invasive pests, storm damage, and damage from severe drought conditions, that have all led to heightened tree waste disposal challenges. Key questions that arise within this context include:

- How many trees (how much wood) must be removed from urban areas each year?
- What are the major impediments to utilizing this wood? (see next section)
- Are there viable examples of urban tree utilization industries?
- What role should bio-energy play in urban tree utilization

We offer suggestions to several of these questions through out this document. For now, we will focus on the volumes involved. Estimates of how much wood is removed from Canadian urban forests each year are hard to come by. But again, American data is a little more readily available - although still not great - and we can *very roughly* approximate our situation by simply assuming numbers that are 10% of the American figures[4]. It has been estimated that 200 million cubic yards of green waste is removed from the American urban environment alone, and that this figure would almost double should the metropolitan environment be included. From this, it is *conservatively* estimated that approximately 30 million cubic yards could be recovered as good saw logs each year. This in turn would result in approximately 4 billion board feet of lumber in the US alone - enough to fulfill 25% of the entire hardwood demand in the US.

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[3] This figure is derived by calculating the average ratio of waste to be a little over 8%, based on assuming half the wood waste is solid wood (half the input), and approximating the weight of construction lumber to be 1 tonne per 1000 board feet (using air dried spruce as a proxy from www.globalwood.org)

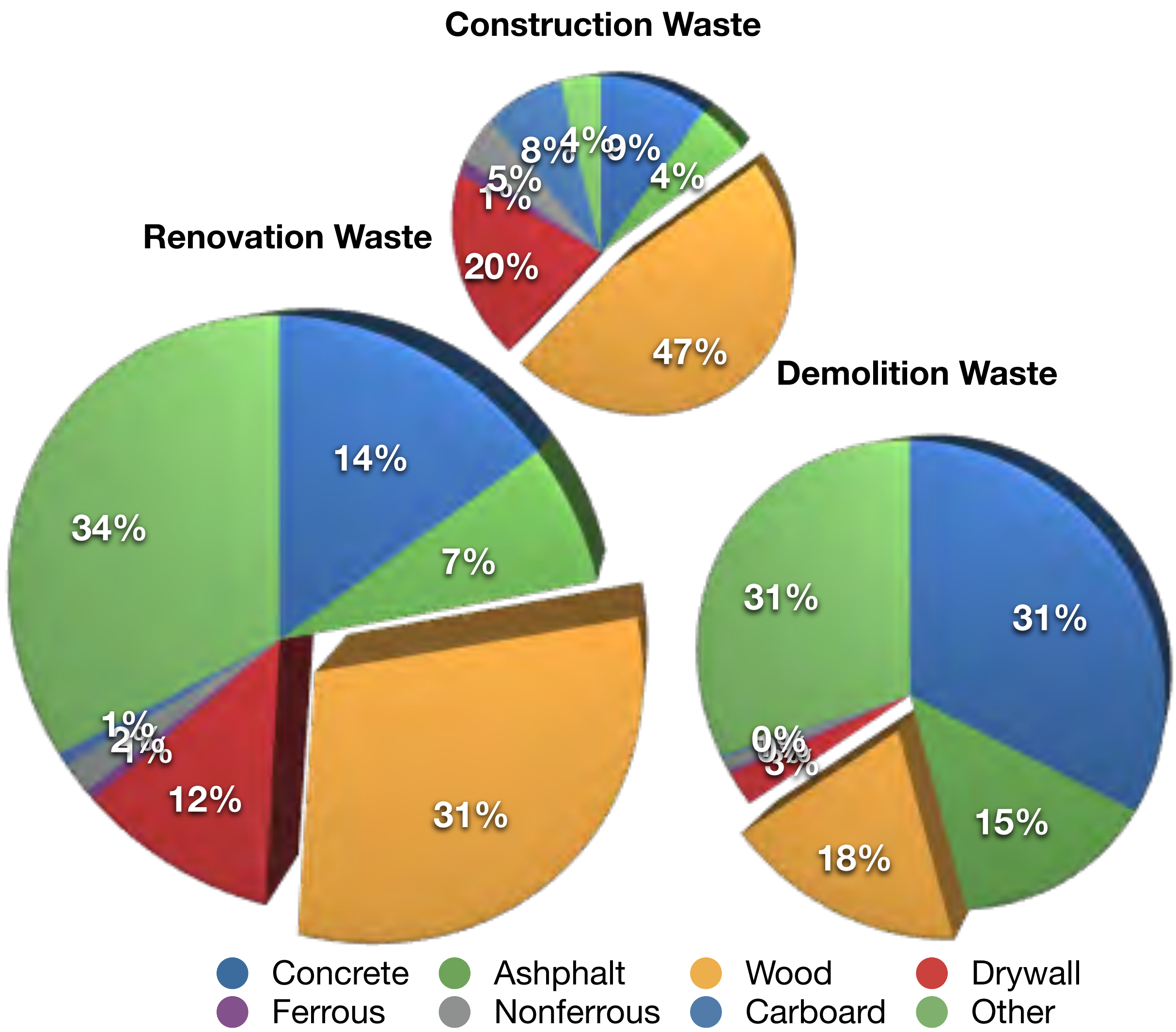
[4] This further assumes that the number of trees in our urban areas - on a per capita basis - is similar between Canada and the USA.

Per our earlier assumption, this would mean that roughly 3 million cubic yards could be recovered annually as good saw logs in Canada, resulting in approximately 400 million board feet of wood a year, or more than 20% of the solid wood required for housing each year in Canada. This figure would be significantly greater if we were to include trees in the broader metropolitan environment.

Building Renovations and Demolition

There is dramatically more overall waste generated from renovation and demolition than there is from construction. In fact, NRCan estimates that 89% of CR&D waste material comes from renovations and demolition, with only 11% of the total coming from Construction. From a wood perspective, however, its is not quite so unbalanced, since per table 2, the percentage of wood content in the renovation and demolition streams is less than it is in construction. Regardless, from the NRCan study data, it is clear that over 3 times as much wood waste is generated from residential building renovation as is generated from construction.

An American study from 2003 arrived at similar but somewhat different conclusions. It determined that the largest overall contributor to CR&D waste was non residential demolition followed by residential renovation. Overall waste volumes from residential renovations was almost 4 times that from new home construction. The percentage of wood in these waste streams was, however, significantly less than the percentage found in construction waste. NRCan data is illustrated below.



Unfortunately, wood waste coming from demolition and renovation is much ‘dirtier’ than that coming from construction, and so a greater proportion will end up in landfills today. Moreover, these projects are often managed by smaller companies and on a smaller scale than most construction projects, making it more challenging to successfully implement aggressive material recovery and recycling protocols

Consequences

The impacts of resource wastage of this magnitude can be felt in environmental, economic and quality of life terms.

Environmental Implications

Environmental impacts of wood waste are not always simple, or what they may seem at first blush. In an effort to influence people to their opposing positions, some *experts* will talk of the benefits of harvesting wood - that it increases the carbon store - while others highlight the danger of removing trees from the forest due to the degradation of the carbon sequestering capacity of the forest that results. Still others talk about the greenhouse gases that are emitted from landfill sites, and the then danger of burying wood waste in landfills.

The problem is that there is truth in all these positions. So what then is the real net implication of this wood waste and increased demand on our forests, for the environment?

Simply put, cutting down and removing a tree from the forest to be manufactured into products for the urban population, will normally result in:

i) an immediate reduction in the carbon sequestering process of that forest

ii) locking most of the removed wood based carbon into products (assuming it is not used as biomass energy)

iii) promoting / accelerating biomass regeneration in the forest which will *eventually* improve the net sequestering of carbon beyond what it would otherwise have been, had the trees not been cut and removed from the forest[5]

iv) removing organic material from the forest, and therefore marginally reducing its long term regenerative capacity

v) burning of fossil fuels and consuming energy from other sources and adding to pollution in the process of milling, packaging and transporting the wood and wood product

Of course the above list represents a gross simplification of the issues, but it does highlight some key considerations when trying to understand environmental sustainability and implications of harvesting wood in the forest.

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[5] In June 2010 the Manomet Center for Conservation Science released a report on Woody Biomass Energy, that attempted to illuminate the Life Cycle Assessment implications of using woody biomass for energy production. It was, however, widely misinterpreted to be a negative assessment of Wood Biomass Energy, and they quickly released a clarification note at: http://www.manomet.org/sites/manomet.org/files/Manomet%20Statement%20062110b.pdf. Yet another perspective based on a LCA is offered by Dovetail Partners in their 2011 report, http://www.dovetailinc.org/reportsview/2011/responsible-materials/pdr-jim-bowyerp/life-cycle-impacts-forest-management-and-bioe

Most trees being harvested today are being removed well before their carbon sequestering processes have peaked, so unnecessary/wasteful harvesting of the wood is certainly contributing to climate change in the short and medium term. Increasing demand for saw grade lumber leads to shortening of the harvest cycle, and causes foresters to seek out progressively smaller diameter trees that are earlier in their carbon sequestering cycle.[6] This in turn exacerbates the initial carbon deficits arising from the harvest. Just to put this into perspective; if we assume that the average tree being removed is capable of sequestering 50 pounds of carbon a year (a common assumption), then wastefully removing 1 million trees a year will contribute about 23,500 tonnes of carbon to the atmosphere (the amount of carbon that these trees would otherwise have soaked up in a year). This doesn't even include the impact of the harvesting and manufacturing processes, which actually could contribute a great deal more in the first year. Of course these effects will eventually be compensated for over time with new growth. But that will take decades.

Over harvesting and tree plantations also tend to reduce biodiversity, not only in the trees being regrown, but also in other other elements of the ecosystem. A healthy forest requires a

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[6] Although forestry people are quick to point out that the forested area of North America has been relatively stable for over a century despite increased wood consumption, and forested areas have actually increased in size in some European regions, the areas of so-called old growth forests have fallen dramatically. This can easily been seen in the ever smaller tree sizes that are being harvested for saw lumber from Canadian forests. Difficulty in obtaining large-diameter logs has led to use of plantation-grown trees and material from thinnings (a good thing), as well as the expanded use of new wood composite products such as Oriented Strand Board (OSB) in order to make effective use of these smaller trees. These technologies have made possible the dramatic increase in the use of engineered wood products. Prefabricated wood I-joists are replacing wide lumber for both floor and ceiling joists in residential applications. These products are made with a web of either plywood or OSB and with flanges of either solid-sawn mechanically graded lumber or laminated veneer lumber and tend to introduce greater challenges to recycling efforts

broad range of tree species, sizes and age, which demands active forest management and thinning operations, that are not widely practiced in Canada. Over harvesting can therefore contribute to a loss of biodiversity as well as increase the forest's vulnerability to catastrophic fires, among other threats.

It is worth noting that in countries like Sweden, where they have developed a robust biomass energy market, industry is able (with policy guidance) to do a better job of maintaining forest health through thinning operations and practices that include returning spent biomass fuel (organics) to the forest.

Disposal options for wood waste also carry different environmental 'costs'. Many have argued that landfilling trees and wood must be avoided at all costs since, the consequences of releasing GHGs such as carbon dioxide and methane from these materials can significantly contribute to climate change. While we don't advocate landfilling wood waste, some of these positions are overstated. For one thing, most landfill sites capture methane and burn it - in some cases generating energy in the process. In addition, studies have shown that when buried in landfills, trees and wood can remain a relatively stable store of carbon. As anecdotal evidence of this, Forest Echo (a wood recovery company in Ottawa) participated in the recovery of some elm trees that had been buried in an Ottawa landfill site for over 30 years. When rediscovered, these trees were in remarkable shape, and other than some minor staining the sawn wood looked 'fresh'. Burying trees and wood in landfill sites does however consume land that could often be used for more productive purposes, and more importantly, it fails to make use of a material that could reduce logging requirements and associated environmental impacts, or provide a relatively benign source of fuel energy.

Wood waste places an unnecessary stress on our forests, encouraging the harvest of ever smaller diameter trees that can threaten forest ecosystems. The harvesting of over a million trees every year in order to compensate for wood waste, also results in the unnecessary production and consumption of millions of liters of fossil fuels and associated GHG emissions in order to harvest, process, package, ship and then dispose of the waste wood. This is clearly not a desirable or even sustainable practice in an increasingly resource constrained world.

Economic Implications

The most immediately obvious economic consequence of wood waste, is the cost of disposal. There are, however, externalities that should be accounted for as well as direct costs. Direct costs are pretty clear. Most communities across Canada charge waste disposal fees to businesses and individuals for handling - typically landfilling - waste, including wood waste. These fees are increasing every year as public pressure to avoid the need for unsightly landfill sites is placing growing constraints on these operations. Moreover, most municipalities have already adopted differential rates for different materials in order to enforce public policy and to encourage greater recycling or reuse of certain materials. Due to the relatively large volume of wood in our municipal waste streams and the perceived reuse options, municipalities have typically moved to charge more for some types of wood waste, such as whole tree removals. Disposal costs for different types of wood waste has now exceeded $100 per tonne in some jurisdictions.

If you extend the economic costs to include various externalities - the costs that society bears - total costs can be ***much*** larger. Given some serious environmental challenges that society is facing, there is a growing movement to formalize these costs in chain of custody protocols that products will need to support. For example; the International Organization for Standardization has established ISO 14025/TR as an Environmental Product Declaration, which is a first step towards establishing an environmental cost accounting standard. Organizations would be well advised to begin preparing for this broader interpretation of costs when designing any new manufacturing and waste disposal plans.

There are also very real opportunity costs involved with disposing of the material. Certainly saving cash flow and even capital from wasteful resource use enables that money to be directed to other business opportunities. Additionally, reuse and recycling of resources represents an economic opportunity for the communities within which these are practiced. Studies have indicated that recycling and reuse practices are most cost effective when practiced on a local or regional scale. In fact, resource recovery businesses and remanufactures are often only viable if they can be located close to the resource thereby offsetting extra acquisition costs with lower transportation costs. This is especially true for wood, which is a less valuable commodity by weight and volume than other recycled material, such as metal or plastic. As a result, a successful wood recycling ecosystems will, by necessity, require mostly local content and green jobs, thus boosting economic development for the community.

Opportunities for Improved Utilization

There are few greater opportunities to help reduce our collective eco footprint and stimulate job growth at the same time, than what can be achieved by improving wood recovery and utilization in communities across Canada. Practical solutions are available today and do not require the invention of new technology or major additional public investments. Nor do these opportunities require broad based changes in individual behaviours within our society. Moreover, building certification systems like LEED reward aspects of improved local utilization of wood 'waste' resources in construction, by providing incentives through credits such as:

- MR Credit 4: Recycled Content
- MR Credit 5: Regional Materials
- MR Credit 7: FSC Wood (smart wood)
- EQ Credit 4.4: Low-Emitting Materials, Composite Wood and Laminate Adhesives

Opportunities exist to further improve utilization of wood from CR&D operations as well as from Urban Forestry.

Reducing Material Demands in Construction

Design is Key:

Innovative design of the build environment and construction processes can go a long way to providing the most effective answer to improving utilization - that is, to reduce material use and potential waste in the first place, and to ensure a durable structure that will stand the test of time. By aligning key performance indicators with reduction goals, as integral to project success, project designs could focus on:

- Reducing wood waste
- Eliminating redundant or excess wood use
- Using wood from non-depleting "environmentally certified" and "reclaimed" sources
- Enhancing the durability of homes / buildings

Building Technology and Practices:

More modular, prefabricated building construction is one proven approach (with a few caveats to be discussed later) that can be very effective at reducing waste, encouraging limited reuse of materials, and cost effectively improving building performance on other green building design criteria such as energy demands, and maintenance requirements. Increasing the attractiveness of this somewhat more restrictive design option to home purchasers and builders alike, could go a long way to encouraging cost effective greener homes and reducing wood waste. For the vast majority of buildings that will be constructed using traditional 'stick' methods over the coming years, local governments could encourage adoption of the latest construction technologies such as advanced framing (also known as Optimum Value Engineering - OVE), or similar method. These techniques have demonstrated material demand reductions in the order of $1,000 for a 2,400 sf house, along with a corresponding reduction of up to 5% in labour costs. All of these reductions are accompanied by a potential to improve the thermal envelop with associated significant energy savings. For more information on OVE see: http://www.eere.energy.gov/buildings/building_america/pdfs/db/35380.pdf

Greater Reuse of Wood Components

While some reuse of wood components does of course happen in construction, the greatest opportunity to improve *reuse* in CR&D will depend on careful deconstruction as an alternative to demolition. Doors, mantels, windows and the like can be easily reused on other projects. As is the case with many other opportunities discussed in this document, a ready market for the products that are recovered is critical. Beyond enabling reuse on a given project, a market for reusable products from construction demolition is essential. There are several examples of successful profit oriented and non profit building supply recycling depots in communities across the US and Canada. Supporting the establishment of this type of facility (especially ones that can handle significant volumes of wood products) is key to encouraging greater reuse and more deconstruction of buildings as opposed to demolition. Providing municipal incentives (perhaps as part of the permit process) for deconstruction over demolition, would be another way to encourage this important form of waste reduction.

Wood Products Recycling

Recycling recoverable wood waste represents an important means of extending the life of the wood resource and reducing the volume of timber harvested for forest products. Recycling can also greatly reduce the amount of wood-based waste sent to landfills. At the same time, it can improve the value of material produced by our trees, create jobs, and encourage economic growth. Realizing these benefits depends most, however, on government policies and market conditions that encourage companies to use recovered materials in products.

Figure: Idealized Wood Biomass Lifecycle

Potential Markets:

Our goal in seeking recycling opportunities - once reduction and reuse options have been exhausted - is to ensure the highest value usage of the material that will both maximize returns on recycling initiatives, as well as extend the useful life of the wood material itself. This is one reason why, for example; we shouldn't simply default to - perhaps the easiest solution - wood biomass energy, as it may not represent the highest value usage at that time.

When there are multiple recycling opportunities for the wood resource, determining which option will achieve the highest resource value of the material is an important question. The answer will depend on what technologies are commercially available, what end-of-life plans for the material might be, what is the business case for each option and what are the prevailing local conditions, and availability of markets. An example hierarchy of options is offered below. The list is not exhaustive and ultimately values will be determined by the market place, and will change over time, and vary by location:

1. Furniture and woodworking products
2. Architectural wood including flooring stairs, etc
3. Rough sawn lumber

4. Animal bedding
5. Mulch and other landscaping material, including compost
6. Wood Fibre products such as Rayon and Pulp & Paper
7. Remanufactured (composite) wood products
8. Biomass Energy: Wood pellet feedstock
9. Biomass Energy: Hog fuel

Furniture and woodworking products:

Furniture and woodworking represent the premium market for wood derived from old building deconstruction, as well as urban forestry operations and site preparations (i.e. land clearing). Large wood pieces in the construction of old buildings such as factories and barns, were hewn from classic old growth trees that were largely harvested out of existence. A combination of the beauty of the wood, its rarity, and the story behind the wood, causes it to be considered very valuable by a small but growing segment of the population.

Regarding trees grown within the urban environment, they tend to develop a unique character all their own. They typically grow more branches than their wilderness counterparts and inner city environmental stresses help encourage the development of grain patterns that are distinct from what you would find in trees harvested from natural forests. These features can be very appealing to a small group of wood 'connoisseurs' in a similar fashion to the appeal of regional wines to a small group who truly appreciate the complexities in wine. As is the case with wine, these distinctions with urban wood can thus become a source of value to be marketed.

While certainly environmentally superior to wood sourced through traditional channels, and offering local economic development within the region, these products don't follow traditional specifications, and so require purchasing departments to make some accommodations in order to encourage success. Any progressive municipal and/or regional waste management plan should involve supporting regulations and policy to encourage the acquisition of locally sourced products made from materials recovered within the region.

Architectural Wood:

Traverwood Library in Ann Arbor Michigan, is built with wood from EAB damaged trees that were harvested at the building site.

Flooring is a high volume potential market for good wood material coming from the Urban Forest as well as Building deconstruction.   The unique character of wood from these sources offers higher value marketing opportunities that is critical to enabling a profitable operation.

As in the case of Furniture and wood working products, it is important that regional and municipal waste plans also include appropriate procurement policies to encourage the purchase of products made from locally recovered (recycled), and processed wood.

Lumber:

Wood from recovered trees in the Urban Forest, and in some cases from building deconstruction, may be sawn to provide rough cut and dressed lumber for small construction/renovation projects, including wood decks.

Local kiln and milling services need to be readily available to enable an economic solution. The increasing popularity of relatively low cost portable saw mills has made rough sawn lumber services available and economic in most areas, although kiln drying and other milling capabilities necessary to dress the wood may not be as prevalent. Also, wood from Urban Forests generally does not fit nicely into traditional grading systems. As such, if municipalities wish to encourage diversion of Urban Forest waste wood away from landfills and into higher valued applications, then they will likely need to adapt the building codes to accommodate a revised grading standard.

Animal Bedding:

Animal bedding can offer surprisingly lucrative revenue for dry material coming from the so-called white (clean) wood in building construction, deconstruction or demolition. Reasonable volumes may be in demand in regions with a large number of horse farms, beef cattle processing operations, or the like. Somewhat higher prices may be achieved by bagging the material for sale to other smaller animal, pet and retail operations. The available supply of clean 'white' (dry) wood is very limited however, and utilizing more of the waste stream would require better upstream segregation of wood, or a significant investment in very sophisticated material cleaning equipment in order to virtually guarantee that the material does not contain any contaminants.

Another concern is that certain wood species may cause severe reactions in some animals, so segregating material based on species may be necessary for some markets. Wood waste for animal bedding usually involves the sale of wood shavings as opposed to shredded or ground material originating from operations like hammer-mill grinding, since the latter will normally contain dust, which can create problems for the animals.

Landscaping material:

A popular end use of some waste wood is landscaping materials. This is pretty straight forward when it involves waste from urban forestry. In fact, most municipalities already make extensive use of green waste from tree trimmings and the like, as mulch and cover for pathways. Green waste from tree service companies that is dumped in landfills provides a convenient and effective cover material that is frequently utilized, and in some cases may be mixed with other waste material to support composting operations.

In countries such as the UK, where more aggressive wood recycling programmes have been in place for years, waste wood from CR&D and other industrial operations is used extensively as landscaping material. The material tends to last longer since it is dryer and so less susceptible to rot. The challenge, however, is to ensure that the material is sufficiently clean. Although research indicates that most chemicals in wood product composites readily degrade in a compost pile, there are some chemicals (e.g. organochlorines) in older materials, which are resistant to this process. Some experts recommend that composting facility operators limit the proportion of older wood composite material that they accept. We, however, find this advice impractical given the difficulty of effectively implementing these restrictions. Therefore, we recommend that these operators restrict the proportion of all composite wood material in landscaping material. The blending of these contaminated products with non-contaminated feedstocks may help reduce associated concentrations of contaminants, including heavy metal (e.g. As, Cu and Cr) in the composted product to acceptable levels. The applicability (and acceptable risks) of different mixes must be determined on a case by case basis.

Wood Fibre Products:

Some industrial processes are less tolerant of impurity in feedstock than others. Virgin pulp and paper plants will, for example; not accept anything but pure virgin hardwood chips that meet their size requirements. Moreover, they can be particular about the species of wood that they accept. That doesn't however, preclude chipped wood resulting from urban forestry and land clearing operations, but it does place an extra burden of care on the process. Pulp wood represents a more valuable application than biomass energy and has been exploited in markets like Ottawa which is located within 25 minutes or so of Pulp and Paper as well as other wood fibre plants.

If an operation involves significant tree removal it is important to engage a reputable tree and wood reclamation company and/or wood broker, to fully understand options within the particular region.

Remanufactured Wood Product (Composites):

Feedstock for the production of a wide range of Wood Product Composites (WPC) and other wood derivative products, represents one recycling opportunity. An example WPC siding manufacturing facility in the UK, can annually divert 55 million kg of plastic and 77 million kg of urban wood waste from landfills. In fact, performance of products using recycled material has been found to not be significantly different from those using virgin wood. WPCs involve products such as Particle Board, Oriented Strand Board (OSB), Medium Density Fibre (MDF), plywood and even wood plastics. Given the nature of the product, plywood, followed by OSB are the most demanding on the input feedstock, and most reclaimed material would not be appropriate. Future technology innovations may change that, but for now Particle Board can accept the widest range of wood waste feedstock, while MDF is a candidate for Urban Forest waste material. There are 6 MDF plants spread across Canada, and 13 particle board manufacturing facilities within 5 provinces.

It appears that from a Life-cycle Cost Assessment (LCA) perspective (as covered by ISO 1404x standards), recycling material in these manufacturing processes makes a great deal of environmental as well as economic sense. LCA studies on MDF and OSB, for example, consistently highlight that the greatest environmental impact by far is incurred as part of the harvesting and transporting of the raw material. While MDF manufacturing has proven adaptable to changes in raw material supply using some sawdust, shavings and recycled wood previously thought unsuitable, CR&D wood waste is unlikely to provide suitable acceptable feedstock, without the introduction of new re-processing technology.

Immaturity of the Canadian wood recycling industry - when compared to that in the UK and Europe - and the resulting lack of standards, has however, slowed the market for waste wood in these businesses. As a result, use of wood material from the build environment has been spotty at best.

Biomass Energy:

In many ways, biomass energy represents the proverbial 'low hanging fruit', and the easy option to initially improve utilization of wood waste. Biomass energy represents a simple, relatively low cost way to conveniently handle a large volume of waste and in the process, to create energy in an environmentally benign manner. It can also be the least stringent in terms of demands on the purity and consistency of the feedstock material. In countries like Sweden which has a very high recovery rate of 95%, incinerating low grade material for energy represents a key high-volume component of their waste diversion strategy.

Biomass Energy - Wood Pellets:

The notion of utilizing waste wood in the production of wood pellets can be very appealing to manufacturers - after all, in theory it should lower their costs by reducing their material drying requirements. Waste wood moisture content is typically around 20% and can be lower, while the moisture content of green wood can be as high as 60%.

As with other industrial processes that consume wood feedstock, pellet manufacturers are looking for clean and consistent (size and moisture content) material. Although the pellets are only going to be burned, the majority of this product will be burned in home appliances, where contaminants could pose a health risk, and high ash content can be problematic.

Again, given the lack of standards within the Canadian market, and a lack of understanding of the level of contaminants that should be considered acceptable, many operators err on the side of caution, and reject the use of reclaimed material as a feedstock for wood pellets.

Biomass Energy - Hog Fuel:

Hog fuel is a term used to describe course chipped, ground or shredded wood material that can be of somewhat uneven consistency. It is primarily used as fuel for large wood boilers, but also can serve in a diverse set of applications such as providing a cost-effective, light weight fill material for the construction of road embankment foundations.

Not all boiler systems are capable of safely (i.e. from an air quality perspective) burning most types of wood waste, but many are. These systems are proven, safe and offer reasonable end-of-life value from contaminated wood products. People often scorn the burning of material, but that is the process by which most of our energy is generated today, and displacing the burning of fossil fuels with a mostly renewable resource (that has already provided value) is superior to pumping oil out of the ground, transporting it; refining it; and transporting it some more. Yes, burning wood 'waste' for energy offers one of the lowest value uses of recovered wood - that is why we should work hard to develop markets for the higher value applications - but ultimately we also need a reliable cost-effective market for the high volume of low grade end-of-life wood material that is produced every day in our society. Virtually all communities across Canada could make effective use of heat energy provided by burning wood waste, and the technology has been proven to be cost effective and environmentally sound, in numerous applications around the world. These include large scale power plants as well as Co-Heating and Power (CHP) applications that are found in many European cities or School heating systems that are popular in the US. The Nexterra system in operation at the Dockside Green development in Vancouver, British Columbia, represents a very progressive use of a 'waste wood to energy' solution.

Biomass Energy, represents an essential component of providing a comprehensive, sustainable and cost effective regional wood waste management solution.

Opportunities for Improved Wood Waste Recovery

It is possible to have identified great markets for reusing and recycling wood from the build environment, but if you can't cost effectively and reliably fulfill that demand with recovered material that meets the requirements, then you have not achieved a sustainable solution.

Construction Renovation & Demolition (CR&D):

Effective recycling demands reliable sorting and separation of wood materials in a manner that will enable the highest possible use. Improvements in the segregation of materials at construction sites, as well as providing a better means of ensuring that material not be contaminated, are two important improvements that will ensure higher value end uses. Once commingled with other waste material, it is virtually impossible to ensure 'clean' wood[7]. It is not just about the lack of contamination that is important, rather, which wood re-processors are available locally, and what exact type of wood material they require is also important to designing an effective segregation system. Regardless, it is crucial that large CR&D projects provide recycling centres, with clear separation of the different categories of wood material that will enable effective recycling of the material. Determining the exact project size, wood product category and other protocols requires discussion with local stakeholders to determine what is most appropriate for that region.

By forming a wood recycling industry association, involving stakeholders from the recycling sector, government, environmental agencies and regulatory bodies - similar to the Wood Recycler's Association in the UK - appropriate standards can be established to improve the supply of this recycled wood. Improving confidence in the reliability and consistency of supply, will help foster more robust markets for the material.

An example of a trivial initial categorization of material that would none the less be useful, could include the following wood classification.

- Clean, clear wood
- Mixed Grade: i.e. it could include a mix of plywood, OSB, but not MDF or treated wood.
- Fuel Grade: includes any of the WPCs, but not treated wood
- Hazardous wood: wood treated with preservatives

[7]Without changes to current practices, source separation is often inadequate, and not much better than commingled processing, which is one reason that some argue for the efficiency of processing a commingled waste stream

Urban Forestry:

There is a movement afoot across North American, and being lead by EAB affected states like Michigan and the US department of Forestry, to develop viable markets for wood from urban forests. As more cities are creating strategies to 'green' their communities or to adapt to an increasingly carbon constrained economy, urban tree utilization planning has the potential to aid in these plans.

Urban areas, and adjacent metropolitan land, will continue to expand throughout Canada, as will the extent of the urban forest. The volume of urban trees removed annually - already quite large - will increase as well, and new strategies for dealing with such material are needed, especially within the context of the break out of pests such as the EAB. Consequently, more consideration and municipal investment should be given to the potential for urban forests to provide a source of useful products, including bio-energy. This will also help create 'green' jobs in the process.

Today, it is the exception rather than the rule, for municipalities to landfill trees and wood from trees. The majority of felled urban trees are chipped on-site, and either trucked to municipal landfills to be used as cover/compost, or utilized as mulch in city gardens and pathways. A large portion of material is also disposed of following a mostly unregulated, but common practice, in which the woody material is delivered to various small private depots around the region. The larger logs are sometimes cut up and left on the property but usually they too are removed to numerous private and unregulated depots, typically outside the urban boundary. The principle utilization of this wood is as firewood for resale[8].

In addition to being a very low value use of this material, it is also worth noting that from an environmental perspective, the practice of delivering logs to firewood depots around the region can be even worse than landfilling the wood waste. This is due to a number of factors that become apparent once you consider the following:

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[8] Over the past few years there has, however, been a growing interest by private citizens to have wood from trees felled on their property to be processed into some kind of product. This appears to correspond to a growing awareness on the part of the public, of all things 'green'.

- Significant emissions arise from the transportation of material to depots, as well as emissions arising from the transportation of small loads of firewood to individual households through out the region

- Anecdotal evidence suggests that a significant portion of the material is left to rot - contributing further to GHG emissions

- Log burning fireplaces, and many of the wood stoves that consume this material, are very inefficient (fireplaces in most older homes range from -10% to +10 efficiency) and can emit up to 50g of particulates every hour! In fact, residential wood burning was estimated to account for as much as 15 percent of Ontario's VOC. The city of Toronto Public Health Department was so concerned, that they published a report in 2002 calling for action from multiple levels of government to address the problem.

- The transportation of firewood has been cited as a key enabler of the rapid spread of pests like the Emerald Ash Borer, which is currently devastating urban forests in central Canada.

- Easy access to firewood feedstock, has contributed to a fall in sourcing firewood from private woodlots. This in turn leaves dead and dying trees to rot in urban and rural forests, while reducing the incentive to manage and maintain the health of these forests.

- Counter to conventional wisdom, studies have indicated that burying trees and wood in landfills, can effectively sequester the carbon, and does not contribute significantly to GHG emissions. Decay is so slow under these conditions, that very little of the carbon is released to the atmosphere, whereas waste in the firewood supply chain discussed above will contribute a great deal more GHGs

- The fragmented nature of the current situation makes it virtually impossible to monitor wood utilization to ensure environmentally sound practices.

By implementing an intelligent urban tree removal and recycling protocol, communities can encourage the highest value use of this resource, and ensure that all of it is consumed in ways that are beneficial to the community - both in terms of public health and economic development.

Impediments to Improved Utilization

Despite the promise of substantial value through more effective utilization of wood from CR&D and Urban Forestry, Canadian companies and communities have, at times, been slow to respond due to the potential opportunity. Treating wood from these sources as the asset it is, rather than a waste management issue, would represent a positive change, but first several practical issues need to be overcome.

CR&D Wood Utilization

Challenges specific to the the Construction, Renovation and Demolition industry are examined below.

Resource Efficiency (reduction):

Building certification systems such as LEED, already recognize the merits of prefabricated and modular construction, and award points for its use and some of the ancillary benefits of using modular/prefab construction.

There are, however, real limitations to achieving solid benefits from modular and prefabricated construction. Everything from negative public perception of modular construction, to demands for virtually infinite customizability by customers, to building code restrictions, financing challenges, and even potential weaknesses with the 'green' claims of the prefabrication industry themselves, have slowed the growth of this building concept.

Claims of significantly less wood waste in the construction of prefabricated houses don't always hold up to close scrutiny. Although prefabricated homes do tend to waste much less material on-site, there is material waste at the manufacturing plant that needs to be properly accounted for. Moreover, one needs to consider the amount of material that is used in constructing these homes. In some cases prefabricated homes demand significantly (up to 30%) more wood material in construction than a typical 'stick built' home, due to the need to over engineer the product so that it can withstand transportation and other related stresses. Also, there are very few of these 'factories', and so they tend to be remote from most constructions markets, thus imposing greater transportation related costs and pollution. Alternatively, more basic modular construction systems, similar to SIP systems are used today with some benefits. Whereas more ambitious systems - such as that practiced by Elements in the UK http://www.elements-europe.com/index.php - can provide greater savings, they would require a critical mass of builders to adopt, and would also likely involve changes to local building codes in order to enable the integration of plumbing and electrical into building structural components.

One of the greater impediments today to minimizing waste is the demand for virtually infinite customizability of designs by clients. Constraining design choices to standard dimensioned components, could lead to significant savings, not just in terms of materials, but also labour costs. Success in this regard requires education of customers as to the implication of various design choices.

Greater Reuse of Wood:

Greater reuse will come from improved demolition practices and the greater adoption of building deconstruction vs. demolition. This will require greater government encouragement through tax breaks and public awareness campaigns, as well as more education regarding the value and best practices of building deconstruction over demolition. Today there is a growing specialization of deconstruction practices being promoted by the Buildings Material Reuse Association in the US.   They have sponsored an annual conference specifically focused on the Deconstruction industry in order to encourage better deconstruction practices.

Recycling:

The major impediments to greater recycling of wood material from Construction, Renovation and Demolition may be summarized in order of greatest importance, as:

1. Contamination
2. Inconsistency
3. Lack of Local Markets

Pretty much all markets for recycled wood require ‘clean’ wood to varying degrees.   Even most biomass energy applications require clean to pristine wood, and will turn away material that they believe is at risk of containing contaminants.   These constraints seem to becoming more restrictive as society is becoming more environmentally concerned.

Unfortunately, very little of the material from CR&D operations today is ‘clean’. By way of example; a detailed British study of CR&D samples from across the UK found only a small portion of the wood to be uncontaminated.   Approximately 6% of the waste was untreated hardwood, while 19% was untreated softwood.   The rest was either structurally contaminated as in the case of MDF and chipboard (which contain adhesives or other binding agents) or involved surface treated wood. Almost 70% of the wood waste had structural contaminants but no surface treatments. And 10% of the wood contained hazardous surface treatments like CCA. This is mostly due to the heavy, and growing reliance on WPC materials in construction - a similar trend to that being experienced in Canada and the US. Ironically, while WPCs offer a positive opportunity to improve the utilization of harvested trees and also present the potential for higher value wood recycling opportunities - both good things - they also present significant recycling challenges due to the resins that they often contain.

Construction waste tends to naturally be cleaner than demolition waste, and given that demolition projects also tend to be on a smaller scale, economically providing clean wood from the demolition stream will be more challenging. Regardless, better and stricter segregation protocols than exist today will be critical to success.

Some of the restrictions on recycled wood use due to 'contamination' are based on valid concerns, while in other cases - often when biomass combustion is involved - customer trepidation can be due in part to a lack of understanding of the real risks. Education is important to addressing these misconceptions. But perhaps more importantly, there is a need to develop and achieve a consensus over a set of clearly defined standards that would apply to potential downstream uses of this material, that CR&D businesses could manage to.

Of particular concern regarding contamination, is the category of hazardous contaminants that includes CCA treated wood. The amount of this material that must be handled as waste is increasing dramatically in Canada, from 0.57 million cubic meters in 2000 to an estimated 2.5 million cubic meters by 2020 This kind of volume demands that we find better recycling options for the material. Waste-to-energy offers the most likely candidate, but options for economically extracting the biocide or incorporating the material into a wood cement product, are currently being explored.

In addition to ensuring a clean supply, industrial processes usually require consistency in the feedstock size, precise material content, wood species and moisture content levels. For example; even large industrial boiler systems are sensitive to size variations of the biomass feedstock. If the feedstock contains too much fine sawdust, this can lead to premature ignition, which can damage the boiler feed mechanisms. If the material is too large it can jam the same feed mechanisms.

In order to help ensure the environmental, as well as economic benefits of wood recycling operations, it is essential that local markets for the material and resulting end products. Without viable markets - involving remanufactures and bio-energy facilities within the region to consume the material, as well as healthy markets for the resulting end products - there will be no incentive to recover and improve utilization of the wood. Municipal and regional government policies to encourage procurement of products made from locally recovered wood as well as incentives for bio-energy (or waste to energy) facilities is a critical part of any wood recovery and municipal waste management plan!

Urban Forestry Wood Utilization

Some of the challenges to improving utilization of felled urban trees are summarized below.

Wood Quantity & Supply Fragmentation:

With the exception of storm events, severe droughts or a large pest outbreak, most individual urban tree removal projects generate small quantities of wood. One off recovery of trees within a city just isn't generally cost effective. Worse yet, the large number of tree service companies operating within a given region or municipality just aggravates the challenge of fragmented supply. Companies don't have enough volume to make any kind of urban forestry operation economic. In addition, reliable supply is key to managing the costs within a largely commodity based business, and that requires large supply volumes that are not possible in a fragmented market.

Wood Quality:

Urban trees are typically grown in more open areas than trees in a natural forested setting. This often results in shorter trunks and more branches. When the possibility of embedded materials - nails, cables, and other hardware is included, it is understandable that many timber buyers are frightened away. In addition, among both urban wood generators and many in the traditional wood products industry, there is a perception that urban trees have no value.

Markets:

The lack of consistent species composition of the supply makes it difficult to develop markets for the trees. In urban areas, especially after an invasive species attack (i.e., emerald ash borer or Dutch elm disease), greater availability of a single species or two is more likely, thus limiting the number of potential buyers, utilization options, and markets. Urban tree removals can also generate small volumes of a diverse set of species that are not valued in traditional timber markets.

Inventories:

Tree inventories in urban areas often lack the scope and specificity (such as log volume and grade) needed by wood-using industries to set-up an effective utilization program.

Utilization Plans:

Most urban forestry programs have weak or non-existent utilization plans. This lack of planning includes a poor understanding of local markets and potential products, a lack of existing wood-using industries, and a general lack of knowledge of how to stimulate a viable utilization plan.

Local Government Support:

Local government departments face numerous competing priorities and a conservative risk averse decision process. Asking them to develop and/or incorporate new ideas for how they dispose of urban tree removals is very difficult, even if it could result in savings or economic development for the city. In many cases, communities aren't aware of the waste issue, and are happy so long as the material is removed in an efficient manner.

When all these challenges are taken together, and given the lack of a strong private sector advocate, it is not surprising that progress on developing a sustainable Urban Forest Products industry has been so slow.

Conclusion and Recommendations

Wood is the single largest component of waste from Construction, Renovation and Demolition activities, accounting for around a million tonnes of debris being disposed annually, and representing the waste of over a million trees annually! When you add in trees felled in the 'build' environment as part of the construction process, or as a result of storm, pests and other damage, the amount of wood waste more than doubles. Little wonder that there is a good deal of interest in trying to recover more of that material to extend its value, and divert it from our growing landfill sites. Unfortunately, the wide variety of wood content in these waste streams, combined with high-levels of contamination and fragmented supply, have made broad based waste wood collection (recovery) and recycling of wood seem daunting indeed.

Much more, however, can and should be done. The CR&D industry in cooperation with other stakeholders, including local / regional governments, wood recycling companies and reprocessors can significantly improve the utilization of wood, by focusing on:

1. Promoting more resource efficient designs, and customer education
2. Working with local governments to adopt procurement policies that favour products containing locally recycled wood content - this includes biomass energy production.
3. Developing a Wood Recycling Association, as well as recycled material standards
4. Enforcing wood recovery protocols on larger CR&D projects to ensure proper segregation of wood material
5. Encouraging (mandate in defined cases) deconstruction practices over demolition

It is critical to develop local markets for products derived from recycled and reclaimed wood material. Municipal and regional governments should encourage markets for end products via government procurement policies as well as changes to building codes to allow utilization of wood from the urban forest in construction applications

Local wood biomass energy systems, and/or waste-to-energy systems are an **essential component** of a comprehensive wood utilization plan. It is necessary to offer an end-of-life disposition for large volumes of low grade, potentially contaminated wood, that will also provide a higher value use than landfilling, and one that provides energy diversity in a relatively benign way. Municipalities need to help educate the public on the facts and encourage the adoption of scalable CHP biomass energy systems, as alternative heat and power sources within the region.

The wood recycling industry needs to come together with the key stakeholders to establish a wood recycling association and to specify a set of standards for waste wood recovery.

Municipal governments should encourage more aggressive modular construction technologies by removing potential building code restrictions. Governments should also encourage the greater use of building deconstruction as opposed to demolition. This could be achieved by offering tax incentives on purchases from building component recycling depots, as well as through changes to the demolition permitting process. Finally, we recommend that consideration be given to establishing requirements that development projects over a certain size be required to demonstrate clean segregation of wood material on the job site. Regulations exist today in some provinces - i.e. Ontario's Regulations 103/94 and 104/94 for projects with greater 2000 square meters of floor space. However, this only addresses a small minority of projects. Moreover, it doesn't mandate the segregation of different wood product classes, that is critical to maximizing reuse potential.

The recovery of value from wood waste simultaneously reduces the impacts of wood waste 'disposal' while adding value to society in the form of additional material and energy flows, and increased economic activity. It is not enough to recycle wood in order to be sustainable, instead we must strive to find the most appropriate and highest value applications of the material to extend its 'life' as much as is practical, and to offer the greatest net return on the material.