1 COMPOSITION AND QUANTITY: A CRITICAL EVALUATION OF EXISTING DATA

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A Municipal Solid Waste Management Study by THE POLLUTION PROBE FOUNDATION

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I. INTRODUCTION

The purpose of this background report is to provide the physical parameters of the municipal solid waste problem in Metropolitan Toronto and the Golden Horseshoe. The Golden Horseshoe is composed of the Regional Municipalities of Niagara, Hamilton-Wentworth, Halton, Peel, York, Durham and Metropolitan Toronto. This regional approach was taken because it was felt that municipal solid waste management has suffered in the past from the lack of such a total, overall approach.

This study addresses itself to three elementary questions: what is it? how much is there? and what is the composition?

This was not a simple task. Witness the fact that the footnotes and appendices are far more extensive than the main body of the report. The footnotes are meant for those readers who want to know where the information was found, how it was used or developed, its limitations, as well as other specific details. The three appendices contain some of the raw data and analysis that are used in this study, but were too lengthy to include within its main body.

A clear understanding of the municipal solid waste problem begins with an appreciation of its physical parameters and is a very important first step in the development of solution scenarios. Decisions concerning the optimal solid waste management process depend upon, among other things, the quantity of particular materials present in municipal solid waste.

One further comment. In the past, insufficient attention has often been paid to some of the basic questions examined in this study. This has led to considerable confusion. This study has developed some answers and has highlighted some problem areas. It is hoped that this study has established a framework which other studies can use as a point of departure.

II. SUMMARY OF FINDINGS

First and foremost, municipal solid waste is defined as "all the solid wastes, excluding agricultural and mining wastes, generated in a municipality that must be managed".

Metropolitan Toronto generated about 2,400,000 tons of municipal solid waste in 1973, less than half of which came from residential sources. The municipal solid waste generated in the six regional municipalities surrounding Metropolitan Toronto (which make up the rest of the Golden Horseshoe) was also found.

Upon examination of 31 previous studies which analysed the composition of solid waste, six distortion factors were identified:

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
6. the moisture transfer that occured before sampling

With consideration given to these six distortion factors, the following percentage figures were 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%.

The information currently available did not permit a further breakdown of the paper component into types of waste paper. This is unfortunate because such information is important to any system designed to recover waste paper since the different grades require different recycling processes and have different market possibilities and prices.

And although the metal component was broken down into ferrous and non-ferrous sub-components, the further breakdown of the non-ferrous fraction is important to any system designed to recover these valuable non-ferrous materials. Such a sub-breakdown was also not possible in this study.

No estimate was considered possible for the composition of commercial or industrial solid waste in Metro Toronto or the Golden Horseshoe. The composition of commercial and industrial solid wastes vary considerably from area to area, depending upon the extent and mix of commercial and industrial enterprises in a particular area. However, these two separate compositions could be computed for any area with a known commercial and industrial mix, if the composition of solid wastes generated by each category of commercial and industrial enterprise was known. Although this information is not currently available, it has been highlighted by this study as an area that deserves further attention.

This study was able to estimate that about 4,200,000 tons of paper entered the Canadian residential, commercial and industrial solid waste stream in 1973. This represented between 21% and 35% of Canada's residential, commercial and industrial solid waste.

III. DEFINITION OF MUNICIPAL SOLID WASTE

Fundamental to any comprehensive study of municipal solid waste is a clear understanding of precisely what is meant by the term. Failure to address this question in the past has led to no end of confusion.

For the purposes of this study, municipal solid waste is defined as all the solid wastes, excluding agricultural and mining wastes, generated in a municipality that must be managed.

Notice we use the term 'managed' and not 'disposed of'. Municipality includes any incorporated town, borough, city or region.

According to this definition, the following distinct components make up municipal solid waste:

- residential solid waste - all solid wastes from homes and apartments, except for large bulky items (see below)
- commercial solid waste - all solid wastes from the operation of business or commercial establishments (banks, offices, etc.), wholesale and retail trades, churches, shopping centres, restaurants and publicly owned facilities (governments, hospitals, schools, universities, etc.)
- industrial solid waste - all solid wastes from industry, both 'trade' waste (which depends upon the industry) and 'non-trade' wastes (from the office and cafeteria)
- construction and demolition wastes - non-inert - primarily lumber
  inert - concrete, plaster, bricks, etc.
- ash - from power generating stations and incinerators (for both solid waste and sewage sludge)
- street sweepings
- trees
- sewage sludge
- bulky items - old refrigerators, washing machines, furniture, but not derelict automobiles (see below)
- hazardous solid wastes - pathological, radioactive, chemical and explosive solid wastes from hospitals and special industries, but not hazardous liquid wastes
- derelict autos - automobiles that are no longer operational

Excluded from this definition of municipal solid wastes are:

- agricultural solid wastes	- animal: 150 million tons/year in Canada (1) - non-animal: 55 million tons/year in Canada (1)
- mining solid wastes	- 440 million tons/year in Canada (1)
- solid wastes currently being recycled	- wastes handled by paper mills, scrap steel operations, etc. which never enter the solid waste stream. The 'Resource Map of the Golden Horseshoe', contained in the main report, presents an estimation of these amounts
- liquid industrial wastes	- approximately 20 million gallons/year in Metro Toronto, and environs, including hazardous liquid wastes (2)

These four types of wastes are recognized as being significant problems which deserve special attention. They are, however, beyond the scope of this study.

The definition of municipal solid waste used here is much broader than that used in most other studies (3). This definition has been adopted because the emphasis of this study is on the utilization of any and all materials that are solid waste in Metropolitan Toronto and surrounding area.

Although many solid wastes such as sewage sludge and ash are collected separately (and currently 'disposed of' separately), it is advantageous and conceivable that complementary uses can and will be found for these special wastes. They should certainly not be ignored and are thus included in this study's definition of municipal solid waste.

IV. QUANTITY OF MUNICIPAL SOLID WASTE

Having defined the term municipal solid waste, it is now possible to proceed to determine the quantity of municipal solid waste generated in a given area in a year. This is, of course, necessary in order to appreciate the scale of the current problem.

1. Quantity of Municipal Solid Waste Generated in Metropolitan Toronto

The following table gives a breakdown of the amount of municipal solid waste (in tons) generated in Metropolitan Toronto in 1973. Some of the figures for 1974 became available only after most of this table has been completed (see Footnote 28). The rather detailed breakdown into twenty nine categories was necessary to avoid double accounting of certain wastes in estimating the total amount of municipal solid waste generated, to indicate the relative size of the various components, and to show how different solid wastes are currently being collected and 'disposed of'.

Throughout this study, municipal solid waste is measured in terms of its weight in tons. Some people consider volume in cubic yards a more useful measurement. However, volume figures depend too much on the degree of compaction and are thus not a reliable measurement of the amount of any material in municipal solid waste. Volume is useful in determining landfill site capacity, but this is not a landfill study!

The table headings in Table 1 are relatively self-explanatory. There are primarily two types of collection: municipal (paid for by public funds) and private (paid for privately). There are also two types of disposal facilities (29): public ones (publicly owned landfill sites and incinerators) and private ones (30) (privately owned landfill sites). Two types of vehicles are used to collect municipal solid waste: public and private. The various types of municipal solid waste are collected and disposed of by these different means. The last five types of municipal solid waste (#25-29) are collected and disposed of in special ways.

From Table 1, the amount of residential, light commercial and non-trade industrial waste generated in Metro Toronto in 1973 was 906,396 tons (31); the amount of commercial, industrial and some residential solid waste from apartments was 567,416 tons (32), and the amount of other waste 924,249 tons (33). Unfortunately, it is not possible to calculate the amount of purely residential solid waste, purely commercial solid waste or purely industrial solid waste from Table 1 or any other source.

Many of the 29 components could and perhaps should be the subject of future studies themselves. Brief comments on where the figures in the table are from, what they include, and other comments are contained in footnotes 4-26.

TABLE 1

QUANTITY OF MUNICIPAL SOLID WASTE GENERATED IN METROPOLITAN TORONTO IN 1973 (IN TONS)

Type of Collection	Disposal Facility	Collection Vehicle		Type of Waste	Amounts	Totals
Municipal	Public	Public, mixed together in city or borough truck	1)	Residential	N.A.(4)	1,113,753(27)
			2)	Light commercial	N.A.(5)	
			3)	Non-trade industrial	N.A.(6)	
		In separate Metro trucks	4)	Metro parks waste	30,151(7)	
			5)	Incinerator ash	42,328(8)	
			6)	Sewage sludge	99,378(9)	
		In separate city or borough truck	7)	Street sweepings	50,000*(10)	
			8)	Bulky items	50,000*(11)	
			9)	Leaves	7,500*(12)	
		Private, together in private truck	10)	Residential	N.A.(13)	
			11)	Light commercial	N.A.(13)	
			12)	Non-trade industrial	N.A.(13)	
Private	Public	Private in bulk container	13)	Apartment buildings	N.A.(14)	435,416(27)
			14)	Commercial (large)	N.A.(15)	
			15)	Industrial (trade wastes)	N.A.(16)	
			16)	Construction & Demo. (non-inert)	24,000*(17)	
			17)	Trees	10,000*(18)	
	Private	Private in bulk container	18)	Apartment buildings	N.A.(19)	200,000*(28)
			19)	Commercial (large)	N.A.(19)	
			20)	Industrial (trade wastes)	N.A.(19)	
			21)	Construction & Demo. (non-inert)	24,000*(19)	
			22)	Trees	10,000*(19)	

TABLE 1 (cont'd)

Type of Collection	Disposal Facility	Collection Vehicle	Type of Waste	Amounts	Totals
Private		In separate trucks	23) Ash from power generating stations	216,108(20)	
			24) Hazardous wastes		
			- pathological	500*(21)	
			- radioactive	30*	
Municipal & Private	Special	Public & Private	25) Construction & demo. (inert)	100,000*(22)	648,892*
None	On-Site	None	26) Apartments	72,000(23)	
			27) Sewage sludge ash	155,075(24)	
			28) Incinerator ash	105,179(25)	
None	None	None	29) Derelict automobiles	N.A.(26)	

GRAND TOTAL - 2,398,061*

Unfortunately, the city and boroughs in Toronto each have slightly different collection procedures reflected in the different collection by-laws. Generally speaking, the city or boroughs are responsible for collecting 6-8 containers of solid waste (about 24 cu. ft.)/establishment or dwelling/collection day. Some are responsible for collection of the solid waste from all apartments, and some are not (14). The 8-bag a day limit generally allows for the collection of light commercial solid waste and non-trade or housekeeping wastes from industry. The collection and management of this waste is a municipal responsibility and paid for out of the public purse.

Large commercial operations, such as universities, hospitals, shopping centres, and office buildings usually must make their own arrangements with private disposal companies to have their solid wastes collected and 'managed'. Likewise the collection of solid wastes from industry must be privately arranged and privately paid for by the industry.

Some figures in this table are very precise, some are very rough approximations (*) and some were not available (N.A.).

2. Quantity of Municipal Solid Waste Generated in the Golden Horseshoe

Although the origin of the term Golden Horseshoe is somewhat obscure, it is generally meant to be the area around the south, west and north-west part of Lake Ontario, stretching from St. Catharines to Oshawa. More precisely, this study has defined the Golden Horseshoe as being the sum of the seven Regional Municipalities bordering Lake Ontario from St. Catharines to Oshawa: Niagara, Hamilton-Wentworth, Halton, Peel, Metro Toronto, York and Durham.

This regional approach to the municipal solid waste problem is necessary to convey the scope of the problem in not just one municipality, but in a number of municipalities which are quite close to each other. The reason for this is that a plant or process that may not be justified by the scale of the municipal solid wastes generated in one particular regional municipality, may be justified for a number of regional municipalities together. There may be much to be gained by inter-municipal co-operation.

Table 2 gives the best available information on the amount of municipal solid waste generated in the Golden Horseshoe. The figures in brackets represent the tons/capita/year of each category.

The table is complicated by the fact that figures for each separate type of municipal solid waste were often unavailable. Where these separate types of municipal solid waste were referred to using different terms, the actual term used in the study is put in brackets and parenthesis (" "). Figures for all the regions for one year (1973 for instance) were not available.

TABLE 2

QUANTITIES OF MUNICIPAL SOLID WASTE GENERATED IN THE GOLDEN HORSESHOE (IN TONS)

(Tons/Capita/Year in Brackets Underneath the Totals)

Regional Municipality	Information Source Year of Figures	Residential	Commercial	Industrial	Other	Total	1971 (34) Population	Tons/ Capita/ Year
Niagara	Letter from Region 1973	153,682 (0.44)	8,320 ("retail") 404,976 ("service") 413,296 (1.19)	314,496 (35) ("manufacturing") (0.91)	47,975 (municipal & bulk) (0.14)	929,449	347,330	2.68
Hamilton-Wentworth	Proctor & Redfern Study 1972	121,080 (0.30)	308,454 ("non-residential") (0.77)		656,317(36) (1.63)	1,085,851	401,885	2.70
Halton	MacLaren Study 1972	82,166 (0.43)		60,358 (0.32)	18,979 (0.10)	161,503	190,470	0.85
Peel	Phone Conversation with Region 1974	140,000 (0.54)	260,000 (1.00)		N.A.	400,000	259,400	1.54
Metro Toronto	This Study 1973	906,396(37) ("residential, light commercial and non-trade industrial") (0.44)	567,416(37) ("commercial, industrial and some residential from apartments") (0.27)		924,249 (0.44)	2,398,061	2,086,020	1.15
York	Letter from Gore & Storrie (Consultants) 1974	183,100 (1.10)			N.A.	183,000	166,060	1.10
Durham	Letter from MacLaren (Consultants) 1974	78,100 (0.35) ("municipal")	89,000 (0.40)		N.A.	167,100	221,505	0.75
TOTAL		3,677,444 (1.00)			1,647,520 (0.45)	5,324,964	3,672,670	1.45

V. COMPOSITION OF MUNICIPAL SOLID WASTE

Having determined the quantity of municipal solid waste, the material composition of municipal solid waste will not be examined. This is an important component of any study since the decision concerning the optimal type of solid waste management process depends upon, among other things, the quantity of particular materials present in municipal solid waste.

This problem will be approached by first examining various previous compositional studies, and will then attempt to develop the composition of residential, commercial and industrial solid waste in Metro Toronto and the Golden Horseshoe. The composition of residential, commercial and industrial solid waste are very different from each other and will thus be analysed separately.

All the remaining types of municipal solid waste either do not require a compositional breakdown by material because their composition is obvious (sewage sludge, ash, etc.) or was not found possible in this study (bulky items).

An arguement can be made that it would be more useful to find the composition of 'residential, light commercial and non-trade industrial solid waste' because the quantity of this solid waste, not residential solid waste, that is known for Metro Toronto from Table 1. This has not been done in this study because such a category of solid waste is completely dependent upon the local solid waste collection by-laws of the area and thus is different for virtually every area. It can, however, be noted that light commercial and non-trade industrial solid wastes are primarily 'housekeeping' wastes and would thus be more similar to the composition of residential solid waste than to the composition of commercial or industrial solid waste.

There are three basic types of compositional breakdowns of municipal solid waste.

a) breakdown by chemical composition (carbon, oxygen, etc.)
b) breakdown by product end-use (packaging, newspapers, etc.)
c) breakdown by material (paper, glass, metal)

Each breakdown serves a different purpose. The first is primarily used to analyse the combustion properties of municipal solid waste (its BTU or heating value, as well as the gases and residue that can be expected to be created) and the effects that a given component of solid waste would have on the natural environment, especially watercourses, if this waste is landfilled. The second is useful for a study concerned with product flows through society. The third is most useful for a study of the materials flow through society. The last two breakdowns could be by either weight or volume. As stated previously, the weight measurements are being used in this study.

As this study is primarily concerned with finding ways to maximize the reclamation and recycling of the materials available in municipal solid waste, the last type of compositional breakdown is the most useful. The breakdown by product end-use is also useful in some cases because it often reflects the different grades of the materials present in municipal solid waste. The best example of this is paper, where there are very different markets and market potentials for reclaimed newsprint, cardboard and fine paper. Comments on such a further breakdown by product end-use will be made where possible.

Practically every major study of 'solid waste' (variously defined) and 'recycling' has addressed itself to the question of the composition of this waste. In North America there are well over fifty professionally conducted separate studies which actually sorted and sampled this waste and many more studies that attempted to summarize and draw conclusions from these original studies. Of the many studies available, the 31 studies selected were those most often referred to in the popular literature on the subject, as well as the original studies which some of these studies based their composition figures upon. Other studies were chosen because they illustrate a particular aspect of the problem of determining the composition of municipal solid waste.

Summaries of the 31 compositional studies can be found in Appendix 1 at the back of this report.

1. The Six Distortion Factors

Examination of these 31 studies indicates that there are considerable variations between the different compositional studies. Six distortion factors were identified which account for these differences:

1. the 'solid waste' that was being studied
2. the geographical 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
6. the moisture transfer that occured before sampling

Also of importance is, of course, the reliability of the data in each particular study; this depends upon the size of the sample, the method of sampling, the means of sorting and classifying, and the type of classifications. Comments regarding these variables are given in Appendix 1 for each separate study.

It is hoped that the professional nature of these studies has minimized this reliability problem. Furthermore, by analysing a number of

different studies, the inherent errors in any one study will tend to be outweighed by the other studies.

i. The 'Solid Waste' that was being studied

Examination of the many studies on 'solid waste' reveals an almost equally large number of definitions of 'solid waste'. It is no wonder that two compositional studies which based their analysis on different definitions and different portions of municipal solid waste (as defined by this study) have widely different results. Unfortunately, many authors used terms such as 'refuse' and 'municipal solid waste' without defining precisely which solid wastes they include. Other studies defined 'municipal solid waste' quite differently from the definition used in this study. Many studied the solid waste that the particular municipality must pick up. This varies from municipality to municipality depending upon the municipal regulations regarding collection procedure.

The definition of municipal solid waste used in this study was stated previously - it includes all solid wastes generated in a municipality except for agricultural and mining wastes. Only the CLARK 1974 study has the same definition of municipal solid waste as this study. But since this analysis will refer to the other 30 studies as well, the term 'solid waste' (variously defined) will be used throughout this study in referring to the waste that the various different studies are referring to and breaking down by composition.

These studies have been classified in Table 3 under the various different definitions of solid waste that were found in the 31 studies. The names and years refer to the studies in Appendix 1.

As a check to ensure that different authors are basing their composition studies on the same portion of municipal solid waste, the per capita generation per day of waste studied in pounds has been included where possible. These pounds per capita per day figures appear directly below the study names and approximate ranges for each category are given on the right hand side.

Table 3 also distinguishes between actual studies and studies based on other studies. Eighteen of the studies are original solid waste classification studies where actual quantities of solid waste were sorted or are input analyses which calculated the amount of material that must eventually end up as solid waste. The other 13 studies made conclusions as to the composition of solid waste based on other classification studies.

Most of the 31 compositional studies are concerned with either 'residential solid waste' or, the solid wastes that are collected by the municipality (residential, light commercial

TABLE 3

ANALYSIS OF THE 31 COMPOSITION STUDIES BY TYPE AND AMOUNT PER CAPITA (IN POUNDS PER CAPITA PER DAY) OF WASTE STUDIED

Type of Waste	18 Actual Studies	13 Studies Based on Other Studies	Range of Lb/ Capita/Day
Residential	HOFFMAN 1968, HICKMAN 1967, GALLER 1969, - 2.6 - LOUISVILLE 1970, WILSON 1972, 1.97 1.7 & 1.4 PROCTOR & REDFERN 1975. 2.44	ALARIE 1967, CLARK & BROWN 1971, 2.0 2.50 GOLUEKE NATIONAL 1970. 2.04	1.5 - 2.5
Residential, Light Commercial and non-trade Industrial (i.e. Municipally collected)	MACLAREN 1967 (38), CITY OF MONTREAL 1971, 2.13 - MINISTRY OF THE ENVIRONMENT 1973, KALLER 1970, - 1.4 WATTS FROM WASTE 1973, GOLUEKE-BERKELEY 1970. - -	PAYNE 1974. -	1.5 - 2.5
Residential & Commercial	SNC 1972, MOULTON 1961, QUAD CITY 1968, - 3.04 2.74 NCRR 1974, EPA 1974. 3.00 3.32	GLASS CONTAINER COUNCIL 1972, NIESSEN 1970, 2.74 - KILBORN 1974, HICKMAN 1969, - residential - 1.5 - 5.0 commercial - 1.0 - 3.0 bulky 0.3 - 2.5 GOLUEKE SANTA CLARA 1970, NIESSEN 1972. 3.5 -	2.5 - 4.0
Commercial Only	LOUISVILLE 1970, 0.78 PROCTOR & REDFERN 1972, PROCTOR & REDFERN 1975. Retail - 0.17 Retail - 0.13 Service - 0.54 Service - 6.43 0.71 6.56	CLARK & BROWN 1971. 3.0	0.5 - 6.5
Industrial Only	QUAD CITY 1968, LOUISVILLE 1970, 3.31 3.7 PROCTOR & REDFERN 1972, PROCTOR & REDFERN 1975. 3.39 4.99		3.0 - 5.0
Refuse Undefined		KAISER 1966, WESTERHOFF 1969. 4.5 -	4.0 - 5.5
Municipal Solid Waste, as defined by this study		CLARK 1974. 5.22	

and non-trade industrial waste, although this varies). This is because most of the studies were done for municipalities and thus only dealt with the solid wastes that the municipality had to handle. However, the purpose of this study is to examine all the solid wastes generated in a municipality.

ii. The Geographic Location of the Study

People in Toronto inevitably have slightly different buying habits (and thus, ipso facto, municipal solid waste generation habits) than people in any other part of Canada. And Canadian municipal solid waste is probably different from American municipal solid waste. One notable difference would be the much higher aluminum content of American solid waste; this is primarily due to the large number of aluminum beer and pop cans which are produced in the States, but not in Canada. Any differences in life style are most certainly observable from the quantity and composition of a country's municipal solid waste!

The MAC LAREN 1967, MINISTRY OF ENVIRONMENT 1973 and WATTS FROM WASTE 1973 studies analysed the solid waste generated in Metropolitan Toronto. There is a wide variation between these three studies which makes it very difficult to estimate the importance of geographic location as a variable.

The MAC LAREN 1967, KALLER 1970, CITY OF MONTREAL 1971 , SNC 1972, PROCTOR & REDFERN 1972 and 1975, MINISTRY OF ENVIRONMENT 1973, and WATTS FROM WASTE 1973 studies are actual Canadian solid waste classification studies; they also exhibit considerable variation.

The MOULTON 1961, HOFFMAN 1968, HICKMAN 1967, QUAD CITY 1968, LOUISVILLE 1970, GOLUEKE-BERKELEY 1970, GALLER 1969, and WILSON 1972 studies are actual American studies which classified solid waste.

The CLARK & BROWN 1971 study is perhaps one of the most widely known Canadian studies on solid waste. Most of the information used to derive the composition of domestic solid waste was taken from American studies.

The GLASS CONTAINER COUNCIL 1972 and PAYNE 1974 studies are also Canadian studies based on other Canadian studies, including some of the ones which appear in this analysis. Again, there is a fairly wide variation between these two studies.

The KILBORN 1974 study is the most recently published Canadian study included in this study and is based on both Canadian and U.S. studies.

The geographic location of the study will also affect the degree of seasonality which the figures may exhibit. This effect is discussed in the NEISSEN 1970 study which is examined in the following subsection iii.

iii. The Season of the Year When the Study was Undertaken

This appears to be a very significant variable affecting the composition of municipal solid waste, especially the composition of yard wastes. The CITY OF MONTREAL 1971 study indicated that the yard waste component ranged from 0% in January to 11.44% in June. The NIESSEN 1972 study, which was based on forty-one different studies, found the variations in yard wastes produced at different times of the year to be so great that four sets of composition figures were necessary, one for each season of the year. The percentage yard waste varied from 0.4% in the winter to 27.1% in the summer. This change in the percentage of yard wastes also changes the relative percentage of the other components.

The NIESSEN 1970 study applied the relationship between the amount of yard wastes produced and the number of frost free days to determine the average yearly percent of yard wastesthat could be expected in three different climates: unseasonal (Florida), semi-seasonal (Alabama) and seasonal (Massachusetts). The average yearly percentage composition of yard wastes on an 'as generated' basis varied from 14.1% in Massachusetts to 26.1% in Florida. (39)

The season of the year could also affect the amount of moisure in the solid waste sample. The HOFFMAN 1968 study analysed twenty samples in the wet season and twenty samples in the dry season. Although a range of percentages were reported, it was not stated whether this range was a result of analysing the solid waste in two different seasons. The effects of moisture on the composition of solid waste is treated further under subsection vi of this chapter.

Spring and fall 'clean ups' could also affect the composition of solid waste by increasing the percentage composition of wood, leather, cloth, rubber and yard wastes.

Some of the actual classification studies may have attempted to analyse the waste from what they considered to be an 'average month'. However, such an assumption was not explicitly stated in any of the studies.

iv. The Year of the Study

The composition of solid waste undoubtedly changes from year to year with the constant introduction of an incredible number of new products and packages. Such variables as product lifetime, planned obsolescence (either mechanical or stylistic), material substitution, and changing consumer habits all affect the consumption of solid waste.

The 31 studies being analysed vary in age from 1961 (MOULTON) right up to 1974 (NCRR, EPA, KILBORN & PAYNE) and 1975 (PROCTOR & REDFERN). Some changes will have occured over this period of time. The KAISER 1966 study, which is based on previous studies, listed a plastic content of only 0.76%. This has clearly increased. In fact, even the HICKMAN 1967 study which was actually undertaken in 1966, found the composition of plastic to be 2%. No other major difference due to the year of the study seem apparent.

The NIESSEN 1970, NIESSEN 1972 and PAYNE 1974 studies attempted to project the future composition of solid waste up to the year 2000. All agreed that plastics will increase to about 4% of solid waste and that paper, and to a smaller extent cloth, will also increase in percentage composition. Meanwhile, yard and food wastes will decrease in relative percentage. The studies were inconclusive as to any changes in the composition of glass and metal. The other components appear to change very little.

v. The Socio-Economic Background of the Area Where the Study was Conducted

Both the GALLER 1969 and LOUISVILLE 1970 studies compared the composition of residential solid waste from areas having different socio-economic backgrounds. A general observation appears to be that wealthier families throw out a higher percentage of paper and a lower percentage of food and yard wastes. The GOLUEKE BERKELEY 1970 study also found the food and yard waste component to be higher in the lower income areas.

Some studies may have overcome this variable by collecting samples of solid waste for study from controlled socio- economic areas. The HICKMAN 1967 study, for instance, sampled residential solid waste from a medium income residential area. The NCRR 1974 and EPA 1974 studies were input analyses for the entire United States, so that their figures are national averages.

vi. The Moisture Transfer that Occured before Sampling

The most significant variable of all is the moisture transfer that occurs between the time the solid waste is generated and discarded and the time it is received at the waste management facility. The pre-moisture transfer state is variously referred to as being on an 'as discarded' basis (the NIESSEN 1970 and 1972 studies), on a 'before moisture transfer' basis (the NCRR 1974 study) and on an 'as generated' basis (the EPA 1974 study). The term 'as generated' is used in this study. The post-moisure transfer state is variously referred to as being on an 'as fired' basis for incinerators (the NIESSEN 1970 and 1972 studies), on an 'after moisture transfer' basis (the NCRR 1974 study) and on an 'as disposed' basis (the EPA 1974 study). The term 'as received' at the waste management facility will be used in this study.

The following table presents the moisture levels for 'as generated' and 'as received' solid waste.

TABLE 4

PERCENTAGE MOISTURE IN SOLID WASTE ON AN 'AS GENERATED' AND ON AN 'AS RECEIVED' BASIS

	Percent Moisture	
Category	'As Generated'	'As Received'
Paper	8.0	24.3
Food Wastes	70.0	63.6
Yard Wastes	55.3	37.9
Plastic	2.0	13.8
Rubber and Leather	2.0	13.8
Cloth	10.0	23.8
Wood	15.0	15.4
Glass	2.0	3.0
Metal	2.0	6.6
Miscellaneous	2.0	3.0

From: 1972 National Incinerator Conference - (the NIESSEN 1972 study)

Wet wastes (such as food and yard wastes) lose some of their moisture to dry wastes (such as paper, plastic, leather, rubber, textiles and even metals) when they are all mixed together in solid waste. The average moisture content of solid waste, which can change when moisture gets into the solid waste while it is waiting

for pick-up, was estimated to be 25% by the CLARK & BROWN 1971 study, 24.4% by the CLARK 1974 study, 28.3% by the NIESSEN 1970 study and 16.62% by the HOFFMAN 1968 study (which was in San Diego).

Thus, the composition by weight of solid waste will vary, depending upon whether the waste is analyzed 'as generated' or 'as received'.

The NIESSEN 1970, NIESSEN 1972, NCRR 1974 and EPA 1974 studies took account of this moisture transfer - their composition percentages are based on an 'as generated' basis. The 'as generated' figures are more useful to this study because it is primarily concerned with the weight of the materials that are currently being lost to solid waste in the form that these materials are manufactured and used.

Because most of the composition studies have sampled solid waste after it has been discarded, the percentage composition of paper, plastic, leather, rubber, textiles and metal have been exaggerated and the composition of food and yard wastes have been underestimated in all but these four studies.

The HOFFMAN 1968, CLARK 1971, and KILBORN 1974 studies resolved this moisture problem by expressing the compositions as a percent by weight on a 'dry basis'. Thus, the amount of moisture or the transfer of moisture between components would have no effect upon these figures. The 'dry basis' figures give an accurate reflection of the 'as generated' weight of the dry components of solid waste (paper, plastic, rubber, leather, cloth, wood, glass, metal and miscellaneous). Each of the dry components would be in the form in which these materials were manufactured and used. The 'dry basis' figures would be different from the 'as generated' figures for the weight of the wet components of solid waste which would also distort the other percentage composition figures. Although it can be argued that even the food and yard waste components of solid waste should be considered on a 'dry basis', the 'as generated' percentages will be used in this study since they reflect a truer representation of the relative weights of the components of solid waste as they actually enter the solid waste stream.

A good demonstration of the moisture transfer effect is the NCRR 1974 and the EPA 1974 studies which, unlike any of the other 29 studies, are based on an 'input analysis' of the weight of the various materials that are manufactured into products and eventually end up in solid waste. Figures for these analyses came directly from published industry production statistics. It is significant to note that the percentage of paper is lower than most of the other actual classification studies. The NIESSEN 1970 and NIESSEN 1972 studies also have a similarly low percentage composition of paper. This difference seems to be due to the moisture transfer that occurs between the time the waste is discarded and the time most studies actually analyze the waste.

2. Composition of Residential Solid Waste

This study is now in a better position to estimate the composition of municipal solid waste. As a first step, the following table shows the estimated yearly average composition by weight of residential solid waste in Southern Ontario on an 'as generated' basis. It should be understood that these are estimates, based upon the analysis developed in Appendix 2 at the back of the report. It is estimated that these figures are accurate to within ± 20%.

For instance, paper represents $35\% \pm \frac{20}{100} \times 35\% = 35 \pm 7\ \%$

or between 28% and 42% of all residential solid waste.

The other studies which included estimates of the accuracy of their figures was the EPA 1974 study (20%) and the NIESSEN 1970 study (25%).

TABLE 5

AVERAGE YEARLY PERCENTAGE 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 & Leather	2	
Cloth	2	
Wood	3	
Glass	8	
Metal	8	(ferrous - 7, non-ferrous - 1)
Other Misc.	2	
	100	

Notice that paper is comparatively low and that food and yard wastes are comparatively high. This is because this table is based on an 'as generated' basis.

As can be seen from the 31 composition studies in Appendix 1, there is a wide range of percentage composition for paper, food and yard wastes. Paper, for instance, varies from 28.7% in the WATTS FROM WASTE 1973 study to 67.3% in the SNC 1972 study.

These percentage composition figures could be checked by developing an 'input analysis' for Canada similar to the input analysis that was done in the States by the NCRR 1974 and EPA 1974 studies. Although the development of a complete input analysis was beyond the scope of this study, an input analysis for paper in Canada was performed. The input analysis can be found in Appendix 3 at the back of this report.

The results of this analysis are summarized below:

> About 4,200,000 tons of finished paper products entered the residential, commercial and industrial (R.C.I.) solid waste stream in 1973 in Canada.
>
> Between 12,000,000 and 20,000,000 tons of R.C.I. solid waste was generated in Canada in 1973.
>
> Thus, paper represents between 21% and 35% of Canada's residential, commercial and industrial solid waste.

These are very rough calculations, but they certainly indicate a difficulty in trying to justify a percentage paper content of R.C.I. solid waste in Canada as high as 50%.

Table 5 estimated the paper component of residential solid waste to be 35%. This figure cannot be checked directly since neither the amount of solely residential solid waste generated in Canada per year, nor the amount of waste paper that ends up in residential solid waste per year is known. Estimating these two figures would be even harder than estimating the figures in Appendix 3.

The results of Appendix 3 cannot be directly compared with Table 5; however, the composition of residential solid waste probably does not vary significantly across Canada (see subsection ii of the previous section on the geographic location of the study). And the following section indicates that certainly commercial, and perhaps even industrial, solid wastes have higher paper components than residential solid waste. So the results of Appendix 3 can be used, in a very general way at least, to confirm that the percentage paper component in residential solid waste is closer to 35% than it is to 50%.

It is useful to know the further breakdown of some of the components in Table 5 into different types of materials. The breakdown of the paper and metal components into their different subcomponents would be particularly useful because there are different potential uses and different economics related to the recovery and recycling of the various types of waste paper and scrap metal.

The amount of non-ferrous material in residential solid waste is particularly important because these materials have very high scrap values (aluminum, for instance, at $400 - $600 per ton). Table 5 estimated the non-ferrous fraction of residential solid waste to be 1%; this was based upon the analysis in Appendix 2. No further breakdown is possible at this time, although the two input analyses (NCRR 1974 and

EPA 1974) did break down this non-ferrous component. Such a breakdown would be necessary to determine whether an expensive process designed to reclaim these valuable non-ferrous metals can be justified.

Unfortunately, a detailed breakdown of the paper component of residential solid waste is not possible, based on the information currently available. Although two actual classification studies (MOULTON 1961 and KALLER 1970) and three studies based on other studies (KAISER 1966, GOLUEKE NATIONAL 1970 and CLARK & BROWN 1971) did break down the paper component, it was not felt these studies could be used to derive a detailed sub-component breakdown of paper. As explained in Appendix 1, the three studies based on other studies must be treated with caution and the two original classification studies which broke paper down into sub-components were not very detailed (the 'other' component in each was 24.8% and 33%). And the MOULTON 1961 study is now 14 years old.

The breakdown by product end-use in the two input analysis studies (NCRR 1974 and EPA 1974) are much more authorative. Although neither contains a detailed breakdown of the paper component, the NCRR 1974 study contains a sub-division of the paper component into end-use products which corresponds to types of waste paper. The EPA 1974 study also sub-divides the paper component.

NCCR 1974	
newsprint	6.6%
corrugated	8.7%
Other	17.9%
	33.2%

EPA 1974	
newspaper, books, and magazines	8.2%
container and packaging	16.3%
other	6.7%
	31.3%

It should be noted that these breakdowns are for residential and commercial solid waste, and not purely residential solid waste. They are still somewhat useful, and are the best estimates of the breakdown of paper that can be made at this time. However, this study was unable to make a general conclusion regarding the breakdown of the paper component of residential solid waste.

3. Composition of Commercial and Industrial Solid Waste

It is much more difficult to derive similar composition information for commercial and industrial solid waste. As mentioned previously, most compositional studies have been primarily concerned with the solid wastes that a municipality must handle and this often does not include commercial or industrial solid waste.

i. Composition of Commercial Solid Waste

The LOUISVILLE 1970, PROCTOR & REDFERN 1972 and PROCTOR & REDFERN 1975 studies each contain a separate analysis of commercial solid waste. All of these studies used a questionnaire sent out to some or all of the commercial enterprises in the area to gather their composition information. This is in sharp contrast to most of the residential solid waste analyses where a representative sample of the waste from a random area was sorted into the different components with the results being considered as averages. It is virtually impossible to select a 'representative sample' of commercial solid waste from a 'random area' because different commercial enterprises can be expected to produce very different compositions of commercial solid waste.

Although the three studies are not directly comparable, because the two PROCTOR & REDFERN studies broke down the commercial solid waste in retail and service, they do indicate a high paper content of commercial solid waste, ranging from a low of 51% to a high of 65%. This is not surprising as many commercial enterprises, by their very nature, are huge consumers of paper and thus generators of waste paper. Each study exhibits unique composition characteristics, because each study analyses the commercial solid waste from different areas. The LOUISVILLE 1970 study found the glass component to be 11.32% and plastic to be 9.35%; this contrasts figures of 1-4% for glass and 1-2% for plastic in the other two studies. The amount of miscellaneous waste ranged from 1.12% to 17%, which included a construction debris content of 12%.

The LOUISVILLE 1970 study broke down the commercial solid waste generated by 18 different categories of commercial enterprises. Unfortunately, these breakdowns do not appear in either the report or the special appendix to the report and according to one of the authors, this information has been lost. On the original questionnaire returns, the two PROCTOR & REDFERN studies did have information concerning the category of commercial establishments. However, this information was not stored on their computer and the questionnaires themselves have been destroyed.

Thus, it is not possible to estimate an average composition of commercial solid waste for either Metro Toronto or the Golden Horseshoe. The three studies which examined commercial solid waste specifically do indicate a high paper content of over 50%, but little else can be concluded at this time. A composition of commercial solid waste could be developed if the average composition of various categories of commercial enterprises was known and was then applied to the known commercial mix of the area.

Unfortunately, the composition of the solid waste from different categories of commercial enterprises is not available at this time.

ii. Composition of Industrial Solid Waste

The QUAD CITY 1968, LOUISVILLE 1970, NIESSEN 1972 and the two PROCTOR & REDFERN studies each included a compositional breakdown of industrial solid waste. All the studies, except for the NIESSEN 1972 study, presented aggregated compositional figures for industrial solid waste. The results from these studies are not conclusive, although some trends do emerge. Wood, for instance, is relatively high, ranging from 7.34% to 23.236%. One would expect that this is primarily from waste pellets. The miscellaneous component is also high, ranging from 14% to 51.327%. The glass component is relatively low, at between 3% and 4.409%. Some materials vary considerably; metals range from 0.637% to 18% and paper from 15.576% to 43%.

Again, the difference is probably directly accountable to the different industrial mixes in each area. The presence of any major primary metal, food or paper industry would greatly affect the composition of industrial solid waste. It should be noted that the LOUISVILLE 1970 study reported either the highest or the lowest percentage composition for the four materials which had very high variations (wood, misc., metals and paper). However, the variation is still significant between the other studies.

Both the LOUISVILLE 1970 and the NIESSEN 1972 studies reported compositional breakdowns of industrial solid waste for various categories of industrial enterprises.

Table 6 from the NIESSEN 1972 study presents the average composition by weight of industrial solid waste as well as the tons of industrial solid waste generated/employee/year for nineteen industrial categories.

Also shown on this table are the data points (number of samples) and the standard deviation which is often used to compute the 95% confidence limits. For instance, in the food processing industry, the average percentage composition of paper is 52.3%. This was based upon 30 samples. The figure of 52.3 $\pm$ 11.7% can be assumed to be 95% accurate.

These figures are not, however, similar to the composition figures developed by the LOUISVILLE 1970 study which reported compositional breakdowns of industrial solid waste by similar industrial categories. (Table 10, which reports the findings of the LOUISVILLE 1970 study, is contained in footnote 40 of this report). The fact that the LOUISVILLE 1970 study included in its compositional breakdown wastes that were salvaged does not seriously change the overall findings.

TABLE 6

COMPOSITION BY WEIGHT OF INDUSTRIAL SOLID WASTE BY INDUSTRY CATEGORY -

ERIE, NIAGARA, ESSEX, BERGEN, HUDSON, PASSAIC, UNION COUNTIES (NEW YORK & NEW JERSEY)

SIC CODE	INDUSTRY	Component (Weight %) Paper	Food	Plastics	Rubber	Leather	Cloth	Wood	Glass	Metals	Misc.	Tons/Employee/Year
20	Food Processing											
	Data Points	30	30	30	30	30	30	30	30	30	30	30
	Average	52.3	16.7	.9	-	-	0	7.7	4.9	8.2	9.2	7.949
	Standard Deviation	32.7	29.9	.4	-	-	0	10.9	2.8	3.7	21.1	88.760
	Confidence Limits*	11.7	10.7	.1				3.9	1.0	1.3	7.5	3.13
22	Textile Mill Products											
	Data Points	18	18	18	18	18	18	18	18	18	18	18
	Average	45.5	-	4.7	-	0	26.8	-	-	-	-	2.160
	Standard Deviation	40.3	-	10.7	-	0	38.1	-	-	-	-	1.900
	Confidence Limits*	18.6		4.9			17.6					0.86
23	Apparel											
	Data Points	17	17	17	17	17	17	17	17	17	17	17
	Average	55.9	1.35	-	0	0	36.5	-	0	0	-	2.192
	Standard Deviation	37.4	2.8	-	0	0	37.3	-	0	0	-	6.211
	Confidence Limits*	17.8	1.3				17.7					2.94
24	Wood Products											
	Data Points	9	9	9	9	9	9	9	9	9	9	9
	Average	16.7	0	0	0	0	0	71.6	-	-	7.8	8.531
	Standard Deviation	33.6	0	0	0	0	0	34.8	-	-	19.7	7.648
	Confidence Limits*	22.0						22.7			12.9	4.97
25	Furniture											
	Data Points	7	7	7	7	7	7	7	7	7	7	7
	Average	24.7	-	-	-	0	-	42.1	0	-	-	2.783
	Standard Deviation	12.3	-	-	-	0	-	16.2	0	-	-	3.578
	Confidence Limits*	9.1						12.0				2.64

TABLE 6 (cont'd)

SIC CODE	INDUSTRY	Component (Weight %) Paper	Food	Plastics	Rubber	Leather	Cloth	Wood	Glass	Metals	Misc.	Tons/Employee/Year
26	Paper & Allied Products											
	Data Points	20	20	20	20	20	20	20	20	20	20	20
	Average	56.3	-	-	0	0	-	11.3	-	9.4	14.0	3.987
	Standard Deviation	8.7	-	-	0	0	-	15.5	-	18.2	27.5	8.330
	Confidence Limits*	3.8						6.8		8.0	12.1	3.64
27	Printing & Publishing											
	Data Points	26	26	26	26	26	26	26	26	26	26	26
	Average	84.9	-	-	0	-	-	5.5	0	-	-	5.835
	Standard Deviation	5.8	-	-	0	-	-	12.3	0	-	-	12.575
	Confidence Limits*	2.2						4.7				4.82
28	Chemicals & Allied Products											
	Data Points	48	48	48	48	48	48	48	48	48	48	48
	Average	55.0	-	9.3	-	-	-	4.5	2.2	7.2	19.7	8.862
	Standard Deviation	34.0	-	17.0	-	-	-	6.2	4.2	13.9	32.8	10.999
	Confidence Limits*	9.6		4.8				1.7	1.2	3.9	9.3	3.09
29	Petroleum											
	Data Points	5	5	5	5	5	5	5	5	5	5	5
	Average	72.1	-	15.3	0	0	0	6.8	0	4.4	1.0	1.594
	Standard Deviation	35.7	-	30.7	0	0	0	4.4	0	5.2	1.3	2.751
	Confidence Limits*	31.4		27.0				3.9		4.6	1.1	2.41
30	Rubber, Plastics											
	Data Points	13	13	13	13	13	13	13	13	13	13	13
	Average	56.3	-	13.5	9.2	0	-	5.2	0	-	-	9.835
	Standard Deviation	31.5	-	20.7	20.3	0	-	6.2	0	-	-	9.163
	Confidence Limits*	17.2		11.3	11.0			3.4				4.97
31	Leather											
	Data Points	3	3	3	3	3	3	3	3	3	3	3
	Average	6.0	0	-	-	53.3	0	3.9	-	13.5	-	8.989
	Standard Deviation	4.2	0	-	-	47.3	0	5.4	-	19.2	-	6.986
	Confidence Limits*	4.7				53.6		6.1		21.7		7.89

TABLE 6 (cont'd)

SIC CODE	INDUSTRY	Component (Weight %) Paper	Food	Plastics	Rubber	Leather	Cloth	Wood	Glass	Metals	Misc.	Tons/Employee/Year
32	Stone, Clay											
	Data Points	16	16	16	16	16	16	16	16	16	16	16
	Average	33.8	0	-	-	0	-	4.3	12.8	8.1	40.0	6.412
	Standard Deviation	37.5	0	-	-	0	-	8.4	29.6	24.8	44.8	15.300
	Confidence Limits*	18.4						4.1	14.5	12.2	22.0	7.48
33	Primary Metals											
	Data Points	12	12	12	12	12	12	12	12	12	12	12
	Average	41.0	-	5.4	-	0	0	11.6	2.0	5.5	29.0	3.184
	Standard Deviation	27.4	-	9.8	-	0	0	12.4	4.3	7.8	40.0	15.796
	Confidence Limits*	15.5		5.5				7.0	2.4	4.4	22.7	8.93
34	Fabricated Metals											
	Data Points	36	36	36	36	36	36	36	36	36	36	36
	Average	44.6	-	-	-	0	-	10.3	-	23.2	12.2	6.832
	Standard Deviation	37.7	-	-	-	0	-	20.8	-	34.5	31.0	9.088
	Confidence Limits*	12.3						6.8		11.3	10.1	2.95
35	Non-Electrical Machinery											
	Data Points	48	48	48	48	48	48	48	48	48	48	48
	Average	43.1	-	2.5	-	-	0	11.4	-	23.7	-	3.189
	Standard Deviation	34.3	-	6.8	-	-	0	19.5	-	30.8	-	1.438
	Confidence Limits*	9.7		1.9				5.5		8.7		0.39
36	Electrical Machinery											
	Data Points	19	19	19	19	19	19	19	19	19	19	19
	Average	73.3	1.2	3.5	-	0	0	8.3	-	2.3	-	2.941
	Standard Deviation	24.4	2.4	7.0	-	0	0	10.1	-	3.5	-	7.009
	Confidence Limits*	11.0	1.1	3.1				4.5		1.6		3.2

TABLE 6 (cont'd)

	Component (Weight %)										
	Paper	Food	Plastics	Rubber	Leather	Cloth	Wood	Glass	Metals	Misc.	Tons/Employee/Year
37 Transportation Equipment											
Data Points	8	8	8	8	8	8	8	8	8	8	8
Average	50.9	-	2.1	1.4	0	0	9.4	-	-	19.5	2.562
Standard Deviation	34.2	-	2.9	1.5	0	0	6.3	-	-	33.3	4.097
Confidence Limits*	23.8		2.0	1.0			4.4			23.1	2.84
38 Professional & Scientific Instruments											
Data Points	8	8	8	8	8	8	8	8	8	8	8
Average	44.8	-	6.0	0	0	0	2.3	-	8.4	-	1.769
Standard Deviation	34.0	-	6.4	0	0	0	3.6	-	17.2	-	2.061
Confidence Limits*	23.6		4.4				2.5		11.9		1.43
39 Miscellaneous Manufacturing											
Data Points	20	20	20	20	20	20	20	20	20	20	20
Average	54.6	-	11.9	-	-	-	13.0	-	5.0	8.1	1.603
Standard Deviation	38.7	-	22.2	-	-	-	23.7	-	10.3	14.0	1.901
Confidence Limits*	17.0		9.7		-		10.4		4.5	6.1	0.82

* 95% Confidence Limits

Source: Arthur D. Little, Inc., from the NIESSEN 1972 study

This is verified by examination of the figures for the LOUISVILLE 1970 study in Appendix 1 which recalculated the percentage composition excluding the amount salvaged.

The difference between these two studies could be due to a number of factors; one study may simply be more reliable than the other, there may be differences in what each considers industrial solid waste; a major component of the LOUISVILLE 1970 study ("minerals") did not even appear in the NIESSEN 1972 study; and there could be major differences in solid wastes even within the same industrial category. This study was unable to resolve the major differences between these two studies.

Thus, although some trends did emerge from the five studies which examined industrial solid waste, no conclusions can be made from the available information. The two studies which broke down industrial solid waste by industrial category were also inconclusive, thus making impossible at this time the development of the composition of industrial solid waste for Metro Toronto or the Golden Horseshoe.

iii. Concluding Remarks on the Composition of Commercial and Industrial Solid Wastes

If the size and mix of commercial establishments in Metro Toronto was known, the composition by type of commercial establishment could have been used to estimate the composition of commercial solid waste in Metro Toronto. Similarly, an estimation could have been made of the composition of industrial solid waste in Metro Toronto using the composition by category of industrial enterprise and the mix of industrial establishments in Metro. However, such estimations are not possible at this time.

This section has at least indicated what appears to be the best way to generate composition figures for commercial and industrial solid waste. Representative sampling of randomly collected amounts of mixed commercial or industrial solid waste (not broken down by category of enterprise) is virtually useless. Updated Canadian data concerning the composition by category of commercial and industrial enterprise is clearly required before meaningful estimates of the composition of commercial and industrial solid waste in Metro Toronto, the Golden Horseshoe or any other area can be made.

VI. OVERALL ANALYSIS OF METROPOLITAN TORONTO'S MUNICIPAL SOLID WASTE

It is impossible for this study to make a complete estimation of the overall composition of municipal solid waste in Metro Toronto or the Golden Horseshoe. The information currently available for Metro Toronto is illustrated in Table 7. The figures in this table have been rounded off to the nearest thousand tons. The information came from Tables 1 and 5 of this study. No attempt was made to estimate the overall composition in the Golden Horseshoe because even less detail is known about the quantities of waste generated in that area (see Table 2).

As was stated in the previous chapter, no estimation was possible for the composition of commercial or industrial solid waste, which accounts for 23% of Metro's output. Thus, the amount of paper shown in Table 7 (317,000) does not represent the total amount of paper because large, but unknown, amounts of waste paper that are present in the 567,000 tons of commercial and industrial solid waste are not included. However, from the high estimate for the percentage composition of paper in residential, industrial, commercial solid waste (35%) derived in Appendix 3, the total amount of paper in Metro's 1,473,000 tons of residential, commercial and industrial solid waste would be approximately 500,000 tons. The composition of 'bulky items' is also unknown, although probably consists mainly of wood (furniture) and metals (large appliances).

For the purposes of this table, it has been assumed that the composition of residential, light commercial and non-trade industrial solid wastes is similar to the composition of residential solid waste as per Table 5. This is a fair assumption because, as was mentioned at the beginning of Section V, the solid wastes from light commercial enterprises (small stores) and the non-trade wastes from industry are primarily 'housekeeping' by nature and will thus resemble the residential breakdown.

Although Table 7 is not complete, it presents the extent of the information currently available concerning the quantity and composition of municipal solid waste in Metropolitan Toronto. Of note are the large amounts of ash (519,000 tons) and the almost equally large amounts of material that is readibly compostable and potentially useful as a soil conditioner (food wastes, yard wastes, and sewage sludge).

Just as an input analysis was performed to check the national percentage composition figures for paper in Appendix 3, a similar analysis could be used to estimate the materials that must eventually become municipal solid waste in Metro Toronto. Such an analysis is difficult for most products and packages because there are so many imports and exports into this region. However, some wastes, such as newspapers, can and have been examined by separate input analyses.

Two Toronto studies (41) indicated that between 150,000 and 200,000 tons of newsprint are purchased every year by newspapers in Metro Toronto and

environs. Appendix 3 indicates that about 20% of the waste paper entering the residential, commercial and industrial solid waste stream in Canada is newsprint. Using this national average figure, the amount of newsprint in Metropolitan Toronto's municipal solid waste would be 103,000 tons in 1973.

TABLE 7

COMPOSITION BY WEIGHT OF MUNICIPAL SOLID WASTE GENERATED IN METROPOLITAN TORONTO ON AN 'AS GENERATED' BASIS - 1973 (IN TONS)

Type of Municipal Solid Waste	Components	Weight of Components		Percent of Total
Residential	Paper	317,000		
	Food Wastes	199,000		
	Yard Wastes	136,000		
	Plastic	27,000		
	Leather & Rubber	18,000		
	Cloth	18,000		
	Wood	27,000		
	Glass	73,000		
	Metal	73,000		
	Ferrous	64,000		
	Non-ferrous	9,000		
	Misc.	18,000		
			906,000	38%
Commercial and Industrial	Not Available		567,000	23%
Other	Ash	519,000	(22%)	
	Dirt	150,000	(6%)	
	Sewage Sludge	99,000	(4%)	
	Bulky Wastes	50,000	(2%)	
	Construction & Demo (non inert)	48,000	(2%)	
	Yard Wastes from Park	38,000	(2%)	
	Trees	20,000	(1%)	
	Hazardous	500	-	
			924,500	39%
			2,397,500	100%

FOOTNOTES

1. Thurlow & Associates, "A Preliminary Overview of the Solid Waste Problem in Canada", 1973.

2. The MACLAREN 1967 study estimated the amount of liquid industrial waste to be 19,297,000 gallons in 1967. Tricil Waste Management Ltd., operators of a liquid waste incinerator in Clarkson (just outside Metro Toronto), confirmed this figure.

3. A note of caution is necessary. There is a great deal of confusion surrounding such terms as 'garbage', 'rubbish', 'refuse', 'solid waste' and particularly 'municipal solid waste'. Some consider municipal solid waste to be the solid waste that must be handled by a municipality and paid for out of the public purse. Such a definition would exclude all the solid waste that is handled privately (commercial, industrial, as well as other solid wastes). The American Public Works Association has developed a set of definitions which are used by many authors; they refer to dry household waste (cans, bottles, papers) as 'rubbish'; to wet wastes (potato peels, coffee grounds) as 'garbage'; and to a mixture of the two plus the other solid wastes generated in a municipality as 'refuse'.

   The American Public Works Association's definitions correspond to the common definitions used by the American public. Americans, for instance, use the term 'garbage' to refer to wet waste. However, to most Canadians, garbage refers to all solid wastes, not just potato peels and coffee grounds. We have rejected the American Public Works Association's terminology as more confusing than helpful for a Canadian study. 'Refuse', 'rubbish' and 'garbage', do not, therefore appear in this report.

4. Residential - This is the solid waste that is generated in homes and some apartments, collected by city or borough trucks, and taken to a municipal disposal facility. The City of Toronto and the Boroughs of Scarborough and North York are responsible for collecting solid wastes from all high rise apartments in their areas. East York, Etobicoke and York are not responsible for collecting apartment solid wastes (see footnote 14). No separate figures were available for purely residential waste.

5. Light Commercial - The solid wastes included in this category generally come from small stores that generate less than 8 bags of solid waste/collection day. These wastes are picked up publicly along with residential solid wastes (footnote 4) and non-trade industrial solid waste (footnote 6). No separate figures are available.

FOOTNOTES cont'd)

6. Non-Trade Industrial - This would include the 'housekeeping' wastes from industry that amount to less than 8 bags of solid waste per collection day. No separate figures are available.

7. Metro Parks Wastes - This includes all the solid wastes (mainly vegetation) collected from the eleven Metro Parks. This figure was obtained by subtracting the known amount of incinerator ash and sewage sludge from the known total amount of solid waste collected by Metro, which was 171,857 tons in 1973: (171,857 - 42,328 - 99,378) tons = 30,151 tons.

8. Incinerator Ash - This figure is from the Metro Works Department and represents the amount of incinerator ash taken to Metro's regular landfill sites. Only the ash from the Commissioners Street incinerator was taken to a regular landfill site (Beare Road) in 1973; ash from the other six Metro incinerators was landfilled at the Dufferin and Ingram Drive incinerators (see footnote 25).

9. Sewage Sludge - This figure is also from the Metro Works Department and represents the amount of sewage sludge that was taken to Metro landfill sites. This sludge (85% water) came from the Humber and Highland Creek Treatment Plants. It is anticipated that more and more of the sludge from these two plants may be incinerated in the future. The sewage sludge from the Main Treatment Plant, near Ashbridge's Bay, is currently being incinerated and is not included in this total (see footnote 24).

10. Street Sweepings - This estimate comes from the MACLAREN 1967 study. No accurate figures were available from the city or boroughs. The city and the boroughs each have special street sweeping equipment.

11. Bulky Items - Although each of the boroughs and the city have some sort of special bulky item pick-up, no figures are available. The figure used in the table is an estimate based on the "Report on Solid Waste Management for the National Capital Area" by James F. MacLaren Ltd. (1973). They estimated that 15,790 tons of bulky items were collected in 1972 from the 636,377 people in the National Capital Area (the Regional Municipality of Ottawa-Carleton plus the Outaouais Regional Community). Therefore, the figure for Metro Toronto would be approximately:

$$15{,}970 \times \frac{2{,}086{,}020}{636{,}377} = 52{,}348.9 \text{ tons or approx. } 50{,}000 \text{ tons.}$$

12. Leaves - Although some of the boroughs and the city do have a special leaves collection in the fall, no figures are available. However, the Metro Works Department mixes about 7,500 tons of leaves a year with sewage sludge at the Bear Road landfill site

to produce a compost material that is then used by the Metro Works Department as a final cover material for their landfill operations. This material is also available to the public free at all the Metro Waste Disposal facilities. Most of these leaves come from the City of Toronto's separate fall leaves collection.

13. Residential, Light Commercial, Non-Trade Industrial - In certain parts of Metro Toronto the residential, light commercial, and non-trade industrial solid wastes are picked up by private disposal companies under contract to the City or boroughs. Thus, the collection is still paid for publicly, but is actually done by private trucks. These three types of municipal solid waste were picked up by a private disposal company under contract to the City of Toronto in Forest Hill. This was discontinued early in 1974. These solid wastes were also picked up privately under contract to the borough in parts of Etobicoke. The residential solid waste from some large apartment buildings in North York were also collected privately under contract to the borough.

14. Apartment Buildings - The boroughs of East York, Etobicoke and York are not responsible for picking up the solid wastes from high rise apartments with the result that private arrangements with private disposal firms must be made.

15. Commercial (large) - No figures are available for these solid wastes which are generated by shopping centres, large institutions, etc.

16. Industrial (trade wastes) - No figures are available for this category.

17. Construction and Demolition Rubble (non-inert) - This figure is from the MACLAREN 1967 study which estimated the total non-inert construction and demolition wastes picked up privately to be about 48,000 tons per year. This figure was arbitrarily divided in half between disposal at a public facility and disposal at a private facility. These figures are probably low since they are based on 1967 levels of construction and demolition.

18. Trees - This figure is based on figures from the MACLAREN 1967 study which estimated that the total weight of trees cut each year to be about 38,000 tons. This figure was based on the estimate that approximately 6,000 trees are cut each year by the municipalities and 6,600 are cut by private firms. Each tree was assumed to weigh 3 tons. Thus, approximately 20,000 tons of trees per year would have to be collected privately each year (the other 18,000 tons would be collected by the municipality). The 20,000 ton figure was also arbitrarily divided between disposal at a public facility and disposal at a private facility. These figures are also probably higher now than they were seven years ago.

FOOTNOTES (cont'd)

19. Apartment Buildings - (see footnote 14)
Commercial (large) - (see footnote 15)
Industrial (non-trade) - (see footnote 16)
Construction and Demolition Rubble (non-inert) - (see footnote 17)
Trees - (see footnote 18)

The only difference between these five components of municipal solid waste and the previous five components (footnotes 14-18) is that they are disposed of at private, not public, facilities. Thus, the comments concerning these components are the same as those for the previous five components.

20. Ash from Power Generating Stations - The figures are from Ontario Hydro. 22,812 tons of ash (including 282 tons of fly ash) was generated by the R.L. Hearne Power Generating Station in 1973. This station uses natural gas on an interruptible basis for most of the year and coal for the rest (generally in the winter). This ash is mixed in and dyked with the other fill material used by the Toronto Harbour Commission (see footnote 22). 193,296 tons of ash (including 1823 tons of fly ash) was generated by the Lakeview Power Generating Station in 1973, which burns coal exclusively, and is landfilled under contract. Experiments have been performed using this material to make aggregate sections and a cement-like material called pozzolan.

21. Hazardous Wastes - The figure for pathological waste is based on a number of conversations. A report entitled "Pathological Waste Survey" has been written for the Joint Pathological Waste Committee (chaired by the Province) which examines the nature and extent of the problem and made recommendations for proper disposal. This report has not been made public as of December 1974.

All users of radioactive material are licenced by the Atomic Energy Commission of Canada, and the disposal of any waste material is strictly controlled by them. Such material does not enter the normal municipal solid waste stream.

No estimate was made for the other hazardous solid wastes that might be found in municipal solid waste.

The United States Environmental Protection Agency's "Report to Congress - Disposal of Hazardous Wastes" estimated that the total quantity of nonradioactive hazardous waste generated by U.S. industrial sources in 1970 to be 10 million tons. However, this figure includes sludges, liquids, solids and gases.

22. Construction and Demolition Rubble (inert) - This figure is from the MACLAREN 1967 study. This material is currently being used by the Toronto Harbour Commission to build new headlands and

recreational areas along the Toronto waterfront. W.D. Wilkens, author of a Ministry of the Environment Report "Sediment Quality on the Toronto Waterfront", estimated that an additional 2,000,000 tons a year of earth from subway construction and large buildings construction are also being used by the Harbour Commission. 150,000 tons/year of material dredged from the harbour is used in headland construction as well. The policy of using all these materials for land reclamation was to be reviewed by the Harbour Commission following the results of the provincial study.

23. Apartments - This figure represents an estimate of the amount of material that Metro did not have to handle because some apartments have on-site incinerators which considerably reduce the amount of material that is collected. This estimate is from the MACLAREN 1967 study. No recent figures were available from either Metro Works Department or the Provincial Ministry of the Environment.

24. Sewage Sludge Ash - This figure is from the Metro Works Department, Water Pollution Control Division, and represents the ash that is produced by the sludge incinerator at the Main Treatment Plant. 310,150 tons of sewage sludge (85% moisture) were handled by this plant in 1973, 50% of which remained as ash after incineration. This ash was landfilled on-site and there is space to continue doing this for the next ten years.

25. Incinerator Ash - This figure is derived from figures from the Metro Works Department. A total of 147,507 tons of ash were produced by Metro's seven incinerators in 1973; 42,328 tons of this ash (from Commissioners Street) was handled at regular disposal sites (see footnote 8) and the remaining 105,179 tons was landfilled on smaller sites adjacent to the Dufferin Street and Ingram Drive incinerators.

26. Derelict Automobiles - No figures are available concerning the number or total weight of all the non-operational automobiles currently parked or dumped in Metropolitan Toronto. The Ontario Ministry of the Environment estimates that there are about 750,000 derelict automobiles in Ontario. However, an official of the largest dealer in scrap automobiles in Toronto, Industrial Metals, indicated that the derelict automobile problem does not really exist in and around Metro Toronto because of the high scrap price of a car (about $25/ton in January 1975, down from $50/car in November 1974). Although derelict automobiles may not be a large problem in Metro Toronto at the present time, they may be a significant problem at another time or in another place.

One final comment - officials at the Ontario Ministry of the Environment made a distinction between derelict automobiles and abandoned automobiles. The former are by far the larger group, consisting of non-operative automobiles left or dumped on streets,

parking lots, back yards, fields, etc. The latter are still operative automobiles which usually have been stolen and could be re-sold as fully operational autos. They are a police problem. This distinction between derelict and abandoned automobiles has been followed in this study. Thus, abandoned automobiles are not considered part of municipal solid waste whereas derelict autos are considered to be part of it.

27. Each figure is derived from figures from the Metro Works Department. Metro disposal sites handled 15,985 tons of municipal solid waste which was generated in other jurisdictions (Ajax and Pickering) and 435,416 tons of privately collected solid waste. Since the total amount of municipal solid waste handled at Metro disposal facilities in 1973 is known (1,565,154 tons), the total amount of municipally collected solid waste in Metro Toronto in 1973 was: (1,565,154 - 435,416 - 15,985) tons = 1,113,753 tons. In 1974, 1,678,239 tons of municipally and privately collected solid waste was handled by Metro's disposal sites.

28. No precise figures were available on the amount of municipal solid waste that is disposed of privately. This figure is based on conversations with Ministry of the Environment officials and the company that owns the three private landfill sites in the Toronto area where privately collected Metro waste is currently taken.

29. There are, at present, no operating waste management plants (i.e. reclamation plants) in Metro Toronto. All the municipal solid wastes, apart from some newspapers which are collected separately and other materials recovered through recycling depots and at some incinerators and transfer stations, are currently 'disposed of' at landfill sites or incinerators.

30. The distinction between municipal and private disposal will become more and more important as society demands more than just the 'cheapest' form of solid waste management. Municipalities are being forced into alternatives to landfilling of municipal solid waste which will be more beneficial to society as a whole (in terms of conserving finite supplies of energy, resources and arable land and preventing pollution). However, these alternatives might, in the short term, cost more money than landfilling. Private disposal companies will not willingly opt for a more expensive means of waste management. And yet, the materials available in the solid wastes handled by private disposal firms may be required to justify implementation of large-scale reclamation and recycling schemes.

FOOTNOTES (cont'd)

31. Total amount of residential, light commercial and non-trade industrial solid wastes

= Total of items 1,2,3,10,11,12,26 from Table 1.
= (total 1 to 12) - (total 4 to 6) - 7 - 8 - 9 + 26 (by item)
= (1,113,753 - 171,857 - 50,000 - 50,000 - 7,500 + 72,000) tons
= 906,396 tons

32. Total amount of commercial, industrial and some residential solid waste from apartments

= Total of items 13,14,15,18,19,20 from Table 1
= (total 13 to 17) - 16 - 17 + (total 18 to 22) - 21 - 22 (by item)
= (435,416 - 24,000 - 10,000 + 200,000 - 24,000 - 10,000) tons
= 567,416 tons

33. Total amount of other municipal solid wastes

= Total of items 4,5,6,7,8,9,16,17,21,22,23,24,25,27,28,29
= (total 4 to 6) + 7 + 8 + 9 + 16 + 17 + 21 + 22 + (total 23 to 29) - 26 (by item)
= 171,857 + 50,000 + 50,000 + 7,500 + 24,000 + 10,000 + 24,000 + 10,000 + 648,892 - 72,000
= 924,249

34. The population figures are from the Ontario Ministry of Treasury, Economics and Inter-Governmental Affairs (TEIGA). The following table breaks down the population in each regional municipality by urban/rural distribution - 1971. The urban/rural distinction is useful because a rural population will have very little commercial or industrial solid waste, although they will generate large amounts of agricultural solid waste.

TABLE 8

POPULATION OF THE SEVEN REGIONAL MUNICIPALITIES IN THE GOLDEN HORSESHOE BY URBAN-RURAL DISTRIBUTION - 1971

	1971 Population	Rural	% Rural	Urban	% Urban
Niagara	347,330	12,450	3.6	334,875	96.4
Hamilton/Wentworth	401,885	41,600	10.4	360,285	89.6
Halton	190,470	11,745	6.2	178,720	93.8
Peel	259,400	20,755	8.0	238,650	92.0
Metro Toronto	2,086,020	-	-	2,086,015	100.0
York	166,060	31,290	18.8	134,765	81.2
Durham	221,505	49,475	22.3	172,030	77.7
Total	3,672,670	167,315	4.6	3,505,340	95.4

Table 9 presents the population projections, as estimated by TEIGA on March 7, 1974, for the Golden Horseshoe and for Ontario. The population growth shown by this table represents one of two factors which has lead to a growing generation of municipal solid waste in the past. The other factor is increased municipal solid waste generation per capita. While it is possible that these population projections may be changed, there certainly appears to be little cause for further increases in the per capita generation of municipal solid waste. In fact, it is the belief of many individuals and groups (such as Pollution Probe) that the per capita generation of municipal solid waste can and definitely should be reduced at source.

35. Figures for Niagara seem unusually high for no apparent reason. They do not include solid wastes from mining, agricultural or other primary industries. These wastes totalled only 1,742 tons in 1973.

36. Includes 535,105 tons of construction and earthfill wastes which is much higher than the per capita generation in other areas.

37. No estimate has been made of the amount of light commercial and non-trade industrial solid waste. This would tend to make the 906,396 ton figure high for purely residential solid waste and the 567,416 ton figure low for purely commercial and industrial solid waste. However, this is counterbalanced somewhat because the 567,416 ton figure also contains some residential solid waste from apartments.

38. The composition figures in the MACLAREN 1967 study are based on residential waste only, but the per capita generation is based on residential, light commercial and non-trade industrial solid waste (i.e. municipally collected).

39. The NIESSEN 1970 study computed an equation for estimating the percentage yard wastes:

$$\%\ \text{yard wastes ('as received')} = 20.4\% \times \frac{\text{number of frost-free days/year in area}}{365}$$

This equation gives the percentage yard wastes 'as received' at the waste management facility. This figure would be less than the percentage yard waste 'as generated' in the home since yard wastes lose moisture between the time they are discarded and the time they are received at the waste management facility. The composition figures in both the NIESSEN 1970 and NIESSEN 1972 studies are given in 'as generated' terms. The phenomenon of moisture transfer is treated further under sub-section vi on moisture transfer.

TABLE 9

POPULATION PROJECTIONS BY REGIONAL MUNICIPALITY IN THE GOLDEN HORSESHOE

Assumptions: Medium Fertility; 50,000 net external migration per annum; internal migration at 0.27 per cent of Ontario population

	1971	1976	1981	1986	1991	1996	2001
Niagara	347,328	367,681	391,524	417,303	441,380	461,588	479,176
Hamilton/Wentworth	401,883	418,864	437,451	455,543	470,430	481,254	489,552
Halton	190,469	222,079	257,191	295,551	334,267	371,102	406,500
Peel	259,402	328,043	403,275	484,214	567,951	651,376	734,241
York & Metro Toronto*	2,252,077	2,454,665	2,657,420	2,854,517	3,038,448	3,206,692	3,364,473
Durham	221,500	244,600	270,600	299,300	328,100	354,500	378,700
Total - Golden Horseshoe	3,672,659	4,035,932	4,417,461	4,806,428	5,180,576	5,526,512	5,852,642
Total - Ontario	7,703,106	8,333,161	9,027,306	9,752,536	10,444,754	11,067,787	11,646,140

* Separate projections were not available for the Regional Municipality of York and Metropolitan Toronto.

FOOTNOTES (cont'd)

40. Table 10 shows the compositional breakdown of industrial solid waste for various categories of industrial enterprises from the LOUISVILLE 1970 study. These figures have been re-calculated to exclude chemical (liquid) wastes. The % response of industry was based upon the proportion of production employees from the firms that reported to the total number of production employees for each industry category.

41. The Pollution Probe "Recycling Project; Summer 1971 Final Report" estimated that 145,000 tons of newsprint were purchased by the three Toronto dailies (Globe & Mail, Star, Telegram) in 1970. Dr. R.G.W. Laughlin of the Ontario Research Foundation (private communication - January 15, 1975) estimated that a total of about 200,000 tons of newsprint was purchased in Metro Toronto and environs (e.g. Mississauga) by newspapers in 1973. Neither of these figures took into account the recycling of overuns, rejects, etc. which was estimated to be between 5-10% by Dr. Laughlin. Although a certain amount of Toronto newspapers are read and discarded outside Metro, non-Toronto papers are also undoubtedly discarded in Metro Toronto.

TABLE 10

COMPOSITION BY WEIGHT OF INDUSTRIAL SOLID WASTE BY INDUSTRIAL CATEGORY
JEFFERSON COUNTY, KENTUCKY

SIC Code	Industry	Component (Weight %) Paper	Food	Rubber	Cloth	Wood	Glass	Metals	Minerals	Other	% Salvaged*	% response of industry	Ton/ Production Employee/ Year
19	Ordnance Related Industries	0.1	0	1.9	0	27.8	0.2	51.3	18.7	0	49.8	100	2.80
20	Food Related Industries	27.7	33.7	0	0	0.3	0.9	1.5	32.5	3.4	12.6	50.5	4.90
21	Tobacco Related Industries	40.2	0.6	0.1	8.7	9.0	1.1	3.2	37.1	0	10.8	52.3	1.43
22	Textiles and Mill Product Related Industries	77.4	0	0	9.7	12.9	0	0	0	0	0	79.6	0.15
23	Apparel Related Industries	30.2	0	0.6	57.5	0.1	0	4.3	0	7.3	60.7	22.9	1.85
24	Lumber Related Industries	0.6	0	0	0	95.6	0.1	0.1	1.7	1.9	8.2	65.3	18.86
25	Furniture and Fixture Related Industries	16.1	0.1	0.5	8.7	40.7	0.9	6.6	3.8	22.6	10.3	47.3	1.53

* Composition figures include the amount of material that each industry had salvaged.

TABLE 10

COMPOSITION BY WEIGHT OF INDUSTRIAL SOLID WASTE BY INDUSTRIAL CATEGORY

JEFFERSON COUNTY, KENTUCKY

SIC Code	Industry	Component (Weight %)									% Salvaged*	% response of industry	Ton/ Production Employee/ Year
		Paper	Food	Rubber	Cloth	Wood	Glass	Metals	Minerals	Other			
26	Paper Related Industries	90.3	0	2.2	0	7.0	0	0	0.1	.4	85.2	86.1	4.08
27.	Printing & Publishing Related Industries	80.3	1.4	2.4	0.2	6.0	0.7	5.7	3.4	0	51.8	75.2	1.22
28	Chemical Related Industries	8.4	0.3	2.8	0	0.8	0.1	2.0	76.2	9.4	12.8	46.8	17.67
29	Petroleum and Coal Related Industries	28.4	0	0	0	0	0	0	43.7	27.9	0	20.0	63.56
30	Rubber & Plastic Related Industries	61.7	2.3	32.6	0	0	0	3.5	0	0	1.2	86.5	1.21
32	Stone, Clay and Glass Related Industries	0.5	0	0	0	0.5	16.5	0.5	82.0	0	0.5	56.5	31.11
33	Primary Metals Related Industries	8.3	0.04	0	0.04	4.1	0	0.3	87.2	0	0	56.0	5.99

* Composition figures include the amount of material that each industry had salvaged.

TABLE 10

COMPOSITION BY WEIGHT OF INDUSTRIAL SOLID WASTE BY INDUSTRIAL CATEGORY

JEFFERSON COUNTY, KENTUCKY

SIC Code	Industry	Component (Weight %)									% Salvaged*	% response of industry	Ton/ Production Employee/ Year
		Paper	Food	Rubber	Cloth	Wood	Glass	Metals	Minerals	Other			
34	Fabricated Metals Related Industries	12.7	0.3	0	0	7.2	0.4	72.7	0.4	6.2	72.6	62.2	3.97
35	Machinery except Electrical Related Industries	8.6	0	0.2	0.1	2.1	0	30.8	57.0	1.1	27.2	15.8	4.92
35	Machine Shop Related Industries	33.0	0	0.9	0	5.3	0.1	58.0	2.7	0	13.4	17.4	0.67
36	Electrical Machinery Related Industries	63.9	0.3	9.0	0	10.7	0.1	4.0	11.9	0.1	C	97.6	2.15
37	Transportation Related Industries	5.6	0	0	0	84.9	0	0.9	8.6	0	0.9	13.8	1.17
38	Instrument Related Industries	62.5	15.1	2.1	0	11.2	0	4.8	0	4.2	1.5	29.0	0.19
39	Misc. Manufacturers Related Industries	0.2	0	0.8	0.1	98.4	0.2	0.2	0.1	0	0.2	67.8	20.13

* Composition figures include the amount of material that each industry has salvaged.