Environment Canada Environnement Canada

Information Technology (IT) and Telecommunication (Telecom) Waste in Canada

ENVIROSRIS

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Prepared for:
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Executive Summary

The *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada* report was commissioned by Environment Canada to develop baseline estimates of the amount of IT and telecom equipment waste that is currently being generated in Canada. The study is also designed to provide a broad overview of how such products are handled and to estimate the amounts of these products and materials that will enter the waste stream in the next few years. These tasks were accomplished through the development of a Waste Flow Tool that was modified slightly for each of the main streams of IT and telecom waste that are addressed in this report.

Information Technology and telecommunication equipment waste is receiving increased attention for the following reasons:

- Rapid advances in technology result in IT and telecom equipment becoming obsolete at an increasingly rapid pace. This is resulting in an increase in the rate and quantity of IT and telecom equipment entering the waste stream;
- A piece of IT or telecom equipment was, or is typically of high value, both in terms of its component parts and the equipment itself;
- IT and telecom equipment commonly contains toxic materials, which are hazardous if not managed properly.

The specific waste streams addressed in the study include:

- personal computers,
- monitors,
- laptop computers,
- peripherals (e.g., printers, scanners),
- telephones,
- mobile telephones and
- facsimile machines

The study did not include mainframe computers and other large equipment, such as telecom switching stations.

The report includes a summary of the infrastructure that currently exists in Canada for handling IT and telecom equipment waste. Finally, the report also highlights experience in other jurisdictions, particularly in the U.S. and Europe, to assess how this material is addressed in other countries. Recommendations on additional areas of research are included in the last section of the report.

Separate waste flow tools were developed for four different types of IT waste (personal computers, monitors, laptop computers and peripherals) and three types of telecom waste (telephones, mobile telephones and facsimile machines). The waste flow tool for each type of equipment incorporates annual sales of the component in the Canadian market, assumptions on what percentage of the equipment is stored, reused, recycled or disposed at the end of its first useful life in Canada, and the weight of the component, in order to estimate the flow of that equipment type over a 13-year period (1992 to 2005).

Information Technology Wastes

Based on the Waste Flow Tool, it is estimated that in 1999, approximately 33,972 tonnes of IT equipment waste (including PCs monitors, laptops and peripherals, but excluding mainframes and other large equipment) was disposed, 15,592 tonnes was recycled, 24,507 tonnes was sent for reuse and 6,128 was put into storage. Some pieces of IT equipment which had been stored or reused in previous years entered the waste stream in 1999. Of the IT waste disposed, PCs and servers accounted for an estimated 10,833 tonnes, monitors accounted for an estimated 10,688 tonnes, peripherals (scanners, printers, etc) accounted for about 11,474 tonnes and laptops accounted for about 977 tonnes.

The Waste Flow Tools predict that approximately 67,324 tonnes of IT equipment waste (including PCs monitors, laptops and peripherals, but excluding mainframes and other large equipment) will be disposed in 2005, 47,791 tonnes will be reused, 11,948 tonnes will be stored and 43,428 tonnes will be recycled. Of the total IT waste that will be disposed, PCs and servers will account for an estimated 23,349 tonnes, monitors will account for an estimated 24,472 tonnes, peripherals (scanners, printers, etc) will account for about 17,396 tonnes and laptops will account for about 2,107 tonnes.

Many of the materials contained in IT equipment can be potentially hazardous if improperly managed. For example, printed circuit boards contain heavy metals such as antimony, silver, chromium, zinc, lead, tin and copper. The lead oxide used in the cathode ray tubes (CRT) of computer monitors is of particular concern because it is in a soluble form. It is estimated that 1,356 tonnes of lead was contained in the PCs and monitors disposed in 1999 in Canada. This equipment also contained approximately 2.0 tonnes of cadmium and 0.5 tonnes of mercury. Based on the prediction that 47,821 tonnes of PCs and monitors will be disposed in 2005 and assuming that the average composition of this equipment will not change significantly by that year, the weight of lead, cadmium and mercury that will be disposed with this stream in 2005 will increase to 3,012 tonnes, 4.5 tonnes and 1.1 tonnes respectively.

Information Technology Waste Reuse and Recycling

There are a number of organizations, both for-profit companies and non-profit agencies, across Canada that are involved in IT equipment reuse. These organizations typically receive used IT equipment (large amounts from private companies in many cases), which they test to see if it can be easily reused. Repairs and minor modifications are often made to enhance the reuse potential of the equipment (e.g., adding memory to the hard drive, etc.). Where pieces of equipment can not easily be reused, they are dismantled to recover valuable parts, which can be used in the operation or sold to other operations. Non-reusable pieces are sent for recycling. 'Reuse' companies pay for some components delivered, handle some for free, and sometimes charge a fee for handling the equipment, depending on its age. The age of equipment received by these organizations can range from less than one-year to 15-20 years old.

The IT equipment recycling infrastructure in Canada is far from uniform and has limited coverage. It is an immature business, with a relatively small number of companies across the country, but the numbers are growing. It is expected that the demand for this type of service will continue to grow as increasing quantities of IT waste enter the waste stream in future years. The infrastructure for computer recycling is more mature in the US than Canada, with a number of facilities across the country to handle IT waste from large leasing companies such as IBM, etc.

There are already a number of computer recycling companies across Canada. Some recycling companies use manual separation to dismantle and sort the IT equipment into its various components (sometimes into 40 separate categories) in order to get the highest market price for high quality material streams (i.e., wire, circuit boards, power bars, semi-precious and base metals etc.). There are also some automated computer recycling companies that provide secure destruction services for information contained on hard drives, that also recycle component materials. Many companies who recycle IT equipment also handle telecom equipment.

The most challenging component of the IT equipment to recycle is the monitor, which contains a cathode ray tube (CRT). The CRT poses a concern for recycling because soluble lead is incorporated into the frit. Recycling options for this component (if it cannot be reused) are to use the glass as a fluxing agent at a lead smelter, or recycling the component for use by CRT manufacturers.

Telecommunications Wastes

The telecom sector Waste Flow Tools estimate that in 1999, approximately 2,961 tonnes of telephones, facsimile machines and mobile telephones were disposed, 2,256 tonnes were recycled, 2,253 tonnes were reused and 482 tonnes were put into storage in Canada.

In 2005, the Waste Flow Models predict that approximately 4,328 tonnes of telecom equipment waste (including telephones, fax machines and mobile phones) will be disposed in Canada, 3,729 tonnes will be reused, 786 tonnes will be stored and 4,087 tonnes will be recycled.

The infrastructure to handle telephones is relatively mature in Canada, because only a few companies operated the telephone business in the past. As the number of companies providing telecom services increase, more options are available for telephone discards, and recycling and reuse will likely be managed by a larger number of players.

Overview of Developments in Europe and the United States

The study provides a brief look at some U.S. programs and an overview of European IT and telecom waste diversion initiatives.

Although still immature, the infrastructure for collecting IT equipment for reuse and recycling is slightly more developed in the U.S. than it is in Canada. This may partly be due to the fact that the U.S. market is larger than the Canadian market.

There has been significant policy development activity in Europe to handle the burgeoning issue of IT and telecom equipment waste, both through the European Union (EU) and through its member states. The EU publicly released the most recent draft of their proposed Waste Electrical and Electronic Equipment Directive (WEEE) on June 13, 2000. This directive is intended to harmonize the EC's member states' national measures on WEEE in order to avoid obstacles to trade and to ensure the functioning of the internal market. Five years after the directive is adopted by member states EEE (Electronic and Electrical Equipment) producers, including those outside of Europe, will be legally responsible to pay for reuse and/or recycling of their products and the end of their life.

The WEEE Directive requires an overall recovery rate of 4kg/household/year by January, 2006 for all WEEE[1]. An IT and telecom recovery rate of 75% and a reuse and recycling rate of 65% is required by 2006. The recycling and reuse rate prescribed for equipment containing a cathode ray tube is 70%.

Conclusions and Recommendations

The study team recommends that more research be conducted to complete a comprehensive picture of the amount of IT and telecom equipment waste being generated in Canada and the amount of reuse and recycling that is currently occurring. The Waste Flow Tool developed in this study will then provide a more accurate account of the flow of IT and telecom waste in Canada.

[1] WEEE includes large and small household appliances, IT and telecommunication, consumer and lighting equipment, electrical and electronic tools, toys, medical equipment systems monitoring and control instruments and automatic dispensers.

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1.0 INTRODUCTION, OBJECTIVES AND STUDY APPROACH

1.1 Introduction

A quote from a PC World magazine on "The Digital Future" said, "in the future, people will live twice as long, computers will die twice as fast"[2]. As computer technology continues to accelerate at an unprecedented rate, information technology (IT) equipment waste is becoming an increasingly significant portion of the solid waste stream. Rapid advancements in telecommunications (telecom) services and technologies may also result in generation of increasing quantities of mixed telephone equipment waste.

Information Technology and telecommunication equipment waste is receiving increased attention for the following reasons:

- Rapid advances in technology result in IT and telecom equipment becoming obsolete at an increasingly rapid pace. This is resulting in an increase in the rate and quantity of IT and telecom equipment entering the waste stream;
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The *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada* report was commissioned by Environment Canada to develop baseline estimates of the amount of IT and telecom equipment waste that is currently being generated in Canada. The study is also designed to provide a broad overview of how such products are handled and to estimate the amounts of these products and materials that will enter the waste stream in the next few years.

1.2 Study Objectives

The primary objectives of this study were to:

- Identify the amount of IT and telecom sector generated by both the residential and IC&I sectors in Canada;
- Analyze the flow of IT and telecom waste in Canada, including reuse, recycling and disposal;
- Identify the companies and organizations involved in managing IT and telecom waste in Canada;
- Develop a measurement protocol (Waste Flow Tool) for the estimation of future waste disposal and waste diversion activities, and;
- Describe policy initiatives implemented in other jurisdictions to manage the flow of IT and telecom waste.

[2] THE Digital FUTURE (Technology Information), GLENN MCDONALD and CAMERON CROTTY, PC World, January, 2000, v.18 i1, p.116.

1.3 Study Approach

The specific waste streams addressed in the study include:

- personal computers,
- monitors,
- laptop computers,
- peripherals (e.g., printers, scanners),
- telephones,
- mobile telephones and
- and facsimile machines

The study did not include mainframe computers and other large equipment, such as telecom switching stations.

The study team determined that for the purpose of the current study, there was a logical separation between computer systems and equipment and telecommunications systems and equipment, therefore these two general waste streams are dealt with separately in the report. Reasons for this separation include:

- The telephone service providers in Canada have been in place for many years (since the 1930's) and have been largely regulated until recently;
- Telephone service providers have always provided take-back programs for residential telephones. Therefore the recovery and refurbishing infrastructure for telephones is in place and mature;
- The telecommunications sector has a direct, ongoing relationship with customers through the provision of land-line or cellular service, and
- Even with decreased regulations and increased competition, the telecommunications sector is more homogeneous and centralized than the computer industry, which includes many, largely foreign based original equipment manufacturers (OEMs) and thousands of retailers.

Information for the study was obtained through a number of sources including an extensive literature review of articles, reports and web sites, and discussions with industry representatives, federal, provincial and municipal government staff and others.

A survey of companies involved in IT and telecom equipment reuse and recycling throughout Canada was carried out to identify the range of activities carried out by different companies and organizations, the amounts of material handled, end markets used for these materials, and perceived barriers to increased reuse and recycling.

The draft study report was peer reviewed by four experts from industry and the academic community, to provide additional information and insights that have been incorporated into the final report. Most of the study research was carried out in February and March 2000, with some minor updates in July, 2000.

Section 2 of the report presents estimates of the flow of IT equipment waste in Canada from 1992 to 2005, and describes the Waste Flow Tool developed as part of the study.

Section 3 of the report describes IT Equipment reuse and recycling activity in different parts of Canada at this time.

Section 4 focuses on waste generation and management of telecommunications equipment waste.

Section 5 describes current activities in the US, and actions taken in Europe in response to, and in anticipation of, the European Union WEEE (Waste Electrical and Electronic Equipment) Directive, which mandates 75% recovery of IT and telecom waste by the year 2006 in the most recent draft proposal, released in June 2000.

Section 6 identifies data gaps which could be addressed in future studies.

Appendix A contains information on municipal IT and telecom waste recycling initiatives in the US, and Appendix B describes a number of IT and telecom waste recycling initiatives and programs in Europe.

2.0 WASTE ESTIMATES FOR IT EQUIPMENT

This section will address the generation and flow of computer equipment waste from both residential and IC&I sources in Canada. The types of computer equipment addressed in this study and discussed in this section include:

- Computers (personal computers, servers);
- Monitors;
- Laptop computers;
- Printers;
- Note-pads/note-books, and;
- Peripherals (scanners, modems, keyboards etc.).

Mainframes and other large IT equipment were not addressed in this study.

2.1 IT Equipment Waste Generation and Flow

The flow of computer equipment in the solid waste stream will require increasing attention in the future for the following reasons:

- The decreasing lifespan of IT products and their increasing annual sales, resulting in greater discards of computer equipment waste on an annual basis;
- The mixed composition of computer equipment (i.e., metals, plastics, glass), which makes dismantling and recycling challenging;
- The presence of hazardous materials; and,
- The life cycle ecological burden represented by waste IT equipment.

Computer equipment can become obsolete as a result of technological advancements, for example:

- Increasing microprocessing speed – from 80386 to 80486 to Pentium I, II and now III generation systems;
- Increasing memory capacity to support faster microprocessors and expanded storage requirements;
- Internet developments that cannot be accessed using older systems;
- New and expanding operating systems and software that cannot run on older systems;
- Advancements in colour, resolution and technology for monitors (i.e., flat panel monitors);
- Increasing speed and colour performance for laser and ink-jet printers, and
- Merging technologies such as “all-in-one” equipment, with faxing, printing and scanning capabilities provided in one unit.

These factors have reduced both the average first life and total lifespan of computer equipment – where first life refers to the amount of time a product is useful to its original owner and total lifespan is the period from manufacture to disposal[3].

[3] *Electronic Product Recovery and Recycling Baseline Report (EPR2 Baseline Report)*, National Safety Council’s Environmental Health Center, May 1999, page 13.

Computer equipment sales are projected to continue to grow as a result of decreasing lifespan and the increased use of computers in businesses, institutions and at home. The largest growth in computer sales is into the residential market. In 1998 there were 1.9 million computers installed in Canadian homes and in 1999, there were 2.2 million – an increase of 16%. In the education sector, installed computers increased by 9% in 1999, to 1.4 million. Installed computers in the business sector increased from 6.2 million in 1998 to 7.0 million in 1999 – an increase of 13%.[4]

Figure 2-1 presents a simplified schematic of the lifespan of computer equipment from point of sale, through use, to end of first life, to diversion (reuse and recycling) and to disposal. Each of these steps is discussed in further detail in this section.

IT Waste Generation

Each year millions of new computers, monitors, laptops and peripherals are sold into the Canadian marketplace. Some of these sales represent 'new' customers who are purchasing computer equipment for the first time, while the majority are those that are replacing old or out dated equipment found in residential, commercial and institutional settings. The obsolete equipment is typically 3-5 years old[5] and, while often still usable (i.e., not broken), it no longer meets the needs of the user. The point at which a computer becomes obsolete is also referred to as the end of the equipment's first life.

Obsolete computer equipment will be directed to one of four destinations/outlets:

- Storage
- Reuse
- Recycling
- Disposal

Storage: In many instances, discarded computer equipment is placed in storage. For residential computers this may mean storage in basements, or for business computers this may mean placement in storage or warehousing areas. In many cases IT equipment is stored largely because the owner hopes that the out-dated equipment has some potential resale value, or that they may use it in the future. In other cases, equipment is stored simply because people do not know what to do with it and are resistant to throwing out a piece of equipment that may have cost them thousands of dollars a few years ago. Accurate quantification of the number of computers being stored is not available, but estimates range from 45% to 50% of obsolete computers[6]. Eventually, stored computers will end up being disposed.

Reuse: End of first-life computer equipment typically goes to one of two reuse applications: 1) resold as used equipment, or 2) donated to a charity organization.

[4] *Canadian IT & Telecom Industry Data Service, Vol. XVII, 1999,* Canadian Office Automation Research, May 1999, p. 34.
[5] *Electronic Product Recovery and Recycling Baseline Report (EPR2 Baseline Report)*, National Safety Council's Environmental Health Center, May 1999.
[6] *Disposition and End-of-Life Options for Personal Computers*, Green Design Initiative Technical Report #97-10, Carnegie Mellon University, 1997, page 5.

Retail outlets, both traditional and Internet-based are increasingly becoming avenues for the sale of used computer equipment. IT manufacturers are also getting into the business of selling used equipment.

Used IT equipment that retains some useful value will likely be resold into the secondary computer market under the following scenarios:

- When businesses sell or auction IT equipment into the secondary market for resale through retail outlets as used computers or for computer parts and components (e.g., hard drives, motors/fans, CPU's etc.), and
- End-of-lease IT equipment that is returned to the leasing company at the end of a two or three year lease is typically sold or auctioned by the leasing company to secondary computer companies and brokers. (See section 5.1.)

A smaller percentage of used business IT equipment is often sold to employees for personal use. With the rapid development of computer technology, this option is diminishing.

Computer equipment and dismantled components can be reused and resold through a variety of outlets, including:

- Cascading or informal distribution of a computer within a company or within a family;
- Through private resale companies that purchase used equipment in order to refurbish and resell computer equipment for a profit in local or foreign markets;
- The sale of component parts that have been dismantled by primary recyclers (see below);
- The redistribution of donated equipment (nationally or internationally) through nonprofit organizations, sometimes in partnership with other companies that can refurbish equipment.

Recycling: The recycling infrastructure for computer equipment includes a mix of primary and secondary recyclers and metal smelting facilities. Typically, primary recyclers refurbish equipment for resale where possible and dismantle and sort the remaining equipment into component parts, such as circuit boards, CRT's (cathode ray tubes), plastic housing and wires. Sorted materials are then sold to secondary recyclers or smelters for further processing, or are sent to disposal outlets. Primary recyclers rely mainly on manual labour for refurbishing and dismantling, although some mechanical and automated systems are now available.

Secondary recyclers process metals, plastics and glass contained in the IT equipment to recover raw materials. These recyclers generally use highly automated processing equipment, requiring minimal manual dissassembly.

Electronic and computer waste can also be processed at smelting facilities to recover precious metals. The pyrometallurgical process utilized at a smelting facility involves the melting and fusing of ores to separate metallic constituents, such as lead or copper.

Smelters can also use the leaded glass contained in CRTs as a fluxing agent in the production of pure lead[7]. Noranda's Horne facility in northwestern Quebec is the largest North American copper and precious metal smelter.[8]

CRTs require special processing because they can contain from 0.7 to 2.7 kg of lead depending on the monitor size and year of manufacture. (See Section 2.3 for more detail on the lead composition of CRTs.) Monitors that can not be refurbished can be recycled into new CRTs or used as fluxing agents by a secondary lead smelter. To reuse an old CRT in the manufacture of a new CRT, the face glass is separated from the neck and funnel glass and the frit bonding compound by sawing the CRT at the frit bonding compound. If the CRT glass is to be used as a fluxing agent it does not require separation. The glass can be recovered in this process as well. [9]

Disposal: IT equipment as a whole or as its dismantled component parts can be disposed in landfills or incinerators. At this time, there is limited information available on the percentage of the waste stream that is made up of IT equipment. A 1999 waste composition study in the City of Calgary found that electronic equipment (including computers, radios, televisions etc.) comprised 1.2% of the residential waste stream or 3,000 tonnes per year[10]. This is comparable to US solid waste data that shows that electronic waste comprises 1-2% of the solid waste stream.[11] Equivalent information is not available for IC&I waste at this time but could form the focus of future studies.

2.2 IT Waste Flow Tool

To estimate the quantity and flow of computer equipment that becomes obsolete in Canada each year, Enviros RIS combined the lifespan model approach from the 1999 EPR2 Baseline Report and the disposition model approach cited in the 1997 Carnegie Mellon University Study[12]. The combined model, which is the Waste Flow Tool used in this study, was modified to suit Canadian conditions. Annual Canadian sales estimates of computer equipment to businesses, institutions and homes in Canada were needed to use the Waste Flow Tool, and were obtained from a number of sources. Estimates of the amount of personal computers, laptops and peripherals (printers and scanners) sold into the Canadian market for each year from 1992-2005 were generated from sources including International Data Corporation (IDC) Canada, and information from the Canadian IT & Telecom Industry Data Service Volume XVII 1999 report and other industry sources.

The first part of the IT Waste Flow Tool followed the EPR2 approach of using annual computer sales and assumed product lifespans to estimate the quantity of computer equipment that reaches the end of its first life and becomes obsolete. The Waste Flow Tool assumes a range of lifespans for each year's shipments, based on variations in usage patterns. For each year from 1992 to 2005, the Waste Flow Tool assumes an average lifespan and distribution of lifespan (from 2 to 5 years) for the computer

[7] *EPR2 Baseline Report*, page 3.
[8] *Background Document on Hazards and Waste From Computers*, Silicon Valley Toxics Coalition, 1999, page 7.
[9] *Reclaiming End-of-Life Cathode Ray Tubes and Electronics: A Florida Update*, Presentation by Jack Price, Florida Department of Environmental Protection to the 1999 Hazardous Materials Management Conference, November, 15, 1999.
[10] *City of Calgary 1999 Residential Waste Study*, City of Calgary Solid Waste Services Division, Table 3-1.
[11] Personal communication with Pat Dillon, Tufts University, July 2000.
[12] *Disposition and End of Life Options for Personal Computers, Carnegie Mellon Univeristy, 1997*.

equipment shipped[13]. This leads to a calculated average first life estimate in years. Enviros RIS adjusted the lifespan percentages to ensure that in 1999 the average first year life matched estimates provided in the EPR2 report[14].

Using the annual sales estimates and product lifespan distribution patterns, the Waste Flow Tool is designed to calculate the estimated number of units and tonnage that become obsolete or reach the end of their first life at the end of each year. For example, it is estimated that of all computers sold in 1997, 50% will become obsolete after three years (2000) and 50% will be obsolete after four years (2001) for an average first life of 3.5 years.

The estimated weight of each IT equipment component used to convert units into tonnes was obtained from the EPR2 Baseline Report. It should be noted however that these estimates have not been modified to reflect the change in weight of equipment over the years.

The second part of the IT Waste Flow Tool follows the approach cited in the *Disposition and End of Life Options for Personal Computers*.[15] Once again, Enviros RIS modified assumptions to suit Canadian conditions.

Using the estimates of obsolete equipment generated each year, the Waste Flow Tool calculates unit and tonnage quantities of IT equipment that is destined for one of four possible outlets:

1) Reuse application (i.e., resold, donated, 'cascaded');
2) Placed in storage (e.g., basement, warehouse, etc.);
3) Sent to a recycling or dismantling operation;
4) Sent directly to a disposal outlet (e.g., landfill or incineration).

Projections for the flow of IT equipment and storage patterns can be further refined as more recovery information becomes available regarding quantities of computer equipment that are reused and recycled in Canada. Table 2-1 presents the assumptions on the percentage of IT equipment directed to storage, reuse, recycling and disposal, which were used to generate the estimates in Tables 2-3 to 2-6, based on information in the literature, modified in some cases based on discussions with industry representatives.

[13] *EPR2 Baseline Report*, page 28.
[14] *EPR2 Baseline Report*, page 29.
[15] *Disposition and End of Life Options for Personal Computers, Carnegie Mellon Univeristy, 1997.*

Table 2-1 - Management Tool Material Flow Assumptions

Outlet for Obsolete IT Equipment	1995-1999	2000-2005
Reuse	40%	40%
Storage	10%	10%
Recycling	10%	15%
Disposal	40%	35%
	100%	100%

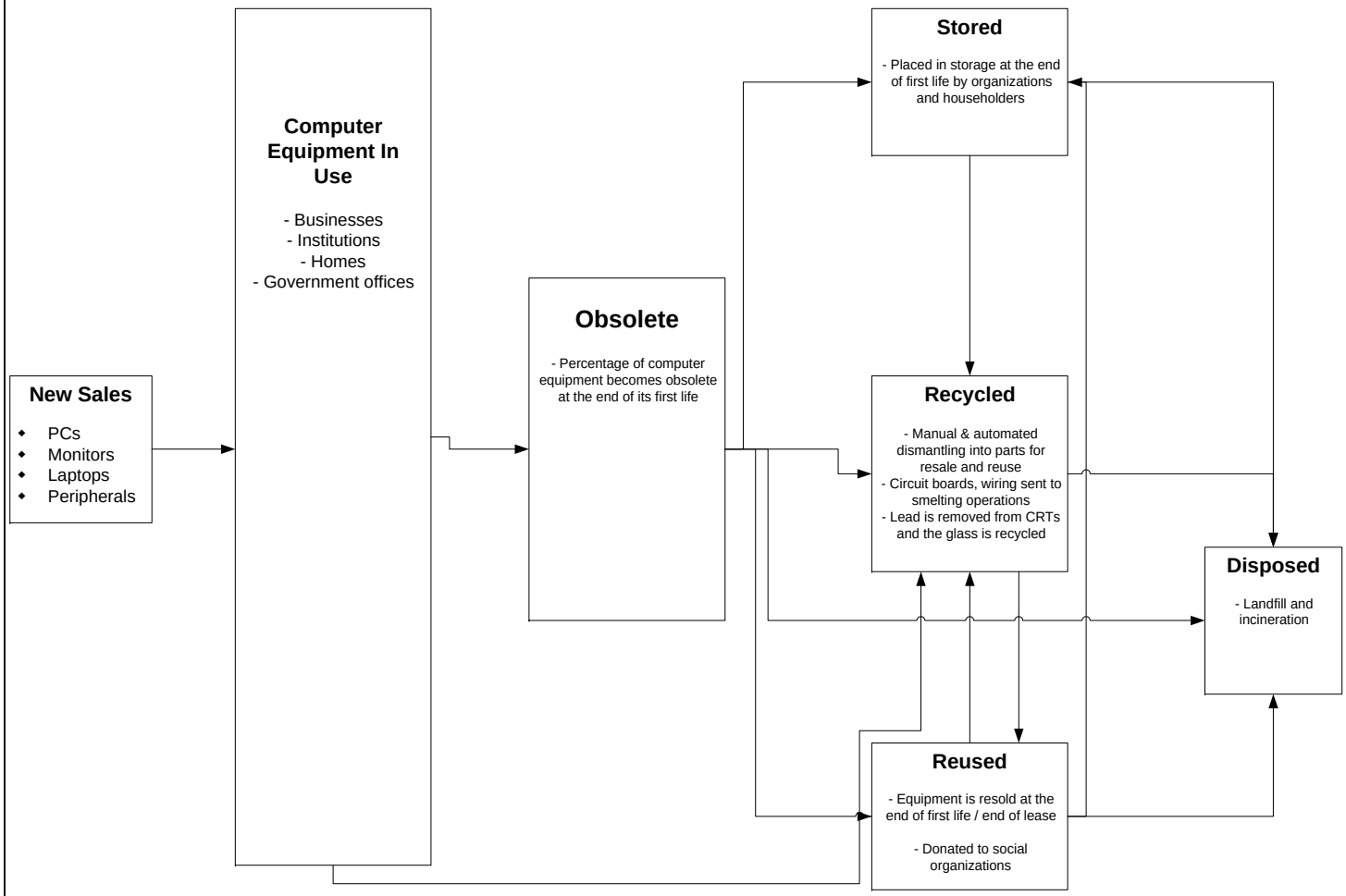
The Waste Flow Tool also takes into consideration computer equipment that reaches the end of its second or total lifespan. For example, a personal computer that is donated to a reuse organization at the end of its first lifespan of 3 years is estimated to have a total useful lifespan of 5 years[16]. Therefore, a computer that reaches the end of first life in 1999 and is resold or donated, will reach the end of its useful life in 2001.

At that time, the Waste Flow Tool estimates that 50% of computer equipment at the end of its second or total life (both in reuse and storage) will be recycled and the remaining 50% will be disposed. The total number of personal computers that were disposed in 1999 include a percentage of obsolete equipment from 1999 and 50% of computers that went into reuse applications and 50% of computers that were stored in 1996.

A Waste Flow Tool for notepads and Palm organizers was not prepared. While this relatively new technology is experiencing tremendous growth around the world, the overall unit sales in Canada is small (153,100 units in 1999)[17] at this time, but is expected to grow substantially. This waste stream should be added to the estimates when sufficient information is available.

[16] *EPR2 Baseline Report*, page 29.
[17] Industry Snapshots – PC Market Fourth Quarter 1999, Evans Research

Figure 2.1 - IT Equipment Waste Generation and Flow



The waste flow estimates for various pieces of computer equipment are presented in the following tables:

- Table 2-2– Personal Computers
- Table 2-3– Monitors
- Table 2-4– Laptop Computers
- Table 2-5– Peripherals

A summary table of IT equipment that were reused, stored, recycled or disposed in Canada in 1999 is presented in Table 2-6. Note that the totals in the table do not add to the amount of IT equipment that became obsolete in 1999. This is because IT equipment from storage and reuse from earlier years enters the IT equipment waste stream each year.

The Waste Flow Tool allows estimates to be revised as new information becomes available. Developing accurate reuse, resale and storage estimates will be challenging due to the wide distribution of equipment and lack of cohesion of the companies and organizations involved in this business. In particular, these estimates could be refined, if research was conducted in the following areas:

- Analysis of the storage/reuse/recycling patterns and lifespans for residential versus IC&I IT equipment and leased versus owned IT equipment;
- A breakdown of the percentage of total computers in Canadian homes versus businesses;
- The extent to which leasing (currently 25% of total) is different for the residential and IC&I sectors, and
- Comprehensive surveying of the rapidly expanding recycling and reuse sectors across Canada.

Based on the Waste Flow Tool, it is estimated that in 1999, approximately 33,972 tonnes of IT equipment waste (including PCs monitors, laptops and peripherals, but excluding mainframes and other large equipment) was disposed, 15,592 tonnes was recycled, 24,507 tonnes was sent for reuse and 6,128 was put into storage. Some pieces of IT equipment which had been stored or reused in previous years entered the waste stream in 1999. Of the IT waste disposed, PCs and servers accounted for an estimated 10,833 tonnes, monitors accounted for an estimated 10,688 tonnes, peripherals (scanners, printers, etc) accounted for about 11,474 tonnes and laptops accounted for about 977 tonnes.

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Table 2-2 - Waste Flow Tool for Personal Computers (PCs) & Servers in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:	Obsolete Disposed
1995-1999	= 40%	= 10%	= 10%	= 40%
2000-2005	= 40%	= 10%	= 15%	= 35%

New Computer Sales			**Computer First Use Life Span**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**		**Annual Disposal[9]**	
Year	Units[1] (M)	Tonnes[2]	Share of PCs Lasting (years)[3] 5	4	3	2	Average First Life[4] (Yrs)	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Units (Tonnes)	Units (M)	Tonnes
1992	0.685	9,311	40%	60%			4.4	0.331	2,066	0.132	826	0.033	207	0.093	580	0.192	1,199
1993	0.805	10,954	30%	60%	10%		4.2	0.389	5,289	0.156	2,116	0.039	529	0.109	968	0.226	2,555
1994	0.948	12,888	10%	70%	20%		3.9	0.458	6,223	0.183	2,489	0.046	622	0.128	1,139	0.266	3,006
1995	1.115	15,162		70%	30%		3.7	0.538	7,321	0.215	2,928	0.054	732	0.151	2,054	0.313	4,251
1996	1.312	17,837		60%	40%		3.6	0.782	10,639	0.313	4,256	0.078	1,064	0.193	2,620	0.427	5,811
1997	1.543	20,985		50%	50%		3.5	0.947	12,875	0.379	5,150	0.095	1,287	0.229	3,118	0.513	6,980
1998	1.815	24,689		40%	60%		3.4	1.239	16,856	0.496	6,742	0.124	1,686	0.320	4,345	0.691	9,402
1999	**2.016**	**27,415**		**15%**	**70%**	**15%**	**3.0**	**1.400**	**19,037**	**0.560**	**7,615**	**0.140**	**1,904**	**0.377**	**5,122**	**0.797**	**10,833**
2000	2.217	30,157		10%	70%	20%	2.9	1.558	21,195	0.623	8,478	0.156	2,120	0.544	7,393	0.855	11,632
2001	2.428	33,021		5%	70%	25%	2.8	2.163	29,418	0.865	11,767	0.216	2,942	0.674	9,172	1.107	15,056
2002	2.659	36,158			70%	30%	2.7	2.581	35,097	1.032	14,039	0.258	3,510	0.777	10,563	1.293	17,583
2003	2.911	39,593			60%	40%	2.6	2.462	33,477	0.985	13,391	0.246	3,348	0.910	12,376	1.402	19,071
2004	3.188	43,355			50%	50%	2.5	2.719	36,978	1.088	14,791	0.272	3,698	1.053	14,321	1.597	21,717
2005	3.491	47,473			40%	60%	2.4	3.147	42,799	1.259	17,120	0.315	4,280	1.087	14,789	1.717	23,349

Footnotes

1 Canadian IT & Telecom Industry Data Service, Vol. XVII 1999, page 8-34.

2 Unit weights provided in Electronic Product Recovery & Recycling (EPR2) Baseline Report, National Safety Council's Environmental Health Center, May 1999, page 15.

3 Estimated range in years of a computers' first life before being reused, stored, recycled or disposed. The original methodology was presented in the EPR2 Baseline Report (p. 29). However the model has been modified to ensure that the average first lifespan is 3 years as estimated in the EPR2 Report (page 29).

4 Average First Life = annual sales x share (%) of computer's first life. The assumed average first life in 1999 is 3 years and the total lifespan is 5 years (EPR2 Report, page 29).

5 Represents the number of computers that become Obsolete at the end of first life

6 Annual Reuse includes equipment that is resold or donated to third party organizations.

7 Estimated number of computers that are placed in Storage at the end of first life.

8 Estimate of computers that are sent for recycling at end of first life, plus 50% of stored from 2 years ago + 50% of reused from 2 years ago (difference between first life and total lifespan).

9 Estimate of computers that are sent to disposal at end of first life, plus 50% of stored from 2 years ago + 50% of reused from 2 years ago (difference between first life and total lifespan).

Table 2-3 - Waste Flow Tool for Computer Monitors in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:	Obsolete Disposed
1995-1999	= 40%	= 10%	= 10%	= 40%
2000-2004	= 40%	= 10%	= 15%	= 35%

New Monitor Sales			**Monitor First Use Life Span**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**		**Annual Disposal[9]**	
Year	Units[1] (M)	Tonnes[2]	Share of Monitors Lasting (years)[3] 5	4	3	2	Average First Life[4] (Yrs)	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Units (Tonnes)	Units (M)	Tonnes
1992	0.916	12,452	70%	30%			4.7	0.442	6,013	0.177	2,405	0.044	601	0.112	1,524	0.245	3,328
1993	1.077	14,650	60%	40%			4.6	0.520	7,074	0.208	2,830	0.052	707	0.132	1,793	0.288	3,916
1994	1.267	17,235	50%	50%			4.5	0.612	8,322	0.245	3,329	0.061	832	0.155	2,110	0.339	4,607
1995	1.527	20,765	40%	60%			4.4	0.720	9,791	0.288	3,916	0.072	979	0.183	2,482	0.398	5,419
1996	1.840	25,019	40%	60%			4.4	0.664	9,028	0.266	3,611	0.066	903	0.196	2,671	0.396	5,380
1997	2.190	29,784	30%	60%	10%		4.2	1.072	14,577	0.429	5,831	0.107	1,458	0.260	3,538	0.582	7,911
1998	2.570	34,952	30%	60%	10%		4.2	1.280	17,408	0.512	6,963	0.128	1,741	0.308	4,188	0.692	9,411
1999	**2.620**	**35,632**	**20%**	**60%**	**20%**		**4.0**	**1.550**	**21,077**	**0.620**	**8,431**	**0.155**	**2,108**	**0.321**	**4,365**	**0.786**	**10,688**
2000	2.730	37,128	10%	60%	30%		3.8	1.934	26,296	0.773	10,518	0.193	2,630	0.558	7,589	0.945	12,848
2001	2.676	36,400		70%	30%		3.7	2.307	31,373	0.923	12,549	0.231	3,137	0.666	9,058	1.127	15,332
2002	2.624	35,686		60%	40%		3.6	2.723	37,033	1.089	14,813	0.272	3,703	0.796	10,824	1.340	18,231
2003	2.573	34,987		60%	40%		3.6	3.162	43,003	1.265	17,201	0.316	4,300	0.958	13,024	1.590	21,625
2004	2.474	33,641		50%	50%		3.5	2.965	40,323	1.186	16,129	0.296	4,032	1.021	13,892	1.614	21,956
2005	2.378	32,347		50%	50%		3.5	3.196	43,467	1.278	17,387	0.320	4,347	1.160	15,778	1.799	24,472

Footnotes

1 Personal communications with staff from International Data Corporation (IDC) Canada.

2 Unit weights provided in Electronic Product Recovery & Recycling Baseline Report, National Safety Council's Environmental Health Center, May 1999, page 15.

3 Estimated range in years of a monitors' first life before being reused, stored, recycled or disposed. The original methodology was presented in the EPR2 Baseline Report (p. 29). However the model has been modified to ensure that the average first lifespan is 3 years as estimated in the EPR2 Report (page 29).

4 Average First Life = annual sales x share (%) of monitor's first life. The assumed average first life in 1999 is 4 years and the total lifespan is 7 years (EPR2 Report, page 29).

5 Represents the number of monitors that become Obsolete at the end of first life.

6 Annual Reuse includes equipment that is resold or donated to third party organizations.

7 Estimated number of monitors that are placed in Storage at the end of first life

8 Estimate of monitors that are sent to a recycling organization at end of first life, plus 50% of stored from 3 years ago + 50% of reused from 3 years ago (difference between average first life and total lifespan).

9 Estimate of monitors that are sent to disposal at end of first life, plus 50% of stored from 3 years ago + 50% of reused from 3 years ago (difference between average first life and total lifespan).

Table 2-4 - Waste Flow Tool for Laptop Computer in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:	Obsolete Disposed
1995-1999	= 40%	= 10%	= 10%	= 40%
2000-2005	= 40%	= 10%	= 15%	= 35%

New Laptop Sales			**Laptop Life Span - First Use**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**		**Annual Disposal[9]**	
Year	Units[1] (M)	Tonnes[2]	Share of Laptops Lasting (yea 5	4	3	2	Average First Life[4] (Yrs)	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Units (Tonnes)	Units (M)	Tonnes
1992	0.152	683	30%	40%	30%		4.0	0.065	290	0.026	116	0.006	29	0.018	53	0.038	140
1993	0.185	833	20%	40%	40%		3.8	0.072	326	0.029	130	0.007	33	0.023	105	0.045	203
1994	0.226	1,016	10%	30%	60%		3.5	0.088	397	0.035	159	0.009	40	0.027	121	0.053	240
1995	0.275	1,238		30%	70%		3.3	0.153	689	0.061	276	0.015	69	0.037	168	0.083	375
1996	0.336	1,510		25%	75%		3.3	0.169	760	0.068	304	0.017	76	0.055	248	0.106	476
1997	0.409	1,842		20%	75%	5%	3.2	0.255	1,147	0.102	459	0.025	115	0.068	305	0.144	649
1998	0.499	2,246		15%	75%	10%	3.1	0.297	1,338	0.119	535	0.030	134	0.093	421	0.183	822
1999	**0.561**	**2,523**		**15%**	**70%**	**15%**	**3.0**	**0.357**	**1,606**	**0.143**	**642**	**0.036**	**161**	**0.110**	**495**	**0.217**	**977**
2000	0.617	2,775		10%	70%	20%	2.9	0.441	1,984	0.080	793	0.044	198	0.155	699	0.243	1,096
2001	0.675	3,039		5%	70%	25%	2.8	0.540	2,432	0.100	973	0.054	243	0.143	861	0.251	1,347
2002	0.740	3,328			70%	30%	2.7	0.591	2,658	0.120	1,063	0.059	266	0.166	1,007	0.284	1,538
2003	0.810	3,644			60%	40%	2.6	0.685	3,081	0.160	1,232	0.068	308	0.192	1,127	0.329	1,743
2004	0.887	3,990			50%	50%	2.5	0.695	3,126	0.200	1,250	0.069	313	0.218	1,239	0.357	1,864
2005	0.971	4,369			40%	60%	2.4	0.842	3,787	0.240	1,515	0.084	379	0.261	1,349	0.429	2,107

Footnotes

1 Canadian IT & Telecom Industry Data Service, Vol. XVII 1999, page 8-35.

2 Unit weights provided in Electronic Product Recovery & Recycling Baseline Report, National Safety Council's Environmental Health Center, May 1999, page 15.

3 Estimated range in years of a laptops' first life before being reused, stored, recycled or disposed. The original methodology was presented in the EPR2 Baseline Report (p. 29). However the model has been modified to ensure that the average first lifespan is 3 years as estimated in the EPR2 Report (page 29).

4 Average First Life = annual sales x share (%) of laptop's first life. The assumed average first life in 1999 is 3 years and the total lifespan is 4 years (EPR2 Report, page 29).

5 Represents the number of laptops that become Obsolete at the end of first life

6 Annual Reuse includes equipment that is resold or donated to third party organizations.

7 Estimated number of laptops that are placed in Storage at the end of first life

8 Estimate of laptops that are sent to a recycling organization at end of first life, plus 50% of stored from 1 year ago + 50% of reused from 1 year ago. (difference between average first life and total lifespan)

9 Estimate of laptops that are sent to disposal at end of first life, plus 50% of stored from previous year + 50% of reused from previous year (difference between average first life and total lifespa

Table 2-5 - Waste Flow Tool for Peripherals (printers, scanners) in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:	Obsolete Disposed
1995-1999	= 40%	= 10%	= 10%	= 40%
2000-2005	= 40%	= 10%	= 15%	= 35%

New Peripheral Sales			**Peripheral Life Span - First Use**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**		**Annual Disposal[9]**	
Year	Units[1] (M)	Tonnes[2]	Share of Perihperals Lasting (ye 5	4	3	2	Average First Life[4] (Yrs)	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Units (Tonnes)	Units (M)	Tonnes
1992	1.012	11,441	50%	50%			4.5	0.457	5,166	0.183	2,067	0.046	517	0.123	1,385	0.260	2,935
1993	1.125	12,712	20%	70%	10%		4.1	0.558	6,300	0.223	2,520	0.056	630	0.149	1,689	0.317	3,579
1994	1.250	14,125	10%	60%	30%		3.8	0.680	7,683	0.272	3,073	0.068	768	0.182	2,060	0.386	4,365
1995	1.389	15,694		60%	40%		3.6	0.829	9,370	0.332	3,748	0.083	937	0.222	2,512	0.471	5,323
1996	1.543	17,438		50%	50%		3.5	0.962	10,869	0.385	4,348	0.096	1,087	0.266	3,008	0.555	6,268
1997	1.715	19,375		25%	70%	5%	3.2	1.294	14,619	0.517	5,848	0.129	1,462	0.337	3,804	0.725	8,190
1998	1.905	21,528		20%	70%	10%	3.1	1.531	17,295	0.612	6,918	0.153	1,729	0.394	4,447	0.853	9,635
1999	**2.160**	**24,410**		**15%**	**70%**	**15%**	**3.0**	**1.730**	**19,548**	**0.692**	**7,819**	**0.173**	**1,955**	**0.496**	**5,610**	**1.015**	**11,474**
2000	2.383	26,930		10%	70%	20%	2.9	1.972	22,282	0.789	8,913	0.197	2,228	0.678	7,666	1.073	12,122
2001	2.602	29,404		10%	70%	20%	2.9	2.086	23,575	0.835	9,430	0.209	2,357	0.745	8,423	1.163	13,138
2002	2.836	32,051		5%	70%	20%	2.7	2.370	26,778	0.948	10,711	0.237	2,678	0.848	9,587	1.322	14,943
2003	3.092	34,935		5%	70%	20%	2.7	2.513	28,393	1.005	11,357	0.251	2,839	0.898	10,153	1.401	15,831
2004	3.370	38,080			70%	30%	2.7	2.389	26,993	0.956	10,797	0.239	2,699	0.951	10,744	1.429	16,142
2005	3.673	41,507			70%	30%	2.7	2.604	29,423	1.042	11,769	0.260	2,942	1.019	11,512	1.539	17,396

Footnotes

1 Printer sales estimates from Canadian IT & Telecom Industry Data Service, Vol. XVII 1999, page 1-9. Scanner sales data for 1998-2001 provided by IDC Canada.

2 Unit weights provided in Electronic Product Recovery & Recycling Baseline Report, National Safety Council's Environmental Health Center, May 1999, page 15.

3 Estimated range in years of a peripherals' first life before being reused, stored, recycled or disposed. The original methodology was presented in the EPR2 Baseline Report (p. 29). However the model has been modified to ensure that the average first lifespan is 3 years as estimated in the EPR2 Report (page 29).

4 Average First Life = annual sales x share (%) of peripheral's first life. The assumed average first life in 1999 is 3 years and the total lifespan is 5 years (EPR2 Report, page 29).

5 Represents the number of peripherals that become Obsolete at the end of first life.

6 Annual Reuse includes equipment that is resold or donated to third party organizations.

7 Estimate of peripherals that are placed in Storage at the end of first life

8 Estimate of peripherals that are sent to a recycling organization at end of first life, plus 50% of stored from 2 years ago + 50% of reused from 2 years ago . (difference between first life and total lifespan).

9 Estimate of peripherals that are sent to disposal at end of first life, plus 50% of stored from 2 years ago + 50% of reused from 2 years ago (difference between average first life and total lifespa

Table 2-6 – Summary of Weight and Number of IT Equipment Components Being Sent to Storage, Reuse, Recycling and Disposal in Canada in 1999.

IT Equipment Type	Reuse		Storage		Recycled		Disposed	
	Units (millions)	Tonnes	Units (millions)	Tonnes	Units (millions)	Tonnes	Units (millions)	Tonnes
PCs and Servers	0.56	7,615	0.14	1,904	0.38	5,122	0.80	10,833
Computer Monitors	0.62	8,431	0.15	2,108	0.32	4,365	0.79	10,688
Laptop Computers	0.14	642	0.04	161	0.11	495	0.22	977
Peripherals (scanners, printers, etc.)	0.69	7,819	0.17	1,955	0.50	5,610	1.02	11,474
Total		**24,507**		**6,128**		**15,592**		**33,972**

Note: The quantities disposed, recycled, stored and reused do not add to the amount of IT equipment that became obsolete in 1999 because a portion of IT equipment from storage and reuse from earlier years enters the IT equipment waste flow in 1999.

2.3 Materials Contained in IT Equipment

The challenge encountered in diverting computers and peripherals from the waste stream through recycling and refurbishing activity result from the diversity of products and variety of materials contained in each product. For example, each hard drive contains a range of metals and plastics that can be difficult to separate. It is also difficult to identify the different plastics contained in each piece of equipment by resin type. The composition of an average PC and monitor is shown in Tables 2.7 and 2.8.

Table 2-7 - Composition of Personal Computer and Monitor

Component	% Composition
Silica/glass	25%
Ferrous metal	20%
Plastics	23%
Aluminum	14%
Copper	7%
Lead	6%
Zinc	2%
Various precious metals*	3%
Total	**100%**

*** Precious metals include nickel, manganese, cobalt, barium, tin, silver, antimony, chromium, cadmium, selenium, mercury, gold and arsenic.**
(Source: Electronics Industry Environmental Roadmap*, Microelectronics and Computer Technology Corporation, *1996.)

The American Plastics Council (APC) conducted an analysis of plastics found in electronic equipment collected in Hennepin County, Minnesota, and found computer plastics to be comprised of 57% ABS, 36% polyethylene oxide (PPO), 5% high-impact polystyrene (HIP) and 2% polycarbonate.[18] It should be noted however that the composition of IT equipment will change over time.

Many of the materials contained in IT equipment can be potentially hazardous if improperly managed. For example, printed circuit boards contain heavy metals such as antimony, silver, chromium, zinc, lead, tin and copper and a CRT in a computer monitor can contain from 0.7 to 2.7 kg of lead depending on the monitor's size and year of manufacture.[19]

Electronic products contribute the second and third largest amount of lead and cadmium to municipal incinerator ash, respectively, after batteries.
(Source: Winka, M., F. Peluso, and J. Carpenter, Pollution Prevention Review, Autumn 1995, V.5, #.4.)

[18] *Plastics from Consumer Electronics Recycling Report 1999*, American Plastic Council, web site www.plasticresource.com/recycling/ARC99.
[19] Price, John L., *Reclaiming End-of-Life Cathode Ray Tubes (CRTs) and Electronics: A Florida Update*, 1999 Hazardous Materials Management Conference, November 15, 1999.

The production of semiconductors, printed circuit boards, disk drives and monitors use a number of hazardous materials[20]. The lead oxide used in the cathode ray tubes (CRT) of computer monitors is of particular concern and it has been estimated that computer monitors represent approximately 15% of the lead found in the municipal waste stream.[21]

Hazardous materials found in obsolete computer equipment can be released to the environment through the following pathways:

- Incineration of computer equipment concentrates heavy metals in ash residue;
- Landfill disposal of computer equipment, and;
- Recycling and recovery of computer equipment waste.

Table 2-8 – Estimated Quantities of Various Materials Contained in Obsolete and Disposed PCs and Monitors in Canada in 1999 and in 2005.

Materials	Composition of Average PC & Monitor (%)	Obsolete 1999 Tonnes PC & Monitors	Disposed 1999 Tonnes PC & Monitors	Obsolete 2005 Tonnes PC & Monitors	Disposed 2005 Tonnes PC & Monitors
Glass/Silica	24.880%	9,980.5	5,354.5	21,463.4	11,898.0
Plastics	22.991%	9,222.5	4,947.9	19,833.3	10,994.3
Ferrous	20.471%	8,211.8	4,405.7	17,659.8	9,789.5
Aluminum	14.172%	5,685.1	3,050.1	12,226.0	6,777.3
Copper	6.929%	2,779.4	1,491.1	5,977.2	3,313.4
Lead	6.299%	2,526.7	1,355.6	5,433.8	3,012.1
Zinc	2.205%	884.4	474.5	1,901.8	1,054.3
Tin	1.008%	404.3	216.9	869.4	481.9
Nickel	0.850%	341.1	183.0	733.5	406.6
Barium	0.032%	12.6	6.8	27.2	15.1
Manganese	0.032%	12.6	6.8	27.2	15.1
Silver	0.019%	7.6	4.1	16.3	9.0
Beryllium	0.016%	6.3	3.4	13.5	7.5
Cobalt	0.016%	6.3	3.4	13.5	7.5
Tantalum	0.016%	6.3	3.4	13.5	7.5
Cadmium	0.009%	3.8	2.0	8.1	4.5
Antimony	0.009%	3.8	2.0	8.1	4.5
Chromium	0.006%	2.5	1.4	5.4	3.0
Mercury	0.002%	0.9	0.5	1.9	1.1
Gold	0.002%	0.6	0.3	1.4	0.8
Selenium	0.002%	0.6	0.3	1.4	0.8
Arsenic	0.001%	0.5	0.3	1.1	0.6
Totals	**100.0%**	40,100	21,514	86,237	47,804

(Source: Electronics Industry Environmental Roadmap microelectronics and Computer Technology Corporation, 1996)

The hazardous materials contained in computer equipment that are of greatest concern are summarized below.

[20] *Background Document on Hazards and Waste From Computers*, Silicon Valley Toxics Coalition, website report, page 2.
[21] *Reclaiming End-of-Life Cathode Ray Tubes and Electronics: A Florida Update*, Presentation by Jack Price, Florida Department of Environmental Protection to the 1999 Hazardous Materials Management Conference, November, 15, 1999.

Lead

Lead is found in the CRT, in the soldering of printed circuit boards and in other components of IT equipment. Lead represents approximately 6.3%, by weight of an average PC[22]. Based on the total number of obsolete PC's and monitors in Canada in 1999, this translates to about 1,356 tonnes of lead disposed in 1999.

Based on the prediction that 47,821 tonnes of PCs and monitors will be disposed in 2005 and assuming that the average composition of this equipment will not change significantly by that year, 3,012 tonnes of lead will be disposed with this stream in 2005.

A CRT in a computer monitor can contain from 0.7 to 2.7 kg of lead depending on the monitors size and year of manufacture. This lead is contained in various components of the CRT, including:[23]

- The glass funnel, which is glass that is 22-25% lead (bound into the glass). Lead is used in the funnel to shield users from radiation produced by the electron gun.
- The faceplate, which contains 2-3% lead bound into the glass.
- The frit (a glass solder that joins the faceplate and funnel components of the CRT), which contains 15 to 100 grams per CRT.

The lead contained in the frit is of greater concern because it is in a soluble form (primarily lead oxide) that can leach,[24] while the lead contained in the glass funnel and in the faceplate is in an insoluble form.

More than 40% of the lead discarded into Florida's municipal solid waste in 2000 is estimated to come from CRTs in computer monitors and TVs. (Source: Price, John L., *Reclaiming End-of-Life Cathode Ray Tubes (CRTs) and Electronics: A Florida Update*, 1999 Hazardous Materials Management Conference, November 15, 1999.)

Cadmium

Cadmium is present in certain components, including chip resistors, infrared detectors, semiconductors, older CRTs and is sometimes present in plastics as a stabilizer. Cadmium represents approximately 0.009% of a PC by weight[25]. Based on the total number of disposed PC's in Canada in 1999, this translates to 2.0 tonnes of cadmium.

Based on the prediction that 47,821 tonnes of PCs and monitors will be disposed in 2005 and assuming that the average composition of this equipment will not change significantly by that year, 4.5 tonnes of cadmium will be disposed with this stream in 2005.

[22] *1996 Electronics Industry Environmental Roadmap*
[23] Price, John L., *Reclaiming End-of-Life Cathode Ray Tubes (CRTs) and Electronics: A Florida Update*, 1999 Hazardous Materials Management Conference, November 15, 1999.
[24] ibid
[25] *1996 Electronics Industry Environmental Roadmap*

Mercury

Mercury is used in printed circuit boards, batteries, switches and printed wiring boards. While the percentage found in the average PC is only 0.002%,[26] based on the total number of disposed PCs estimated in Canada in 1999, this represents 0.5 tonnes of mercury. Mercury is also found in the fluorescent lamps that were previously used to backlight laptop computer screens, but have now been replaced with xenon.

Based on the prediction that 47,821 tonnes of PCs and monitors will be disposed in 2005 and assuming that the average composition of this equipment will not change significantly by that year, 1.1 tonnes of mercury will be disposed with this stream in 2005.

Brominated Flame Retardants

Brominated flame retardants are used to reduce the flammability of plastics in electronic products. They are most typically used in circuit boards, connectors, plastic covers and cables.[27] There are many types of BFRs (more than 60), some of which are more toxic than others. The European Union Waste Electrical and Electronic Equipment (WEEE) Directive has chosen to focus its efforts on the two classes of BFRs that pose the highest cause for concern, that is, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE). These are the compounds that are most likely to form dioxins and furans during the incineration process. When these compounds are burned, brominated materials are converted into polybrominated dibenzo furans (PBDF) and polybrominated dibenzo dioxins (PBDD) and can be released into the atmosphere.[28]

Therefore, when plastics containing BFRs, in particular PBB and PBDE, are extruded during the recycling process or when they are incinerated for disposal, hazardous compounds may be released into the environment.

Polyvinyl Chloride Plastic (PVC)

Although most computer mouldings are now made using ABS plastic, PVC has been widely used in computer cabling and housings. There is a risk that dioxins and furans will be formed when PVC is incinerated. In addition, PVC is a difficult plastic to recycle if mixed with styrenics and contaminates other plastics (e.g., PET) in the recycling process.

[26] *1996 Electronics Industry Environmental Roadmap*
[27] Silicon Valley Toxics Coalition, 'Just Say No to E-Waste: Background Document on Hazards and Waste from Computers', p. 7, viewed on March 7, 2000.
[28] Source: Toshiba viewed March 27, 2000.

2.4 IT Equipment Design Changes to Reduce Toxicity and Facilitate Recycling

Many manufactures are attempting to eliminate substances of concern from their products, including, lead, arsenic, brominated flame retardants, cadmium, hexavalent chromium, mercury and PVC. Examples are provided below.

- Hewlett-Packard's OfficeJet 500 multi-purpose printer uses a metal chassis and power supply enclosure to eliminate the need for flame retardants and light-emitting diodes (LEDs) instead of a mercury lamp for the scanner, and eliminates the need for batteries by using flash memory technology.[29]
- The primary plastic resin used in Intel's PCs and servers (ABS and polycarbonate) does not use flame retardants that contain PBBs or PBDEs. None of their products contain asbestos, or include lead or cadmium as plastic additives.[30]
- Philips Consumer Electronics evaluate all of its products against their list of banned substances (asbestos, cadmium, mercury, CFC/HCFC, PCP, PCB, PCT, PBB/PBBE) before their introduction.[31]
- Motorola conducts research with their suppliers of printed wiring board laminates, plastics, and electronic components to replace lead and BFRs.[32]
- Panasonic has identified 37 substances of concern in their manufacturing process with 13 targeted for elimination and the remaining 24 for reduction.[33]
- Sony Corporation is developing a non-lead based solder for some products and seeks to eliminate dioxin forming compounds through design guidelines.[34]
- Toshiba has introduced the Satellite 2520 notebook with a halogen-free motherboard and plans to switch over to halogen-free boards for the entire PC product range by the end of 2000.[35]
- Digital's (now Compaq) Corporate Regulated Material Specification includes the banning of PBBs, PBBOs and PBBEs. Numerous other halogenated compounds are listed in this specification including the 25 halogenated dioxins and furans, which are restricted by the German Dioxin Ordinance.[36]
- As a part of Sony's Green Management 2002 Plan, they will eliminate the use of halogenated flame retardants in all European models by 2000 and in all models by 2002.

Many manufacturers are improving the recyclability of their products by incorporating recyclable materials into products, by making their products easier to dismantle and by marking the various materials contained in the equipment, for example:

- Plastic components of Apple products that are greater than 100 grams are made from the same type of plastic material;

[29] Compendium Of Design-For-Environment Efforts Of The Electronics Industries (Draft), Electronics Industry Association, March 8, 2000, p. 5.
[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] Ibid.
[34] Ibid.
[35] Source: Toshiba viewed March 27, 2000.
[36] Source: Compaq, "Working Together for Environment, Health & Safety", **Error! Bookmark not defined.**, viewed March 27, 2000.

- Apple designs its product with latches, snap-in connections, and single screw-types requiring no specialized tools;37
- Hewlett Packard designs many of its products so that they are easier to take apart; many components simply snap apart, making it easier to separate metal from the plastic;
- IBM's DfE (Design for the Environment) guidelines encourage the use of snap fits instead of fasteners, and where fasteners are used, they use a minimum number of standard sizes that do not require special tools when dismantling, and
- Intel's product design checklist encourages ease of disassembly and appropriate materials choice.

2.5 Future Trends in IT Technology

The IT and telecom sectors are converging at a rapid rate and with the development of fibre optic networks, data, sound and video will be accessible at a rapidly expanding rate. It is challenging to predict the extent to which the future will be different to the present. This section will describe a number of trends identified through the literature review and survey carried out for this study, but will not attempt to estimate the potential impacts of these trends because of the significant uncertainty involved.

General Trends

Moore's Law, based on a 1965 prediction by Intel cofounder Gordon Moore, states that processing power will double every 18 months. This has been the case since the early 1970's and it is not expected to change even ten years from now[38].

Recent advancements in wireless phone and notepad/Palm organizers have resulted in predictions of the demise of the PC.

> *Rumours of the PC's demise may be premature, but they aren't necessarily exaggerated. No one can say for certain whether the PC will survive the coming onslaught of supersmart alternative computing devices ranging from wireless phones to household appliances. Such products could make the PC less essential. In short, you can expect PC to become smaller and more powerful, with thinner and lighter screens, and advances in voice recognition could ultimately make your mouse and keyboard a museum piece. But while the aging PC may undergo some cosmetic nips and tucks, it probably won't disappear altogether – at least not in the near future.*[39]

There is a new trend away from PCs to NCs (network computers) in the workplace and for networks data to be contained on the Internet rather than on a computer based network server. This approach means that the computers on people's desks at work will not have hard drives, which will all be located on one server. Units of hardware, such as monitors and keypads are predicted to last at least ten years, and the server will be upgraded only

[37] Ibid, p. 12.
[38] *The Digital Future*, PC World Magazine, January 2000, p 116.
[39] *The Digital Future*, PC World Magazine, January 2000, p 116.

as needed. This approach will significantly reduce computer system maintenance requirements. Also, from this study's point of view, the size of equipment involved - a small desktop NC - will be considerably smaller than existing PCs, and the rate at which these units will be discarded may be slower than for current technology, thus reducing the flow of IT waste to disposal.

Sales and Leasing Trends

Leasing is becoming an increasingly popular way for businesses and organizations to acquire up-to-date computer equipment. The trend is projected to continue and expand rapidly, especially in Canada. About 25% of computer hardware is leased in Canada, compared to 35-50% in the U.S.[40]
The benefits of computer equipment leasing include:

- Planned and controlled replacement strategy;
- Reduced risk of obsolescence;
- Improved asset tracking;
- Freeing up working capital;
- Increased tax benefits;
- Improved financial planning, and;
- Elimination of equipment disposal issues (the leasing company is responsible for managing the used equipment).

Any company that is involved in leasing computer equipment to business generally manages end of lease equipment. In these agreements, companies return equipment to the lessor at the expense of the customer, or a fee is pre-charged for this expense. Some companies, such as IBM, manage the equipment internally. Other companies out source the asset management to a third party[41].

Technology Changes in Computer Equipment

Flat panel displays (FPDs) such as plasma display panels and liquid crystal displays (LCD) offer several environmental advantages over CRTs, including reduced weight-volume, energy consumption and lead content. Lifecyle analysis and recycling of FPDs is being researched at the University of Tennessee. It should be noted that while FPDs do not contain leaded glass, they do contain levels of mercury that are comparable to fluorescent lights[42]. While FPDs are currently available, they are prohibitively expensive for many users. FPDs are expected to be priced more competitively in 2003, but will still be more expensive than CRTs[43].

[40] IBM website, and comments by Pat Dillon, Tufts University, July 2000.
[41] Personal communication, David Weisz, IBM Canada, March 13, 2000.
[42] Proper Management of Cathode Ray Tubes, online discussion group coordinated by the National Recycling Coaltion, January 13, 2000
[43] *The Digital Future*, PC World Magazine, January 2000, p 116.

Many manufacturers are also attempting to design their equipment to facilitate upgrading. For example, IBM Printing Systems Company's InfoPrint 3900/4000 printer engine has been upgraded 19 times since 1990, enabling customers to upgrade their equipment rather than dispose of it.[44]

Another example of advancements in computer technology is the development of one machine with printing, faxing, scanning and copying capabilities. The development of these comprehensive machines will replace the need for four separate pieces of equipment with one, at a lower or comparable price. This may result in a significantly reduced amount of waste IT equipment at the end of its useful life.

Given the rapid technological advancements and the reducing "lag time" or lifespan of computer equipment, it will be challenging for waste management planners and policy makers to keep pace.

Corporate Environmental Developments

Worldwide trends in corporate environmental programs such as ISO 14001, EMS and Extended Producer Responsibility (EPR) are beginning to impact computer manufacturers in North America. Design for the Environment (DfE) programs at IBM, Apple and Compaq are addressing issues such as eliminating brominated flame retardants (BFR) in plastics, finding alternatives to lead for circuit board solder, and labeling of plastics to aid in dismantling.

[44] Compendium Of Design-For-Environment Efforts Of The Electronics Industries (Draft), Electronics Industry Association, March 8, 2000, p.9.

3.0 IT EQUIPMENT REUSE AND RECYCLING ACTIVITIES IN CANADA

This section describes some of the organizations and companies across Canada that are involved in reuse and recycling of IT equipment waste. This is not an exhaustive list of organizations involved in this business, but profiles a number of companies across Canada to show the range of activity currently taking place.

The IT equipment reuse and recycling infrastructure in Canada is far from uniform and has limited coverage. It is an immature business, with a relatively small number of companies across the country, but the numbers are growing. It is expected that the demand for this type of service will continue to grow as increasing quantities of IT waste enter the waste stream in future years.

That said, there are already a number of IT equipment waste reuse and recycling companies across Canada. Most companies try to refurbish viable IT equipment where possible, as this generates the highest revenue per unit. Units which can not be repaired, upgraded or sold, are manually dismantled by most recycling companies, who sort the IT equipment into its various components (sometimes into 40 separate categories) in order to get the highest market price for high quality material streams such as wire, circuit boards, power bars, semi-precious and base metals, etc. There are also some automated computer recycling companies that provide secure destruction services for information contained on hard drives, that also recycle component materials. Many companies who recycle IT equipment also handle telecom equipment.

3.1 Management of Leased IT Equipment

IT equipment leasing to businesses is a growing trend, involving large organizations such as IBM, Dell, Compaq, GE Financial Services and others. IBM Leasing indicated that the majority of their off-lease computer equipment is typically resold, either to the customer (lease to own) or in bulk sales to retailers/brokers. It is estimated that roughly 70% of end-of-lease computer equipment is resold. A small percentage, roughly 5% is donated to organizations such as Computers for Schools, In-Kind Canada and Re-Boot (see following page). The balance of equipment is 'witness destructed'[45]or transported to IBM's facility in Endicott, NY for dismantling and recycling.[46]

[45] Sent to a facility where the hard drive is destroyed to ensure that no confidential information is transferred to a new owner.

[46] Personal communication, David Weisz, IBM Canada, March 13, 2000.

3.2 IT Equipment Reuse Organizations

This section describes some Canadian organizations involved in IT equipment reuse activities. Reusable IT equipment having limited resale value is commonly donated to charitable nonprofits organizations, some of which are described below.

The Computers for Schools (CFS) Program, works with institutions, communities, business and governments to redistribute surplus computer equipment and software to Canadian elementary and secondary schools. The organization, sponsored by Industry Canada and the Telephone Pioneers (an industry-wide service club for current and former employees of the entire telecom industry in Canada, the U.S. and Mexico) has over 60 offices throughout Canada. It was established as part of Canada's objective to become *the most connected nation in the world*, and serves the dual objectives of providing computer technology to schools, and also training students and youth to repair and refurbish computer equipment. The organization runs over 60 workshops across Canada, staffed by volunteers from Telephone Pioneers and labour supplied under the federal Youth Employment Strategy. Private companies such as CN Rail, Sears Canada, Canadian Tire and others donate shipping services to distribute the equipment across Canada. All usable donated equipment is tested, refurbished and then delivered to recipients free of cost.

CFS distributed 73,000 computers to schools in 1999, and over 60,000 in 1998. Their goal is to increase annual quantities donated to 80,000, 100,000 and 115,000 units in the next three years. As of March, 2000, CFS had distributed nearly 187,000 refurbished/reused computers to Canadian schools and libraries since 1993. Their goal is to place 250,000 computers in schools and libraries by March 31, 2001. In addition, CFS has channeled 28,600 printers to schools since 1993.

CFS estimates that 50% of the equipment that they collect cannot be redistributed and this is sent to recyclers. Each province deals with their surplus stock individually. In Ontario, this equipment is sent to EPR in Mississauga or a recycler in Quebec. Approximately 1500 pallets per year of used equipment is sold to recycling companies at government auctions.

A shortage of useable monitors became a problem for CFS, so they started to investigate methods of repairing them. They are now successfully repairing a large number of monitors and are currently teaching CFS branches across the country this technique[47].

In-Kind Canada, based in Toronto, matches material surpluses of business, including IT and telecom waste, to the needs of charities. Through the program, businesses dispose of surplus goods for which they may receive an income tax receipt and member charities obtain goods and services at little or no cost. The program was piloted in Fall 1995 and was officially launched January 1, 1996.

[47] Personal communication with Paul Gagnon, Computers for Schools, March 22, 2000

In-Kind Canada currently works with 300 businesses and has 900 charity members. In 1999, the program distributed 1,092 CPUs (usually with monitors and keyboards), 47 laser printers, 28 deskjet printers, 56 dot matrix printers, 230 phones and 20-30 cell phones. Significant numbers of laptops have not been handled by the program to date.

While companies and charities are connected through the program across Canada, the majority of equipment is sourced from Toronto-area companies and other large centres. Charities are charged a fee of $100-$500 per year to participate in the program. This fee is based on In-Kind Canada's budget for the previous fiscal year and is not charged again until the member has received value for their membership (i.e., until they have purchased items of value exceeding the cost of their membership).

To supplement this income, In-Kind Canada receives corporate and foundation support. They also introduced pick-up fees for companies in January, 2000. The fee, which is calculated as 5% of the market value of the product they donate, will be waived for high-value donations.

In-Kind Canada's business has been primarily generated by word-of-mouth, but they are now stepping up promotion and communication efforts with an advertising campaign. In addition, a new E-commerce web site was launched in May 2000, and a program to collect, reuse and recycle cell phones is currently being developed[48].

Re-Boot, based in Toronto and Vancouver, collected 3,500 personal computers including 350 laptops, 2,500 monitors, and 1,000 printers from large companies and computer manufacturers (at end of lease) in 1999. Of the 3,500 computers, 500 were scrapped and the remaining 3,000 resold. Re-Boot estimates that 25% of incoming monitors could not be reused and therefore had to be disposed[49]. Re-Boot sends scrap to Hi-Tech Recycling in Toronto for manual dismantling and recycling. According to Re-Boot, computers with 386 processors have completely disappeared, 486 processors are slowly disappearing, and they are now beginning to handle Pentium 100 processors.

Waste exchanges are organizations that link generators of wastes with those organizations that can utilize the waste product. Provincial waste exchanges are active in B.C. and Ontario. The B.C. Materials Exchange (MEX) has been active in matching generators of computer equipment with organizations or companies that want the equipment for reuse applications. In 1998, the B.C MEX helped divert 106 tonnes of computers and electronics, with one match accounting for 100 tonnes. Several smaller matches make up the other 6 tonnes[50]. The Ontario Waste Exchange (OWE) provides generators with information on reuse and recycling outlets in the province.

[48] Personal communication with Elizabeth Stanton, Program Manager, In Kind Canada, March 21, 2000
[49] Personal communication with Kevin Smith, Re-Boot, March 3, 2000.
[50] Personal communication with Recycling Council of B.C., February 28, 2000.

3.3 IT Equipment Recycling Organizations

A number of companies throughout Canada recycle IT equipment. While the numbers are small, they are growing.

A list of IT equipment recyclers in Canada was derived through contact with provincial recycling organizations (e.g., Recyc-Quebec, Recycling Councils of Alberta, B.C, Ontario, etc.), municipal contacts and Internet searches. Enviros-RIS study team members surveyed a number of these companies to identify the type of recycling the company provides, their sources of IT equipment, markets used for materials produced by the recycling facility, barriers to increased recycling and estimates of the quantities handled. The response rate to the survey was not sufficiently high to draw firm conclusions on the amount of IT equipment waste recycled across Canada. A more comprehensive effort to obtain quantitative data from all companies in the IT equipment recycling business across Canada could form a future research project.

The IT equipment recycling business in Canada was found to cover a wide range of activities. Many of these activities are often performed by the same company. Most IT equipment recyclers will try to recover reusable equipment for refurbishment and sale to second hand outlets. Equipment at many locations is refurbished for resale or manually dismantled and sorted into its component parts and sent to scrap dealers for recycling. Refurbishment typically entails cleaning, testing, data destruction and sometimes parts replacement.

It should be noted that a considerable quantity of electronics equipment collected in North America is sent to markets and processors in China. An announcement early in 2000, by the Chinese government will impact this flow of electronics scrap. In February, 2000, China's State of Environmental Protection Administration (SEPA) announced a ban on imports of ten categories of waste electronics into the country beginning April 1, 2000. The end-of-life electronics to be banned include:

- air conditoners;
- computers, monitors and CRTs;
- copiers;
- microwaves;
- refrigerators;
- telephones;
- TV sets and tubes;
- video cameras;
- electric rice cookers, and
- video games.

SEPA officials responsible for drafting the Waste Ban Circular have indicated that recently conducted "market investigations" have determined that "there is no current demand in China for the continued supply of foreign electronics waste to be used as raw materials."[51]

[51] National Recycling Coalition (NRC) Electronics Recycling Initiative, Online discussion on March 2, 2000 on Contracting for Proper Recovery and Recycling of Electronic Products,

Canadian recyclers are now attempting to source alternate markets for monitors, CRT tubes and other scrap from electronic equipment, for which it has been typically difficult to find markets for Canada.

Information collected on specific recycling operations in this study is presented for different regions across Canada in the following sections.

3.3.1 IT Equipment Recyclers in British Columbia and Alberta

British Columbia

British Columbia is experiencing a significant growth in IT equipment recyclers. In 1997 there were only about three or four companies collecting used electronics in B.C., now there are more than twenty-five companies. Most of these companies are refurbishing equipment for resale and/or manually dismantling equipment to sell components to scrap dealers. A selection of these companies is described below.

Advanced Industrial Manufacturers (AIM) collects, refurbishes and scraps any type of electronic product. Equipment is refurbished for resale or manually dismantled, sorted into component parts and sent to scrap dealers for recycling. AIM collects roughly 100 tonnes of electronic equipment per year, including approximately:

- 20 tonnes of PCs
- 60 tonnes of monitors
- 10 tonnes of printers
- 10 tonnes of miscellaneous peripherals (including scanners fax machines and laptops)
- a small number of telephones and cell phones

Of the equipment collected, AIM successfully refurbishes and sells approximately:

- 33% of the monitors
- 10% of the PCs
- 1% of the printers
- 50% of the keyboards

It is estimated that 95% of the materials that are not refurbished are sent to scrap dealers for recycling. AIM sources its material from contacts provided by the Recycling Council of B.C. and from contacts at local businesses. All equipment is picked up free of charge.[52]

[52] Personal communication with Tom Fisher, AIM, March 21, 2000.

Cal's Computer Warehouse collects, refurbishes and scraps IT and telecom waste. Equipment is manually dismantled, sorted and refurbished for resale or sent to scrap dealers for recycling. The warehouse collects approximately 24 tonnes of IT and telecom waste per year from B.C. companies. PCs and keyboards make up about 50% of the equipment collected, while monitors and printers make up the majority of the remainder, at about 25% each. A small number of laptops, fax machines and telephones (including cell phones) are collected each year. Of the materials collected, approximately:

- 25% are refurbished and resold (higher for computers and monitors at 35% and 30% respectively)
- 49% were sent to China for recycling (however, this market is no longer available as of April 2000)
- 21% are put on an in-house 'reuse' table (or old models are placed in their museum).

Genesis Recycling collects and scraps 360 tonnes of IT and telecom waste each year from large corporations like BC Hydro, Telus, BC Tel and Ryder Computers. Sixty percent of the waste they handle is IT waste and the remaining 40% is telecom waste. None of the equipment that Genesis handles is refurbished for resale. Through a partnership with a local prison, inmates dismantle all equipment, which is then sorted by Genesis. The majority of the sorted material is sold to local scrap dealers, except for plastic residues, which are sold through a broker internationally. Genesis also has a special contract with an asphalt company that uses glass from monitors, including CRTs, as an aggregate. Genesis is also involved in a pilot monitor refurbishing program.[53]

electronics-recycling.com (ERC) collect, refurbish and recycle up to 7,000 tonnes of electronic equipment in Western Canada each year. The company provides collection containers and pick-up for its clients. Most of this material is sent to their recycling facility in China that handles about 25,000 tonnes of electronic waste from Japan, China and North America each year. Eight to ten per cent of all the electronics that they collect can be refurbished and reused and remaining materials are dismantled, sorted and ground for recycling. Reclaimed plastic is used in the production of plastic lumber and in the arts and crafts industry. Copper, aluminum, gold, silver, nickel and other metals are recovered and returned to related industries.

In China, CRTs are separated from the casing and crushed under high pressure and gravity separated.

For security purposes, ERC issues certificates of recycling and guaranteed destruction of data for the equipment they collect. The company is currently working with the B.C. Environmental Council to develop a municipal collection program that they hope to launch in 2000.[54]

[53] Personal communication with Al Graber, Genesis Recycling, March 21, 2000
[54] Personal communication with Kathy Yin, ERC, March 17, 2000.

Alberta

Discussions with IT equipment recyclers in Alberta indicate that there are two main companies involved in the business at this time. Another Calgary based company, TechnoTrash, previously handled IT equipment waste, but no longer handles this stream.

Triple Two Communications, based in Alberta, collects more than 2,000 tonnes of computers and peripherals and more than 2,000 tonnes of telecom products from large corporations, government and individuals throughout North America. This waste stream includes:

- Approximately 500 tonnes of computers (including a small number of laptops);
- Approximately 500 tonnes of monitors;
- Approximately 500 tonnes of peripherals (printers and scanners), and
- More than 2,000 tonnes of telephones (including a small number of cellular phones).

Triple Two refurbishes and resells one-third of the computers and peripherals that it collects and two-thirds of the telecom equipment that it collects. They estimate that 5% of the materials entering their facility (including packaging) is sent to landfill, 47.5% had been sent to China and 47.5% is manually dismantled into component parts, which are stockpiled for sale into the reuse market.[55]

Shankt Metals

Shankt metals opened in Edmonton in November 1999 and are already collecting and recycling eight to nine tonnes of PCs a month. Unusable PCs and mainframes are collected from various sources, including school boards, businesses and individuals. All equipment is manually dismantled, and separated into component metal and plastic streams. One hundred percent of the materials are diverted - scrap metal is sent to refineries and plastics are sent to China for recycling. Shankt is planning to increase their capacity and are also considering setting up their own refinery, in partnership with Triple Two Communications. They are also investigating technologies to recycle CRTs, which they currently do not accept.

The owner of this company has a successful computer recycling business in South Africa that is currently recycing 50-80 tonnes of scrap electronics per month.[56]

3.3.2 IT Equipment Recyclers in Northwest Territories, Yukon, Saskatchewan and Manitoba

No IT equipment recyclers were identified in the Northwest Territories or the Yukon during this study. There are a few small IT equipment retailers that are collecting equipment for reuse in Manitoba. These operations refurbish equipment where possible or dismantle it to use component parts.[57] No further information on these operations was available at the point of submitting this report.

[55] Personal communication with Jason Donaher, Triple Two Communications, March 13, 2000.
[56] Personal communication with Mone Haasbroek, Shankt Metals, July 2000.
[57] Personal communication with David Crawford, Manitoba Product Stewardship Corporation, August 1,2000.

The following operations were identified in Saskatchewan:

Syrotech Industries collects approximately 100 tonnes of computer equipment per year. All equipment is manually dismantled and separated materials are sold to recyclers.[58]

Regina Computer Exchange collects about 100 computers (including monitors) each year. They estimate that they are able to divert 90% of this equipment by refurbishing and reselling entire systems, or using component parts in a variety of ways. The Exchange does not collect telecom equipment.[59]

Saskatchewan Property Management Association

All government agencies in Saskatchewan are expected to send waste electronics to a centralized point for redistribution to other agencies or for public auction. Anything that can not be redistributed or sold is sent to a scrap dealer in Prince Albert.[60]

Saskatoon Computer Exchange is coordinated by Chris Little, who is based in Calgary and manages stores in both Saskatoon and Calgary. Further information on these two operations was unavailable at the time of submitting this report.

3.3.3 IT Equipment Recyclers in Ontario

The study team contacted the major IT equipment recyclers in Ontario. A summary of information obtained from some survey respondents is presented below, to illustrate the range of activity underway at this time.

Computer Recyclers Inc. is based in Nepean, Ontario. The company has six employees and has been in business for eight years. Incoming computers and peripherals are dismantled, primarily to recover resaleable parts such as hard-drives, video cards, motors, fans, keyboards and many other computer components. The recoverable items are manually removed and the components are resold through the store. Components that cannot be resold or are not required (e.g., metal housings) are sorted into categories for shipment to metal and smelting markets. The owner estimates approximately 48% of incoming material is recovered for parts, 48% is separated for recycling and 4% is disposed due to damage or age of equipment (i.e., old monitors)[61].

[58] Personal communication with Tom Syrota, Syrotech Industries, March 31, 2000.
[59] Personal communication with Martin Dodson, Regina Computer Exchange, July 2000.
[60] Personal communication with Dan Saskatchewan Property Management Association, July, 2000.
[61] Personal communication with Bo Brodie, Computer Recyclers, March 9, 2000.

Hi Tech Computer Recyclers is a Toronto-based computer equipment recycler that manually dismantles a wide range of computer and electronics equipment. Recoverable items are salvaged for resale and plastics, metals, wiring and circuit boards are recycled. Approximately 130 tonnes of circuit boards are recovered and sold to smelters for recovery of the precious metals. The monitors go to a joint venture company where they are crushed and the glass and metals are separated and recovered. Reusable computers are sent to Computers for Schools or Re-Boot for distribution and they in turn send non-reusable computers that have been donated to Hi Tech for recycling[62].

Electronic Product Recovery (EPR) Services Inc. opened a fully automated, high-capacity electronics recycling facility in Mississauga in 1999 (the first of its kind in Canada). The process involves a three stage reduction (shredding and granulation) system, together with automated material separation (magnets, eddy currents, fluidized bed and electrostatic dust recovery) that produces roughly nine streams for markets:

- a ferrous stream, which is clean and of consistent size;
- two streams of aluminum that are also clean and of consistent size;
- a stream of mixed, non-ferrous precious metals, such as copper, brass, zinc, for recovery;
- two streams of copper wiring, non-ferrous fines, including trace precious metals for off-site recovery by smelting and refining;
- a stream of mixed 'clean' plastics for metal value or use in building products, and;
- a stream of small particles, dust and fines that may also contain trace precious metals.

The facility has an operating capacity of about 2.7 tonnes per hour and can handle everything from large mainframe computers, to PC's, to cellular phones and telephones, fax machines, printers, VCR, software, cash registers and military hardware, without the need for manual dismantling. A separate system is being developed to process computer monitors and televisions (including the CRTs that they contain), which requires a method to control dust and particulates.[63]

EPR currently acquires equipment from OEM's and end-of lease equipment, schools boards, the Government of Ontario, municipal programs (e.g., Toronto, Peel, Barrie etc.) and large computer and systems integration companies.

EPR also offers its clients secure destruction, certification of recycling, depackaging, parts and components recovery and documented product tracking and logistics.

Accu-Shred is based in Mississauga and provides a secure destruction for OEMs and end-of lease equipment. The destructed material is sent off-site for metal and material recovery.

[62] "Hightech Recycling", Article posted on August 25, 1999.
[63] Personal communication with Gordon Weis, EPR, March 15, 2000

3.3.4 IT Equipment Recyclers in Quebec

The most significant IT equipment recycling activity in Quebec occurs at the Noranda Horne Smelter in Rouyn-Noranda and at the CCR refinery in Montreal. These and some other recycling operations are described below.

Noranda Recycling, Rouyn-Noranda and Montreal
Noranda Recycling is the largest recycler and end-user of computer and electronic end of life materials in the world. The Noranda facilities involved in the recycling of electronic scrap include the Horne Smelter in Rouyn Noranda and the CCR refinery in Montreal.

Noranda handles some 150,000 tonnes of recyclable copper and precious metal scrap annually. Of the 150,000 tonnes of recyclables handled annually, 78% is from U.S. sources, 13% (19,500 tonnes) are from Canadian sources and 9% from Europe. In total, 18 countries ship electronic and copper recyclables to Noranda for copper and precious metal recovery. Approximately 50,000 tonnes of the total is from electronic scrap from production and IT equipment recyclers.

Copper and precious metal bearing scrap is shipped to Noranda in a pre-processed state (generally 25mm to 50mm squares). The metal scrap is assayed for metal content, and the recyclers are paid based on the assessed metal value of the shipment, after a smelting and refining fee has been charged. The economics are such that loads are shipped to Noranda from California and overseas.

The copper and precious metal bearing materials are fed to the Horne copper smelter along with raw copper ore. Copper anodes are formed in the smelter. The copper anodes are then shipped to the CCR refinery in Montreal, where impurities (including precious metals such as gold, silver and palladium) are removed from the anodes through an electrolytic process. The Horne smelter produces 5% of the world's copper supply.[64]

Noranda has identified a number of growth areas for recycling, of which obsolete electronics and platinum/palladium from electronics is one target area. Some issues which have been identified is the decreasing quantities of precious metals contained in newer computers, as the design becomes more efficient.

The Horne smelter is the largest of its kind in North America. Other similar smelters include the Boliden facility in Sweden, Union Miniere of Belgium and a facility in Hamburg, Germany. The Cometco smelter in St Louis is similar, but of smaller scale.

Noranda also runs the following facilities in the U.S.:

- **Micro Metallics Corporation** that operates two facilities in California, including a joint venture electronic equipment disassembly and automated processing facility with Hewlett-Packard, and
- **Noranda Sampling** in Rhode Island which is dedicated to sampling and sample preparation of high grade precious metals materials generated primarily by the electronics and telecommunications industries.

[64] CJM, April 1999

Gestion ECOSYS Inc., Dorval

Gestion ECOSYS Inc. is a Dorval based computer asset management company that services eastern Ontario, Quebec and the Maritimes. ECOSYS services include buying, selling, renting and recycling of computer equipment as well as managing the computer assets of clients. ECOSYS estimates that roughly 70-80% of computer equipment managed is resold with the other 20-30% manually dismantled. It is estimated that roughly 40-50 tonnes of computer equipment are processed annually.

CFER, Quebec

CFER is a training program for unemployed people in the 18-25 age group (generally high school drop-outs) in Quebec. It is funded 50% by the Government of Quebec, and 50% by revenues from sale of equipment and materials. The program has been in place for almost two years, and there are a number of workshops located throughout Quebec. In partnership with Computers for Schools, young adults are trained during a 6-month period to recycle and upgrade computer equipment. Their training also includes inventory control (for computer parts) and handling warehouse loading equipment. IT equipment that can not be repaired is disassembled and the parts are sold.

As an example of the level of activity involved, the Montreal CIFER location has a staff of 10 (5 technicians, 1 social worker, 1 sales rep and admin staff). Every three month cycle, 12 new interns enter the 6-month program, which handles about 5,000 computers each year. The facility has trained 100 interns to date. At the end of the 6-month internship, CFER staff assist the interns with a job search.

A1 Vente Ordinateurs, St Laurent, PQ

This company has been in business for 3 years, and handles about 200 skids a month (80,000 lbs a month or 436 tonnes/year) of used IT equipment which it buys at government auctions and obtains through other sources. Six staff repair IT equipment which can be salvaged. All non-salvageable materials are sent to a general purpose recycler. The reconditioned units are sold to computer dealers and also at the company-owned store on Decarie in Montreal. The company operates a 2,300 sq m (23,000 square foot) warehouse in St Laurent.

3.3.5 IT Equipment Recyclers in the Maritimes

Research revealed that there are currently no companies specializing in recycling of IT equipment in the Maritimes. There are however a few organizations that will collect the IT equipment for reuse, depending on the quantities involved.

Dartmouth Metal & Bottle handles mostly scrap metals and glass but will accept scrap computer and electronic equipment, depending on the composition and condition of the equipment.

Rider Computer Services has offices across Canada that conduct some level of IT equipment recycling and salvaging.

3.4 Municipal Diversion Initiatives in Canada

Many small business and most residential units across Canada depend on the municipal waste management system, including municipal recycling services, to provide options for the management of IT equipment.

The study team contacted representatives of provincial recycling organizations and municipal waste management departments in Canada's larger cities for information on initiatives undertaken by municipalities to divert IT equipment waste from disposal.

In general, a significant amount of activity occurs at the school board level across Canada, to ensure that older IT equipment is used where possible before disposal.

This section outlines the results of this research, grouped by geographic area

Western Canada and the Prairies

Greater Vancouver Regional District (GVRD)

The GVRD does not currently offer collection and recycling programs for IT waste. They do however provide fact sheets containing contact information for local recyclers of IT waste. In addition, a hotline offered by the Recycling Council of British Columbia also directs callers to local recyclers that will accept residential and commercial IT waste.

Alberta IT Waste Project

The Government of Alberta, in partnership with the Alberta Plastics Recycling Association and the Capital Region Waste Minimization Advisory Committee (City of Edmonton and 19 other municipalities) commissioned a study to address IT waste in April, 2000. The study will identify the number of computers landfilled in Alberta each year, assess what is happening about computer waste elsewhere, and identify partnerships which would be essential to make computer recycling viable in Alberta. The study is currently underway, with a draft report expected in August, 2000.

City of Edmonton

The City began accepting computers and electronic equipment at their two Eco Stations and at Garbage Fairs (volunteer-run reuse exchanges) in September 1999. The equipment goes to either Shankt Metals. A total of 20 gaylords (pallet boxes) have been diverted between September 1999 and March 2000.[65]

City of Calgary

The City of Calgary does not currently offer any IT equipment recycling services to residents.

City of Winnipeg

[65] Personal communications with Garry Spotowski, City of Edmonton, Waste Management Branch, March 24, 2000.

The City of Winnipeg does not currently offer its residents a collection program for electronic waste.

Ontario

It is of particular interest that many municipalities in southern Ontario will implement some type of IT equipment collection programs some time in the year 2000, partly in response to public requests for this service, and also because of a perception that amounts of IT waste are rapidly increasing.

City of Barrie

The City of Barrie, Ontario (population 70,000) pilot tested the collection of computer equipment through their HHW depot. The City advertised to residents in Barrie that they could drop-off their old computers for recycling on a particular Saturday. The HHW depot is open Fridays and Saturdays during spring, summer and fall. Arrangements were made with EPR (Mississauga) to have the computers picked up on the following Tuesday. Staff at the depot placed the computers in gaylord boxes on skids. EPR collected a total of seven gaylord boxes of computers. The City is planning another trial for spring 2000 with EPR. Neighbouring Simcoe County piggybacked with Barrie's collection program and plans to integrate the collection of waste computers with its household hazardous waste collection events, which are provided four days a year.

City of Toronto

City of Toronto (population 2.4 million) collected old computers at 28 Environment Day events (one per ward) in 1999. The Environment Day events include a range of waste reduction activities, such as education, distribution of recycling Blue Boxes, purchasing home composters, collection of used clothing, tires, non-perishable food, and household hazardous waste. In 1999, a total of 14 tonnes of computers were collected for reuse and recycling (approximately 1,025 computers). Computer equipment was also collected at two Scarborough drop-off sites. The total collected for 1999 was 4.3 tonnes (315 computers). In both instances, EPR collected and processed the equipment.

Region of Peel

The Region of Peel (population 900,000), neighbour to Toronto, currently operates reuse areas at its landfills and staff report that computers are frequently dropped off and picked up by the next car. Therefore it is reasonable to assume that significant reuse of IT equipment occurs in the region. The region is also in the process of establishing a collection program for IT waste at its four depot sites and is negotiating a contract with EPR for the recycling of the equipment.

Region of Halton

As of May 2000, the Region of Halton provides their residents a drop-off bin at the landfill site for the collection of electronic waste. EPR has been contracted to recycle the equipment.

Centre and South Hastings

Centre and South Hastings, in Ontario, has an arrangement with local businesses to take back old computers and refurbish them for distribution to schools, welfare recipients, etc. Sears, Northern Telecom and other local entrepreneurs offer take back programs for computers. The computers are refurbished for sale or donation.

Regional Municipality of Ottawa-Carleton

Monitors, keyboards, toner cartridges and other hardware are returned to manufacturers through the region's Take It Back! program. An Internet directory contains a listing of retailers that participate in this program. The Region will continue to expand this program by enlisting the participation of additional retailers and promoting the service to residents.

Quebec and the Maritimes

Montreal Island Municipalities

There are currently four 'Eco-Centres' on the island of Montreal that act as depots where residents can drop-off a variety of products, including IT and telecom equipment. These centres are owned by the municipality, but their operation is contracted out to various organizations that operate the depots. Only items that are perceived to be of reuse value will be accepted.[66]

Halifax Regional Municipality

There are several companies in Halifax Regional Municipality that refurbish old computers for use in schools and non-profit organizations. A listing is available at the Nova Scotia Materials Exchange. However, the City of Halifax does not run an active recovery program at this time.

[66] Personal communication with Josee Methot, Inter-municipal Waste Management Board of the Island of Montreal, July, 2000.

3.5 Corporate Initiatives

The following are examples of end-of-life initiatives undertaken by original equipment manufacturers (OEMs). This information has been found through a survey carried out as part of this study, through a search of corporate web sites and corporate environmental health and safety reports. In some cases, it is not clear the extent to which services are offered to Canadian customers. Company representatives were contacted as part of this study but response to the study survey was limited. In most cases, product take-back is not occurring in Canada because the companies are based in the U.S. and they have not yet expanded initiatives into Canada. The information collected is presented for information. These programs could possibly extend into Canada at a future time.

Apple Canada

Apple Canada does not coordinate or participate in a Canadian-based take-back program.

Corning-Asahi

Corning-Asahi has established process technology and installed materials handling systems that can accommodate end-of-life recycled glass and currently recycles CRT glass recovered by recyclers into new CRT glass.[67]

Hewlett-Packard

Hewlett-Packard has product recovery centres in France, Germany and California, where the company reuses or recycles more than 1.6 million kg each month, or 99% by weight of materials received from its customers and company operations.[68]

The facility in Roseville, California was developed through a partnership with Micro Metallics (Noranda precious metals recycling). Together they built and operate a 20,000 sq m (200,000 square foot) full service electronic hardware recycling operation. This fully automated computer- controlled metal separation plant went on-line at the end of 1997 and now has 180 employees. The end of life materials management facility recycles 100 percent of incoming material.

Electronic product dismantling is performed at workstations, complete with network links to a parts requirement database. Useful parts and components are recovered, sorted, tested and prepared for sale. The dismantling process produces a large volume of mixed-metals hardware materials. These materials go through a sophisticated shredding and separation process, resulting in clean metals ready for direct sale to metal producers. Materials not requiring separation are collected and prepared for third party recycling. The equipment processed at the facility includes personal computers, workstations, printers, copiers and telecommunications equipment[69].

All of the electronic scrap is shipped to the Horne smelter in Rouyn-Noranda, Quebec (described in Section 3.3).

[67] Compendium Of Design-For-Environment Efforts Of The Electronics Industries (Draft), Electronics Industry Association, March 8, 2000, p.17.
[68] Amore, Dawn, *Study Finds Computer Recycling Not Clicking*, Waste Age Magazine, December 1999, p. 15.
[69] Micro Metallics website,

IBM

IBM began offering product takeback programs as early as 1989 in Europe and continues to expand these programs. There are currently twelve product take-back programs in Europe and South Africa. The IBM Credit Corporation announced the Product End-of-Life Management Service for U.S. commercial customers in 1997.

IBM operations include 10 major reutilization and materials recovery centers around the world, with additional locations supporting parts return and regional collection. In 1997, these operations processed more than 62,000 metric tonnes of manufacturing scrap, IBM owned end-of-life machines and customer returned equipment. More than 90 percent of this amount was recycled and less than 5 percent was sent to landfills[70]. Dismantling and recycling expertise is shared among these centers to increase recycling efficiencies and reduce the amount of waste sent to landfills[71].

Intel Corporation

Used PCs from Intel internal use are refurbished and reassigned throughout the company. The company also helps coordinate a donation program for used PCs to local communities and schools.[72]

Pitney Bowes

Pitney Bowes operates an asset recovery program for mailing systems and office equipment that has been returned because of an upgrade or the expiration of a service term. In 1998, the company remanufacturered over 270,000 units and over 1.2 million parts were reused in the U.S.

Various U.S. Manufacturers and the New Jersey Institute of Technology (NJIT)

The EIA, its members and the (NJIT) are working on developing markets for recycled CRT glass, such as using re-engineered CRT glass as x-ray shielding materials for wall coverings in hospitals, medical centers, and industrial radiological departments, or in portable applications for mobile x-ray barriers.[73]

[70] Amore, Dawn, *Study Finds Computer Recycling Not Clicking*, Waste Age Magazine, December 1999, p. 14-15.
[71] IBM website, www.ibm.com/ibm/environment/annual98/product.phtml
[72] Compendium Of Design-For-Environment Efforts Of The Electronics Industries (Draft), Electronics Industry Association, March 8, 2000, p. 10.
[73] Compendium Of Design-For-Environment Efforts Of The Electronics Industries (Draft), Electronics Industry Association, March 8, 2000, p.16.

4.0 TELECOM EQUIPMENT

Similar to the IT sector, the telecommunications industry in Canada, and throughout the world, is experiencing tremendous change and growth. The changes in the industry are due to a number of factors, including:

- Deregulation and technological innovation around wireless networks and data networks;
- Deregulation of industry and increasing competition in the long distance, data and wireless services and increasing competition in local services;
- Consolidation in Canadian telecommunications (e.g., consolidation of regional providers and the formation of larger companies such as TELUS and Aliant; foreign investment from GTE, British Telecom, AT&T in Canadian industry);
- Telecommunication companies are moving from regional, single service companies to national integrated telecommunication providers with local, long distance, business data, wireless, internet, cable/video/multimedia services (e.g., Bell group of companies, Rogers Communications etc.). This is due in part to increasingly open competition, industry consolidation and technological advancements;
- Telecom equipment is now sold by a variety of retailers, and
- Downsizing and expanding capabilities of telecom equipment (i.e., expandable equipment, integrated wireless service).

The distinction between the IT and telecom sectors will blur in the future as IT and telecom applications, markets, products converge with further developments of the Internet and wireless communication.

This section addresses the generation and flow of the following elements of waste telecom equipment:

- Telephones (residential and business);
- Wireless phones (e.g., cellular, digital, pagers),and
- Facsimile machines.

Large pieces of telecom equipment such as Central Office Equipment, transmission equipment, Private Branch Exchanges (PBXs), key systems, routers, switches and other types of public and private network data and voice equipment for both land-line and wireless networks are beyond the scope of this study, which focuses on consumer, business and individually generated waste components rather than telecom company generated waste.

4.1 Telecom Waste Flow Tool

Waste generation and management estimates were prepared for telecom equipment using a lifespan model similar to that used to generate the IT equipment waste flow, assuming that similar management options and waste generation principles apply for telecom equipment.

One difference of note between IT equipment and telecom equipment is the difference in average first use lifespans. Whereas most IT equipment reach the end of their first life (or become obsolete) between 3-5 years, longer lifespans of between 5-10 years are projected for telephones, mobile phones and facsimile machines[74].

It should also be noted that the annual shipment estimates for telecom equipment were not as readily available as for IT equipment. Estimates of annual shipments for telephones and mobile phones were based on Canada Industry and trade import figures (in dollars) from 1996-1999. These figures were converted to unit sales by dividing by an estimated average price per unit.

Facsimile machines sales figures for 1998-2001 were obtained from a study published by the Canadian Office Automation Research in May 1999, entitled Canadian IT & telecom Data Service Vol.XVII, 1999.

Tables 4-2 to 4-4 present projected flows of discarded telephones, cellular telephones and fax machines in Canada for the period 1992 to 2005. Data contained in these tables is summarized in Table 4-1, below.

Table 4-1 – Summary of Weight and Number of Telecom Equipment Components to Storage, Reuse, Recycling and Disposal in Canada in 1999.

Equipment Type	Reuse		Storage		Recycled		Disposed	
	Units (millions)	Tonnes	Units (millions)	Tonnes	Units (millions)	Tonnes	Units (millions)	Tonnes
Telephones	1.07	1,450	0.11	145	1.14	1,554	0.82	1,119
Mobile phones	0.08	19	0.31	76	0.13	34	0.52	129
Fax machines	0.08	784	0.03	261	0.07	668	0.17	1,713
Total		**2,253**		**482**		**2,256**		**2,961**

[74] Personal communications with Wendy Luther, TELUS and Don Blenz, SaskTel, March, 2000.

Table 4-2 - Waste Flow Tool for Telephone Handsets in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:	Obsolete Disposed
1995-1999	= 50%	= 5%	= 30%	= 15%
2000-2005	= 50%	= 5%	= 35%	= 10%

New Telephone Sales			**Telephone Life Span - First Use**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**		**Annual Disposal[9]**	
Year	Units[1]	Tonnes[2]	Share of Telephones Lasting (				Average First	Units	Tonnes	Units	Tonnes	Units	Tonnes	Units	Units	Units	Tonnes
	(M)		8	6	4	2	Life[4] (Yrs)	(M)		(M)		(M)		(M)	(Tonnes)	(M)	
1992	2.015	22,771	40%	30%	20%	10%	6	0.955	10,786	0.48	5,393	0.05	539	0.41	4,595	0.26	2,977
1993	2.121	2,885	40%	30%	20%	10%	6	1.568	2,132	0.784	1,066	0.078	107	0.597	2,070	0.362	1,750
1994	2.233	3,037	40%	30%	20%	10%	6	1.650	2,244	0.825	1,122	0.083	112	0.628	2,179	0.381	1,843
1995	2.350	3,196	40%	30%	20%	10%	6	1.737	2,362	0.869	1,181	0.087	118	0.784	3,675	0.523	3,321
1996	2.474	3,365	40%	30%	20%	10%	6	1.828	2,487	0.914	1,243	0.091	124	0.980	1,332	0.705	959
1997	2.604	3,542	40%	30%	20%	10%	6	1.925	2,618	0.962	1,309	0.096	131	1.031	1,402	0.742	1,010
1998	3.393	4,615	40%	30%	20%	10%	6	2.026	2,755	1.013	1,378	0.101	138	1.085	1,476	0.782	1,063
1999	**3.767**	**5,124**	**40%**	**30%**	**20%**	**10%**	**6**	**2.133**	**2,900**	**1.066**	**1,450**	**0.107**	**145**	**1.143**	**1,554**	**0.823**	**1,119**
2000	4.325	5,881	40%	30%	20%	10%	6	2.310	3,142	1.155	1,571	0.116	157	1.222	1,662	0.876	1,191
2001	4.411	5,999	40%	30%	20%	10%	6	2.451	3,334	1.226	1,667	0.123	167	1.415	1,924	0.802	1,091
2002	4.499	6,119	40%	30%	20%	10%	6	2.746	3,735	1.373	1,868	0.137	187	1.548	2,105	0.861	1,171
2003	4.589	6,241	40%	30%	20%	10%	6	2.916	3,966	1.458	1,983	0.146	198	1.656	2,252	0.927	1,261
2004	4.681	6,366	40%	30%	20%	10%	6	3.322	4,519	1.661	2,259	0.166	226	1.837	2,498	1.006	1,369
2005	4.775	6,493	40%	30%	20%	10%	6	3.513	4,778	1.757	2,389	0.176	239	1.985	2,699	1.107	1,505

Footnotes

1 Canadian Imports Report for 1996 to 1999 from Industry Canada (http:/strategis.ic.g.ca). Figures provided were in dollars. Assumed average cost of telephone is $80 and of a cordless phone is $100.

2 Assuming average handset weight 1.36 kg per unit (W. Luther, TELUS)

3 Personal communications with Wendy Luther, TELUS and Don Benz, SaskTel - Feb/2000

4 Average Lifespan = annual sales x share (%) of telephone first life

5 Represents the number of telephones that become obsolete at the end of first life

6 Annual Reuse includes equipment that is refurshished or resold by telephone companies or donated to third party organizations,

7 Estimated number of telephone that are placed in Storage at the end of first life

8 Estimated number of telephone that are sent to a recycling organization at end of first life, plus 50% of stored from 3 years ago + 50% of reused from 3 years ago

9 Estimated number of telephone that are sent to disposal at end of first life, plus 50% of stored from 3 years ago + 50% of reused from 3 years ago

Table 4-3 - Waste Flow Tool for Mobile Phones in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:	Obsolete Disposed
1995-1999	= 10%	= 40%	= 0%	= 50%
2000-2005	= 5%	= 40%	= 5%	= 50%

New Mobile Phone Sales			**Mobile Phones Life Span - First Use**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**		**Annual Disposal[9]**	
Year	Units[1] (M)	Tonnes[2]	Share of Mobiles Lasting (years) 5	4	3	2	Average First Life[4] (Yrs)	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Tonnes	Units (M)	Units (Tonnes)	Units (M)	Tonnes
1992	0.581	145	30%	30%	20%	20%	3.7	0.461	115	0.046	12	0.184	46	0.104	26	0.335	84
1993	0.683	171	30%	30%	20%	20%	3.7	0.485	121	0.049	12	0.194	49	0.110	27	0.352	88
1994	0.804	201	30%	30%	20%	20%	3.7	0.511	128	0.051	13	0.204	51	0.115	29	0.371	93
1995	0.946	236	20%	20%	30%	30%	3.3	0.654	164	0.065	16	0.262	65	0.121	30	0.448	112
1996	1.113	278	20%	20%	30%	30%	3.3	0.587	147	0.059	15	0.235	59	0.128	32	0.421	105
1997	1.309	327	20%	20%	30%	30%	3.3	0.540	135	0.054	13	0.216	54	0.164	41	0.433	108
1998	0.851	213	10%	10%	40%	40%	2.9	0.730	182	0.073	18	0.292	73	0.147	37	0.512	128
1999	**1.423**	**356**	**10%**	**10%**	**40%**	**40%**	**2.9**	**0.764**	**191**	**0.076**	**19**	**0.306**	**76**	**0.135**	**34**	**0.517**	**129**
2000	1.566	391	10%	10%	40%	50%	3.1	0.804	201	0.080	20	0.322	80	0.223	56	0.585	146
2001	1.722	431		10%	40%	50%	2.6	0.825	206	0.082	21	0.330	82	0.232	58	0.603	151
2002	1.894	474		10%	40%	50%	2.6	0.916	229	0.092	23	0.366	92	0.247	62	0.659	165
2003	2.084	521		10%	40%	50%	2.6	0.854	213	0.085	21	0.341	85	0.249	62	0.633	158
2004	2.292	573		10%	40%	50%	2.6	0.988	247	0.099	25	0.395	99	0.278	70	0.723	181
2005	2.522	630		10%	40%	50%	2.6	1.087	272	0.109	27	0.435	109	0.268	67	0.757	189

Footnotes

1 Statistics Canada mobile phone usage for 1996-1999. Statistics Canada estimates 6 million mobile phones in use in 1999.

2 Assuming average mobile weight 0.25 kg per unit (Average weight of 5 different mobile phones by Enviros RIS, Feb/2000)

3 Personal communications with Wendy Luther, TELUS, Feb/2000

4 Average Lifespan = annual sales x share (%) of mobile phone first life

5 Represents the number of mobile phones that become obsolete at the end of first life

6 Annual Reuse includes equipment that is resold or cascaded to within a family

7 Estimated number of mobile phones that are placed in Storage at the end of first life

8 Estimated number of mobile phones that are sent to a recycling organization at end of first life, plus 50% of stored from 2 years ago + 50% of reused from 2 years ago

9 Estimated number of mobile phones that are sent to disposal at end of first life, plus 50% of stored from 2 years ago + 50% of reused from 2 years ago

Table 4-4 - Waste Flow Tool for Facsimile Machines in Canada from 1992-2005

Timeframe	Obsolete Reuse:	Obsolete Stored:	Obsolete Recycled:
1995-1999	= 30%	= 10%	= 10%
2000-2005	= 30%	= 10%	= 15%

New Fax Sales			**Fax Machine Life Span - First Use**					**Annual Obsolete[5]**		**Annual Reuse[6]**		**Annual Storage[7]**		**Annual Recycled[8]**	
Year	Units[1]	Tonnes[2]	Share of Fax Lasting (years)[3]				Average First	Units	Tonnes	Units	Tonnes	Units	Tonnes	Units	Units
	(M)		8	6	4	2	Life[4] (Yrs)	(M)		(M)		(M)		(M)	(Tonnes)
1992	0.202	2,017		30%	40%	30%	4.0	0.146	1,457	0.044	437	0.015	146	0.033	338
1993	0.219	2,193		30%	40%	30%	4.0	0.158	1,584	0.048	475	0.016	158	0.043	367
1994	0.238	2,383		30%	40%	30%	4.0	0.172	1,722	0.052	516	0.017	172	0.046	475
1995	0.259	2,591		30%	40%	30%	4.0	0.187	1,871	0.056	561	0.019	187	0.050	479
1996	0.282	2,816		30%	40%	30%	4.0	0.203	2,034	0.061	610	0.020	203	0.055	520
1997	0.306	3,061		30%	40%	30%	4.0	0.221	2,211	0.066	663	0.022	221	0.060	565
1998	0.333	3,327		30%	40%	30%	4.0	0.240	2,403	0.072	721	0.024	240	0.065	615
1999	**0.358**	**3,579**		**30%**	**40%**	**30%**	**4.0**	**0.261**	**2,612**	**0.078**	**784**	**0.026**	**261**	**0.070**	**668**
2000	0.383	3,831		30%	40%	30%	4.0	0.284	2,839	0.085	852	0.028	284	0.091	868
2001	0.408	4,083		30%	40%	30%	4.0	0.308	3,075	0.092	923	0.031	308	0.098	942
2002	0.437	4,369		30%	40%	30%	4.0	0.332	3,325	0.100	997	0.033	332	0.107	1,021
2003	0.468	4,675		30%	40%	30%	4.0	0.357	3,575	0.107	1,072	0.036	357	0.115	1,104
2004	0.500	5,002		30%	40%	30%	4.0	0.384	3,841	0.115	1,152	0.038	384	0.124	1,191
2005	0.535	5,353		30%	40%	30%	4.0	0.438	4,375	0.131	1,313	0.044	438	0.137	1,321

Footnotes

1 Canadian IT & Telecom Industry Data Service, Vol. XVII 1999, page 1-9.
2 Assuming average facsimile machine weighs 10 kg.
3 Enviros RIS estimate on lifespan for fax machines
4 Average Lifespan = annual sales x share (%) of peripherals first life
5 Represents the number of facsimile machines that become Obsolete at the end of first life
6 Annual Reuse includes equipment that is resold (from end of lease or to brokers) or donated to third party organizations,
7 Estimated number of facsimile machines that are placed in Storage at the end of first life
8 Estimated number of facsimile machines that are sent to a recycling organization at end of first life, plus 50% of stored from 3 years ago + 50% of reused from 3 years ago
9 Estimated number of facsimile machines that are sent to disposal at end of first life, plus 50% of stored from 3 years ago + 50% of reused from 3 years ago

4.2 Telephones

Since the 1930's local telephone service has traditionally been provided on a provincial basis by telephone companies. Currently, this delivery structure remains in place, although there has been considerable industry consolidation and formation of strategic and business alliances. The companies involved in providing local telephone services are presented in Table 4-5 for information.

Table 4-5 - Overview of Canadian Telecommunications Providers

Provider	Service Area
Bell Canada	- Serves Ontario and Quebec
TELUS	- Serves B.C. and Alberta (merger of TELUS in
SaskTel	- Serves Saskatchewan
NorthwesTel	- Serves the Territories
MTS	- Serves Manitoba
NB Tel	- Serves New Brunswick and part of Aliant Group
MTT	- Serves Nova Scotia and part of Aliant Group
Island Tel	- Serves PEI and part of Aliant Group
Newtel	- Serves Newfoundland and part of Aliant Group
AT&T Canada	- Limited to business service across Canada (linked

According to Statistics Canada, the public-switched telephone network wireline access reached 19 million lines at the end of the second quarter of 1999. Residential lines account for 66.3% of the total and business lines represent 33.7% of PSTN lines.[75].

Assuming there are four telephones for each PSTN line with an average weight of 1.36 kg per telephone[76], there are approximately 100,000 tonnes of telephones currently in use throughout Canada's households and businesses.

The composition of the average telephone has also changed considerably with the transition from rotary dials to phones with circuit boards and silicon keypads. The average composition of today's telephone is shown in Table 4-6.

[75] *Telecommunications Statistics, 2nd Quarter, 1999*, Catalogue No. 56-002-XIB, Vol. 23 No. 2, Statistic Canada.
[76] Personal communications with Wendy Luther, TELUS, February 28, 2000.

Table 4-6 - Average Telephone Composition

Material Composition	% by Weight[77]	Quantity In Use (based on 100,000 tonnes of telephones in use)
Ferrous/Non-ferrous Metals	50%	50,000
Circuit boards/pads	30%	30,000
Plastics (mostly ABS)	20%	20,000
Totals	100%	100,000

The average lifespan of today's phone is seven years, and can be as high as 10 years or more, depending on usage patterns and whether the customer wants new features (e.g., call display) or a new colour or style[78]. One common repair issue with telephones is the silica keypad, which can wear out and need replacing.[79] A second repair issue is damage due to spills of coffee and other liquids on workplace phones. Business phones are often replaced for cosmetic reasons, when an office is redecorated.[80]

4.3 Refurbishment/Reuse of Telephones

Traditional provincial telephone service companies provide residents or business with telephones equipment either through renting or purchasing. Due to the limited number of companies that were involved in manufacturing the rotary dial telephone systems, the provincial telephone companies established a return and equipment refurbishment system for broken equipment.

Return and refurbishment systems were established because the provincial telephone companies owned all of the phones (residents were not allowed to purchase a telephone in Canada until relatively recently) and the economics were good for a central repair facility. The situation is very different now because there are many more vendors and models of telephones, most are owned by end-users, and cheap residential models are essentially throw away items that can be replaced for less than they would cost to repair.

In most instances, residents who had a broken telephone simply returned the unit to the telephone company who in turn provided a replacement telephone. The broken system was then repaired by the telephone company, either internally or through a contracted third party. The refurbished telephone was then returned to service as a replacement. Telephone sets that could not be refurbished were either dismantled for parts by the company or sold to a contracted recycler. This system has been in place for approximately the past 60 years in Canada and continues today.

Information from Bell Canada, TELUS, SaskTel, MTS and NB Tel indicated that an estimated 1.387 million residential and business telephone sets were refurbished and

[77] Personal communications with Charles Whatman, Triple Too Communications, March 15, 2000.
[78] Personal communications with Wendy Luther, TELUS, February 28, 2000.
[79] Personal communications with Don Benz, SaskTel, March 3, 2000.
[80] Personal communication with Duncan Noble.

returned to the marketplace in 1999[81]. Together, these four companies represent approximately 93% of the Canadian market for telecom services. Assuming that this is a reasonable reflection of the volume of telecom equipment handled, through extrapolation for the rest of Canada, the estimated number of telephone systems that were refurbished in 1999 was 1.491 million, representing an estimated 2,028 tonnes (assuming a unit weight of 1.36 kg).

4.3.1 Dismantling and Recycling of Telephones

Information of the number of telephone sets that were sold to secondary and recycling markets was obtained from Bell Canada, SaskTel and NB Tel. Together these three companies sell some 256,500 telephone sets to secondary markets for either dismantling or resale out of the country. Together, these three companies represent approximately 59% of the Canadian market. Therefore, extrapolating for the rest of Canada, an estimated 435,000 telephone sets (590 tonnes) were sent for recycling or off-shore reuse.

Some of the companies involved in dismantling and recycling of telephone sets across Canada are described briefly below.

Triple Two Communications is a Calgary based company that is involved in telephone system dismantling and reselling. Telephone sets that cannot be resold are manually dismantled into their component parts such as ferrous and non-ferrous metals, plastics (primarily ABS) and circuit boards that are shipped to Micro Metalics in California for consolidation and to Noranda in Quebec for processing to recover various metals. Telephones that can be resold are consolidated and sold through a separate company (Mid Com). Bulk loads of telephones are sold to customers in Brazil, China and Indonesia. There is also a resale market for cellular telephones in Brazil.[82]

Genesis Recycling collects an estimated 145 tonnes of telecom waste each year from TELUS in B.C. Through a partnership with Corrections Canada, prison inmates dismantle equipment. Sixty percent of the waste they handle is IT waste and the remaining 40% is telecom waste.

Progistix-Solutions Inc. specializes in providing logistics services to technology and telecommunication companies. Progistix has two main warehouses in Toronto and Montreal and handles equipment for Bell Canada and Nortel. The equipment is refurbished where possible and systems that cannot be reused are either sold or dismantled for recycling.

Triple R Telecom is a Saint John, NB company that specializes in the sales of new and used telecommunications equipment. Triple R Telecom has also expanded their telecommunications removal to include computer mainframe and networking systems. They primarily sell used equipment on the international market, particularly in the Asian market. They send equipment that cannot be resold to various recyclers. They currently recycle over 20 tonnes of month of various types of electronic equipment. Sources of equipment include NB Tel and private companies in Quebec, the Maritimes and the U.S. Triple R is affiliated with a similar company in Nova Scotia (Communications Link) and with Mid Com in Alberta (discussed above).

[81] Information received from Bell Canada website, and surveys from Wendy Luther, TELUS, Bob Reynolds, NB Tel and Don Blenz, SaskTel.
[82] Personal communications with Charles Whatmore, Triple Too Communications, March 20, 2000.

4.4 Corporate Initiatives in Telephone Recycling

In September 1997, Nortel and Environment Canada embarked on a joint $1.2 million research project to explore environmentally preferable design technologies for telephones. The project explored sustainable design and production practices to decrease environmental impact and provide a competitive edge in the global economy.

The Vista design is another example of a model that incorporates sustainable design principles. Three new Vista models were designed with two parts - a standard base with basic telephony features and an upgradeable slide-in module, that allows the addition of features (i.e., incoming caller ID, call waiting, or a larger screen and better graphic display). The base is designed to hold its functionality for a long time, while the modules can be interchanged to provide the latest features at half the price of replacing the phone.

4.5 Wireless Telephone Systems

According to Statistics Canada, cellular telephone network access reached six million subscribers at the end of the second quarter of 1999.[83] Another estimate provided by the technology research firm International Data Corporation (Canada) is that the cellular phone market is expected to grow from 6.7 million subscribers at the end of 1999 to 16.6 million by 2003[84].

Technological advancements have reduced the volume and weight of cellular phones from the 0.3 kg for early 1990's 'flip phones' to the 0.22 kg units in the late 1990's, to the current units, which weigh 0.08 to 0.15 kg. Assuming an average weight of 0.2 kg per unit, the 6.7 million units in 1999 represent a total weight of 1,350 tonnes and will reach some 3,300 tonnes by 2003[85]. No specific composition information was found for cellular phones.

The cellular phone market in Canada consists of service providers including Bell Mobility, Rogers AT&T Wireless, TELUS Mobility, Clearnet, Fido/Microcell and a number of small regional services. The cellular phone suppliers include Motorola, Nokia, Ericsson, and Qualcom.

According to one of the telephone companies contacted by Enviros RIS, even though there have been many new models and styles of cellular phone introduced to the marketplace, customers typically do not discard cellular phones, instead they are stored or passed on to others.

Wireless communication systems (which include electronic pagers) were not addressed in this study, but it is of interest to note that Statistics Canada reports that paging subscribers reached 1.4 million at the end of the second quarter of 1999.[86].

4.5.1 Re-Chargeable Batteries

[83] *Telecommunications Statistics, 2nd Quarter, 1999*, Catalogue No. 56-002-XIB, Vol. 23 No. 2, Statistic Canada.
[84] The Globe and Mail Report on Business, September 16, 1999, Tyler Hamilton.
[85] Personally measured weights from 6 cellular phone sets including a Nokia, Motorola, Qualcom and 3 different sets from Ericsson.
[86] *Telecommunications Statistics, 2nd Quarter, 1999*, Catalogue No. 56-002-XIB, Vol. 23 No. 2, Statistic Canada.

The first generation of cellular phones use a rechargeable nickel-cadmium (Ni-Cd) battery to provide power to the unit. These batteries are up to 25% by weight nickel and up to 18% by weight cadmium.

The majority of Canadian cellular phone service providers and suppliers participate in the Canadian component of the Recyclable Battery Recycling Corporation (RBRC) program. RBRC is a Florida based company that has established a North American wide program to collect and divert rechargeable Ni-Cd batteries from landfill.

RBRC will begin recycling nickel metal hydride and lithium ion rechargeable batteries commonly found in cellular phones, laptop computers and other portable electronics by early 2001. This is an expansion of their currently existing program that recycles nickel-cadmium batteries.

4.5.2 Dismantling and Recycling of Cellular Phones

Through our research, we have been unable to identify any programs that actively collect and recycle used cellular phones in Canada. The new EPR facility in Mississauga is capable of processing the phones if they were collected and consolidated.

ECTEL, the international cellular telephone trade association, has launched a number of initiatives throughout Europe, the most recent of which was launched in Britain in May 1999. Results are not yet available, but the details of the program are as follows:

- Ten industry partners have joined ECTEL- Alcatel, BT Cellnet, Ericsson, Motorola, Nokia, Orange, One 2 One, Panasonic, Philips and Vodafone;
- Research suggests that there are over 14 million cellular phone users in the UK, and that half the population will own one by 2002. Since cellular phones have been used in the UK since 1985, the industry estimates that there may well be more than 2 million disused or broken telephones already in circulation, which are likely to end up in landfill;
- Under the new program, customers will be able to return their old phones and all associated equipment to recycling points around the country, either in person or by mail, and
- The recycling is being undertaken by Shields Environmental Ltd. (based in Essex), who manage end-of-life products, ensure safe disposal of hazardous substances and provide full financial and environmental audit trails.

4.5.3 Corporate Initiatives on Cellular Phones

A small number of companies supply cellular phones around the world. The following are some examples of corporate environmental and take-back initiatives undertaken by OEMs.

Ericsson

– Located a Swedish company to dismantle cellular phones collected by the country's take-back program. The operation dismantles roughly 5,000 cellular phones each month. Plastics, aluminum and circuit boards are recovered and recycled.
– Published the "Environmental Supplier Requirements" guide and environmental fact sheets

on each of their cell phone models.
- Completed an environmental study of an entire cellular system in operation. The LCA study was conducted to determine how much the network contributes to CO2 emissions in the Stockholm network[87].

ECTEL

- ECTEL, an industry trade association, operates a collection program in Sweden. It was originally piloted in 1997, and is now a fully operational national operation recycling in excess of 35,000 mobile telephones annually.

Motorola

- Motorola serves as the chair of the European Telecommunication Trade Association's environmental group and its take-back subgroup.
- Take-back pilot programs have begun in Sweden and the U.K.
- The Sweden demonstration is fully-operational and the potential startup of a similar program in Italy is being investigated.
- Participated in the startup of the Rechargeable Battery Recycling Corporation (RCBC) (see earlier discussion).
- Established take-back program for Ni-Cd, nickel-metal hydride and lithium ion batteries in Japan[88].

Nokia

- Part of the industry group that established take-back pilot programs in Sweden and the U.K.
- Instrumental in organizing the Rechargeable Battery Recycling Corporation (RBRC).[89]

Telenor

- Telenor, the Norwegian telecoms operator initiated a program in 1998 to nationally collect and recycle mobile phones and all their accoutrements – batteries, chargers, etc.
- The program is targeted at users and dealers only, and does not involve manufacturers. All material collected is exported to recycling plants in Sweden and France for reprocessing.
- Of particular interest are the batteries and the hazardous material contained in the cellular phones. It is anticipated that between 670,000 and 1.3 million batteries will be collected per year and recycled into steel production, and the manufacture of new batteries.

4.6 Facsimile Machines

While some analysts have predicted that the expansion of the Internet and email would reduce the sales of facsimile (fax) machines, this has not been the case. On the contrary, sales across North American increased by 24% in 1999 over the previous year. The need

[87] Ericsson website **Error! Bookmark not defined.**
[88] The Journey to a Sustainable World, Motorola Environmental Health and Safety Results for 1998, page 11.
[89] *Nokia and the Environment*, 1999 Corporate Environmental Report, page 27.

for a 'hard copy', combined with declining prices have been factors in the increasing sales figures[90].

It is likely that the conversion from the older thermo-paper fax machines to plain paper machines resulted in a large number of machines either being placed in storage or disposed. Thermo-paper machines are no longer sold partly due to the higher operating costs associated with the thermo-paper costs. This combined with increased speed and improved quality of plain paper faxes has generated large stockpiles of operating equipment that is no longer in demand. One contact indicated they have a large number of thermo-paper machines stored on pallets following a complete conversion within their company a few years ago[91].

4.6.1 Dismantling and Recycling

Companies that produce fax machines include Canon, Xerox, Ricoh, Sharp, Panasonic, Hewlett-Packard, Brother, Toshiba and others. For these companies, fax machines represent a smaller portion of their business when compared to other reproduction equipment such as printers, scanners and copiers. Many of these companies have extensive equipment remanufacture and parts reuse systems in place. For example, Xerox diverted over 65,000 tonnes through parts reuse and recycling. The vast majority of this diversion was from copier systems and in fact, fax machines are not mentioned in their environmental literature.

4.6.2 Additional Data Collection Needs

Further research should be conducted to address additional telecom equipment, including central office equipment, transmission routers, PBXs, Key systems, etc.

[90] *Facsimiles still favourite way for people to send paper*, Toronto Star, September 2, 1999.
[91] Personal communications with Don Blenz, Sasktel.

5.0 INITIATIVES TO ADDRESS IT AND TELECOM WASTE IN THE U.S. AND EUROPE

This section describes the current status of IT equipment recycling in the U.S., including a review of selected regulatory initiatives, and includes a description of activity in Europe, mostly in preparation for the European Union WEEE (Waste Electrical and Electronic Equipment) Directive.

5.1 IT and Telecom Equipment Management and Initiatives in the U.S.

5.1.1 U.S. National Statistics

The National Safety Council's (NSC) *Electronic Product Recovery and Recycling Baseline Report, "Recycling of Selected Electronic Products in the United States,"* , referred to as the EPR2 Study, is the most comprehensive recent information available on IT and telecom waste generation and management in the US. The study was carried out as a result of the NSC Electronic Product Recovery and Recycling Roundtable, an organization founded in 1997 comprised of representatives from electronic equipment manufacturers, recyclers, academic institutions and federal, state and local government agencies concerned about electronic equipment waste. The Roundtable's missions is to promote environmentally and economically responsible management of electronic products throughout their lifecycle[92].

The study concluded that approximately 20.6 million personal computers became obsolete in the United States by 1998, while only 11 percent – about 2.3 million units - were recycled. This number only includes PCs shipped in 1992 or later. It does not include older PCs already disposed or those in storage or in use. The study concluded that relatively few old personal computers (PCs) are recycled. Instead, most are stored in warehouses, basements or closets, or have been disposed in municipal landfills or incinerators.

The study, conducted by Stanford Resources Inc., San Jose, California, addresses sales and recycling information for eight equipment categories:

- Desktop PC central processing units (CPUs);
- Mainframe computer CPUs;'
- Workstation computer CPUs;
- Laptop computers;
- Cathode ray tube (CRT) computer monitors;
- Computer peripherals, for example, printers, plotters and scanners;
- Telecommunications equipment (routers and switches); and
- CRT consumer television sets.

A total of 123 firms across the US were surveyed, including recyclers, third-party organizations that refurbish equipment, original equipment manufacturers (OEMs) and large corporate users of electronic equipment. Findings of the study include:

[92] Amore, Dawn, *Study Finds Computer Recycling Not Clicking*, Waste Age Magazine, December 1999, pp. 14-15

- In 2002, the number of desktop PC CPUs reaching obsolescence will, for the first time, exceed the number of desktop PC CPUs shipped by approximately 3.4 million;
- The cumulative total of PC CPUs that will have become obsolete between 1997 and 2007 will be nearly 500 million;
- Federal government donations of used PCs to schools have met with limited success because of complex federal requirements that apply to the transfer of equipment ownership;
- Growth in desktop PC CPU recycling will be significant as more units in storage are sent to recyclers and as household penetration of PCs (currently about 50 percent) continues to rise.

NSC hopes that the information in the baseline study will be useful in strategic planning and policy decisions at federal, state and local levels, and that it will help non-profit organizations join with manufacturers or government agencies to promote recycling.

The report predicted that equipment manufacturers would take a more aggressive approach to product stewardship in the future in response to customers' needs and other market forces. It also predicts that the volume of obsolete equipment will continue to grow along with the rapid pace of technological change. Overall, the report concluded that an efficient, workable electronics recycling system will depend on partnerships and collaborations among manufacturers, transportation providers, recyclers and third-party organizations.

Previous research by Carnegie Mellon University in 1991 and 1997 also came to similar conclusions.

5.1.2 Selected State Diversion Initiatives in the United States

Table 5.1 summarizes the status of state initiatives to address the management of IT equipment waste in the US. In addition, the legislative activities of the State of Massachusetts and the State of Florida are profiled in greater detail in this section.

Table 5-1: State Initiatives Affecting Electronic Equipment Disposition

STATE	INITIATIVE	STATUS
California	Universal waste classification for CRTs [93]	Proposal expected in 2000
Connecticut	Legislation requiring labeling of devices containing mercury and legislation requiring manufacturers to provide for recycling.	Under consideration
Kansas	Universal waste classification for CRTs.[1]	No decision; no timetable
Maine	Legislation requiring labeling to inform consumers of mercury content, plus report and recommendations regarding manufacturer-managed collection system. Universal waste classification for CRTs.[1]	Proposed Proposed 1999; adoption expected mid-2000
Massachusetts	Prohibition of CRT disposal in landfills or incinerators and elimination of the classification of CRTs as hazardous waste (in order to facilitate recycling).	Adopted, but implementation pending establishment of CRT recycling programs
Minnesota	Combination of regulatory and non-regulatory initiatives, with industry participation, to end disposal of CRTs and other electronic equipment. Universal waste classification for CRTs and other mercury-containing equipment.[1]	Pilot program established; producer responsibility legislation expected in 2000. Proposal expected in 2000
New Hampshire	Universal waste classification for CRTs.[1]	Proposal expected in 2000
New Jersey	Universal waste classification for CRTs.[1]	Proposed in 1999; adoption expected mid-2000

[93] Regulatory standards on transportation, handling and disposition that are more lenient than application of existing hazardous waste regulations, in order to facilitate movement of CRTs for recycling/reuse purposes.

STATE	INITIATIVE	STATUS
New York	Extended product responsibility legislation, including disposal prohibition and recycling requirements for manufacturers.	Under consideration
North Carolina	Landfill and incineration prohibition on most electronics; requirement for retailers or wholesalers to accept such products back for recycling.	Discussed at committee level; never considered by full legislature
South Carolina	Legislation requiring payment of additional fee upon purchase of television or monitor to fund collection and recycling.	No action in 1999; to be re-considered in 2000
Vermont	Requires manufacturers to label products informing consumers of mercury content; prohibits disposal until mercury is removed or recycled.	In effect
Wisconsin	Legislation requiring manufacturer responsibility for product disposition.	Legislation expected in 2000

(Source: Table 1: State initiatives affecting electronic equipment disposition, Closing the Circuit on Electronics Recycling, JD Porter, Resource Recycling, June 2000, p. 25.)

The State of Massachusetts and the State of Florida are taking concerted action to address end-of-life electronic equipment, especially CRTs. The strategies in both states include the following: regulatory streamlining, development of the electronics recycling infrastructure, time-limited state funding and possible disposal restrictions. Both for example, encourage CRT recycling through the implementation of state-wide contracts. The State of Massachusetts has gone even further by banning CRTs from landfill as of April 1, 2000, which includes the banning of CRT transfer for disposal.

To facilitate the collection of CRTs for recycling, the State of Massachusetts issued a Request for Responses (RFR) for the provision of a single contract for the collection of CRTs from permanent regional facilities across the state for a three-year period. The state expects to provide $200,000 to $400,000 to finance these collections. In 1999, before the ban, 367 tonnes were recovered from 10 permanent sites across Massachusetts and tonnages are expected to increase as a result of the ban.[94]

5.1.3 Municipal Diversion Initiatives in the U.S.

A number of computer diversion pilot programs have been undertaken in the U.S. A study completed by the U.S. Environmental Protection Agency (EPA) evaluated the cost and recovery of community-based end-of-life electronic and electrical equipment recovery programs. The study assessed the costs associated with various residential collection approaches, such as curbside collection, drop-off events and permanent collection depots. These studies were generally funded by the individual states with some support from the US Environmental Protection Agency. The findings and conclusions presented in the *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment* report include:[95]

- The net costs of the programs were driven by the demanufacturing costs;
- In terms of weight collected per resident, the curbside collection programs appeared to be more efficient than other collection models, while the one-day collection events appeared to be least efficient (more and better collected data is necessary to confirm this);
- The electronic equipment collected by these programs was generally outdated and in poor condition. Consequently, the material was expensive to manage and little valuable scrap was extracted from this equipment;
- Items that contained CRTs predominated in the collection programs. Since the cost to manage these materials is quite high, the large number of CRTs had a substantial impact on the net costs, and;
- The heavy metals found in electronic equipment was a fundamental driver in Union and Hennepin Counties where most of the residential waste stream is incinerated.

More detail on these programs is contained in Appendix A.

5.1.4 New Technologies in the U.S.

[94] *Announcement: Massachusetts State Contract RFP*, WebBoard, Thursday February 24, 2000, viewed at webboard.capu.net/~nrc/read?38661,198.
[95] *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment*, U.S. EPA, Region 1, EPA-901-R-98-003, page 70-71.

A number of initiatives to recycle IT and telecom waste are currently being developed by non-profit organizations in the U.S. A few of these include:[96]

- **Concurrent Technologies Corporation**, under contract with the Department of Defense (Washington), is constructing a demanufacturing facility for end-of-life electronic equipment. This demonstration project will be operational by fall, 2000

- **Per Scholas**, based in New York, is building a facility where end-of-life equipment will be refurbished and parts will be reharvested for resale. The plant will also have a large-scale shredder that will be capable of recycling virtually all electronic equipment. This project is focused on job training and providing access to technology for schools and needy families.

- **Ecolibrium**, based in Austin, Texas, is developing the concept for an eco-industrial park that will process end-of-life equipment. The materials extracted from end-of-life equipment at a de-manufacturing facility in the eco-park would be used as raw materials for various manufacturing facilities in the park.

- **The Rechargeable Battery Recycling Corporation**, will begin recycling nickel metal hydride and lithium ion rechargeable batteries commonly found in cellular phones, laptop computers and other portable electronics by early 2001. This is an expansion of their currently existing program that recycles nickel-cadmium batteries.

5.2 The European Union Waste Electronic and Electrical Equipment (WEEE) Directive

The most significant initiative addressing IT, telecom and other electrical and electronic waste in Europe is the WEEE (Waste Electronic and Electrical Equipment) Directive. The broad objectives of this Directive are to prevent waste generation, promote recovery, encourage recycling and minimize environmental impact. The Directive is intended to harmonize the EC's member states' national measures on WEEE in order to avoid obstacles to trade and to ensure the functioning of the internal market. Five years after the Directive is adopted by member states EEE (Electronic and Electrical Equipment) producers, including those outside of Europe, will be legally responsible to pay for reuse and/or recycling of their products and the end of their life.

The Directive encourages manufacturers to reduce the hazardous content of their products and to improve their recyclability. In fact, it requires the phase-out and substitution of heavy metals including lead, mercury, cadmium and hexavalent chromium.[97]

The most recent draft proposal for the Directive was published on 13 June, 2000. The Directive aims to achieve an average collection rate of four kilograms of electro-scrap annually per person by January 2006.[98]

The strategy for achieving these objectives is based on the producer responsibility principle and relies on a joint approach to setting targets and financial obligations. In particular, the Directive

[96] Resource Recycling, June 2000, p. 26.
[97] *Europe Proposes Producer 'Take-Back' of Electronic Waste; Precedent Setting Initiative Moves Forward Despite U.S. Lobbying*, NewsEdge Corporation Business Wire, June 14, 2000.
[98] *DGXI stands firm on draft electro-scrap law*, ENDS Environment DAILY, August 12, 1999.

will require Member States to set up systems to allow for the recovery of separately collected waste electrical and electronic equipment. The EC is supportive of community-based take-back schemes, the cost of which should not be imposed on the final user.

The rationale for the WEEE Directive is stated very clearly in the Explanatory Memorandum in the draft proposal, which states:

The production of electrical and electronic equipment is one of the fastest growing domains of (the) manufacturing industry in the Western world. Both technological innovation and market expansion continue to accelerate the replacement process.[99] *New applications of electrical and electronic equipment are increasing significantly. There is hardly any part of life where electrical and electronic equipment are not used. This development leads to an important increase in waste electrical and electronic equipment (WEEE).*

The WEE stream is a complex mixture of materials and components. In combination with the constant development of new materials and chemicals having environmental effects, this leads to increasing problems at the waste stage. The WEEE stream differs from the municipal waste stream for a number of reasons:

- *The rapid growth of WEEE is of concern. In 1998, six million tonnes of waste electrical and electronic equipment were generated (4% of the municipal waste stream). The volume of WEEE is expected to increase by at least 3-5% per annum. This means than in five years 16-28% more WEEE will be generated and in 12 years the amount will have doubled. The growth of WEE is about three times higher than the growth of the average municipal waste.*[100]

- *Because of their hazardous content, electrical and electronic equipment cause major environmental problems during the waste management phase if not properly pre-treated. As more than 90% of WEEE is landfilled, incinerated or recovered without any pre-treatment, a large proportion of various pollutants found in the municipal waste stream comes from WEEE.*[101]

- *The environmental burden due to the production of electrical and electronic products ("ecological baggage") exceeds by far the environmental burden due to the production of materials constituting the other sub-streams of the municipal waste stream.*[102] *As a consequence, enhanced recycling of WEEE should be a major factor in preserving resources, in particular energy.*

In view of the environmental problems related to the management of WEEE, Member States began drafting national legislation in this area. The Netherlands, Denmark, Sweden, Austria, Belgium and Italy have already presented legislation on this subject. Finland and Germany are expected to do so soon. The Member States which have so far not drafted national legislation expressed their concern about the lack of harmonised European legislation for this waste stream during various consultation meetings preceeding the present initiative.

In view of the Internal Market, national approaches to the subject of WEEE give rise to various problems:

- *Different national policies on the management of WEEE hamper the effectiveness of national recycling policies as cross-border movements of WEE to cheaper waste management systems are likely.*
- *Different national applications of the principle of producer responsibility lead to substantial disparities in the financial burden for economic operators.*
- *Diverging national requirements on the phasing-out of specific substances, could have implications on trade in electrical and electronic equipment.*

In order to address adequately the environmental problems associated with the current methods for the treatment and disposal of WEEE, it is considered appropriate to introduce measures at (the) Community level that aim, firstly, at the prevention of WEEE, secondly at the re-use, recycling and other forms of recovery of such wastes and, thirdly, at minimising the risks and impacts to the environment from the treatment and disposal of WEEE. It is also the aim of this initiative to contribute to the harmonisation of national measures on the management of waste electrical and electronic equipment in order to ensure the functioning of the internal market. These measures are being proposed in two separate Directives. The first – the draft Directive on WEEE – deals with the management of waste and is based on Article 175 of the Treaty. The second, which seeks to harmonise national measures on the restriction of the use of certain hazardous substances in electrical and electronic equipment, is based on Article 96 EC Treaty. These two Directives will be accompanied by a further proposal on the design and manufacture of electrical and electronic equipment later this year.

[99] The first computers in the 1960s were used for an average period of 10 years. Today, that period is to 4.3 years and, for the most innovative products, already less than two years. (UMWEltvertragliche Produktgestaltung (Munchen 1998), Ferdinand Quella/Siemens (editor) Publicis MCD Verlag.)

[100] AEA Technology, Recovery of WEEE: Economic and Environmental Impacts, June 1997.

[101] Environmental Consequences of Incineration and Landfilling of Waste from Electrical and Electronic Equipment (Copenhagen, 1995), Nordic Council of Ministers. According to the study "Pilotsammlung von Elektroaltgeraten in Bregenz, 95% of WEEE arising in Austria is either simply disposed of with the municipal waste or introduced into the metal recycling chain without any pre-treatment.

[102] Compare, for example, Malley "Schwergewicht" c't 1997, Vol. 5, p. 170.

(Source: *Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment on the restriction of the use of certain hazardous substances in electrical and electronic equipment*, Commission of the European Communities, June 13, 2000, pp. 5-6.)

The Directive requires collection and recycling for the following categories of electrical and electronic equipment and bans on certain materials contained in them.[103]

1. *Large household appliances*
2. *Small household appliances*
3. *IT & Telecommunication equipment*
4. *Consumer equipment*
5. *Lighting equipment*
6. *Electrical and Electronic tools*
7. *Toys*
8. *Medical equipment systems (with the exception of all implanted and infected products)*
9. *Monitoring and control instruments*
10. *Automatic Dispensers*

There are specific requirements for IT & telecom equipment (Category 3) imposed on Member States by the Directive. Specifically, by 1 January 2006, the recovery rate for all category 3 waste, with the exception of equipment containing CRTs is set at a minimum of 75% by weight of appliances. Further, reuse and recycling of this equipment must reach a minimum of 65% by weight of appliances within the same time line. Recovery and recycling for CRTs must reach 75% and 70% respectively by 1 January 2006.[104]

The Directive also proposes common standards in terms of the materials that are used in the manufacture of EEE, and for treatment and disposal methods. It also proposes that EEE products be marked with a wheeled bin symbol with a cross through it in order to promote recycling.[105]

The environmental policy of the EC is *based on the precautionary principle, on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay*. Thus, as well as stringent requirements for the general prevention of waste, it is also a stated obligation for:

- *Electrical equipment be designed in a way which facilitates repair, upgrade, re-use, disassembly and recycling (which includes ensuring that producers use common component and material coding standards);*
- *A ban on certain hazardous materials / substances in new equipment;*
- *A reduction in the number of different types of plastics used in individual items to facilitate recycling;*
- *Producers to be encouraged to integrate recycled material into new equipment;*
- *Systems to be set up to facilitate the return of WEEE (distributors must offer to take back WEEE free of charge when supplying new products; producers should be encouraged to set up take-back systems; Member States shall ensure systems are set up so that*

[103] *Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment on the restriction of the use of certain hazardous substances in electrical and electronic equipment*, Commission of the European Communities, June 13, 2000.
[104] *Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment on the restriction of the use of certain hazardous substances in electrical and electronic equipment*, Commission of the European Communities, June 13, 2000, p. 65.
[105] *EC draft paper on waste EEE*, Warmer Bulletin, May 1998, p.11.

distributors & last holders can return WEEE).

5.3 Policies and Legislation Adopted by European Countries to Address IT and Telecom Equipment Waste

This section summarizes action taken by various European countries (presented in alphabetical order) to address IT and telecom waste.

Some countries are taking proactive stances in anticipation of the promulgation of the full WEEE Directive. At present, Denmark, The Netherlands, Norway and Switzerland actually have dedicated electronics recycling legislation in place, while Belgium, Italy and Sweden have proposals in various states of completion, and Germany and Finland are expected to produce legislation soon.

Some countries appear to be waiting for the appearance of the official EC legislation before creating or finalizing domestic policy. Specific actions by different countries are presented below.

Austria

Austria has had legislation on the take-back of white goods (i.e., washers, dryers, refrigerators and freezers) since the mid-1990s, which now involves an end-of-life fee. A draft Ordinance for Re-use and Recycling of Electronic Waste was prepared for the entire WEEE stream in 1994, but was suspended until EU legislation enters into force.

Austria banned the use of PBB in 1993.

Belgium

The Flemish Waste Act permits the regional environmental agency (OVAM) to negotiate with industry on the establishment of take-back and recovery schemes for many waste streams including WEEE. Consultations are proceeding on voluntary take-back and recovery for refrigerators and also brown goods.

The Flemish region of Belgium adopted legislation in 1998 that requires manufacturers, importers, distributors and retailers to take back white and brown goods, including IT equipment, free of charge.[106]

Denmark

A new law signed in December 1998 brought the requirement for electronics recycling to the fore, and placed the onus for recovering WEEE material primarily upon the local authorities through waste management charges levied on householders. Industry will be responsible for the disposal of its own WEEE. It estimated that approximately 20,000 tonnes of waste could be recovered annually in this manner, at an average cost of $200 - $300 per household. However, this system diverges from the requirements as laid down in the draft Directive in two ways – firstly the collection and return facility is not being provided "free of charge", and secondly, the responsibility of collection does not rest with the producers (which was the original recommendation by the Danish Environmental Protection Agency).

[106] *Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment on the restriction of the use of certain hazardous substances in electrical and electronic equipment*, Commission of the European Communities, June 13, 2000, p. 17.

Finland

There have been no developments in Finland since the Priority Waste Stream Group produced its final Recommendations Document. The Finnish Basic Waste Act enables the Government to issue orders under Producer Responsibility. Only one Order on scrap tires has been issued to date. The country is planning to present legislation on WEE soon.

France

The 2nd DesGeorges report recommended that a 'framework agreement' be adopted to implement a national WEEE recovery and recycling scheme and that pilot projects be set up to gain practical experience. Two regions were proposed - namely Rhone-Alpes and Poitou-Charente. The outcome of these trials is at present unknown.

Germany

The Cycle Economy and Waste Law entered into force on 7 October 1996. This law provides the basis upon which producer responsibility regulations can be put into place. In March 1996, the German Government issued a draft Ordinance on the recovery of IT equipment, but the conservative government making the proposed law lost the 1998 elections before it could be finalized. However, an Ordinance is now in the final stages of the legislative procedure. Draft legislation gives responsibility to local municipalities for the collection of WEEE and producers the responsibility to treat, recover and dispose of this waste.[107]

Greece

No plans are currently underway to develop a national WEEE strategy, and details of the framework into which such a program might fit, were it to be proposed, are unknown.

Ireland

Ireland has no specific national legislation on WEEE, but the Waste Management Act 1996 provides necessary powers to regulate for specific waste streams including WEEE. No national programmes or agreements currently exist for the management of WEEE. It is understood that there are no recent 'state-of-the-art' operations, schemes or pilot projects on recovery of WEEE in Ireland. An estimate for the total annual generation of WEEE is of the order of 49,000 tonnes. No estimates are available for individual categories. Drop-off centres exist in most local authority areas in the country - usually associated with landfill sites. The number of such centres is expected to increase in the future with development of recycling & civic amenity facilities. Components of collected white goods are recycled further in the non-ferrous (cables, pyro etc) or ferrous scrap (iron) systems.

Italy

[107] ibid.

A waste management decree in December 1997 established take-back and recovery obligations for several types of durable goods, including certain IT equipment. As a result, a nation-wide network of collection centres and recovery facilities was to be established through agreements with industry. End-users must deliver this equipment ot an authorised dealer or to public or private waste management organisations. To date, this decree has not yet been fully implemented.

The decree specifically seeks to implement the EC Packaging & Packaging Waste Directive, the Waste and Hazardous Waste Directives (94/62, 91/156 and 91/689) and also covers other waste issues including product take-back. In line with the EU proposals, the responsibility will lie with the producers to collect and recycle the WEEE, through the mandatory provision of product take-back schemes, but the current suggestion is that this will not be forcibly imposed by the government (at least to begin with). It is proposed that producers should in the first instance be allowed to set up voluntary schemes to recover the waste in their own manner, but that if they don't, the government will implement a 10% deposit tax scheme to pay for WEEE recycling by levying a revenue on every product sold.

Luxembourg

Luxembourg has no specific legislation pertaining to WEEE and no discussions are currently taking place. There are proposals to establish a project on collection and dismantling of WEEE.

Netherlands

The "disposal of white and brown goods decree" was approved by the government in 1997, and extended twice in 1999 to encompass virtually all household electrical and electronic appliances (lighting is an exception). This action means that the Dutch scheme is now the most comprehensive in Europe. Selected elements of the scheme are as follows:

- Retailers and local authorities will collect (and finance collecting) of WEEE;
- After collection, retailers and local authorities need not incur any costs for further disposal and recycling: producers/importers have to accept the collected apparatus without charge;
- Producers and importers will be responsible after the moment of collection for transport and recycling of WEEE (financially and organization);
- CFC-containing products have to be dismantled according to specific requirements;
- Producers/importers will be obliged to inform the Minister how they intend to meet the above commitments;
- Only non-recyclable material may now be landfilled, and dumping charges are to be radically increased.

Norway

Norway has a scheme in force, and have had for a number of years. Elements of the scheme include:

- An annual separate collection of 80% of WEEE;
- An imposed duty on individual manufacturers/importers to arrange for the collection and recycling or acceptable final disposal of WEEE;
- An imposed duty on distributors of EEE to accept discarded products;
- Private consumers will be able to hand WEEE items free of charge to distributors, and WEEE from business activities can be returned free of charge if a corresponding quantity of new products is purchased;
- Local authorities are obliged to accept WEEE items from households free of charge, but can finance this activity through waste disposal charges.

Sweden

An ordinance for WEEE was adopted by the Swedish government in April 2000, which should come into effect by July 1, 2001. This ordinance allows consumers to bring their waste back to retailers or municipal collection points. Furthermore, the ordinance bans WEEE from landfill, incineration and shredding, before it has been treated by a certified operator.

The Swedish National Chemicals Inspectorate proposed a ban of PBDE and PBB, which is currently being considered by the Swedish government.

United Kingdom

The UK Department of Trade & Industry and Department of the Environment appear to have no immediate plans for establishing mandatory take-back schemes. Discussions with industry and voluntary arrangements for the improvement of recovery of WEEE are preferred. Discussions have been taking place periodically with ICER (Industry Council on Electrical & Electronic Equipment Recycling) since July 1993, and ICER planned to present their proposals to the UK Government in autumn of 1997 – there have still been no developments to date. The Environment Act 1995 introduced clauses which enable Government to implement regulations under Producer Responsibility for individual waste streams (the first waste stream tackled to date being the packaging waste stream and national implementation of the EC Packaging and Packaging Waste Directive) where it deems to be necessary.

Switzerland

In 1994, manufacturers of office equipment launched, through their industry organization SWICO, a take-back scheme for purchased, leased, or rented office equipment. This is based on a guarantee given at the time of sale (a charge is added to the sale price) that the owner can return it free of charge. The WEEE items are then delivered to a recycler licensed by SWICO. The Swiss Environmental Protection Agency built on this voluntary arrangement by introducing a new environmental protection law in 1997 designed to catch free riders, and to bring more material and individuals into the system.
Switzerland have had a formal WEEE recycling scheme running for the past two years. As in the EU Directive, there is an obligation on distributors, manufacturers and importers to take back end-of-life products free of charge (when a similar new product is purchased). Disposal costs are shared between producers and consumers through the application of a disposal fee on products, which makes the scheme self-financing. The ordinance also contains guidelines for environmentally sound recycling, and the aim is to recycle only products for which there are markets (i.e., recycling should be economic).

The Swiss Environment Agency recently conducted a survey of its WEE take-back regulation.

The Agency found that there has been no significant increase in recycling rates, meanwhile WEE recycling firms in the country have grown in terms of employee numbers. The review also points out that the manufacturers of small kitchen equipment, games machines and televisions have not yet developed a system for financing collection and recycling. As a result, the government may step in and enforce a single system of financing for all electrical and electronic products commencing in 2001. This mechanism would involve incorporating the cost of recycling into the retail price of new products. The agency also feels that a major flaw in the implementation of the law is that consumers know little about the rules or are confused about the various funding mechanisms being implemented. As a result, many small electrical and electronic appliances are still being thrown away.[108]

Spain and Portugal

No action on WEEE to date.

Appendix B contains descriptions of various pilot studies undertaken in different European locations to address IT and telecom waste.

[108] Gaps in Swiss electroscrap law revealed, ENDS Daily, July 13, 2000.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Waste Quantities Involved: This preliminary baseline study estimated that approximately 33,972 tonnes of IT waste and 2,961 tonnes of telecom waste were disposed in Canada in 1999. This number is expected to rise as IT technology continues to develop at its currently rapid pace, and IT equipment faces continuous redesign and shorter life spans. . By 2005, the disposed quantities of IT and telecom waste are projected to increase to 67,324 tonnes and 4,328 tonnes respectively. No other baseline estimates are available to compare to this, as other estimates typically include all electrical and electronic waste in the same category.

Information Needed by IT and Telecom Waste Generators: It is assumed that a significant amount of this waste is currently in storage, because people and businesses are unsure of what to do with it. Throughout Canada, both residential and commercial IT and telecom waste generators are willing to recycle or reuse this equipment, but do not know how to go about doing this. A directory of all the options available across the country would help considerably to increase recovery of this waste stream, as people are reluctant to dispose of equipment which cost a lot of money a few years ago. A number of Southern Ontario municipalities are implementing some type of municipal collection system this year to address this need.

Current Recycling and Reuse Infrastructure: The infrastructure to reuse and recycle IT waste is relatively undeveloped in Canada at this time, but is beginning to develop at a rapid pace. As an example of this growth, there were 4 companies in Western Canada until recently who dealt with the recycling of IT waste, but this number has grown to about 25 this year, with increasing need for this type of service. The Canadian infrastructure is considerably less developed than in the US, in part due to our geography and smaller population. The capacity for handling CRTs is particularly low, as it is globally. The telephone management system is mature and well developed, resulting in little waste being generated. There is no mobile phone take-back system in place in Canada. While processing capabilities are in place, industry has not expressed an interest in conducting a take-back program similar to those operating in the UK or Sweden.

Challenges and Future Trends: IT waste presents a number of challenges because of the complex combination of materials involved (specialized plastics and precious metals). Technologies are available to effectively refurbish and recycle this equipment, therefore many options to disposal are available. Trends in the IT business include a focus on designing IT equipment to facilitate easier dismantling, and a focus on identifying options to recycle CRTs. Recycling and refurbishing of CRT's is less developed than for other equipment.

Structure of IT and Telecom Business in Canada: The IT business in Canada is characterized by numerous suppliers and agents, but relatively little manufacturing directly in Canada. Any manufacturing by large IT companies is carried out in the US or overseas. The telecom business involves a small number of companies. These two different industry structures need to be considered if policy options to address this waste are assessed.

Recent Market Challenges: A number of companies contacted during this study were sending a considerable amount of equipment to China. This market was closed to overseas outlets on 1 April, 2000, which may have significant impacts on a number of the companies in Canada who deal with this waste.

Complete Industry Survey Required: This study surveyed companies who could be identified and contacted within the timeframe of the assignment. At a future date, a complete listing of all

companies and organizations in Canada who deal with IT and telecom waste should be developed, and a comprehensive survey of all of these companies should be carried out to identify their current operations and capacity and any barriers to increased recovery.

Additional Information Needs: If future recovery strategies are to be considered, a greater level of detail to that contained in this document be required. Leased IT and telecom equipment is easier to recover than purchased equipment, because of the relatively limited number of suppliers involved, and the relatively easy recovery mechanism. At this time, an estimated 75% of IT equipment in Canada is purchased rather than leased, therefore this is the predominant pathway which needs to be disaggregated as much as possible. Also, recovery options are different for IT and telecom equipment generated by households, compared to businesses, therefore at a minimum, a split between residential and commercial IT equipment owners needs to be identified. Information which would assist in refining these estimates includes:

- A better breakdown in the number of computers and other IT and telecom equipment purchased or leased by residential vs commercial customers;
- An estimate of the different lifespans of IT and telecom equipment purchased by residential vs commercial customers (this study assumed the same lifespan for both, but suspects that residential users would take longer to replace IT equipment because of the high cost involved);
- An updated waste composition estimate and weight for IT and telecom equipment sold in 1999 (the data applied in this study were measured in 1995);
- Residential and commercial waste composition studies are in progress or planned in a number of municipalities across Canada (Calgary, Province of Quebec, a number in Ontario). Options to include IT and telecom waste in these studies should be explored to collect more accurate information;
- Larger IT equipment such as mainframe computers and various components of telecom systems could be addressed in future estimates.

Update: This study should be updated in 18 to 24 months, to reflect new information available at that time, and the newer trends in IT and telecom equipment.

Appendix A

Municipal Diversion Initiatives
in the United States

APPENDIX A

MUNICIPAL DIVERSION INITIATIVES IN THE UNITED STATES

This appendix describes some initiatives to collect IT and telecom waste at the municipal level in the U.S.

The U.S. Environmental Protection Agency (EPA) evaluated the results of five computer diversion pilot programs in San Jose, CA, Hennepin County, MN, Naperville/Wheaton, IL, Union County, NJ, Somerville, MA and Binghamton, NY, each of which are profiled below. The weighted averages of electronic equipment collected during these pilots are shown in Table A-1.[109]

Table A-1 - Summary of Equipment Collected From Five Pilot Programs

Type of Electronics	Weighted %
Televisions	36%
Audio/stereo equipment	16%
CRT Monitors	11%
Computers/PCs	8%
VCRs	6%
Keyboards	5%
Printers	4%
Telephones	3%
Microwave Ovens	1%
Other Peripherals	1%
Misc/Other	9%
Total	**100%**

San Jose, California

San Jose conducted a five-week pilot project in 1997 that offered a point of purchase drop-off program involving three retailers and a local computer demanufacturer. During the pilot, residents brought unwanted computer equipment to one of three local electronic and computer retailers in the City. The retailers covered operational costs and the demanufacturer provided collection of consolidated pallets. In all, 28 tonnes of equipment was collected representing some 156 cubic yards of material. The net cost of the pilot project was US$0.07 per pound or approximately US$155 per tonne. Costs would have been four times higher if CRT monitors had been processed locally, but to reduce costs they were exported to China[110].

Hennepin County, Minnesota

[109] *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment*, U.S. EPA, Region 1, EPA-901-R-98-003, page 19.
[110] *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment*, U.S. EPA, Region 1, EPA-901-R-98-003, page 12.

The county has been collecting electronic equipment since 1992, with the goal of eliminating metals, specifically lead, mercury and cadmium, from the county's waste stream. The program includes permanent drop-off facilities, one-day drop-off events and curbside collection in Minneapolis. In 1997, 62% of material collected came from the permanent facilities, 26% came from city/county collection events and 12% from the curbside collection in Minneapolis, with a total of 332 tonnes collected. Average household recovery across the County worked out to 0.75 kg/household/year. The processing and dismantling of the equipment takes place at a "train-to-work" non-profit organization. The net cost of the program in 1997 was US$0.48 per pound or approximately US$1,054 per tonne.[111]

Union County, New Jersey

The county and the NJ Department of Environment began collecting electronic equipment in a effort to reduce the flow of lead, mercury, cadmium and other heavy metals entering the County's Resource Recovery (energy-from-waste) facility. An agreement with a local company, Electronic Processing Associates, was signed to establish a dismantling facility in the County and participate in a one-year pilot. Three municipalities in the County used existing permanent drop-off depots to collect electronics equipment; three collected them through existing curbside bulk waste programs; and four other communities participated in a regional collection approach with quarterly collection events rotating in each community. A total of 51 tonnes was collected in 1997, with an average household recovery across the County of 0.94 kg/household/year. After the pilot program, heavy metal concentrations measured at the incinerator stack and in ash tests indicated that the program had successfully diverted equipment containing metals from the waste stream. The net cost of the program in 1997 was US$0.14 per pound or approximately US$309 per tonne[112].

Naperville and Wheaton, Illinois

Naperville and Wheaton, two neighouring communities, located just west of Chicago organized three one-day drop-off events with a local demanufacturer. Naperville ran Saturday collection events in October 1996 and April 1997, collecting 11 and 27 tonnes respectively. The average household recovery for the two Naperville events was 0.34 and 0.85 kg/household/year respectively. Wheaton ran a similar program in April 1998 and collected 10 tonnes (0.56 kg/household/year) of equipment. The net cost of the programs ranged from US$0.13 to US$0.36 per pound or approximately US$286 to US$794 per tonne[113].

[111] *Ibid*, page 12.
[112] *Ibid*, page 22-24.
[113] *Ibid*, page 26-27.

Binghamton, New York/Somerville, Massachusetts

Under the Common Sense Initiative, the U.S. EPA sponsored a pilot residential electronic equipment recycling pilot program in Binghamton and Somerville. The program characterized type and volumes of equipment in the municipal waste stream and assessed the viability of collecting and demanufacturing these materials. Binghamton was initially chosen to participate because of its existing relationship with a demanufacturer. Somerville was included as a second community because of its similarity to Binghamton (e.g., demographics) and its existing recycling and HHW drop-off program. The pilots were modeled on one-day household hazardous waste collection events held on a Saturday in the Fall of 1996 and Spring of 1997. The two Binghamton events recovered a total of five tonnes (0.20kg/household/year). The two Somerville events recovered a total of 9.6 tonnes (0.32kg/household/year). The net cost of the programs ranged from US$0.08 to US$0.44 per pound, or approximately US$176 to US$970 per tonne not including promotional costs[114].

Electronic collection pilot projects have also been undertaken in the City and County of San Francisco and the Alameda Country Waste Management Authority. Four pilot projects were initiated using four models[115]:

Model 1- City of Hayward

The City of Hayward's annual Recycling Drop-off program invites residents to bring white goods, yard trimmings, mattresses and wood waste to a municipal lot during the last weekend in March. Electronics will added to the list of materials collected.

Model 2 – San Francisco Super Recycling Day

The Super Recycling Day allows residents to opportunity to discard bulky waste items a part of the residential collection program such as white goods, yard trimmings and scrap metal. Electronic equipment will be allowed on two of the Super Recycling Days

Model 3 - San Francisco Public Disposal and Recycling Area

A two-week collection pilot will allow residents to drop-off electronic equipment with other items such as yard waste, metals and wood at a public disposal site.

Model 4 – Oakland Bulky Waste Pick-up Collection

Oakland residents are provided with an annual bulky waste pick-up day in which a contractor collects white goods, brown goods, tires, furniture, yard waste and scrap metal. Electronic equipment will be collected over a two-week period.

[114] *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment*, U.S. EPA, Region 1, EPA-901-R-98-003, page 8-11.
[115] Materials for the Future Foundation website, **Error! Bookmark not defined.**

A number of programs are moving on from pilots to contracting for ongoing electronics collection. These include:[116]

- Massachusetts has recently released a Request for Proposals (RFP) for the collection, repair, salvage and processing of TVs and computers. This coincides with Massachusetts' April 1, 2000 ban on the disposal of CRTs at solid waste facilities;
- Bluestream Solid Waste Agency in Cedar Rapids, Iowa recently issued an RFP for computer equipment processing;
- Florida issued an RFP in the Spring of 2000 with emphasis on TV and computer monitors;
- Hennepin County in Minnesota issued an RFP for electronics recycling and waste management contract;
- Fairfax County, Virginia has sent out a request for Expression of Interest to determine potential vendors to try a pilot collection program for computers and electronic scrap from waste transfer stations[117].

[116] National Recycling Coalition (NRC) Electronics Recycling Initiative, Online discussion on March 2, 2000 on Contracting for Proper Recovery and Recycling of Electronic Products, **Error! Bookmark not defined.**
[117] Email message from Charles Harris, County of Fairfax, Virginia. NRC Online Forum.

Appendix B

Examples of IT and Telecom
Equipment Recycling in Europe

APPENDIX B

EXAMPLES OF IT AND TELECOM EQUIPMENT RECYCLING IN EUROPE

B.1 IT and Telecom Equipment Recycling Recycling in Vienna

Despite having no formal waste electrical and electronic equipment (WEEE) recycling regulations in place, various initiatives are being pursued. Of the 2,300 municipalities in Austria, 1,400 have local collection sites open for WEEE for at least half a day every two weeks, and a further 700 have sites permanently available. Together around 2 million items are collected each year.

A larger initiative is the ABA recycling facility on the outskirts of Vienna, which handles almost all of the recyclable wastes generated by the 1.7m population of the city, including WEEE. In 1998:

- 32,000 televisions and monitors were dismantled on site, together with
- 33,000 refrigerators and freezers, plus
- 50 (on average) oil-filled electrical heaters per week.

Of some relevance to this study is the recycling of televisions and monitors – a process that has traditionally been exceptionally difficult. The first stage is the casing removal, which is sent for incineration. The printed circuit boards are destined for a shredding process to recover the non-ferrous metals, and the cathode ray tubes (CRTs) are kept intact to be further treated.

It is the CRT recycling which is the difficult and most costly element of the operation because they contain two differing types of glass – the front screen containing barium, and the back cone consisting of lead glass. At the ABA plant processing of each screen costs £11, and involves the use of a hot wire wrapped around the CRT at the point where the two glass types meet to snap then apart.

Glass recovered this way is at present only going on to low grade recycled operations, but it is hoped that higher-grade uses can be found for them in the near future.

An alternative recycling method is to smash the cones underwater, which causes the glass types to fracture into different sized (thickness) pieces which can be separated. However, this technique is not so efficient as the hot wire, and tends to lead to cross contamination.

B.2 Computers for Schools Recycling in The Netherlands

Stichting Computerbemiddeling Onderwijs (Computers for Classrooms), or SCBO for short, seeks to supply quality used commercially redundant PCs to primary & secondary schools, and also to Institutes for intermediate vocational education and adult training. Its mission is to be able to supply reliable machines, in sufficient numbers and at an acceptable price.
SCBO follows on from a number of other schemes, which have attempted to provide the same product and have failed. Learning from them, SCBO have identified several harleyconditions for success:

- The scheme must take responsibility for after-sales service – SCBO therefore offer a 3 year warranty and a 24 hour help line
- Schools have small budgets – cost must be as low as possible – the subsidized price for a machine is approximately £65 including VAT and warranty
- The scheme should address the end-of-life environmental problem – SCBO take on the responsibility for product take-back and ensure that it is recycled, reprocessed and disposed of in an environmentally responsible manner

In the currently booming technological market, the depreciation period for PCs is very short, but by the time they become redundant in a commercial environment, they are still more than adequate for use in classrooms. SCBO therefore persuades donor organizations to offer their equipment free of charge for the benefit of the pupils. Every received machine then has any stored data or software deleted for security reasons, and refurbishment is performed by Frazier Europe.

As Table B-1 indicates, schools have reacted very positively to the scheme. Furthermore, remarkably few problems have been encountered, with calls to the help desk averaging about 14% of PCs installed, and less than 3% of PCs installed have necessitated a return for repair.

Table B-1 – Demand for Reused Computer Equipment in Holland

ORDERED		
School Type	**Number of Schools**	**Number of PCs**
Primary	5303	43426
Special	516	20309
Secondary	614	5707
Vocational	59	2986
Agricultural	26	740
TOTALS	**6518**	**73168**
DELIVERED		
School Type	**Number of Schools**	**Number of PCs**
Primary	3779	23290
Special	349	8532
Secondary	411	2666
Vocational	59	2986
Agricultural	26	740
TOTALS	**4624**	**38214**

B.3 City of Bilbao Pilot Trial in Spain

In Spain, a take-back project in the city of Bilbao ran from October 1994 to December 1996 covering brown goods (TV sets, video recorders etc) and IT/Office equipment (personal computers, photocopiers etc.) from households and companies respectively. The objectives of the trial were:

- To identify a practical method to reduce the flow of WEEE to disposal;
- That the model be flexible and adaptable, thus suited to application throughout the Basque country, and beyond;
- That the experience be a diverse one, dealing with WEEE from both residential and IC&I sources;
- The option chosen was to decontaminate and value-enhance, to seek a dynamic balance between the available recycling methods and the economic cost, and;
- To make the population aware (i.e., inform and educate the citizens via the media).

The trial was sponsored by the Basque Government: participants were the Municipality of Bilbao (population 375,000 and area 41.3 square km), a hypermarket chain, the MSW contractor for the municipality, an authorized recycler and a number of firms (financing the storage, classification, shipment and treatment of their end-of-life capital goods). Selective recycling sites were used as places for the classification and consolidation of optimal volumes for final transportation to the recycler for domestic material flows. Enterprises had various options for financing the management and treatment of their end-of-life goods.

The total quantity of material collected and treated was 494 tonnes derived from the municipal, hypermarket and enterprise sources detailed in Table B-2.

Table B-2 - WEEE Collected by Bilbao Trial

Source Type	Units of Equipment	Weights Collected (Tonnes)
Municipal	5,048	105.7
Hypermarket	520	14.8
Enterprise	110,747	374.0
TOTALS	**116,415**	**494.5**

Interestingly, TV's and monitors accounted for over 95% of the municipal flow and virtually all of the hypermarket flow. The materials obtained from the WEEE treated were mainly metals, glass and plastics. The detailed breakdowns are presented in Table B-3.

Table B-3 - Materials Obtained from WEEE Treated in Bilbao Trial

Material	Municipal & Hypermarket		Enterprise	
	%	Tonnes	%	Tonnes
Iron	16.84	20.3	30.84	115.3
Aluminium	1.38	1.7	11.47	42.9
Copper	3.74	4.5	4.59	17.2
Glass	45.31	54.6	21.59	80.7
Wood, paper, cardboard	12.34	14.9	10.63	39.8
Plastics	20.11	24.2	19.90	74.4
Hazardous	0.28	0.3	0.98	3.7
TOTAL	**100**	**120.5**	**100**	**374.0**

The trial tested the feasibility of collection of WEEE via municipal recycling centres and established the typical quantities likely to be expected (i.e., approximately 0.14 kg/person/year excluding white goods), and the typical age of equipment (approximate average of 15 years).

Some other conclusions of the Bilbao trial were:

- The existence of selective recycling sites for the classification and consolidation of optimal volumes (prior to transportation to the recycler) is of fundamental importance for domestic (i.e., municipal) flow;
- The establishment of selective recycling sites in places close to the hypermarkets would make it possible to keep encouraging the population to deliver obsolete equipment, taking advantage of shopping trips. This could be the solution for the collection of small equipment such as calculators, coffee machines, toasters, hair-dryers etc.;
- The availability of good market access for secondary plastics raw materials would make it possible to achieve 90% recycling. If in addition it were rendered practical to make use of the energy content in complex mixtures of polymers, then the figure could be as high as 98%;
- The task of making citizens aware is essential, but slow and costly, and;
- No special risk in the management or transportation of WEEE was observed.

B.4 The ICER (Industry Council on Electrical & Electronic Equipment Recycling) Trial in the UK

The ICER collection trial came about after discussions with the UK Government. In July 1993, the Government (Department of Trade & Industry) asked ICER to prepare a national plan for increased recovery of both commercial and domestic equipment. Because there were very little data on domestic equipment, ICER was asked to conduct a trial collection and recycling scheme. This trial began in October 1995 in two areas of West Sussex (Midhurst - 2,500 households and Worthing - 5,000 households) and was extended to Crawley, West Sussex - 50,000 households - and the London Borough of Croydon - 50,000 households. The trial was completed in April 1997. The scope of collections was set at all electrical equipment (i.e., any item with a plug or a battery).

The trial aimed to:

- estimate how much and what types of equipment would enter a local authority recycling service;
- find out how much and what types of equipment are already entering a recovery loop;
- assess the costs and efficiency of collecting domestic electrical and electronic equipment for recycling through existing local authority systems;
- gauge public opinion, and;
- compare the costs and yields of different recycling approaches and methods.

Collection of WEEE was by two methods:

1. Via Civic Amenity Sites (Household Waste Sites)
   Skips specially marked "Electrical & Electronic Items for Recycling Only" were used. When full, the contents were transported to a recycler.
2. Curbside Collection (as a complement to the existing scheme at Worthing)
   Participating households were issued with grey plastic bags, marked "Electrical & Electronic items for Recycling Only". Householders were requested to dispose of any small items in the bags and to put them out with the other recyclables for curbside collection.

Recycling/reprocessing of collected items was carried out during the first six months of the ICER trial by Mayer Cohen Industries, which specializes in manual dismantling. Thus, detailed breakdowns by material were obtained. During the second six months of the trial, collected equipment was processed by Sims Bird, during which time shredder trials were evaluated.

Full results of the trial were produced in April 1997, but ICER only release them to industry members. However, initial results show that the amounts collected were very much lower than the estimated theoretically available figure for households (27 kg per household per year). Collection amounts during the first six months were about 3 kg per household per year (i.e., about 11% recovery rate). Furthermore 95% of the total collected was via the Midhurst civic amenity site. Very few items came from the Worthing curbside collection. A number of possible reasons for this very low recovery, especially for curbside collection, have been suggested, including scavenging. However, it must be noted that the ICER trial data obtained so far has only

taken the trial collected amounts into consideration (i.e., amounts that are additional to existing recovery of WEEE. No estimates for the amounts already being recovered via the existing channels have yet been made.

The age profile of the equipment collected ranged from about 5 - 40 years with an average age of about 15 years. This indicates, as with the experience of other trials elsewhere in Europe, that equipment being disposed of is much older than would be expected from manufacturers' estimated lifetimes. This also suggests that re-use or refurbishment is not a sensible option for equipment so old.

B.5 The LEEP Collection Trial in the United Kingdom

The Lothian and Edinburgh Environmental Partnership (LEEP), working in association with the Electronic Manufacturers Equipment Recycling Group (EMERG - an association of over 20 multi-national electronics manufacturers and their material suppliers) conducted a work-place and civic amenity site collection trial in the Lothian region of Scotland over a period of 15.5 months starting in May 1995. The total trial costs were £63,627.

The objectives of the trial were to:

- generate data on WEEE;
- study the economics of a particular collection process;
- assess the value recovered through reprocessing;
- produce a report for circulation to relevant bodies, and;
- suggest how this trial could be replicated nationwide.

The main source of collection of WEEE was from the workplace (i.e., commercial/industrial). The second source of collection was from civic amenity sites (i.e., domestic sources). LEEP approached 1100 workplaces (out of a total number of 17,417 workplaces in Edinburgh and the Lothians). Of these 1100, a total of 150 workplace-recycling sites joined the scheme but only 128 workplaces had WEEE collected during the trial. Thus the trial represented 0.7% of the total number of workplaces in the area, which suggests that there would be plenty of scope to grow this type of collection service. Collection of WEEE (from domestic sources) was established at only 5 out of more than 50 civic amenity sites.

Workplace WEEE formed a large percentage by weight of the total collected during the trial period (89.4% compared with 10.6% from civic amenity collection sites) and, not surprisingly, IT equipment featured strongly in the WEEE collected.

A total of 120 tonnes of WEEE were collected during the trial and these were subsequently reprocessed and evaluated by Mann (UK) Ltd., where 75% of the WEEE was recycled. The waste stream remained as high as 25% because of the type of product mix collected, its age and the inclusion of certain brown goods and domestic appliances that are not generally processed as part of Mann (UK)'s mainstream business. The materials recovered through reprocessing are summarized in Table B-4.

Table B-4 - Materials Recovered in the LEEP Collection Trial by Type

Material	Weight (tonnes)	Weight (%)
Ferrous metals	60.0	50
Precious metals	4.7	4
Non-ferrous metals	15.6	13
Plastics	3.5	3
Wood	6.0	5
Wastes	29.9	25
TOTAL	**119.7**	**100**

Seventy per cent of the waste fraction comprised glass from cathode ray tubes (CRTs), VDUs and terminals. The total value of materials recovered through reprocessing was £9,568. The breakdown of value recovered by material is presented in Table B-5.

Table B-5 - Breakdown of Value Recovered in the LEEP Collection Trial by Material

Material	Value (£)	%
Precious metals	4687	49
Non-ferrous metals	1752	18
Plastics	1596	17
Ferrous metals	786	8
Products for resale	747	8
TOTAL	**9568**	**100**

A total profit of about £691 was generated after the cost of reprocessing and waste disposal was deducted. However, although this showed that reprocessing was cost-effective, it did not generate sufficient surplus revenue to offset the cost of collection. Actual operating costs for collection during the trial were estimated at £307 per tonne averaged over the duration of the trial. This cost per tonne figure is comparable with those found in the Austrian collection trials. The detailed operating costs for the pilot are presented in Table B-6.

Table B-6 - Costs of Collection During the LEEP Trial (Unique Costs Removed)

Activity	Cost (£)	%
Vehicle depreciation	1250	3.4
Vehicle tax, insurance, maintenance	2690	7.3
Fuel	2482	6.7
Collection labour	10111	27.4
Administration	5796	15.7
Premises	6775	18.4
Handling/storage	1318	3.5
Delivery to Mann	3129	8.5
Publicity/marketing	3340	9.1
TOTAL	**36891**	**100**

Amounts collected each month varied greatly, volumes ranged from a minimum of 2.6 tonnes per month to a maximum of 22 tonnes per month. As the trial did not run at full capacity all the time, projected costs were calculated for potentially higher amounts collected. It was concluded from an analysis of these projected costs that a dedicated collection service within a region or local area would cost at least £100 per tonne to administer and run.

B.6 Industry Initiatives in the United Kingdom

As well as dedicated recycling program, it is important not to ignore the efforts that are being made by individual manufacturers as a proactive response to the WEEE Directive. There are few dedicated large-scale electronics manufacturers based in the UK, the largest of which are the Dixons group, and Hoover.

Hoover:

Hoover recycles all of their machines, but there are two distinct routes that the materials follow:

a) Machines that are returned to distribution centres as faulty in one way or another are either sold on if they are in good enough order, or dismantled and the parts are reused if possible (usually only the motors are reused), and;

b) All old machines that are collected when the new one is delivered, scrap etc. are crunched, and sent as dirty metal recycling. The only exceptions are fridges which are sent back to the factory first for gas reclamation. Most of the plastic in the machines is poly PEP which has a very poor recycling market – currently therefore no effort is made to remove it prior to crushing and dispose of it independently.

The Dixons Group

Dixons deals with three distinct streams of materials, including:

a) Customer faulty returns, which are;

- Either returned to the original manufacturer to deal with;
- Sent to an auction house (mainly white goods only take this route);
- Sold to jobbers who repair them and sell them on, or
- Sent to scrap.

a) Old goods collected when new products are delivered

- Because of the nature of the goods that require delivery from the 18 distribution centres, it is only white goods and a few large brown goods (typically TVs which will require professional installation) which travel this route;
- Trevor Bourne at TKB has the National Contract for dealing with all WEEE that returns to distribution centres, but he sub-contracts to other operators in different parts of the country;
- It is a requirement that any contractor takes ALL the WEEE, no matter what its quality – they therefore pay a set price (about £1.25) per unit and receive the good with the bad. Televisions, however, are basically worthless and are given free;
- Typically, a distribution centre can obtain an income of somewhere in the region of £100,000 in this way, and
- It is unknown exactly what the recycler does with the material, but a large proportion is repaired and sent overseas to developing countries. Many of the irreparable units also follow this route to be used as spares in the developing country.

c) Small household appliances returned to stores.

- A company memo indicated that drop-off bins would be installed in stores in the near future to receive household WEEE brought in by the public.

B.7 Miscellaneous Study Results from Europe

Dixons have run a number of independent public trials (as well as performing the recycling already mentioned). The first trial that was run encouraged consumers to bring back unwanted PCs to PC World (part of the group) for recycling. Despite widespread national advertising on television, newspapers and 90 different journals, only 62 individuals took advantage of the scheme over two weekends, almost all of whom (93%) had made the journey to the store for the express purpose of disposing of a PC. This indicated that clearly only the dedicated recycling public were participating, and these individuals could be attracted at a much lower time and publicity investment cost. The rest of the public, however, appeared to be impervious to the recycling suggestion at any effort level. The second phase of this work is now to work with local authorities and civic amenity sites by publicizing WEEE recycling in store (of all household appliances) and encouraging public recycling at authority sites. The recycling contractor in this scheme is Mayer Parry who's main interest is in the collection of metal scrap from the scheme (they are also working independently with Cambridgeshire County Council on a similar project).

The results from a number of pilot projects in various German cities showed a very low collection rate - about 5% for small household appliances, and about 30% for TV sets. Collected items were also much older than anticipated, and higher collection rates were achieved when the collection system is free of charge to the last owner.

A collection trial in Stockholm showed that most people prefer to take unwanted electrical and electronic products either to a retail store or to a municipal collection point. One processing company in Sweden has developed a method of making use of unused capacity in existing transport activities by other companies to move collected equipment to its processing site. They consider that this is the most cost-effective option.

A number of studies have been conducted in Germany on collection systems for use in take-back schemes; these include collection of electronic equipment, paper towels, and clutch and brake linings. The work has shown that, based on the energy content of the material, it is much more difficult to develop a cost-efficient reverse collection system than an environmentally efficient reverse collection system. Consequently, although the collection of used technical products generally benefits the environment, even with long transport distances, the cost for collection will be very high unless the collection system is well planned. A software planning tool, which can be used to plan collections within a region using postal code data is being developed.

In Switzerland, collection points for WEEE have been set up at a number of railway stations. This offers the dual advantages of siting collection points in places that people frequent and the possibility of utilizing the rail network for transportation.

The ESCOPE (The Electronics Industry Social Considerations of Product End of Life Surveys) programme in the UK is nearing its end, but will not be making its finding public. It looks at the number of household appliances in use across the whole of the UK, and has conducted extensive surveys with homeowners to determine where they end up.